RadioGraphics

Emergency Joint Aspiration: A Guide for Radiologists on Call[1]

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CME FEATURE

See accompanying test at http://www.rsna.org/education/rg_cme.html

LEARNING OBJECTIVES FOR TEST 5

After reading this article and taking the test, the reader will be able to:

- Recognize the typical imaging features of septic arthritis.
- Formulate an expanded differential diagnosis for septic arthritis.
- Describe an appropriate imaging-guided arthrocentesis technique for each joint.

TEACHING POINTS
See last page

Septic arthritis is a disabling and possibly life-threatening disease that requires early diagnosis for optimal management. It is important that clinical and imaging features of septic arthritis be promptly identified. In addition, because other disease entities may have characteristics similar to those of septic arthritis, analysis of a needle biopsy specimen may be necessary for differential diagnosis. Radiologists may be asked to perform emergent aspiration of a possibly infected joint. It is important that those who perform aspiration procedures be familiar with a safe and effective imaging-guided arthrocentesis technique that is tailored to the individual patient and the specific joint affected.

Abbreviation: STIR = short inversion time inversion recovery

RadioGraphics 2009; 29:1139–1158 • **Published online** 10.1148/rg.294085032 • **Content Codes:** ER MK VI

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Introduction

Septic arthritis is a disabling and potentially life-threatening disease that requires early diagnosis for optimal patient care. Delays in diagnosis are a major contributor to poor outcomes (1–3), so it is imperative that patients be evaluated expeditiously. Radiologists should be aware of the imaging findings of septic arthritis, its complications, and diagnostic pitfalls. For those who perform aspiration, familiarity with imaging-guided arthrocentesis techniques also is important.

Septic arthritis is produced by a microbial invasion of the synovial space. Virtually every infectious agent has caused septic arthritis. Bacteria, however, are the most common and important cause of joint infection leading to arthritis. Bacterial infections also produce the most rapid joint destruction. Irreversible loss of joint function develops in 25%–50% of patients with bacterial arthritis, and up to 75% of survivors develop a significant functional disability of the involved joint. Even with improved antibiotics, fatality rates ranging from 5%–15% have remained unchanged over the past 25 years (1,4–7).

The article reviews the clinical and imaging findings of septic arthritis and briefly discusses various other disease entities that may have a similar appearance at imaging. A safe and effective arthrocentesis technique specific to each of the joints is described. Thus, the article provides a guide for radiologists who may be asked to perform emergent aspirations either during their daily work or while on call.

Routes of Infection

Joints can become infected in various ways. Hematogenous seeding may occur in patients with a history of intravenous drug use, endocarditis, or indwelling catheter infection. Direct inoculation may result from penetration by foreign bodies, including teeth (Fig 1). Rarely, intraarticular injections and femoral vessel punctures have been implicated (8,9). The direct extension of infection from adjacent ulcers, cellulitis, osteomyelitis, and bursitis most commonly occurs in patients with diabetes.

Most cases of septic arthritis result from hematogenous seeding of the highly vascular synovial membrane. Because the synovial lining lacks a limiting basement membrane, organisms easily gain entry into the joint. Once bacteria have entered the joint space, rapid destruction occurs because of various factors (10). Proteolytic enzymes from synovial fluid and acute inflammatory cells cause synovial necrosis, which then extends to the articular cartilage in a process similar to pannus formation in rheumatoid arthritis. Pressure necrosis from the accumulation of purulent synovial fluid leads to additional synovial and cartilage destruction, which may be accelerated by the presence of bacteria. For example, the presence of *Staphylococcus aureus* species leads to an increase in proteoglycan release from cartilage, which damages the basic structure of articular cartilage even before any bacteria invade the inflamed synovium. Once the process has begun, the presence of viable organisms is not necessary for ongoing, progressive joint damage to take place (10).

Risk Factors

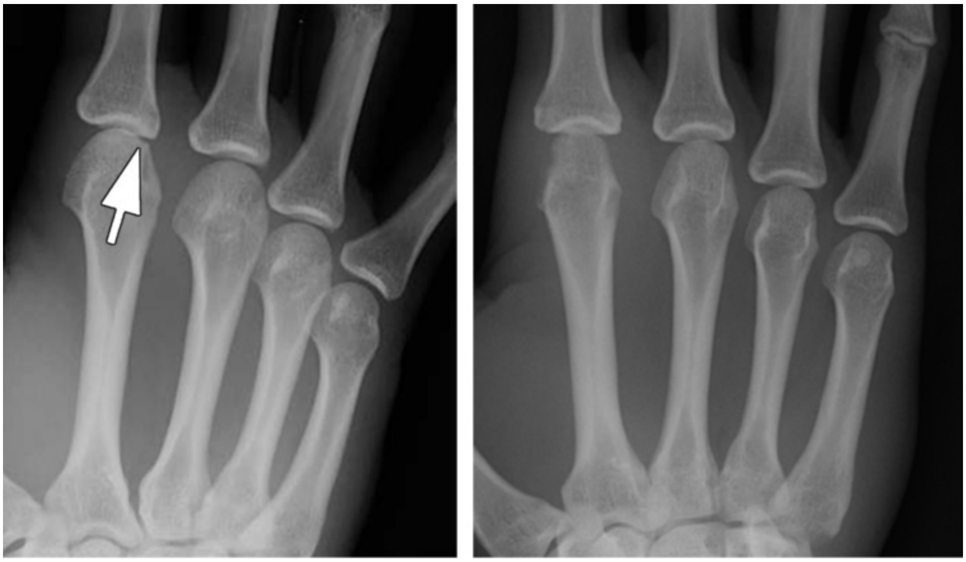
Certain patient groups are susceptible to infectious pathogens and therefore are at risk for seeding of the joints. These groups include the elderly as well as patients with acquired systemic illnesses that cause immunosuppression, such as cancer, diabetes, and chronic liver and renal disease. In addition, patients with preexisting systemic connective tissue disease or chronic arthritis have joint damage that may lead to chronic synovitis and bloody effusions in the joint space, which thus becomes a nidus of bacterial infection. Intravenous drug users are particularly susceptible to infections, which may lead to recurrent bacteremia and endocarditis (10).

Clinical Manifestations

Clinically, patients typically present with a sudden onset of monoarticular arthritis. A joint effusion is often present but is difficult to detect at physical examination of the shoulder, hip, and sacroiliac joints. Fever and rigor have low sensitivity and specificity, as patients may have already used antipyretics. In addition, fever and rigor may be present in patients with crystal-induced arthritis. Nonspecific symptoms include pain while at rest and in motion. The knee is the most commonly involved joint, followed by the hip, ankle, wrist, shoulder, and elbow. Polyarticular joint involvement is rare and usually occurs in patients with a systemic connective-tissue disorder or immunosuppression. When polyarticular joint involvement is encountered, it is usually limited to one or two other joints (11).

Imaging Evaluation

Imaging of septic arthritis should begin with conventional radiography. Unfortunately, radiography has low sensitivity for the depiction of



a. b.

Figure 1. Septic arthritis of the second metacarpophalangeal joint after direct inoculation in a closed-fist injury. **(a)** Posteroanterior radiograph obtained immediately after injury shows a divot (arrow) from a human tooth, with slight narrowing of the joint space. **(b)** Posteroanterior radiograph obtained 2 weeks later shows progressive diffuse joint-space narrowing and erosions.

early changes in acute septic arthritis. Moreover, overlying soft-tissue structures may obscure details of joints such as the sternoclavicular and sacroiliac joints.

Radiographic Findings

Synovial inflammation and effusion manifest at radiography as soft-tissue swelling. Effusions are detectable on radiographs of the elbow, knee, and ankle but are not readily visible on radiographs of most other joints. Diffuse cartilage destruction results in uniform narrowing of the joint space. Marginal or bare area erosions also may be seen; these findings correspond to early bone loss at sites of joint capsule attachment, where the cartilage is thinnest.

MR Imaging Features

If there is a high level of clinical suspicion about the possibility of septic arthritis, joint aspiration is often performed without initial magnetic resonance (MR) imaging, especially if the joint is readily accessible. Erroneous diagnoses of cellulitis, osteomyelitis, and other pathologic processes are relatively common (3,12,13), and such cases may be referred at a later stage for MR imaging. In addition, clinical evaluation of joint effusion is difficult in deep joints such as the shoulder and hip, and referring physicians may have little or no familiarity with the disease process in septic arthritis. Therefore, radiologists must be cognizant of the MR imaging features of septic arthritis, which include joint effusion; surrounding soft-tissue edema; diffuse joint-space narrowing, perhaps better appreciated on radiographs than on MR images; and adjacent bone marrow edema surrounding the affected joint, starting in the bare areas (14).

