Ultrasound Guided Musculoskeletal Procedures

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### Specific ultrasound (US)-guided procedures to be reviewed in this article include aspiration of joint, bursal, and periarticular fluid collections; aspiration of calcific tendinitis; injection of joints and bursa, tenotomy (needling) of tendinosis; and biopsy of soft tissue masses. These procedures may be performed with imaging guidance, or in some cases may be performed blindly, using only anatomic landmarks. Imaging guidance can include fluoroscopy, CT, or US, and has several advantages over procedures done using only anatomic landmarks. When imaging guidance is used, the procedure can be done safely and successfully, avoiding nerves, vessels, tendons, and other structures. With US guidance, the radiologist can visualize the needle tip continually and assure that the needle is placed precisely in the desired location.

US has several additional advantages over CT or fluoroscopic-guided procedures. US is relatively inexpensive and widely available. It is portable and can be done at the bedside, in the ICU, emergency department, or an office setting. The contralateral joint or limb can be evaluated easily for comparison and detection of subtle abnormalities. Correlation can be made with the patient’s site of pain, with direct visualization of the anatomy and pathology at the symptomatic site. Pressure with the transducer can be used to elicit symptoms or assess for compressibility of a fluid collection versus a solid mass. Procedures can be performed rapidly and efficiently with a seamless transition between sonographic evaluation and aspiration or biopsy.

### Ultrasound-guided aspiration of joint, bursal, and peri-articular fluid collections

- **General technique**

### Shoulder

### Elbow

### Wrist and hand

### Hip

### Knee

### Ankle

- Ultrasound-guided injections
- Ultrasound-guided aspiration of calcific tendinitis
- Ultrasound-guided tenotomy
- Ultrasound-guided biopsy of soft tissue masses

### References

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bursal fluid, or other soft tissue fluid collections such as an abscess (Fig. 1). This allows detection of bursal or soft tissue collections that would be undetected by fluoroscopic or blind aspiration, and prevents potential contamination of an aseptic joint during blind or fluoroscopic aspiration through overlying infected tissue such as septic tenosynovitis, or soft tissue abscess (Figs. 2 and 3). In some cases, sonographic evaluation may render aspiration unnecessary, if no joint or soft tissue fluid is detected. If clinical suspicion is high, and no joint or soft tissue fluid is identified, injection of nonbacteriostatic, sterile saline followed by joint aspiration also can be performed.

The approach for US-guided joint aspiration is in most cases similar to that used for arthrography, but can be optimized by tailoring aspiration to the specific location where fluid is visualized by US. A 20-gauge spinal needle with stylet and commercial arthrogram tray typically is used. A 7.5 MHz (or higher frequency) transducer is recommended for most joints. Hip aspiration may require a curvilinear 5 MHz or lower frequency transducer. A compact or hockey stick transducer is used commonly, especially for smaller joints, and often provides superior visualization of the needle within the soft tissues when compared with a transducer with a larger footprint.

With ultrasound, intra-articular joint pathology may be anechoic, hypoechoic, mixed, or less commonly hyperechoic. The sonographic appearance of a joint effusion is not predictive of infection. Fluid aspiration usually is more successful from the more anechoic regions, while synovial or soft tissue biopsy is more successful from the hypoechoic or mixed regions. Doppler evaluation is performed routinely, both of the surrounding soft tissues to exclude vascular structures along the aspiration approach, and also to evaluate for blood flow within and surrounding the intra-articular pathology. Some effusions caused by an infectious or inflammatory etiology can have increased surrounding flow on Doppler imaging. The absence of such flow does not exclude infection, however. Doppler flow within a suspected joint effusion is consistent with synovitis, or other joint pathology, rather than fluid (Fig. 4) [2]. The use of Doppler evaluation in musculoskeletal procedures can be summarized as follows:

- Evaluation of joint fluid (no internal Doppler flow) versus synovitis (may have internal flow)—absence of internal flow does not exclude synovitis.
- Evaluation of cystic (no internal Doppler flow) versus solid soft tissues masses (may have internal flow)—absence of internal flow does not exclude a solid mass.
- Evaluation of hyperemia surrounding a joint effusion—hyperemia can be seen in the setting of infection but the absence of hyperemia does not exclude infection.
- Doppler evaluation can aid visualization of the needle within the soft tissues.

In the differentiation between complex joint fluid and synovitis, joint recess compressibility, movement of intra-articular contents with transducer pressure, joint recess collapse with joint movement, and lack of internal flow on color or power Doppler imaging suggest complex joint fluid.

