Traditionally, joint aspiration has been performed using only external anatomic landmarks (“blind” aspiration) or fluoroscopic guidance. We illustrate the technique and role of joint aspiration of the shoulder, elbow, hip, knee, and ankle with sonographic guidance. Sonographic evaluation and guidance of aspiration offers several advantages over the traditional approaches. The joint can first be examined to determine if fluid is present. This examination can eliminate a potentially traumatic and unnecessary aspiration attempt of a joint that does not contain an effusion.

In addition to joint effusions, sonography can reveal fluid collections, such as bursitis and soft-tissue abscesses, outside the joint. Many soft-tissue abscesses and distended bursae can be detected on physical examination. Not infrequently, however, there is a clinical question of an abscess in a patient with cellulitis, soft-tissue edema, or obesity that limits the physical examination. In such patients, there may also be a question of a joint effusion. Sonographic examination allows detection of joint fluid as well as soft-tissue fluid collections and avoids contamination of an aseptic joint that could occur by blind or fluoroscopic aspiration through an overlying soft-tissue infection such as an abscess, septic bursitis, or septic tenosynovitis.

**Technique**

For each joint, the aspiration approach is similar to that used for arthrography, but the approach is guided by the location of fluid detected sonographically. A commercial arthrogram tray and a 20-gauge spinal needle with stylet are commonly used for aspiration. Sonography of the joint in at least two planes is first performed to precisely localize the effusion [1]. A linear transducer of at least 7.5 MHz is recommended for all joints except the hip, where a curvilinear 5-MHz or lower frequency transducer may be required, depending on the patient’s body habitus. The appearance of an effusion (complex, hypoechogenic, anechoic) does not predict an inflammatory or infectious cause [2]. If a suspected fluid collection contains a region that is anechoic in addition to regions that are hyperechoic or echogenic, we usually have success in aspirating fluid from the more anechoic region.

Doppler evaluation is routinely used to assess for vascular structures surrounding the effusion or along the potential aspiration approach. Increased power Doppler flow around a fluid collection can be shown in some effusions with an infectious or inflammatory cause; however, lack of increased flow on power Doppler imaging does not exclude infection [3]. Doppler flow within a hypoechogenic collection surrounding a joint suggests synovitis or other soft-tissue process and is not compatible with a simple joint effusion [4].

If a joint effusion is detected, the depth from the skin surface to the deepest portion of the fluid is measured along the proposed needle tract. A needle with an appropriate length is selected. With the transducer positioned over the effusion, an ink dot is placed on the skin at the midpoint of each side of the transducer. The dots are connected to form a “+”. Accuracy of the marking is checked by placing the transducer at the “+” in both transverse and longitudinal orientations. An inaccurate skin marking is one potential cause of an unsuccessful aspiration; care must taken to ensure the marking is directly over the center of the effusion. The dots are connected to form a “+”. Accuracy of the marking is checked by placing the transducer at the “+” in both transverse and longitudinal orientations. An inaccurate skin marking is one potential cause of an unsuccessful aspiration; care must taken to ensure the marking is directly over the center of the effusion. We routinely perform aspiration using a freehand technique. However, a guide can be installed on the transducer to direct the needle if desired [1].
Fig. 1.—Glenohumeral joint aspiration using sonographic guidance.
A, Photograph shows transducer positioning for transverse sonography of posterior right shoulder and needle positioning for aspiration. For purposes of illustration, a sterile transducer cover and drape are not shown.
B, Transverse sonogram of normal posterior glenohumeral joint, scanned as illustrated in A, shows no detectable fluid. Humeral head (double arrowheads) is to the left, hyperechoic glenoid labrum (single arrowhead) and infraspinatus muscle and tendon (arrows) are to the right.
C, Septic posterior glenohumeral joint. Sonogram obtained as illustrated in A shows hypoechoic joint effusion (arrows) displacing infraspinatus tendon (single arrowheads). Humeral head (double arrowheads) is to the left. Culture of aspirate grew *Staphylococcus aureus*.
Sonography and Aspiration of Joint Effusions