Teaching Point

Differential Diagnosis

The differential diagnosis of septic arthritis typically includes various types of inflammatory arthritides, both those that are rheumatoid factor (RF)-seropositive and those that are RF-seronegative. Rheumatoid arthritis may have imaging characteristics identical to those of septic arthritis, including joint effusion, synovial inflammation, diffuse joint-space narrowing, and bare area erosions. In some cases, the clinical manifestations may allow differentiation between the two entities. In other cases, differentiation between an acute episode or exacerbation of rheumatoid arthritis and septic arthritis on the basis of clinical manifestations and imaging appearances alone may be challenging, and a laboratory analysis of joint fluid may be necessary. Because any structural joint damage increases the risk of septic arthritis, rheumatoid arthritis puts patients at a greater risk for septic arthritis.

Other inflammatory arthritides, including seronegative spondyloarthropathies such as psoriatic arthritis, reactive arthritis, and ankylosing spondylitis (previously known as Marie-Strümpell disease), also may be considered in the differential diagnosis. Patients with chronic arthritic conditions generally have a higher risk of septic arthritis because damaged joints are more susceptible to infection. Furthermore, chronic arthritic conditions and their treatments may lead to immunosuppression. Finally, arthritides caused by the local deposition of mineral crystals, including calcium pyrophosphate dihydrate deposition disease, gout, and calcium hydroxyapatite deposition disease, may mimic septic arthritis both clinically and radiographically (15). Calcium pyrophosphate dihydrate deposition disease is the most common cause of monoarticular arthritis in patients older than 40 years, and an acute episode of the disease may be accompanied by fever and rigor. Ultimately, aspiration of joint fluid may be necessary to differentiate crystal arthritis from septic arthritis.

Arthrocentesis Technique

Arthrocentesis performed with fluoroscopic guidance must be accompanied by arthrography. Arthrography helps confirm the intraarticular harvest of joint fluid and allows visualization and evaluation of structures that cannot be seen at plain radiography. Arthrography yields additional information about the cartilage, the supporting ligaments, and the joint lining and allows the detection and localization of intraarticular bodies. When fluid from a septic joint is needed for laboratory analysis, arthrography is performed to verify that the location of intraarticular sampling is within the joint cavity. It also is performed to determine whether adjacent bursal collections, abscesses, or sinus tracts are present so that they, too, can be treated during surgical débridement.

Although arthrography and arthrocentesis are considered invasive procedures, they are relatively safe; the risk of infection is very low, and the risk of bleeding is minimal. Urticaria caused by allergy to the contrast agent is a rare complication that occurs in approximately 1 in 10,000 patients. To our knowledge, there is no report in the English literature of a serious allergic reaction resulting from these procedures. Another rare complication, which involves rapid swelling and onset of pain in the joint within hours after arthrography, apparently is caused by irritation of the joint lining by the contrast agent, injected air, or both (16). Swelling usually subsides within a day or two without treatment; however, if necessary, it may be alleviated by aspirating fluid from the joint. Serious complications are rare, and most patients experience no complications. It may be advisable to use a contrast agent with low osmolarity in patients at high risk because of diabetes, renal disease, or myeloma.

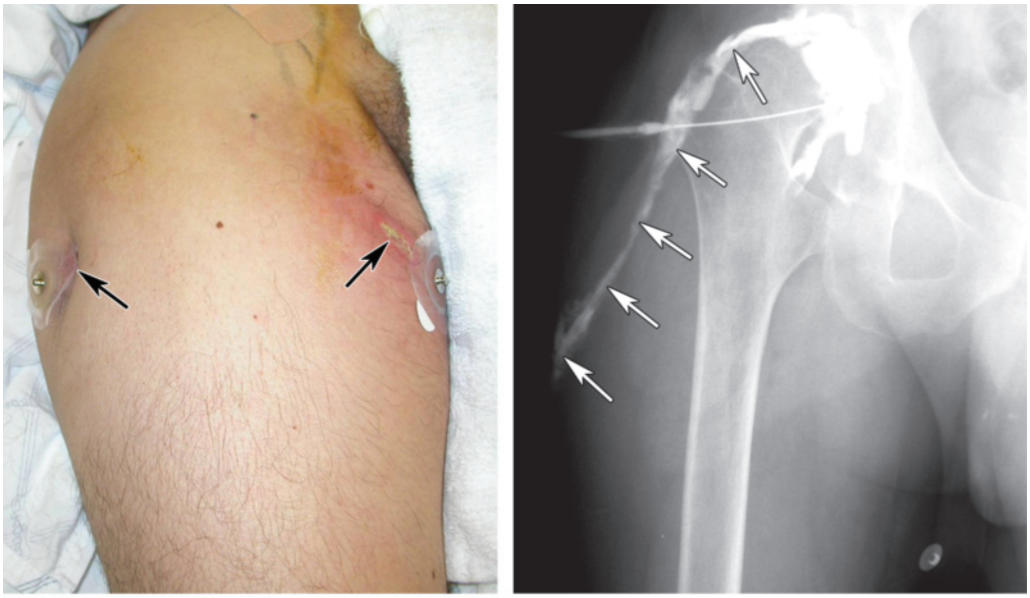
A potential limitation of arthrography is that the introduction of a large amount of contrast material into an infected joint may hinder a proper analysis of fluid subsequently aspirated from the joint. This limitation may be ameliorated by the use of a nonbacteriocidal contrast material. A further concern is that the injection of a large amount of contrast material might flush bacterial products from the joint into the bloodstream, causing septicemia. However, since the goal of the procedure is joint decompression with arthrocentesis performed immediately after arthrography, that complication may be avoided. If desired, a sample of the aspirate, placed in a vial with a specific label (eg, "contrast material wash"), may be sent out for laboratory culture.

Before the procedure, any available imaging studies are reviewed. If MR imaging was performed, the MR images should be thoroughly reviewed to detect any joint effusion or fluid collection and determine its exact location for aspiration. In addition, if a soft-tissue abscess is identified, it should be aspirated separately, and the needle tract to the joint should not transect this area.

A physical examination of the patient should be performed to detect any skin diseases or defects. The presence of a skin ulcer or defect may represent the exit of a sinus tract (Fig 2) and should be marked with an electrocardiographic lead and included in the field of view during arthrography. Needle approaches should never traverse an area of inflammation or a skin lesion such as psoriasis or acne, because the needle may introduce an infectious agent into a joint that was not initially infected.

Informed consent is obtained from the patient before the procedure and after the risks and benefits are explained clearly. The patient is placed in an appropriate position, depending on which joint is to be examined and which imaging modality is to be used to guide the procedure. The safest access route to the joint is marked on the patient's skin. The skin is shaved if necessary (to remove excess hair) and then cleaned, prepared, and draped in accordance with sterile technique. Local anesthesia is infused into the subcutaneous tissues and, if necessary, into deeper tissues.

Spinal needles with trocars are used for arthrocentesis. The inner stylet prevents the needle



a. b.

Figure 2. Septic arthritis of the hip in a 25-year-old man with hip pain for several years. **(a)** Photograph shows two skin ulcers (arrows) with adjacent electrocardiographic leads used for localization at arthrocentesis and arthrography. **(b)** Arthrogram shows a sinus tract (arrows) that extends from the right hip joint to the lateral skin ulcer.

lumen from becoming clogged with skin and subcutaneous tissues. Larger (20-gauge, 3.5-inch) needles are used for large and deep joints such as the shoulder and hip, and smaller (22-gauge, 1.5-inch) needles are used for smaller and more superficial joints such as the wrist and elbow.

The joint of interest may be accessed while using various imaging techniques—fluoroscopy, computed tomography (CT), or ultrasonography (US)—for guidance. Aspiration is performed with sterile technique, and samples of joint fluid are subsequently sent to the laboratory for cell counts and differential, Gram staining, and aerobic and anaerobic cultures. If an atypical infection is suspected, a larger amount of fluid may be needed. The fluid also should be examined with microscopy to determine whether crystals are present. Additional laboratory tests may be requested by the referring clinician, depending on the amount of fluid obtained at arthrocentesis.

If the aspirate contains pus, as much fluid as possible should be aspirated immediately to achieve decompression. The surrounding soft tissues may be manually compressed to express as much pus as possible. The referring service should be notified immediately of a finding of pus.

Contrast material then can be injected, if fluoroscopy or CT is to be performed to verify the intraarticular location of the needle. Secondary signs of infection (eg, synovial irregularities, sinus tracts) may be detected at fluoroscopy or CT. These features also may be depicted at MR imaging; however, sinus tracts that are not actively draining at the time of image acquisition might easily be overlooked on cross-sectional images. Arthrography is the most accurate and sensitive method for detecting sinus tract formation. The needle used for arthrocentesis is removed after arthrography, and hemostasis is achieved with direct compression.