**Fig. 1.** (A) Coronal sonogram at the lateral aspect of a prosthetic hip demonstrates a 9 cm by 3.4 cm hypoechoic fluid collection (arrowheads). Fluoroscopic hip joint aspiration 4 days prior yielded no fluid and did not detect this fluid collection. (B) Transverse sonogram at the lateral aspect of the hip demonstrates the fluid collection (arrow) measuring 3.6 cm (× to ×) by 3.4 cm (+ to +) lateral to the cortex of the proximal femur (arrowheads). The hypoechoic collection was an abscess and was treated with surgical incision and drainage.
After a joint effusion is detected, an appropriately sized needle is selected by measuring the depth from the skin entry point to the deepest portion of the fluid. The skin is marked and the skin entry site checked for accuracy in both longitudinal and transverse planes. The skin is cleaned with Betadine (Purdue Pharma, Stamford, Connecticut) or Chloraprep (Enturia, Incorporated, Leawood, Kansas), sterile drapes applied, and the transducer covered with a sterile probe cover. A freehand aspiration technique commonly is used, with constant monitoring of the needle position with US. If there is difficulty in visualizing the needle tip, minute movements of the transducer are recommended rather than advancement of the needle. Doppler evaluation also can be helpful to detect the needle within the soft tissues (Fig. 5). The more parallel the needle is to the surface of the transducer, the better the needle will be visualized as a linear hyperchoic structure with posterior reverberation artifact. US machine settings of a single focal zone and low persistence have been reported to improve needle visualization in the soft tissues [3].

Complications secondary to US-guided joint aspiration are unusual and should be less frequent than with fluoroscopic or blind aspiration given the constant visualization of the needle tip during aspiration [4]. Potential complications include iatrogenic infection, bleeding, damage to neurovascular structures, vasovagal reaction, and failure to aspirate fluid or detect infection. Discussion of potential complications should be included in the preprocedure informed consent process. Performing aspiration with the patient in the supine position is optimal and helps decrease any complications secondary to a vasovagal reaction. Difficulty with aspiration usually is secondary to poor visualization of the needle during the procedure, improper skin marking, or inability to distinguish synovitis from fluid on the preaspiration ultrasound examination [2]. The use of sonography for evaluating and guiding joint aspiration helps assure a safe and successful aspiration.

**Shoulder**

Both anterior access and posterior access to the glenohumeral joint have been described [5,6]. For joint aspiration, the authors prefer the posterior...
approach, because fluid usually is visualized most readily in this location, even when small in amount (Fig. 6). Dynamic scanning from a posterior approach during abduction and adduction of the arm can aid visualization of even minute amounts of joint fluid, surrounding the posterosuperior labrum and superior to the humeral head (Fig. 7). For posterior aspiration, the patient is sitting upright or leaning forward and must be monitored closely for any signs of a vasovagal reaction. The circumflex scapular vessels and suprascapular nerve course medial to the glenoid rim and must be avoided. Puncturing the joint capsule along the medial aspect of the humeral head, lateral to the joint space, provides safe and effective access. Using this approach, successful needle placement has been reported in 24 patients for arthrography, without complication [5]. Because the presence of joint fluid distends the joint capsule and makes the target even larger, sonographically guided joint aspiration is an even simpler procedure than using sonographic guidance for arthrography.

For aspiration of the shoulder from an anterior approach, the patient usually is positioned supine. When scanning axially, the puncture site is the midpoint between the coracoid and anteromedial humeral head, similar to standard arthrography. The cephalic vein, axillary artery, and brachial plexus course medial to the coracoid. The needle tip therefore always must remain lateral to the coracoid. Using an anterior approach, successful needle placement has been reported in 50 patients for arthrography, without complication [6]. At the authors institution typically only aspirate the glenohumeral joint from an anterior approach in a patient who has to remain supine, or in a patient who has loculated fluid located only in the anterior joint space on the preaspiration sonogram.

The subacromial–subdeltoid bursa also can be aspirated with sonographic guidance (Fig. 8). The entire shoulder always should be scanned with ultrasound to reveal such collections before any approach,
aspiration of the glenohumeral joint. Such bursal fluid collections would not be detected with fluoroscopic joint aspiration or joint aspiration based on anatomic landmarks. Using sonography, septic bursitis thus can be aspirated without the danger of the needle going too deep and into the glenohumeral joint as potentially could happen with an aspiration based on anatomic landmarks or an aspiration using fluoroscopy.

Although seen infrequently, acromioclavicular (AC) joint sepsis is seen more commonly in immune-compromised patients and intravenous drug abusers [7]. Clinically, the presentation may mimic glenohumeral joint infection. Sonography can exclude a septic glenohumeral joint and diagnose an AC joint effusion, preventing a potentially missed diagnosis. Sonography of the acromioclavicular joint is performed in both the sagittal and coronal planes to evaluate for distention of the joint. Comparison with the contralateral side is useful, as well as noting pain with transducer pressure on the acromioclavicular joint. The glenohumeral joint and subacromial–subdeltoid bursa also must be evaluated with ultrasound to exclude fluid at these sites. The normal AC joint has been reported to have less than 3 mm of fluid, measured from the joint capsule to the cortex [7]. Fluid collections communicating with the acromioclavicular joint most commonly are caused by an infected joint or secondary to a ganglion cyst (Fig. 9) [8].