For large and easily accessible effusions, sonography can simply be used for detection, marking of the effusion, and exclusion of a soft-tissue process such as an abscess. In such cases, sonographic guidance during needle placement is not required. If there are no contraindications, the skin is cleansed with Clinidine (povidone-iodine; Clinipad, Rocky Hill, CT) and anesthetized with 1% lidocaine. The bevel of the needle is positioned adjacent to the rounded portion of the joint (e.g., the bevel is toward the humeral head during shoulder aspiration). After sonographic evaluation, if aspiration without sonographic guidance is selected, the needle should be advanced as parallel as possible to the axis of the ultrasound waves. Advancement of the needle with excessive angulation from this axis is a potential pitfall. Ideally, a straight horizontal axis (as with posterior shoulder aspiration performed with the patient in the sitting position) or a straight vertical axis (as with hip aspiration in the supine position) is used. The needle is advanced to the level of the osseous structures and suction from the syringe is applied.

If no fluid is noted after suction is applied, the needle can be rotated clockwise or counterclockwise to adjust the bevel. The stylet can also be replaced and moved to and fro within the needle to dislodge any debris in the needle. The needle is withdrawn slowly, a millimeter at a time, with continuous suction from the syringe.

If the initial aspiration attempt is unsuccessful, the skin marking can be rechecked with sonography, or sonographic guidance during needle positioning can be used. For small or less accessible effusions, sonographic guidance of needle placement is used with the initial aspiration. A sterile cover is placed over the transducer and sterile gel applied. A compact linear or “hockey stick” probe (Fig. 1) facilitates scanning during aspiration.

When aspiration under sonographic guidance is chosen, the needle is advanced at an angle along the long axis of the transducer and appears as a bright echogenic line. If the needle axis approaches 90° to the ultrasound beam, reverberation artifacts may be seen posterior to the needle [1]. If the needle is advanced transverse to the axis of the transducer, an echogenic dot or short linear component may be visualized. The needle is usually well visualized in a cystic fluid collection [1]. Maneuvers to aid visualization of the needle include gentle movement of the needle (side to side or in and out), injection of a small amount of saline or air, and movement of the stylet to and fro within the needle [1]. Power Doppler sonography detects motion and can also be applied to aid detection of the needle tip during advancement.

In cases in which a high clinical suspicion exists for a joint infection but only a borderline or minimal effusion is detected on sonography, sterile, nonbacteriostatic saline can be injected and reaspirated for analysis. Comparison with the contralateral, asymptomatic joint aids evaluation when there is a question of a small effusion, though asymmetry of joint fluid does not always imply an abnormal effusion [5]. Scanning after aspiration can assess residual or loculated fluid collections.

Fig. 2.—Subacromial and subdeltoid bursae aspiration using sonographic guidance.
A, Sonogram of normal anterior shoulder transverse to biceps tendon. Note absence of fluid in subacromial and subdeltoid bursae. Biceps tendon is seen in bicipital groove of humerus (arrowhead).
B, 46-year-old woman in whom a septic glenohumeral joint was suspected on clinical grounds. Sonogram of anterior shoulder transverse to biceps tendon shows heterogeneous fluid collection in subacromial and subdeltoid bursae (arrows). Biceps tendon is seen in bicipital groove (arrowhead). Aspiration of bursa was performed from anterior approach at level of biceps groove. Culture grew Pseudomonas aeruginosa. No fluid was identified in glenohumeral joint (not shown).
Fig. 3.—Elbow joint aspiration using sonographic guidance.
A. Photograph shows transducer positioning for posterior transverse sonography of olecranon fossa and needle positioning for aspiration. For purposes of illustration, sterile transducer cover and drape are not shown.
B. Transverse sonogram of olecranon fossa, scanned as illustrated in A, shows no detectable fluid. Arrows mark olecranon fossa at posterior aspect of distal humerus.
C. 23-year-old man in whom septic elbow effusion was suspected on clinical grounds. Transverse sonogram shows tip of needle (arrow) in fluid collection (arrowheads). Because aspiration was performed with needle perpendicular to long axis of transducer (A), only tip of needle is visualized.
Fig. 4.—Hip joint aspiration using sonographic guidance.