If an insufficient amount of fluid is obtained although the position of the needle appears adequate, the needle may be rotated 180° to change the position of the bevel. If the amount of aspirate is still insignificant, the needle may be retracted slightly and repositioned. The needle should be repositioned in multiple different locations within the joint to confirm the presence of a so-called dry tap (ie, the absence of accumulated fluid in the joint space). If the amount of fluid in the joint is insufficient for sampling, the joint should be irrigated with nonbacteriostatic saline solution (17). The saline wash should then be aspirated, placed in a vial with a specific label (eg, "joint wash"), and sent to the laboratory for aerobic and anaerobic cultures. Subsequently, arthrography with a nonbacteriocidal contrast material should be performed to identify the reason for failure to obtain sufficient fluid aspirate at arthrocentesis. In particular, a sump effect produced by a sinus tract, bursal collection, or both must be excluded.

Teaching Point

Teaching Point

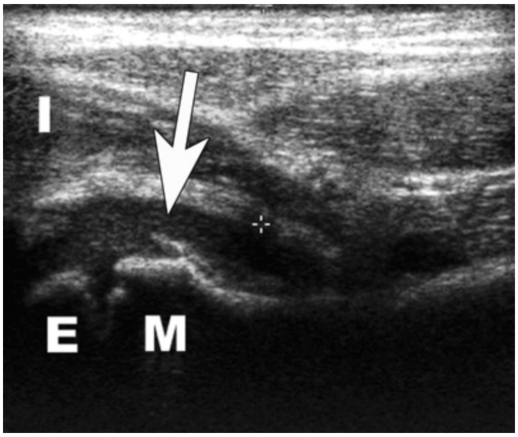


Figure 3. Septic arthritis of the hip in a pediatric patient. Longitudinal US image obtained in the right hip depicts a large effusion (arrow). *E* = epiphysis, *I* = iliopsoas muscle, *M* = metaphysis.

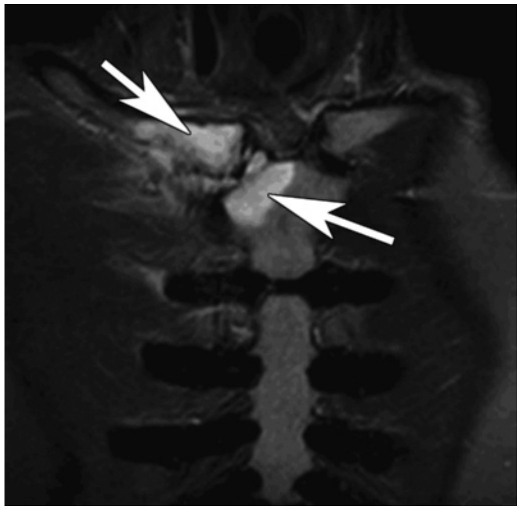


Figure 4. Septic arthritis of the right sternoclavicular joint. Coronal MR image obtained with a short inversion time inversion-recovery (STIR) sequence shows irregularity of the articular surfaces and high-signal-intensity areas representing edema on both sides of the joint (arrows). These findings are noticeable in comparison with the normal appearance of the left sternoclavicular joint.

Other Imaging Methods for Guiding Arthrocentesis

Most joints are easily accessed for arthrocentesis with fluoroscopic guidance. For arthrocentesis in cases in which fluoroscopy provides insufficient information (eg, in the sacroiliac and sternoclavicular joints), CT is the favored modality. The most important goal is to safely obtain a satisfactory sample of joint fluid to allow exclusion or diagnosis of infection. CT is recommended for guidance of arthrocentesis in the sternoclavicular joint to avoid injury to the underlying great vessels.

US also may be used to guide arthrocentesis. US guidance is particularly useful in children and pregnant patients, especially for aspiration of the hip (Fig 3). The use of color Doppler US also allows real-time visualization of vascular structures so they can be avoided during the procedure. US is highly sensitive for the detection of a joint effusion and can be used to guide needle aspiration. In a study by Zawin et al (18), US depicted a hip joint effusion in all patients with proved septic arthritis. However, neither the amount nor the echogenicity of the fluid could be used to distinguish an infected collection from a simple effusion. In addition, associated osteomyelitis was not reliably depicted.

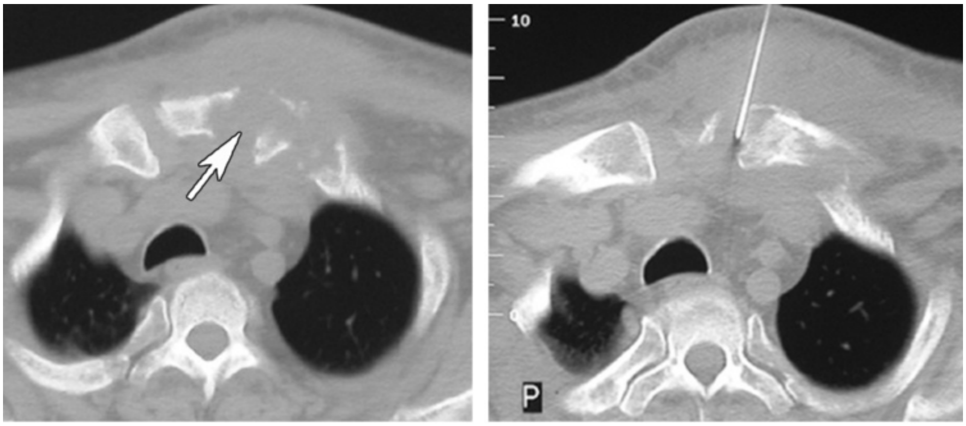
US has many advantages and disadvantages for guidance of joint aspiration. Among its advantages is the relative ease of identifying a fluid collection. In addition, if the appearance of one joint in a paired set seems abnormal, the contralateral joint can be evaluated for comparison. US is readily available; moreover, it does not involve the use of ionizing radiation, a characteristic that makes it particularly suitable for use in pediatric patients. The main disadvantage of US is that it is user dependent. Many on-call radiologists are more comfortable with the use of fluoroscopy or CT and may not have adequate experience in performing US-guided procedures involving the joints. US technologists may not be available during night hours. In addition, orthopedists are generally less comfortable with reviewing US images. US does not easily allow arthrography, and sinus tracts might not be identified. US may be inadequate in obese patients.

There are many possible approaches and techniques for performing arthrocentesis. The imaging modality of choice may vary, depending on the individual radiologist's experience and comfort level.

Evaluation of the Sternoclavicular Joint

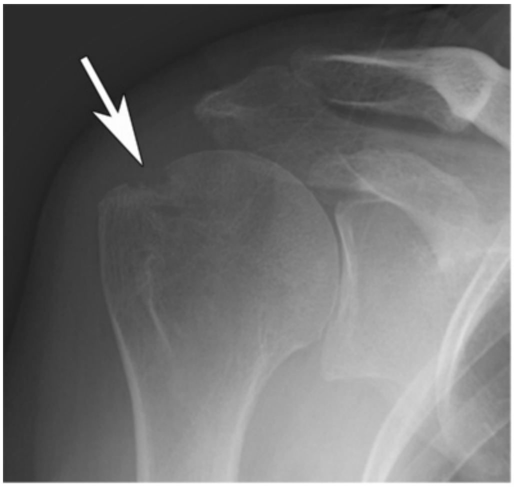
Imaging Findings

The sternoclavicular joint is difficult to evaluate with radiography, and a cross-sectional evaluation with MR imaging or CT frequently is required. MR and CT images of the sternoclavicular joint often demonstrate irregularity of the articular surfaces and edema on both sides of the joint (Fig 4). Effusions are well depicted and usually extend anteriorly from the joint. In addition, since both sternoclavicular joints are included in the field of view, the affected joint can be compared directly with the contralateral one.



a. b.

Figure 5. Arthrocentesis of the left sternoclavicular joint. **(a)** Axial CT image depicts the location of erosive changes in the joint (arrow). **(b)** Axial CT image shows correct positioning of a 20-gauge needle for aspiration in the joint.