Paralabral cysts of the spinoglenoid and suprascapular notches commonly are associated with tears of the glenoid labrum (Fig. 10) [9]. Spinoglenoid notch cysts usually are aspirated from a posterior approach, similar to posterior shoulder joint aspiration (see Fig. 6). The larger the needle, the easier the aspiration of the thick, gelatinous ganglion fluid. If possible, the use of a 15 gauge, or larger needle, is helpful. Paralabral cyst aspiration typically is considered when there is suprascapular nerve compression as a temporizing measure before surgery. Ganglion cysts have been reported in the anterior shoulder, including the following locations: between the deltoid and subscapularis tendon, between deltoid and biceps, and inferior

![Fig. 7. Transverse ultrasound of the posterior glenohumeral joint demonstrates a moderate amount of fluid (large arrows) surrounding the triangular and echogenic posterior labrum (small arrows). Arrowheads denote the cortex of the humeral head.](image1)

![Fig. 8. (A) Longitudinal sonogram of the distal supraspinatus tendon and subacromial–subdeltoid bursa demonstrates a small amount of fluid in the bursa (large arrows). Small arrows denote the bursal surface of the supraspinatus tendon. (B) Longitudinal sonogram of the subacromial–subdeltoid bursa in a different patient demonstrates a small amount of fluid within the bursa (small arrows). The aspiration needle (large arrow) is noted within the bursa. Arrowhead denotes the cortex of the greater tuberosity. Two milliliters of thick, yellow fluid were aspirated under ultrasound guidance. Sonographic guidance can assure safe aspiration of an infected bursa without danger of entering the glenohumeral joint space.](image2)
to the coracoacromial ligament [10]. Chiou and colleagues [10] reported 15 patients who had ganglion cysts of the anterior aspect of the shoulder, aspirated with US guidance. Follow-up ranged from 2 to 24 months (mean 6.4 months). Thirteen of the 15 had marked or complete pain relief, without evidence of recurrence of the ganglion or recurrence of symptoms. Symptom relief in this study was not related to the amount of fluid aspirated. The two patients without symptomatic relief following aspiration also had concomitant rotator cuff pathology. Therefore caution should be exercised regarding expectations of pain relief in patients who have concurrent rotator cuff or other shoulder pathology. The approach for aspiration depends on the location of the cyst, and US guidance affords a high degree of flexibility in the choice of the aspiration approach. Aspiration of shoulder ganglia can be a painful procedure. Premedication and close monitoring for a vasovagal reaction is needed. Aspiration should be performed with the patient supine, or lying on his or her side whenever possible.

**Elbow**

Anterolateral, posterolateral, and posterior approaches have been described for aspiration of the elbow [2,11,12]. Palpation and puncture of the soft spot at the posterolateral elbow frequently are used for blind aspiration. The soft spot is the center of the triangle formed by the olecranon process, radial head, and lateral epicondyle [11]. A lateral approach, with puncture of the radiocapitellar joint, frequently is used with fluoroscopy when performing arthrography. For the posterior approach, the elbow is flexed and the olecranon fossa evaluated with US in longitudinal and transverse planes (Fig. 11). This position optimizes detection of the smallest joint effusion [13]. Sonography from a posterior approach demonstrates fluid in the olecranon fossa (Fig. 12). No major neurovascular structures are encountered with a posterior approach. Radiologists at the authors institution have used the posterior approach successfully and without complication.

**Wrist and hand**

For the radiocarpal joint, a dorsal approach is used for aspiration, with sonographic guidance to avoid tendons, nerves, and vessels (Fig. 13). Flexion of the joint can aid needle placement as with positioning for wrist aspirations.
arthrography. Fig. 14 demonstrates the sonographic appearance of fluid in the radiocarpal joint. Flow within a hypoechoic region on Doppler evaluation can help distinguish synovitis, which can demonstrate flow on Doppler imaging, from fluid which does not demonstrate internal Doppler signal. The absence of flow on Doppler evaluation, however, does not exclude synovitis. Gentle flexion and extension of the wrist during sonography can show fluid communicating with the joint and help distinguish a joint effusion from a ganglion cyst. The flexibility afforded by sonographically guided aspiration allows placement of the aspiration needle at the site of maximal fluid. US evaluation and guidance of aspiration also allow detection of extensor tenosynovitis, which clinically could mimic a septic joint. Diagnosis of such extra-articular fluid collections allows proper treatment and helps avoid potential complications such as seeding of an aseptic joint from needle placement through an undiagnosed superficial abscess or septic tenosynovitis (see Fig. 3).

Wrist ganglia are most commonly located dorsally, adjacent to the scapholunate ligament, and at the volar aspect of the wrist, adjacent to the radial artery. At US, they are most commonly anechoic, possibly multilocular and multilobular, and may be septated. Smaller ganglion cysts may be hypoechoic and may not show increased through transmission [14]. US can detect a ganglion cyst, and US guided aspiration and steroid injection can be used as treatment, with awareness that recurrence may occur (Fig. 15). Doppler imaging can help exclude an aneurysm or other vascular process as the etiology for a wrist mass. Unlike a distended joint recess, wrist ganglion cysts are typically not compressible, do not deform with joint movement, and are more likely multilocular.