A. Photograph shows transducer positioning for longitudinal sonography of hip and needle positioning for aspiration. For purposes of illustration, sterile transducer cover and drape are not shown.

B. Sonography of normal hip joint. Longitudinal sonogram of normal hip joint longitudinal to femoral neck. Acetabulum is to the left, and arrowheads mark femoral head and shaft. No fluid is seen distending joint capsule.

C. 42-year-old male IV drug abuser in whom septic hip joint was clinically suspected. Longitudinal sonogram obtained as illustrated in A shows hypoechoic hip effusion between arrowheads marking femoral cortex and corresponding arrows marking joint capsule. Culture of aspirate grew *Staphylococcus aureus*.

D. 74-year-old man with increasing hip pain after hemiarthroplasty. Longitudinal sonogram of hypoechoic hip effusion noted between arrowhead marking hip prosthesis and corresponding long arrow marking joint capsule. Bone-to-capsule distance, measured between short arrows, is 11 mm. Note reverberation artifact posterior to metal components (curved arrow).
As with traditional arthrography, potential complications include vasovagal reaction, puncture of neurovascular structures, iatrogenic infection, and failure to aspirate joint fluid. Whenever possible, aspiration should be performed with the patient supine to decrease the potential complications of a vasovagal reaction. Visual assessment and close communication with the patient during the procedure aid assessment for a vasovagal reaction. Knowledge of the neurovascular anatomy along with sonographic assessment, including Doppler evaluation, allows avoidance of the neurovascular structures. Iatrogenic infection is extremely rare when proper technique is used [6]. Failure to aspirate joint fluid is most often caused by an inaccurate skin marking or confusion of hypoechoic synovitis with an effusion.

**Shoulder**

Sonographic guidance of needle placement during MR arthrography of the shoulder has been described for both the anterior [7] and posterior [8] approaches. The posterior approach is frequently used because fluid generally accumulates first in the infraspinatus recess of the posterior glenohumeral joint [1] (Fig. 1). Dynamic posterior scanning during adduction or abduction can aid in detecting small effusions. For the posterior approach, aspiration is performed with the patient sitting upright. Close monitoring for any signs of a vasovagal reaction is mandatory. The joint capsule is punctured along the medial border of the humeral head, slightly lateral to the glenohumeral joint. This approach avoids contact with the supraspinatus nerve and circumflex scapular vessels that course medial to the glenoid rim [9]. Using this approach, Cicak et al. [8] reported successful and uncomplicated sonographic needle placement for arthrography in 24 patients. We have routinely used the posterior approach without complication.

The anterior approach is similar to the approach used in standard arthrography. The patient is supine, and the entry site is a central line between the coracoid and the anteromedial humeral head when scanning axially [7]. The entry site must be lateral to the coracoid to avoid major neurovascular structures including the cephalic vein, axillary artery, and brachial plexus [9]. The needle tip can be visualized adjacent to the cartilage of the humeral head on axial imaging [7]. Using this approach, Valls and Melloni [7] reported successful and uncomplicated sonographic needle placement for arthrography in 50 patients. Typically, we would use an anterior approach if fluid is noted only anteriorly (and not posteriorly), or if the patient must remain supine.

Extraarticular fluid collections, including subacromial and subdeltoid bursal fluid, acromioclavicular joint fluid, and soft-tissue abscess, can also be identified and aspirated using sonographic guidance (Fig. 2). Such noncommunicating fluid collections would not be detected by fluoroscopic aspiration of the glenohumeral joint and may not be detected by physical examination. Transducer and needle positioning for aspiration of bursa are variable, depending on the location of the greatest amount of fluid.

**Elbow**

We frequently use the posterior approach for joint aspiration of the olecranon recess [1] (Fig. 3). Evaluation of the olecranon recess in the flexed elbow is the optimal approach for sonographic detection of an effusion [10] (Fig. 3C). The absence of major neurovascular structures in the posterior elbow at the level of the triceps tendon allows a safe approach. We have found the posterior approach to be rapid and without complication.