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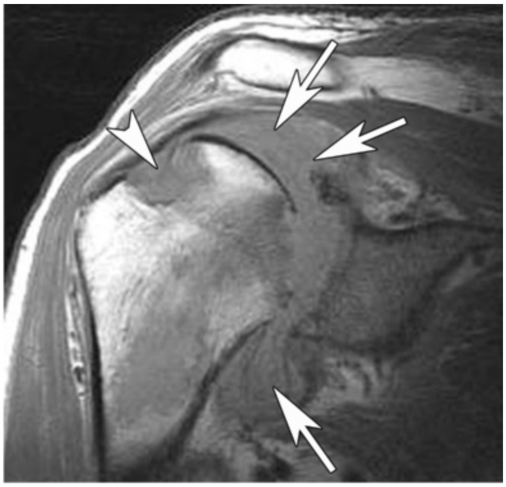


7.

Figures 6, 7. Septic arthritis of the right shoulder. **(6)** Grashey view obtained with conventional radiography demonstrates diffuse glenohumeral joint-space narrowing and a bare area erosion (arrow) near the greater tuberosity. **(7)** Coronal T1-weighted MR image shows a large effusion (arrows), diffuse joint-space narrowing with erosions, and a large bare area erosion (arrowhead).

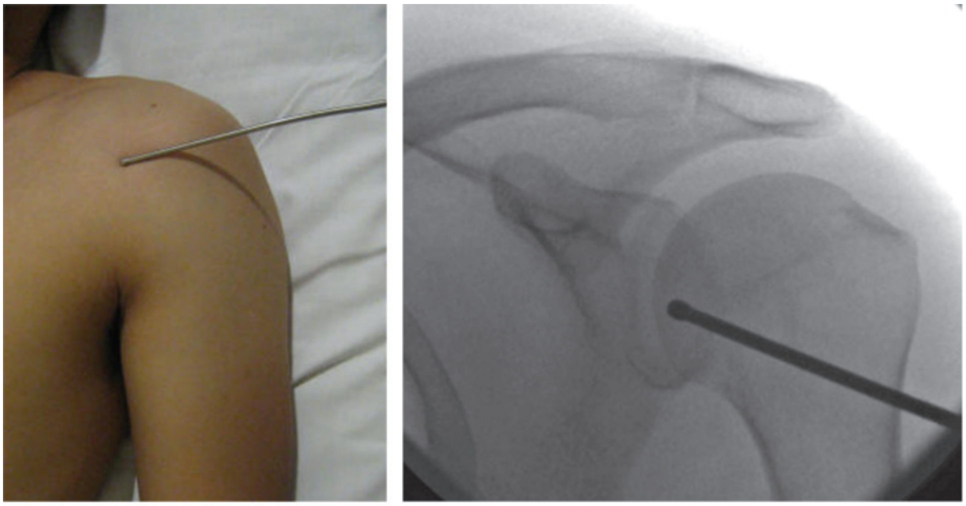
Arthrocentesis Approach

CT guidance is recommended for arthrocentesis in the sternoclavicular joint because it allows the radiologist to avoid deep vascular structures during needle insertion. The patient is placed supine on the CT table, and initial planning images are obtained with a thin-section technique. The appropriate access route is determined (anticipating a slight lateral-to-medial angulation to parallel the orientation of the sternoclavicular joint) and marked on the patient's skin. After preparation and anesthetization of the joint, a needle is advanced under CT guidance, and aspiration is performed (Fig 5). Special care should be taken to ensure that the needle does not extend into the mediastinum and injure adjacent vascular structures.

Evaluation of the Shoulder

Imaging Findings

Radiographic findings include diffuse glenohumeral joint-space narrowing, which represents cartilage loss, and erosions (Fig 6). Erosions start just medial to the greater tuberosity, where the cartilage is the thinnest. This is the bare area of the joint, where the cartilage ends and the rotator cuff tendons insert (19). The presence of a glenohumeral joint effusion cannot be determined on the basis of radiography, and cross-sectional imaging is necessary. MR imaging readily depicts joint effusions, sinus tracts, erosions, and changes in the signal intensity of bone marrow (Fig 7). It is useful also for determining the extent of disease.



a. b.

Figure 8. Fluoroscopically guided arthrocentesis and arthrography of the shoulder. **(a)** Photograph shows marking of the needle insertion site on the skin overlying the middle and lower portion of the glenohumeral joint, inferior to the subcoracoid bursa. **(b)** Fluoroscopic image obtained to verify correct placement of a 20-gauge spinal needle, which was inserted with an orthogonal anterior-to-posterior approach, shows the needle tip within the glenohumeral joint.

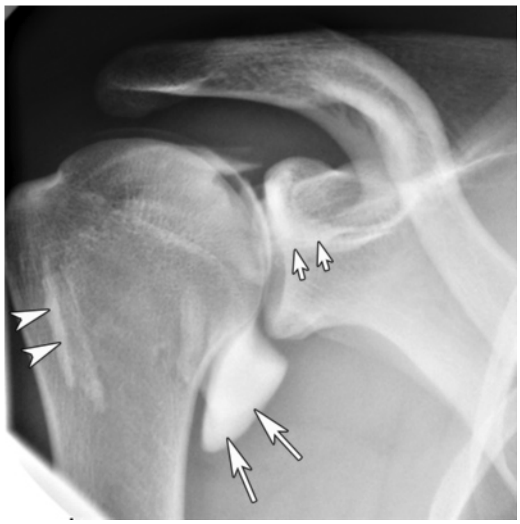


Figure 9. Arthrogram obtained with the shoulder positioned in external rotation shows a normal appearance, with the expected pattern of opacities in the axillary pouch (large arrows), subcoracoid recess (small arrows), and biceps tendon sheath (arrowheads).

Arthrocentesis Approach

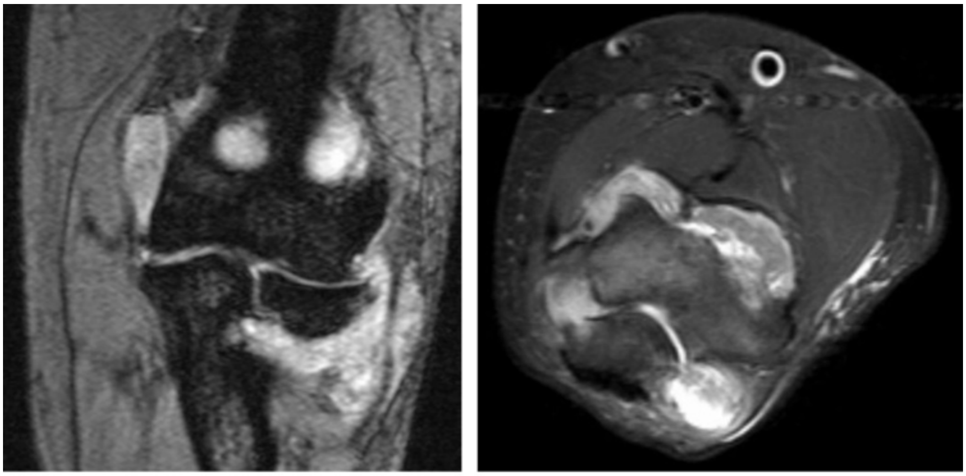
The patient is placed supine on the fluoroscopy table. A sandbag is placed on the patient's palm to maintain external rotation of the shoulder, which helps prevent needle placement through the long head of the biceps tendon. The joint is localized with fluoroscopy, and a mark is placed on the patient's skin overlying the middle to lower portion of the joint (Fig 8). After appropriate sterile preparation and anesthetization, a needle is advanced by using a direct orthogonal anterior-to-posterior approach to the humeral head. When the needle tip is on the humeral head, it is within the glenohumeral joint, and arthrocentesis and subsequent arthrography can be performed. If an insufficient amount of fluid is obtained, as previously mentioned, the needle should be rotated 180° to change the position of the bevel. If no fluid is obtained, the needle should be retracted slightly and then advanced in a more medial direction to the humeral head. Figure 9 shows a normal appearance of the shoulder at arthrography.

Evaluation of the Elbow

Imaging Findings

Radiographic findings include diffuse radiocapitellar and ulnotrochlear joint-space narrowing due

Figure 10. Septic arthritis of the elbow. Lateral radiograph demonstrates a large joint effusion (arrowheads) and erosion of the ulna (arrow).



a. b.

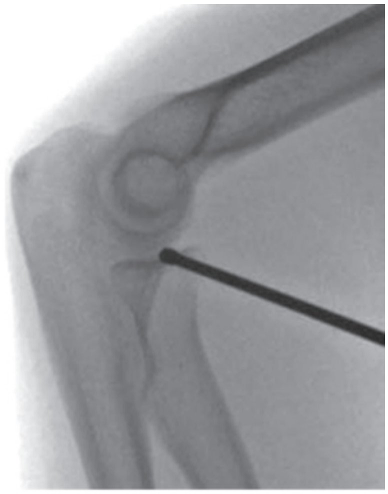
Figure 11. Septic arthritis of the elbow. Coronal **(a)** and axial **(b)** MR images show marked synovitis, joint effusion, and erosive change.

to cartilage loss with associated erosive changes. An effusion is easily identified because of the resultant displacement of anterior and posterior fat pads from the joint space on lateral views obtained with 90° flexion of the elbow (Fig 10). However, in the elbow as in other joints, MR imaging provides more sensitive depiction of joint effusions, sinus tracts, erosions, and marrow signal intensity changes (Fig 11).