For aspiration of the metacarpophalangeal joints, proximal interphalangeal joints, and distal interphalangeal joints, a dorsomedial, or dorsolateral approach can be used (Fig. 16). This approach avoids the medial and lateral neurovascular structures and volar and dorsal tendons. The specific approach used in a given case can be tailored to the site of greatest fluid accumulation and site of easiest aspiration. When compared with attempted intra-articular needle placement based on anatomic landmarks, US-guided placement is more accurate by a wide margin, 56% to 96% [15]. US guidance
also is more successful for aspiration of joint fluid, versus aspiration using only anatomic landmarks, especially in the small joints. Balint and colleagues [16] showed aspiration based on landmarks was successful in 32%, versus 97% with US guidance.

**Hip**

In the authors’ practice, the hip is the joint most commonly requested for aspiration. At the authors’ institution, they advocate the use of US for evaluation of hip joint fluid and soft tissue fluid collections about the hip, especially in the patient who has undergone a hip arthroplasty. In such patients infected soft tissue fluid collections are not unusual, and commonly would not be detected by a blind or fluoroscopic aspiration. Optimal patient positioning for sonographic evaluation of the hip is with the patient supine with the hip extended and the leg in slight abduction. This position tightens the posterior capsule and forces joint fluid into the anterior portion of the hip capsule, aiding aspiration from an anterior approach [17].

Given the depth of the hip joint, a 7.5 MHz or 5 MHz transducer most often is used. The transducer is oriented along the long axis of the femoral neck. This allows visualization of the femoral vessels, joint fluid, and needle as it enters the joint capsule. For safe aspiration, palpation and marking of the femoral artery are performed. Joint aspiration is performed lateral to the neurovascular bundle, usually by several centimeters (Fig. 17).

Displacement of the hip joint capsule away from the femoral neck is noted with a hip effusion (Fig. 18). Contralateral comparison is performed easily with US, and aids detection of subtle or small effusions. A 2 mm or greater difference in joint distention between the symptomatic and asymptomatic hip has been reported as a helpful discriminator for the presence of abnormal fluid in the hip joint [18]. Additional findings that may be seen with a septic hip include thickening of the joint capsule and cortical irregularity of the proximal femur deep to the effusion [18]. Preaspiration Doppler evaluation to discriminate synovitis from fluid, and sonographic visualization of the needle tip in the region of interest, can help assure a successful aspiration. Although joint aspiration does not have an accuracy of 100% compared with surgical

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**Fig. 13.** Diagram illustrating aspiration of the radiocarpal joint from a dorsal approach. Transducer is placed transversely at the level of the radiocarpal joint. The tip of the needle is placed in the radiocarpal space.

**Fig. 14.** (A) Longitudinal ultrasound of the wrist demonstrates a small amount of fluid dorsal to the scaphoid (large arrow). Distal radius (left gray arrow) and carpal bones (middle and right gray arrows) are noted. Superficial extensor tendon (small arrows) is intact. (B) Longitudinal ultrasound of a different wrist demonstrates a small amount of hypoechogenic fluid (black arrows) in the radiocarpal and midcarpal joints, superficial to the carpal bones (white arrows). Absence of flow within this hypoechogenic region on Doppler imaging helps distinguish joint fluid from synovitis. Arrowhead denotes the distal radius.
findings, it can be a helpful procedure, especially combined with US of the soft tissues to exclude bursal fluid or soft tissue abscess. Aspiration of the joint is most helpful when fluid is obtained and confirms a clinical suspicion of infection. Aspiration is less helpful when no fluid can be aspirated. In this situation, a negative aspiration can suggest the absence of infection but does not exclude infection definitively. This is especially true in the setting of a total hip arthroplasty [19].

In cases with a hip prosthesis present, US findings of capsular distention may have decreased accuracy [19,20]. This may be secondary to hypoechoic scar tissue at the expected site of the joint capsule, which can mimic hypoechoic joint fluid (Fig. 19). Doppler evaluation can be especially helpful in such cases and should be included in the US evaluation. Flow within the intra-articular, hypoechoic region is consistent with synovitis, scar, or fibrous tissue rather than hypoechoic joint fluid. In the setting of a hip prosthesis, it is also important to image the incision site and surrounding soft tissues for fluid collection. The presence of joint effusion and associated extra-articular fluid collection suggests infection [21].

Complications from hip aspiration are very rare. In a series of 800 aspirations performed by Berman and colleagues [4], no iatrogenic hip infections were noted. Other complications such as hematoma are also unusual. Inability to differentiate synovitis from joint fluid and thus inability to aspirate fluid may be the most commonly encountered difficulty with hip aspiration. Again, Doppler evaluation may be helpful; however, aspiration ultimately may be needed to assess for joint fluid.

Numerous extra-articular fluid collections commonly are seen about the hip, including greater trochanteric bursitis, iliopsoas bursitis, and less

Fig. 15. (A) Ultrasound of the volar wrist demonstrates a 2.4 × 2.2 cm (between the + and × calipers respectively) anechoic, lobulated ganglion cyst at the level of the radiocarpal joint (joint space not shown). (B) Sonographic guided aspiration demonstrates the needle tip (large arrow) within the ganglion cyst (small arrows).

