Therapeutic and Diagnostic Joint Injections

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KEYWORDS

• Joints • Arthrography • Injection • Shoulder • Wrist
• Knee • Hip

Over the past several decades, various diagnostic and therapeutic indications for joint injections have been developed. Conventional arthrography often provides useful diagnostic information and may be coupled with CT or MR imaging to enhance the performance of these modalities. Relief after injection of local anesthetic strengthens diagnostic confidence that symptoms arise secondary to internal derangement. Intra-articular steroids have been shown to provide weeks of therapeutic relief in various circumstances. Imaging-guided needle placement may also be required for aspiration to rule out infection or crystal arthropathy. Ultrasound and fluoroscopy are commonly used in imaging-guided joint injection. This article focuses on the rationale for injections at different sites and describes different fluoroscopic approaches for common joints.

Temporary relief from intra-articular injection of local anesthetic confirms internal derangement as the source of pain. In many cases, symptomatic improvement after diagnostic block is associated with improved outcome after surgical intervention.[1,2] The presence of an anatomic lesion may be incidental to the clinical presentation. For example, labral tears of the hip are often found in asymptomatic patients. At the author's institution, bupivicaine, a medium-acting local anesthetic, is added as a diagnostic block to MR arthrograms. Relief of pain with activity in the hours following the examination increases clinical confidence that a visualized articular abnormality is the source of symptoms. Intra-articular lidocaine is less useful in this respect because its effects are attenuated by the time the MR imaging examination is completed. The medium-acting local anesthetic also ameliorates the delayed discomfort that patients report due to capsular distention, especially after shoulder and hip arthrograms. Recent literature suggest deleterious effects of the bupivicaine on cartilage.[3,4] Though this has not been found to occur in diagnostic or therapeutic injections, this evolving literature should be known.

Injected steroid is commonly used as a therapeutic strategy for treatment of articular disorders. These steroids are powerful anti-inflammatories that provide short- and medium-term relief and are used by most orthopedic surgeons and rheumatologists.[5–7] The most common local complication is a sterile synovitis causing discomfort within the first days of injection. It is hypothesized that this synovitis occurs secondary to the particulate nature of the injectate.[8] The effect of steroids on articular cartilage is debated. Several investigators have reported deleterious effects, including thinning and chondromalacia of the articular cartilage.[9,10] Other investigators presume that cartilage changes are subclinical because no changes in radiographic appearance or joint replacement rates were found after the use of steroids, compared with controls.[11,12] Local complications include tendon tears and soft tissue atrophy in the setting of extra-articular extravasation, including skin atrophy and depigmentation,[13] important possible complications in superficial injections of the hands and feet. Cases of avascular necrosis and Charcot arthropathies after intra-articular steroid administration have been

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reported.[14,15] Systemic complications may occur but are rare.

Conventional arthrography often offers diagnostic information but is more commonly combined with advanced modalities such as MR imaging or CT. Direct injection of gadolinium into joints improves diagnostic performance in several ways. Distension of the capsule assists in the delineation of small, complex, intra-articular structures. Extension of gadolinium into small defects in cartilage, tendons, and ligaments increases the conspicuity of these lesions. MR arthrography allows the use of primarily T1-weighted sequences, which boast a high signal-to-noise ratio. Finally, extravasation of gadolinium into the adjacent soft tissues, or abnormal communications between adjacent joints, provides critical diagnostic information.