Arthrocentesis Approach

Arthrocentesis and arthrography should be performed on the lateral side of the elbow to prevent ulnar nerve injury. The patient is placed prone on the fluoroscopy table with the arm raised above the head, in the so-called Superman position. Alternatively, the patient may be seated on a chair next to the fluoroscopy table and the arm placed on the table in a flexed position. The radiocapitellar joint is localized at fluoroscopy and marked. After appropriate sterile preparation and anesthetization, a 22-gauge needle is advanced by using a direct orthogonal approach to the radiocapitellar joint space (Figs 12, 13). Alternatively, a posterolateral approach may be used for arthrocentesis with the elbow flexed at approximately 70°. The notch between the olecranon, lateral epicondyle, and radial head can be palpated to locate the appropriate

a.



b.

Figure 12. Fluoroscopically guided arthrocentesis of the elbow. **(a)** Photograph shows appropriate placement of the patient with the arm extended above the head. **(b)** Fluoroscopic image shows localization of the radiocapitellar joint.

Figure 13. Arthrogram shows a normal distribution of contrast material within the anterior portion (straight arrow), posterior portion (curved arrow), and annular recess (arrowhead) of the elbow joint. The needle (straight white line) is seen projecting over the radiocapitellar joint space.

entry site for the needle. The needle is then inserted in the direction of the antecubital fossa. This approach has the benefit of avoiding the ligaments on the radial side of the elbow.

Evaluation of the Wrist

Imaging Findings

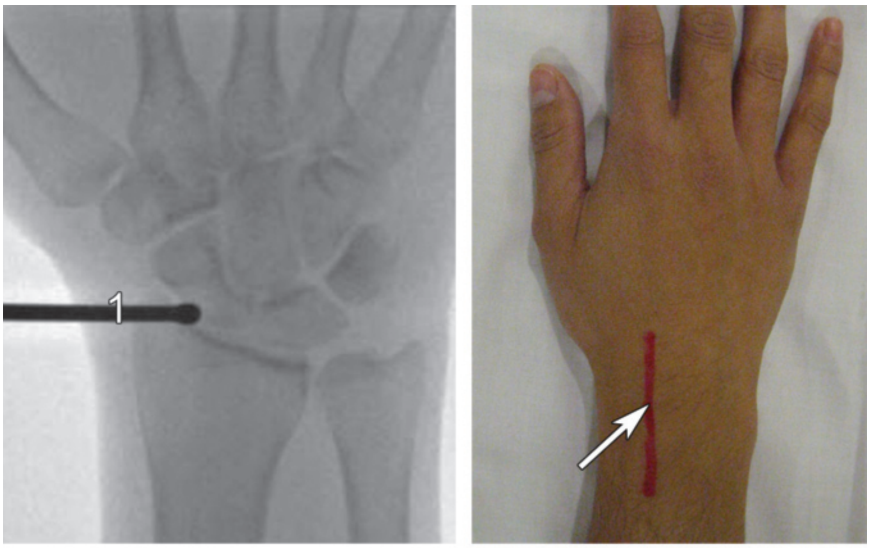
The presence of a wrist joint effusion cannot be determined with radiography. Depending on the compartment involved and the severity of involvement, radiographic findings may include diffuse pancarpal joint space narrowing that represents cartilage loss (Fig 14). Associated erosive changes initially involve the carpus but may extend to the nearby distal radio-ulnar joint or carpal-metacarpal articulations. An important secondary sign that may increase suspicion about the presence of underlying disease is soft-tissue swelling, which usually appears on the dorsal aspect of the wrist. MR imaging also may be useful for determining the extent and severity of disease if clinically indicated (Fig 15).

Arthrocentesis Approach

As for arthrocentesis of the elbow, the patient is placed prone on the fluoroscopy table, with the arm raised above the head in a Superman position. Alternatively, the patient may be seated on a chair next to the fluoroscopy table and the wrist placed on the table. The wrist is always positioned with the palm down.

Figure 14. Radiograph obtained in a patient with septic arthritis of the wrist shows diffuse pancarpal joint-space narrowing, a finding indicative of extensive cartilage loss.

Figure 15. Coronal STIR MR image obtained in a patient with septic arthritis of the wrist depicts erosions, patchy pancarpal bone marrow edema, and an effusion.



a. b.

Figure 16. Fluoroscopically guided arthrocentesis of the wrist. **(a)** Fluoroscopic image obtained with the hand placed palm downward on the table shows the radiocarpal joint *(1)*. **(b)** Photograph shows a line drawn on the patient's skin along the long axis of the radius (arrow) to mark the site for needle insertion.

Two approaches may be used to access the radiocarpal joint. In the first approach, the joint is localized at the approximate level of the scaphoid waist on frontal fluoroscopic projections (Fig 16a). A line is drawn on the patient's skin along the long axis of the radius (Fig 16b). The wrist is then rotated into a lateral position with the ulnar side down, and a metal rod is placed along the previously drawn line. Because the dorsal lip of the radius likely would prevent access to the radiocapitellar joint from this location, the metal rod is repositioned 1–2

17.

18.

Figures 17, 18. **(17)** Fluoroscopically guided arthrocentesis of the wrist. Lateral projection (spot image) shows two metal rods, one positioned at the level of the radioscaphoid joint *(1)* and the other positioned 1–2 cm distally *(2)*. Needle insertion at the latter site (arrow) is more likely to allow direct access to the joint than insertion at the first site (arrowhead), where the dorsal lip of the radius presents an obstacle. **(18)** Normal wrist arthrogram obtained with a contrast material injection of the radioscaphoid joint.

cm distally along the line (Fig 17), and an X is drawn on the patient's skin at the most distal point of the rod. The approach is planned with a 45° proximal angulation to avoid the dorsal lip of the radius.

In the second approach, the wrist is positioned with the palm side down on the table and with a slight ulnar deviation so that the pisiform bone is well depicted on fluoroscopic projections. A skin mark is placed over the pisiform bone, just proximal to the triquetrum. The needle is advanced from a dorsal orthogonal approach to the pisiform bone. A normal arthrographic appearance of the wrist is shown in Figure 18.

Evaluation of the Sacroiliac Joint

Imaging Findings

Radiographic findings include irregularity and widening of the affected sacroiliac joint, findings that are indicative of underlying cartilage loss and erosive changes (Fig 19). The process is typically unilateral, a characteristic that may help differentiate between septic arthritis and other causes of sacroiliitis. Initial changes typically are best appreciated in the synovial portion (lower two-thirds) of the joint (3). Erosive change occurs first on the iliac side and later on the sacral side of the joint because the protective cartilage is thicker on the sacral side. The sacroiliac joints are better visualized with CT and MR imaging than with radiography. Important findings at imaging include unilateral joint-space irregularity and erosive changes. Additional MR imaging findings include adjacent bone marrow edema and joint effusion (Fig 19). Excess joint fluid usually collects just anterior to the sacroiliac joint. Associated edema may be present in the iliac muscle and the adjacent fascial planes.

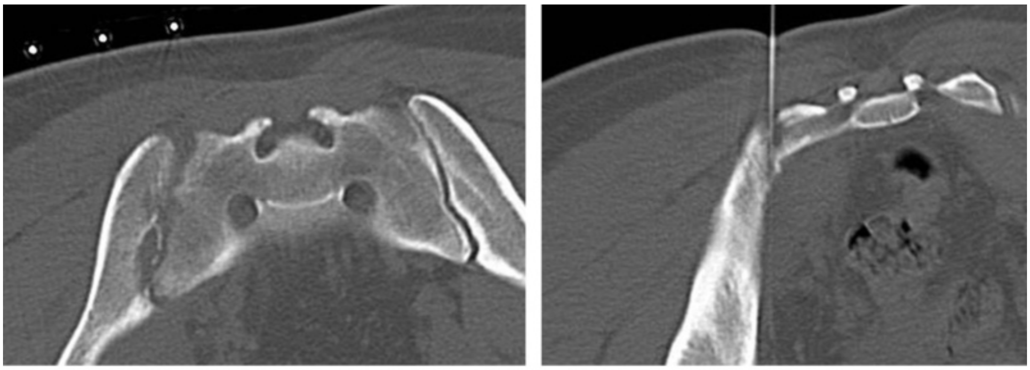
Teaching Point

Arthrocentesis Approach

Although the sacroiliac joint can be localized and aspirated with fluoroscopic guidance, arthrocentesis is more easily performed with CT guidance. In preparation for this procedure, the patient is placed in a prone position on the CT table. The

a. b.