Joint aspiration can also be performed from an anterolateral approach, as with standard arthrography, with the needle tip placed in the radio-capitellar joint [1, 11]. This approach can be more difficult and time-consuming because the needle tip must be placed in a smaller space.

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**Fig. 5.**—68-year-old woman with clinical concern for septic hip after hemiarthroplasty. Transverse sonogram over greater trochanteric bursa shows hypoechoic fluid collection (arrowheads). Arrows mark echogenic cortex of greater trochanter. Hip joint (not shown) showed no fluid. Using fluoroscopic or traditional “blind” aspiration, this fluid would not have been detected and patient would have endured an unsuccessful attempt at joint aspiration.
Fig. 6.—Knee joint aspiration using sonographic guidance.

A. Evaluation for effusion. Photograph shows transducer positioning for longitudinal scanning of suprapatellar bursa to evaluate for joint effusion. Longitudinal imaging is easiest for detection of fluid. However, bony anatomy of patella obstructs needle placement in longitudinal orientation. Therefore, transverse orientation is used for aspiration when sonographic guidance is required.

B. Longitudinal sonogram of normal suprapatellar bursa shows physiologic amount of fluid (arrowhead). Patella is to the right (single arrow) and quadriceps tendon is seen superficially (double arrows). Note hyperechoic prefemoral (PF) and quadriceps (Q) fat pads.

C. 64-year-old woman on chronic corticosteroid treatment in whom ruptured quadriceps tendon was suspected on clinical grounds. Longitudinal sonogram shows hypoechoic effusion (EFF) in suprapatellar bursa. Suprapatellar and prefemoral fat are labeled. PAT = patella, QUAD = intact quadriceps tendon.

D. Joint aspiration using sonographic guidance. Photograph shows transducer positioning for transverse sonography of suprapatellar bursa and needle positioning for aspiration. For purposes of illustration, sterile transducer cover and drape are not shown.

E. 43-year-old woman in whom septic knee effusion was clinically suspected. Transverse sonogram shows hypoechoic effusion in suprapatellar bursa (black arrowheads). Note femoral cortex (single white arrowhead) and patellar cortex (double white arrowheads).
Hip

Sonography is frequently used for evaluation of hip effusions in both the adult and pediatric population [2, 6]. For evaluation of the hip, the patient is supine with the hip in extension and slight abduction [12]. The transducer is oriented anteriorly along the axis of the femoral neck (Fig. 4).

The femoral artery is palpated or localized with sonography and marked for reference, and aspiration is performed at least 1 cm lateral to the neurovascular bundle. The needle tip can be visualized in the capsule, adjacent to the femoral neck. With proper technique, iatrogenic hip infections caused by joint aspiration are very rare, reported in zero of 800 aspirations [6].

Hip effusions are seen as fluid that displaces the capsule away from the echogenic cortex of the femoral neck [2, 6] (Fig. 4C). A difference in joint distention of greater than or equal to 2 mm between the symptomatic and asymptomatic hip has been reported as significant [2]. Thickening of the capsule (≥ 2 mm) and changes in the cortex of the proximal femur have also been reported with septic arthritis [2].

Sonography has also been used to detect joint effusions and extraarticular fluid collections in patients with hip prostheses (Fig. 4D). An effusion with a bone-to-capsule distance greater than or equal to 3.2 mm with a concomitant extraarticular fluid collection has been reported as highly specific for infection [13]. Periarticular fluid collections in such cases may have originally communicated with the joint, with subsequent “walling off” of the periarticular collection, or such collections could be due to a second nidus of infection (in addition to the joint infection).

Extraarticular fluid collections such as greater trochanteric bursitis can also be detected and aspirated using sonographic guidance (Fig. 5). The location of the fluid and major neurovascular structures determines the aspiration approach. Typically, a lateral approach is used for aspiration of the greater trochanteric bursa. Such fluid collections would not be detected by blind or fluoroscopic aspiration of the hip and may not be detected on physical examination.

Knee

The patient is examined supine with the knee extended and the popliteal fossa flush with the examination table (Fig. 6). Longitudinal scanning over the distal quadriceps tendon just proximal to the patella is used to assess the suprapatellar bursa. A small amount of fluid is physiologic and is usually first noted in the lateral recess (Fig. 6B). Larger amounts that displace the suprapatellar bursa are easily detected and are abnormal (Fig. 6C).