Fig. 16. Diagram illustrating sonographic guidance for aspiration of the metacarpal–phalangeal joint. Transducer is oriented transversely at the level of the joint.
commonly obturator bursitis (Figs. 20 and 21). Unlike the bursae about the greater trochanter, the iliopsoas bursa may communicate to the hip joint; therefore, hip joint pathology and effusion may be the cause of iliopsoas bursa distention. Soft tissue abscesses also can occur about the hip. These fluid collections would be undetected by a fluoroscopic or blind aspiration of the hip. Given their depth, they may not be detected on physical examination. Sonography allows rapid and inexpensive detection of these soft tissue fluid collections. For greater trochanteric bursitis, a lateral aspiration approach generally is used. For iliopsoas bursitis, an anterior or anterolateral approach is often optimal. The flexibility of sonographic aspiration is one its strengths and the precise location of the fluid collection and adjacent neurovascular structures determine the exact aspiration approach in each case. Fig. 22 illustrates a posterior approach for aspirating loculated fluid at the posterior aspect of the hip.

**Knee**

US has been shown to be more sensitive than clinical examination for detecting knee effusions and Baker’s cysts [22]. Blind knee aspiration often is performed easily using anatomic landmarks, especially if the effusion is moderate or large in size. Small or loculated effusions, however, can be aspirated using sonographic guidance. The patient is supine with the knee extended. Scanning of the suprapatellar recess and surrounding soft tissues is performed in longitudinal (Fig. 23) and transverse orientations (Fig. 24) relative to the quadriceps tendon. The lateral aspect of the suprapatellar recess is the location where small effusions are usually first detectable. It is important not to apply too much pressure with the transducer, as this may cause collapse the medial or lateral recesses. In partial knee flexion, joint fluid often predominately collects anteriorly, deep to the quadriceps tendon. A small amount of joint fluid is physiologic, and comparison to the contralateral knee aids determination of abnormal fluid. Aspiration can be performed from a medial or lateral approach and is usually done in a transverse orientation relative to the axis of the femur and patella (Fig. 25). The precise location and entry point can be determined based on the site of greatest fluid accumulation.

Numerous bursa and cysts can exist about the knee. These include the pes anserine bursa and semimembranosus medial collateral ligament bursa, Baker’s cysts, meniscal cysts, and ganglion cysts. All can be detected and aspirated with sonographic guidance. Aspiration of meniscal cysts using US guidance has been reported to provide symptomatic relief in two-thirds of cases, followed for an average of 10 months after aspiration [23]. Aspiration of posterior cruciate ganglion cysts also has been reported [24]. US-guided aspiration of Baker’s cysts can be performed for symptomatic relief and as a temporizing measure, because recurrence is not uncommon following aspiration. Aspiration with steroid injection may help prevent recurrence in some cases. When imaging a Baker’s cyst, visualization of fluid extending between the medial head of the gastrocnemius tendon and the semimembranosus tendon is essential to avoid confusion with other cystic masses about the knee (Fig. 26) [25]. Abscesses and other cystic masses such as cystic liposarcoma, and myxoma, can occur in the popliteal fossa but do not have a neck extending between the semimembranosus and medial head of the gastrocnemius tendons (Fig. 27).

**Ankle**

For aspiration of the ankle joint, the patient is supine; the knee is flexed, and the plantar aspect of the foot is flush with the stretcher (Fig. 28) [2]. Plantar flexion optimizes detection of an ankle effusion by distending the anterior joint recess. Normal ankle joint fluid can measure up to 3 mm in thickness (anterior to posterior dimension) and can be asymmetric compared with the asymptomatic ankle [26]. Prior to aspiration, the dorsalis pedis artery is localized with sonography and marked on the skin. The deep peroneal nerve courses immediately lateral to the artery. A skin entry site is chosen to avoid
the neurovascular bundle and extensor tendons (Fig. 29). The needle can be visualized throughout its course, ensuring a safe and successful aspiration.

Septic tenosynovitis of the extensor tendons can mimic a septic joint clinically. Sonography can detect such extra-articular fluid collections and guide aspiration. This avoids potentially infecting an aseptic joint by blind or fluoroscopic aspiration through overlying septic tenosynovitis or other sources of soft tissue infection (see Fig. 2) [2].

Ganglion cysts about the ankle are relatively common and frequently located at the lateral ankle, related to the subtalar joint and sinus tarsi (Fig. 30). Surgical resection and obliteration of the neck of the ganglion is the mainstay of treatment. Aspiration does not obliterate the neck of the cyst; therefore cyst recurrence is not uncommon following aspiration. In some cases, US-guided aspiration may be requested and can be used as a temporizing measure or used as treatment in nonsurgical candidates. Injection of corticosteroids following aspiration may help prevent recurrence [27].
Ultrasound-guided injections

US also can be used to guide injections of steroid or anesthetic into joints and bursae, and for treatment of ganglion cysts, Morton’s neuroma, and plantar fasciitis (see Box 1). The technique for placing the needle in the joint or bursa is as described for aspiration. There are several advantages of US guidance for musculoskeletal injections. The needle tip can be visualized constantly and monitored for correct positioning. The steroid or anesthetic also can be injected precisely at the desired site. Injection within the substance of a tendon, which has been associated with tendon rupture and degeneration, thus can be avoided [3]. Prior to injection, the joint, bursa or tendon sheath should be aspirated, so that the injected medication is not diluted by fluid present in the injected space. The aspirated fluid can be sent for analysis; however, septic joint fluid, septic bursal fluid, or septic tenosynovitis should be excluded clinically or by other means before the injection of steroids.