Figure 19. Septic arthritis of the right sacroiliac joint. **(a)** Conventional radiograph shows subtle irregularity and widening of the joint (arrows). **(b)** Coronal STIR MR image demonstrates edema in adjacent bone marrow (arrows).



a. b.

Figure 20. CT-guided arthrocentesis of the right sacroiliac joint. Axial images obtained with the patient prone show three markers taped to the skin surface for localization of the safest needle access site **(a)** and insertion of a 20-gauge spinal needle directed toward the inferior portion of the joint **(b)**.

sacroiliac joint is localized, and the needle is inserted toward the inferior aspect of the joint (Fig 20). A slight medial-to-lateral angulation of the needle, paralleling the orientation of the sacroiliac joint, is usually required to obtain access.

Evaluation of the Hip

Imaging Findings

Anteroposterior pelvic views and frog-leg lateral views should be obtained to allow a careful comparison between normal and symptomatic hip joints. The main finding in septic arthritis of the hip is diffuse axial joint-space narrowing. Hip effusions in pediatric patients can be diagnosed on the basis of observation of a widening of the teardrop distance on the affected side in comparison with the contralateral joint. A widened teardrop distance does not typically occur in adult hips with a joint effusion. Subtle erosive changes may be evidenced by early loss of the

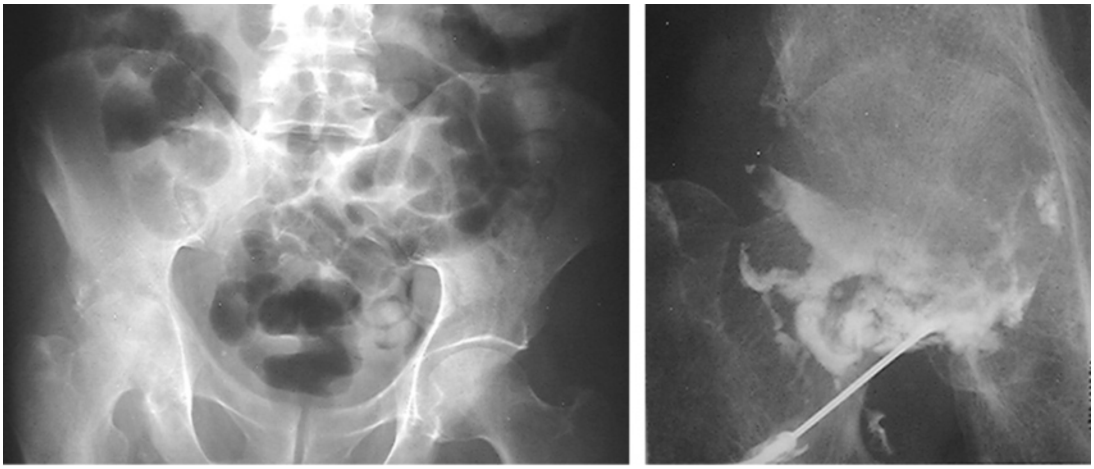


Figure 21. Septic arthritis of the right hip. **(a)** Anteroposterior pelvic radiograph shows diffuse joint-space narrowing and destruction of the right acetabular roof with associated erosive changes. **(b)** Late-phase spot image from right hip arthrography demonstrates synovial irregularity, thickening, and outpouching, signs of chronic synovial irritation secondary to infection. Pus was obtained at aspiration.

cortical line of the femoral head or adjacent acetabulum (Fig 21a). Arthrograms may show synovial irregularity and thickening, which are results of chronic synovial inflammation (Fig 21b). MR imaging is ideal for staging the extent of the disease and for evaluating adjacent abscesses (Fig 22).

Arthrocentesis Approach

The patient is placed supine on the fluoroscopy table. The femoral artery is palpated and marked. The needle entry point, which is localized with fluoroscopy, is usually at least 2 cm lateral to the femoral artery, at the level of the groin crease (Fig 23). To avoid injury to the bowel, the entry point should not be superior to the groin crease. In obese patients, the pannus is pushed superiorly and maintained in this position by the patient or taped securely. After sterile preparation and anesthetization, a needle is advanced to the medial femoral head-neck junction, which is the more dependent portion of the joint, by using a direct orthogonal anterior-to-posterior approach (Fig 24). If this pathway is too close to the femoral artery, the needle may be advanced to the lateral femoral head-neck junction. If the amount of fluid aspirated is insufficient for laboratory testing, the needle may be rotated or repositioned in other sites along the femoral head-neck junction and aspiration repeated.

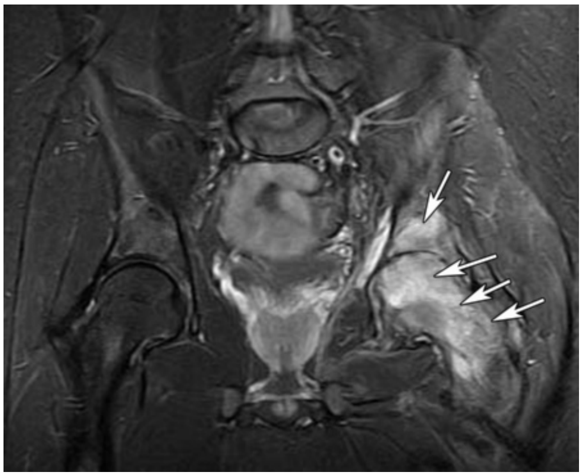
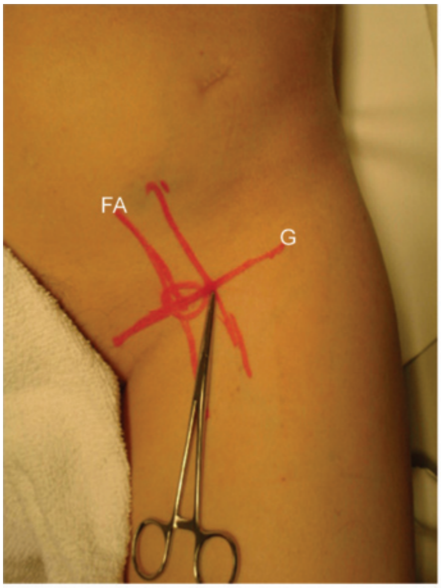


Figure 22. Septic arthritis of the left hip. Coronal STIR MR image at the level of the pelvis depicts diffuse joint-space narrowing and regions of marked high signal intensity due to bone marrow edema in the acetabulum and proximal femur (arrows).



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24.

Figures 23, 24. Fluoroscopically guided arthrocentesis of the hip. **(23)** Photograph shows a line drawn on the skin overlying the location of the femoral artery *(FA)*, which was determined with palpation, and another line drawn perpendicular to the first, along the groin crease *(G)*. The clamp indicates the needle entry site, which is approximately 2 cm lateral to the femoral artery, at the point where the artery intersects with the groin crease (the medial femoral head-neck junction). **(24)** Fluoroscopic image shows a normal distribution of contrast material within the hip joint. Note the elliptical filling defect at the midfemoral neck level, in the zona orbicularis. Needle placement in this location for arthrocentesis may result in insufficient aspirate.