Longitudinal imaging is the easiest for detection of fluid (Fig. 6A). However, the bony anatomy of the patella obstructs needle placement in the longitudinal orientation. Therefore, the transverse orientation is used for aspiration when sonographic guidance is required (Fig. 6D). Aspiration can be performed from an anterolateral or anteromedial approach depending on the location of the fluid. No major neurovascular structures are encountered by these approaches. The tip of the needle can be visualized in the suprapatellar bursa. Extraarticular fluid collections, including abscesses and bursal fluid collections, can also be detected and aspirated with sonographic guidance (Figs. 7 and 8).

Ankles

An ankle joint effusion is optimally detected with the ankle in plantar flexion [14] (Fig. 9). Up to 3 mm (anteroposterior dimension) of joint fluid has been observed in normal volunteers and can be asymmetric when compared with the opposite ankle [2]. An effusion is seen as anechoic or hypoechoic joint fluid that distends the anterior recess (Fig. 9C).

Before aspiration, the dorsalis pedis artery is localized by sonography. An anterior entry site for aspiration is chosen medially or laterally to avoid the artery and adjacent deep peroneal nerve (located immediately lateral to the artery). The tip of the needle can be visualized adjacent to the hypoechoic cartilage of the tibiotalar joint.

Septic tenosynovitis of the extensor tendons can also be seen with sonographic evaluation (Fig. 10). Blind or fluoroscopic aspiration of the joint through septic tenosynovitis could infect an aseptic joint and can be avoided with sonographic evaluation.

Fig. 7.—21-year-old man with sickle cell anemia and distal femoral fluid collection seen on MR imaging (not shown). Transverse sonogram of distal femur shows echogenic fluid collection (arrowheads) and aspiration needle (arrow). Analysis of aspirate yielded >10,000 WBC/ml without identification of an organism, likely a result of antibiotic therapy.

Fig. 8.—75-year-old man with cellulitis surrounding knee in whom clinical findings suggested soft-tissue fluid collection. Transverse sonogram of lateral knee shows complex fluid in lateral knee bursa (curved arrows) and aspiration needle (straight arrows). Analysis of aspirate revealed Gram-positive cocci.
Fig. 9.—Ankle joint aspiration using sonographic guidance.

A. Photograph shows transducer positioning for longitudinal sonography of tibiotalar joint and needle positioning for aspiration. Ankle is placed in plantar flexion to aid detection and aspiration. For purposes of illustration, sterile transducer cover and drape are not shown.

B. Longitudinal sonogram of normal anterior ankle joint shows tibia to left (arrowhead) and talus to right (arrows). No fluid is detected. Note hyperechoic fat pad (X).

C. 55-year-old man with diabetes mellitus in whom septic tibiotalar joint was suspected on clinical grounds. Longitudinal sonogram shows hypoechoic tibiotalar joint effusion (arrowheads). Analysis of aspirate revealed uric acid crystals, confirming diagnosis of gout. Note tibia (single straight arrow), talus (double straight arrows), and extensor tendon (curved arrows).

Fig. 10.—82-year-old woman with diabetes mellitus and clinical findings suggesting ankle effusion. Transverse sonogram of extensor digitorum tendons (single arrowheads) and peroneus tertius (double arrowheads) shows complex fluid surrounding tendons (curved arrows). Culture of aspirate grew Nocardia asteroides. Fluoroscopic or “blind” aspiration of ankle joint through this septic tenosynovitis could have infected an aseptic ankle joint.
Conclusion

With sonographic evaluation, attempted aspiration of a dry joint can be avoided. The number of punctures needed to obtain a diagnostic sample may also be decreased. The use of sonography allows identification and aspiration of extraarticular fluid collections, including abscesses and bursitis. Contamination of an aseptic joint by fluoroscopic arthrocentesis through an undiagnosed abscess, septic bursitis, or septic tenosynovitis can be prevented. With sonographic guidance, the optimal access route to the fluid can be chosen to ensure a safe and successful aspiration.

References