Ultrasound-guided aspiration of calcific tendonitis

Calcific tendonitis can be treated by various methods, including anti-inflammatory drugs, physical therapy and steroid injection. When conservative therapy is unsuccessful, treatment can include open or arthroscopic surgery, US-guided aspiration,
Fig. 21. (A) Transverse sonogram demonstrates a hypoechoic collection in the right iliopsoas bursa (arrow). Doppler shows the femoral vessels at the medial aspect of the bursa. Arrowheads denote the cortex of the femoral head. (B) Axial T2 weighted magnetic resonance sequence without fat saturation demonstrates a 2.8 cm fluid collection in the right iliopsoas bursa (white arrow) with a small posterior communication to the right hip joint. Note a tiny amount of fluid in the left iliopsoas bursa (black arrow).

Fig. 22. (A) Coronal short T1 inversion recovery magnetic resonance sequence demonstrates a lobulated fluid collection (arrow) at the posterior aspect of the ilium, superior to the right hip joint. (B) Transverse sonogram at the posterior aspect of the hip, at the site of the fluid collection noted above demonstrates a lobulated, hypoechoic collection (arrow) adjacent to the cortex of the ilium (arrowheads). (C) Transverse sonogram demonstrates the aspiration needle (large arrows) in the fluid collection (small arrow). Arrowhead denotes the cortex of the ilium.
and shock wave therapy. When first described, two large bore needles (18- to 19-gauge) were used with repeated punctures to fragment and aspirate the calcification. One needle was used for injection of saline and the second needle for aspiration. Water-soluble cortisone then was injected into the subacromial–subdeltoid bursa to complete the procedure. Clinical success rates were reported to be excellent in 74%, moderate in 16%, and poor in 10% of patients [32].

In 2001, Aina and colleagues [33] described a modified technique using a single, 22-gauge needle. An anteroposterior axis of the needle was recommended during aspiration, with the needle kept parallel to the horizontal axis (floor of the procedure room). This orientation aided US localization of the needle and helped prevent reinjection of aspirated calcium. If multiple calcifications were noted, the specific one for aspiration was chosen based on the largest size, the calcification associated with focal tendon swelling, or the most symptomatic with US transducer pressure. Using US guidance, the needle was placed in the center of the calcification and the needle tip gently rotated followed by attempted aspiration. If the consistency of the calcification was paste-like; successive injection and aspiration of lidocaine was performed in an attempt to remove the calcification. Given the horizontal orientation of the syringe, the dense, white aspirate accumulated in the dependent portion of the syringe (Fig. 31). If the calcification was very hard and could be aspirated, grinding of the calcification was performed by means of gentle rotation of the needle tip in the hope of accelerating resumption. A mixture of steroid and anesthetic then was injected at the bursal surface of the tendon and in the subacromial–subdeltoid bursa. In this study, the best clinical results were seen in those patients in whom calcium was aspirated successfully [33].

It may be most beneficial to first use a fine needle (20- or 22-gauge) for aspiration, followed by a larger bore needle if no calcium can be aspirated; however data using this technique have not been reported [33]. At the authors’ institution, the authors generally use a 20-gauge needle and first attempt aspiration. If no calcium can be aspirated, they attempt to break up the calcification with the single needle. Injection of approximately 1 cc of lidocaine within
the calcification is first performed before any attempted aspiration. This dilutes the calcification and creates a pressure effect within the tissue and aids aspiration. Serial injection of lidocaine and aspiration of the calcification are usually successful. A mixture of corticosteroid and anesthetic is injected into the subacromial–subdeltoid bursa following aspiration to help prevent postprocedure bursitis.

Krasny and colleagues [34] compared US-guided needling in conjunction with shock wave therapy versus shock wave therapy alone for treating calcific tendonitis of the shoulder. US-guided needling combined with shock wave therapy gave significantly better outcome. To the authors’ knowledge, no study has compared US-guided needling in conjunction with shock wave therapy with US-guided needling alone.

**Ultrasound-guided tenotomy**

Sonographically guided percutaneous needling of a region of tendinosis also is known as tenotomy. This technique has been reported to be a safe and effective treatment of tendinosis of the common extensor tendon of the elbow, also known as tennis elbow [35]. Compared with other treatment options such as open or arthroscopic debridement, US-guided tenotomy is quick and easy and has low morbidity and a very low to nonexistent complication rate [35]. The procedure is performed in those patients who have failed conservative management such as blind corticosteroid injection, nonsteroidal anti-inflammatory medical treatment, bracing/splinting, and physical therapy. Sonography of the extensor tendon origin first is performed to confirm the diagnosis. Typically, tendinosis of the common extensor tendon is seen as tendon thickening with hypoechogenicity and heterogeneity of the tendon. Intrasubstance tendon tears and small regions of calcification and enthesophytes at the tendon attachment also may be seen.