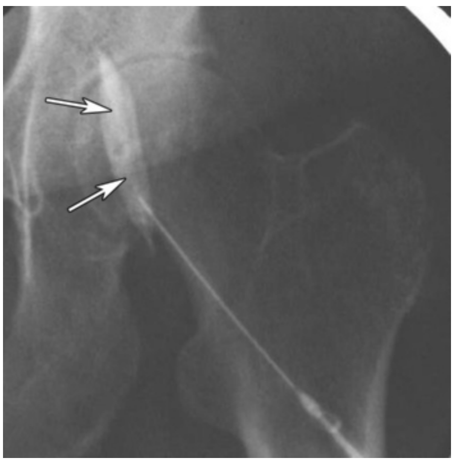


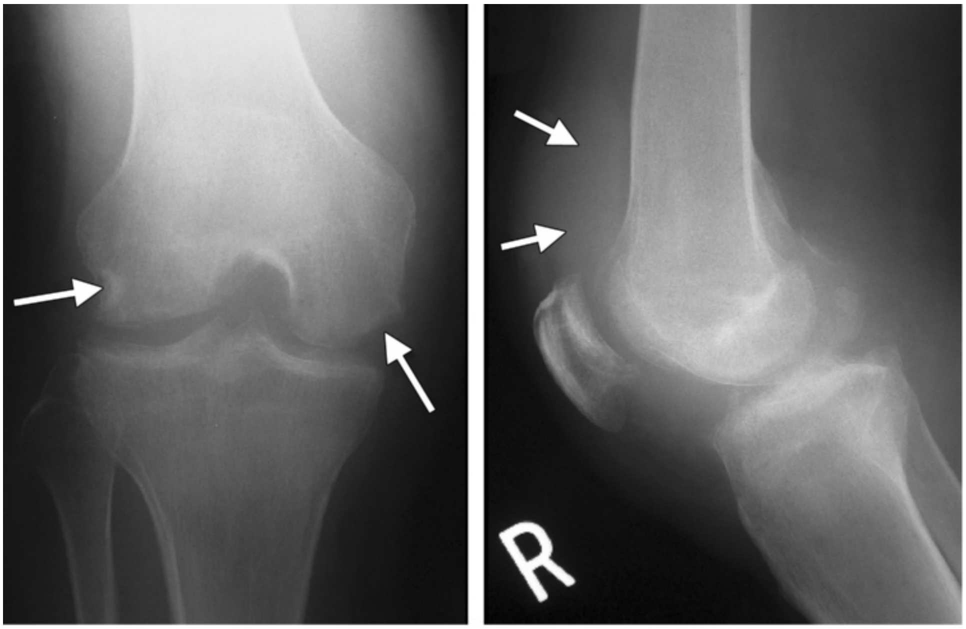
Figure 25. Fluoroscopic image of the left hip demonstrates extraarticular placement of the needle tip within the iliopsoas bursa (arrows), an inadequate location for hip arthrocentesis.

A potential pitfall of hip arthrography is unintended injection of the iliopsoas bursa or iliopsoas tendon (Fig 25). If such an accident occurs, the needle should be repositioned to a more optimal position along the femoral head-neck junction. The intraarticular location of the needle tip is confirmed by observing the typical distribution of injected contrast material within the hip joint.

Evaluation of the Knee

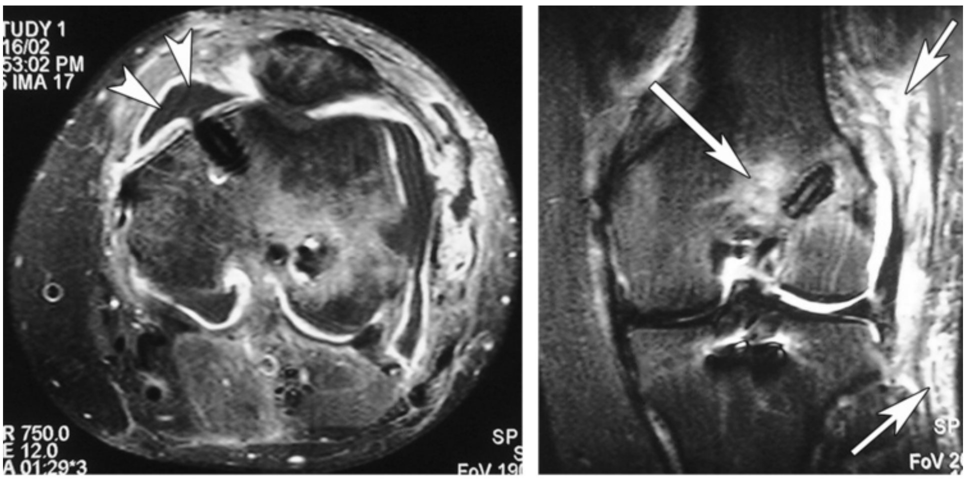
Imaging Findings

Radiographic findings include diffuse joint-space narrowing, which represents cartilage loss, with associated bare area erosive changes



a. b.

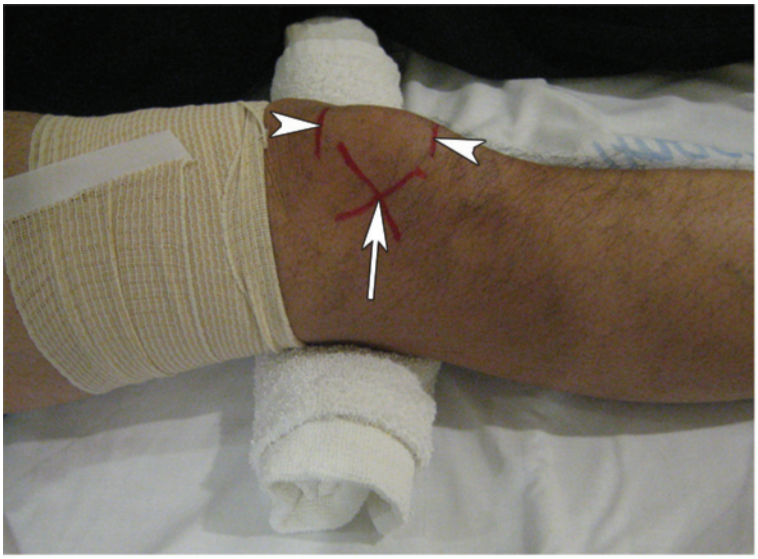
Figure 26. Septic arthritis of the knee. **(a)** Anteroposterior radiograph shows joint-space narrowing with associated erosive changes of the bare area (arrows). **(b)** Lateral radiograph depicts an effusion within the suprapatellar bursa (arrows).



a. b.

Figure 27. Septic arthritis of the knee after arthroscopic surgery for anterior cruciate ligament repair. **(a)** Axial contrast-enhanced T1-weighted fat-saturated MR image shows a joint effusion (arrowheads). **(b)** Coronal STIR MR image shows marrow edema (long arrow) and adjacent soft-tissue inflammatory changes (short arrows).

at the margins of the distal femur and proximal tibia (Fig 26). The presence of an associated joint effusion is demonstrated by distention of the suprapatellar bursa on lateral views. CT and MR imaging also may show joint effusion as well as additional findings such as a popliteal cyst or adjacent inflammatory changes (Fig 27).



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Figures 28, 29. Fluoroscopically guided arthrocentesis of the knee. **(28)** Photograph shows marking of the skin overlying the superior and inferior borders of the patella (arrowheads) and the needle access site at the midpatellar level of the lateral patellofemoral groove (arrow), which was localized with fluoroscopy. **(29)** Fluoroscopic spot image of the knee shows the needle positioned with a lateral patellofemoral approach and a normal arthrographic appearance of the knee.

Arthrocentesis Approach

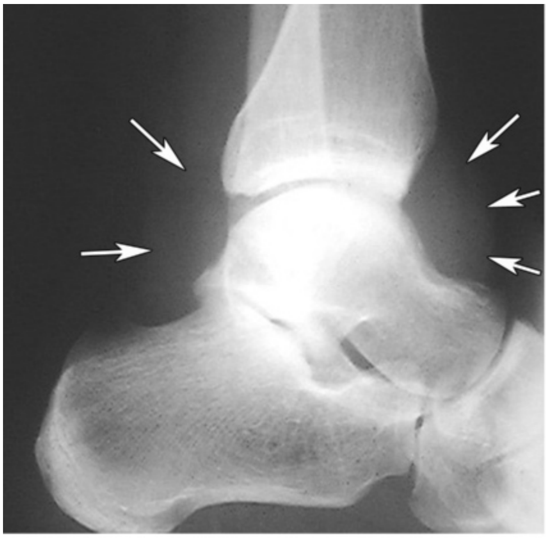
In most cases, fluoroscopic guidance is not necessary for arthrocentesis of the knee, and the procedure often is performed by clinicians at the patient's bedside. Radiologic imaging guidance may be needed for complicated cases in which the knee joint is markedly altered, in morbidly obese patients, or after unsuccessful attempted bedside aspiration.

For fluoroscopically guided arthrocentesis, the patient is placed supine on the fluoroscopy table. An elastic bandage is placed above the patella to displace fluid from the suprapatellar bursa into the knee joint, and a towel is placed to support the undersurface of the knee and maintain mild flexion. Either a lateral or medial approach may be used. The superior and inferior borders of the patella are marked first; next, the midportion of the patellofemoral articulation is palpated and the site for needle insertion is marked (Fig 28). After appropriate sterile preparation, a needle is advanced into the joint beneath the patella (Fig 29). If the patient has prominent patellar or femoral osteophytes that prevent access to the joint by using a lateral or medial patellofemoral approach, or if the patient is morbidly obese and these landmarks cannot be palpated, an anterior approach is used. The distal lateral femoral condyle is localized with fluoroscopy, and a needle is inserted and advanced with an anterior-to-posterior approach to the distal aspect of the lateral femoral condyle. Alternatively, US may be used to localize fluid effusions and guide needle placement.