Following the diagnostic US to identify and localize the region of tendinosis, the skin, subcutaneous

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**Fig. 27.** Sonogram of the popliteal fossa demonstrates an 8.6 cm (+ to +) x 3.0 cm (× to ×) hypoechoic, poorly defined structure with internal septations. Incision and drainage revealed an abscess.

**Fig. 28.** (A) Diagram of the ankle joint from a lateral view illustrating transducer and needle placement for ankle joint aspiration. The tip of the needle is placed into the intra-articular space, along the anterior cortex of the talus. (B) Diagram of the ankle joint from an anterior view demonstrating transducer and needle placement for ankle joint aspiration.
tissue, common extensor tendon origin, and periostium of the lateral epicondyle are anesthetized with lidocaine or bupivacaine. McShane and colleagues [35] used an 18- or 20-gauge needle, with US guidance, to repeatedly fenestrate the area of tendinosis. An inferior-to-superior approach, parallel to the longitudinal plane of the tendon, was used. Palpable and audible crepitation can be noted on the initial needle passes, and calcifications or enthesophytes can be fragmented with the needle tip. McShane and colleagues [35] then inserted the needle a superior to inferior approach, and used the needle tip used to abrade the periosteum of the lateral epicondyle, smoothing any irregularities and fragmenting any enthesophytes. The tendon then was injected with a mixture of corticosteroid and bupivacaine. In their hands, the procedure usually takes 15 to 20 minutes from start to finish. Postprocedure recommendations include a regimen of ice, passive stretching, restricted lifting/repetitive movements, and physical therapy.

In 55 consecutive patients treated with US-guided tenotomy, McShane and colleagues [35] had an average follow-up time of 28 months, with 64% reporting excellent results, 16% good, 7% fair, and 13% poor. There were no adverse events. Eighty-five percent of their patients reported they would refer a friend or close relative for the procedure.

US-guided tenotomy also has been reported for treatment of chronic Achilles and patellar tendinopathy. Color Doppler evaluation may demonstrate increased flow in the region of tendinosis (Figs. 32 and 33). As with chronic extensor tendinosis, a needle can be used to tenotomize the Achilles or patellar tendon. Use of a scalpel, rather than a needle, also has been reported. In the studies by Testa and colleagues [36,37], a #11 scalpel was used, under US guidance, to puncture and tenotomize the tendon. Flexion and extension of the knee or ankle, with the scalpel in the tendon, was used to expand the region of treatment. Results were similar for both the Achilles and patellar tendons, with approximately 73% of patients reporting excellent or good results on follow-up of at least 2 years. No major complications were reported. The tenotomy procedure did not hinder surgical treatment in those patients.

**Box 1: Use of ultrasound for guidance for musculoskeletal injections**

<table>
<thead>
<tr>
<th>Joint injection [3,5,6,28]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biceps brachii tendon, long head (shoulder)</td>
</tr>
<tr>
<td>Tibialis posterior tendon</td>
</tr>
<tr>
<td>Flexor hallucis longus (ankle)</td>
</tr>
<tr>
<td>Peroneal tendons (ankle)</td>
</tr>
<tr>
<td>Extensor pollicis brevis and abductor pollicis longus (wrist): for de Quervain’s tendosynovitis</td>
</tr>
<tr>
<td>Iliopsoas tendon (hip): for snapping conditions</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tendon sheath injection [3,28–30]</th>
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</thead>
<tbody>
<tr>
<td>Bursal injection [3]</td>
</tr>
<tr>
<td>Retrocalcaneal (ankle)</td>
</tr>
<tr>
<td>Subacromial–subdeltoid (shoulder)</td>
</tr>
<tr>
<td>Greater trochanter (hip)</td>
</tr>
<tr>
<td>Iliopsoas (hip)</td>
</tr>
<tr>
<td>Pes anserine (knee)</td>
</tr>
<tr>
<td>Olecranon bursa (elbow)</td>
</tr>
<tr>
<td>Prepatellar bursa (knee)</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Ganglion cyst injection, following aspiration [27]</th>
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</thead>
<tbody>
<tr>
<td>Morton’s neuroma injection [3,28]</td>
</tr>
<tr>
<td>Plantar fascia injection [3,28,31]</td>
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</tbody>
</table>

**Fig. 29.** Longitudinal sagittal power Doppler ultrasound (US) at the anterior aspect of the ankle joint demonstrates a hypoechoic joint effusion (small arrows) deep to the dorsalis pedis artery. Single large arrow denotes the cortex of the tibia, and double large arrows denote the cortex of the talus. The effusion was aspirated under US guidance, avoiding the vessels and tendons.