Evaluation of the Ankle

Imaging Findings

Radiographic findings include diffuse tibiotalar joint-space narrowing due to cartilage loss. Distention of the anterior and posterior recesses, with increased opacity, is indicative of an associated joint effusion (Fig 30). Other radiographic findings may include associated bare area erosions of the distal tibia, talar neck, posterior talus, and superior



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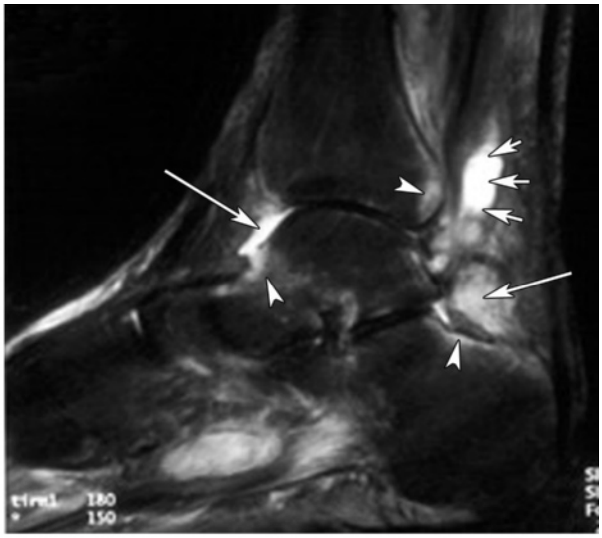


31.

Figures 30, 31. Early septic arthritis of the ankle. **(30)** Lateral radiograph shows a large tibiotalar joint effusion (arrows). **(31)** Sagittal STIR MR image demonstrates accumulated joint fluid (long arrows) and marrow edema at the sites of bare area erosions (arrowheads). The extension of infected joint fluid along the flexor hallucis longus tendon sheath (short arrows) is indicative of communication with the joint space.

Figures 32, 33. Septic arthritis of the ankle. **(32)** Sagittal STIR MR image obtained in a diabetic patient demonstrates proximal extension of a joint effusion along the flexor hallicus longus tendon (arrow). **(33)** Frontal arthrogram, obtained in another patient immediately after aspiration of the ankle joint yielded pus, shows contrast material drainage from the joint via a sinus tract to a medial skin ulcer (arrow). Contrast material extension along the flexor hallicus longus tendon sheath (arrowheads) is suggestive of the proximal spread of infection. The patient underwent amputation below the knee.

32.

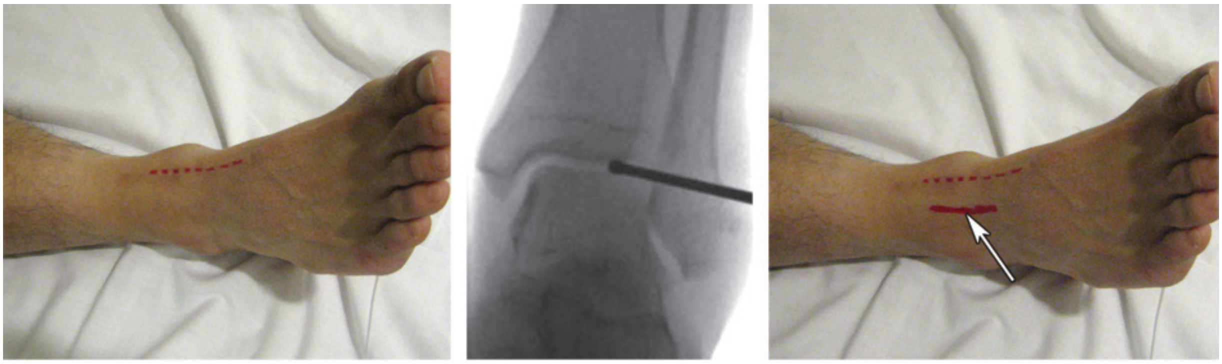
33.

calcaneus; however, these features may be better appreciated on MR images (Fig 31). When performing MR imaging for disease characterization, it is important to remember that the flexor hallucis longus tendon may have a normal communication with the tibiotalar joint and may serve as a conduit for the spread of infection (Figs 31–33).

Teaching Point

Arthrocentesis Approach

The patient is placed supine on the fluoroscopy table. The dorsalis pedis artery is palpated, and a dashed line is marked on the skin overlying the course of the artery (Fig 34a). Next, the tibiotalar joint is localized on anteroposterior fluoroscopic views (Fig 34b). A line is drawn perpendicularly through the joint, along the long axis of the tibia, at a safe distance from the dorsalis pedis artery (Fig 34c). The ankle is then turned to the lateral position, and a metal rod is placed on the solid line, at a location approximately 1–2 cm distal to the tibial plafond (Fig 35a). An X is drawn on the patient's skin in this location. The needle should be inserted with distal-to-proximal angulation of 45° to avoid the dorsal lip of the tibia and obtain unimpeded access to the tibiotalar joint (Fig 35b). Observation of a normal distribution of contrast material provides confirmation of appropriate needle placement in the joint (Fig 36).



a. b. c.

Figure 34. Fluoroscopically guided arthrocentesis of the ankle. **(a)** Photograph shows a dashed line marked on the skin overlying the course of the dorsalis pedis artery, which was localized with palpation. **(b)** Fluoroscopic image shows the tibiotalar joint in the anteroposterior dimension. **(c)** Photograph shows a solid line drawn perpendicularly through the tibiotalar joint, along the long axis of the tibia (arrow).

a. b.

Figure 35. Fluoroscopically guided arthrocentesis of the ankle. **(a)** Photograph shows a metal rod positioned along the solid line drawn along the long axis of the tibia, with the rod tip at the level of the tibiotalar joint, which was determined with fluoroscopy (anteroposterior projection). **(b)** Fluoroscopic image shows the rod tip *(1)* in a position corresponding to that in **a** (arrowhead) and a second rod tip *(2)* in a position approximately 1–2 cm distal (arrow) to the first. Needle insertion at *2* will allow direct joint access, which likely would be prevented by the dorsal lip of the tibia if the needle were inserted at *1*.

a. b.

Figure 36. Lateral **(a)** and frontal **(b)** fluoroscopic images demonstrate normal distribution of contrast material within the tibiotalar joint, a finding indicative of appropriate needle positioning for arthrocentesis.

Conclusions

Septic arthritis is diagnosed on the basis of the combined clinical, imaging, and laboratory findings. Rapid diagnosis is critical, as any delay may result in irreparable damage to the affected joint. Unfortunately, the signs and symptoms at presentation may be atypical and confusing, and referring clinicians may have little experience in diagnosing this disease entity. Therefore, radiologists must be familiar with the typical appearances at radiography and cross-sectional evaluations with MR imaging and CT. MR imaging and CT are increasingly used also to characterize the extent and severity of disease. Radiologists should be able to safely and effectively perform imaging-guided arthrocentesis and arthrography so as to obtain fluid samples from confirmed intraarticular locations and in sufficient amounts to allow diagnostic laboratory studies.

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Emergency Joint Aspiration: A Guide for Radiologists on Call

Hank M. Lin, MD, et al

RadioGraphics 2009; 29:1139–1158 • **Published online** 10.1148/rg.294085032 • **Content Codes:** ER MK VI

Page 1141
Radiologists must be cognizant of the MR imaging features of septic arthritis, which include joint effusion; surrounding soft-tissue edema; diffuse joint-space narrowing, perhaps better appreciated on radiographs than on MR images; and adjacent bone marrow edema surrounding the affected joint, starting in the bare areas.

Page 1143
The needle should be repositioned in multiple different locations within the joint to confirm the presence of a so-called dry tap (ie, the absence of accumulated fluid in the joint space).

Page 1143
Subsequently, arthrography with a nonbacteriocidal contrast material should be performed to identify the reason for failure to obtain sufficient fluid aspirate at arthrocentesis. In particular, a sump effect produced by a sinus tract, bursal collection, or both must be excluded.

Page 1150
The sacroiliac joints are better visualized with CT and MR imaging than with radiography. Important findings at imaging include unilateral joint space irregularity and erosive changes. Additional MR imaging findings include adjacent bone marrow edema and joint effusion.

Page 1156
When performing MR imaging for disease characterization, it is important to remember that the flexor hallucis longus tendon may have a normal communication with the tibiotalar joint and may serve as a conduit for the spread of infection.