**Fig. 30.** Lateral ankle ultrasound shows anechoic ganglion cyst (arrows). Note needle (arrowheads) entering cyst for aspiration and steroid injection. (Courtesy of J. Jacobson, MD, Ann Arbor, MI.)
who had unsatisfactory results from tenotomy. Less successful treatment with tenotomy was seen in Achilles tendons with marked paratenon involvement, multiple nodular regions, or tendinopathy greater than 3 cm in length. Insertional patellar tendinopathy also was treated less successfully with tenotomy compared with tendinopathy in the body of the tendon. Corticosteroid injection was not used as a part of these procedures.

Ultrasound-guided biopsy of soft tissue masses

Soft tissue masses frequently are biopsied percutaneously, using a core biopsy system. Depending on the specific size, location, and lesion characteristics, biopsy with CT or US guidance may be needed. Although sonography often cannot provide a specific diagnosis of a given soft tissue tumor, its speed, efficiency, cost, portability, availability, and ease of visualizing vessels offer advantages over CT for guiding many biopsies. With US guidance, the needle tip also can be visualized constantly, which increases the chance of a successful and safe biopsy (Fig. 34). In tumors that have regions of solid and cystic or necrotic areas, the solid areas have the highest yield, and the needle tip should be positioned for biopsy of these regions (Fig. 35). Certainly it is an advantage to the patient, clinician, and radiologist if US-guided biopsy can be offered when it provides an advantage over blind or CT-guided biopsy.

The biopsy approach must be chosen in conjunction with the orthopedic oncologist, because the biopsy tract may be seeded and may need to be resected if pathologic analysis reveals a malignant primary tumor [38]. The most advantageous form of biopsy, whether imaging-guided or open surgical biopsy, can be determined by means of close collaboration between the radiologist and orthopedic oncologist. For US-guided biopsies, Torriani advocates at least five core biopsies with a 14-gauge automated biopsy gun. Lopez and colleagues [39] use an 18-gauge needle and an average of four biopsies, or a 14-gauge needle for suspected fatty masses. The authors routinely use a coaxial system with a 17-gauge introducer needle through which multiple 18-gauge core biopsies are taken. Therefore, if fine needle aspiration is performed, it is optimal to obtain these samples first, before obtaining any core biopsy samples, because bleeding secondary to
the core biopsy sample can render a fine needle aspiration nondiagnostic. Core biopsy samples are usually more accurate and diagnostic compared with fine needle aspiration of soft tissue masses [38–40]. The introducer needle can be angled to obtain samples from different areas of the mass.

Following the biopsy, direct pressure should be held for 15 minutes, and a compression bandage should be used for 12 to 24 hours. At least 30 minutes of observation in the department after biopsy is prudent to assess for bleeding or neurovascular complications [38].

**Fig. 32.** (A) Longitudinal sonogram of the proximal aspect of the patellar tendon demonstrates thickening and hypoechogenicity extending 1.3 cm (*between the + cursors*) from the proximal patellar attachment. Findings are consistent with tendinosis. (B) Longitudinal ultrasound (US) with power Doppler imaging demonstrates hyperemia of the region of tendinosis. (C) Longitudinal US during tenotomy demonstrates the needle (*arrows*) within the region of tendinosis. Needle is well-visualized when parallel to the surface of the US transducer.

**Fig. 33.** (A) Longitudinal ultrasound (US) of the Achilles tendon insertion on the calcaneus demonstrates thickening and hypoechogenicity with increased flow on color Doppler imaging. Arrows denote the Achilles tendon, and arrowhead denotes cortical irregularity at the calcaneal insertion. (B) Longitudinal US during tenotomy demonstrates the needle (*arrow*) within the region of tendonosis. Arrows denote the Achilles tendon. Needle is well-visualized when parallel to the surface of the US transducer.
Myxoid tumors or largely cystic tumors may not yield enough tissue for definitive diagnosis using a core biopsy technique. Aspiration of fluid with cytologic analysis can be performed with US guidance. Ultimately, surgical resection may be needed for definitive diagnosis in such cases. Although soft tissue cartilaginous lesions are uncommon, it is often difficult to subtype and grade these lesions based on needle biopsy. In such cases open biopsy or resection may be more efficacious.

In a report of 188 US-guided musculoskeletal biopsies performed by Lopez and colleagues [39], no major complications were noted. In most series, a complication rate of less than 1% is typical [38,40,41]. Pain, hematoma, and infection are the most common complications, with rare reports of...
more serious complications such as hemorrhage, severe neurologic damage, pneumothorax, or tuberculous sinus tracts. Accuracy of needle biopsy, compared with findings at surgical resection ranges from 60% to 97%. For the patient who has a soft tissue mass requiring biopsy, optimal outcome is obtained at a treatment center when there is strong communication and cooperation between experienced orthopedic oncologists, musculoskeletal radiologists, and musculoskeletal pathologists.

Summary

US guidance can be used for aspiration, injection, tenotomy, and soft tissue biopsy. The use of US guidance helps assure a safe and successful procedure. For each procedure, the precise approach can be tailored to the specific site of fluid, tendon pathology, or mass. Nerves, vessels, and tendons can be avoided, because the needle tip is monitored constantly with real-time sonographic visualization. US is widely available, portable, and allows dynamic evaluation and rapid contralateral comparison. Appropriate use of this powerful tool can benefit patients and radiologists.

References