GENERAL TECHNIQUE

Relevant imaging should be reviewed before the procedure to confirm the clinical diagnosis, recognize coexistent pathology, and assist planning. Informed consent includes a brief description of the procedure and discussion of the benefits and risks. The risks of arthrography can be divided into local or systemic complications. Local complications include infection, bleeding, and damage to intra-articular structures. Sterile synovitis was more common in the past when ionic contrast agents were used. Systemic complications include allergic and vasovagal reactions. Overall, the risks of arthrography are low. In a survey of 57 radiologists who had performed 126,000 arthrographic studies, no deaths, 3 cases of infection, and 56 cases of hives were reported.[16] In another series, of 25,000 arthrograms, one infection and 20 mild allergic reactions occurred.[17]

Imaging guidance is used to localize the injection site with the patient in an appropriate position. Proper positioning permits patient comfort and optimal anatomic access for performing the procedure. After the patient is prepped and draped, local anesthetic is infiltrated at the needle entry site. For larger joints such as the shoulder, hip, and knee, a 22-gauge spinal needle is most commonly used. If infection is suspected, an 18-gauge needle is better suited to the aspiration of tenacious secretions. Most peripheral joints are easily accessed with a 25-gauge 3.5-cm needle. Once in the appropriate position, an attempt at aspiration is performed, to rule out infection. Gross infection presents a risk for septicaemia if subsequent arthrography pressurizes the joint capsule.[18] An effusion should be aspirated as much as possible when found. The presence of an effusion decreases the concentration of gadolinium or steroid and may decrease the diagnostic performance or therapeutic outcome. The optimal gadolinium concentration for T1 contrast on a 1.5T scanner has been reported to be 2 mmol/liter.[19]

Measurement of pain relief is an important part of a diagnostic block with intra-articular local anesthetic. The level of pain preceding the procedure is compared with the level immediately following the procedure. One method of rating discomfort is on a simple verbal scale of 0 to 10, with 10 being the worst pain ever experienced. Visual analog scores are effective and commonly used in the research setting.[20] If the pain only occurs during certain movements or exercises, the patient is encouraged to attempt these provocative maneuvers in the hours following the injection. Because steroids generally have more delayed effects, the patient is encouraged to keep a pain diary for the referring clinician, to improve the therapeutic response measurement over the following weeks.

SHOULDER

Rationale

Administration of intra-articular gadolinium for direct MR arthrography is the most common indication for glenohumeral joint injection in the radiology department. Direct MR arthrography boasts several advantages over routine MR imaging evaluation of the shoulder. Improved accuracy in diagnosing full-thickness and partial-thickness articular surface tears has been reported.[20–23] Extension of contrast into the subacromial bursa is nearly diagnostic of a full-thickness tear of the rotator cuff. The evaluation of labral pathology is a key advantage of MR arthrography, compared with conventional MR imaging.[24,25] Coexistent, unsuspected labral pathology is often present in young patients, leading some investigators to recommend arthrography in patients younger than 40 years of age.[26] In the postoperative patient, diagnostic difficulty in distinguishing a tear from postsurgical granulation tissue is a common problem in routine MR imaging. Gadolinium extending into the lesion distinguishes a tear from postsurgical changes.[27,28] The rotator interval and biceps pulley are also best assessed with MR arthrography.[29]

Adhesive capsulitis is effectively diagnosed on arthrography. It is generally difficult to inject more than 5 mL of contrast material, and joint recesses are usually absent in patients who have this condition. Symptomatic improvement of adhesive capsulitis has been reported with intra-articular steroids and distention arthrography. In a randomized control trial, steroids and physiotherapy resulted in the greatest clinical improvement, compared with placebo.[30] However, steroids alone also resulted in a statistically significant improvement, compared with physiotherapy alone. Weeks of symptomatic and functional improvement after distention arthrography compared with placebo has been reported in other randomized controlled trials.[31] A posterior approach is preferred to the anterior approach, which can be challenging because of fibrosis in the axillary pouch. After intra-articular placement of the needle is confirmed with contrast, a mixture of steroids and bupivicaine is injected. Twenty to 50 mL of sterile normal saline is infused after the medication until the pain threshold is reached or capsular rupture occurs. The patient should be aware that this procedure may be painful and that discomfort is common the following day.

The significance of acromioclavicular (AC) arthropathy has been debated. AC degenerative changes are frequently asymptomatic and are nearly universal in patients older than 50 years of age.[32–34] Despite this, many patients will have significant improvement of symptoms after a diagnostic block of this joint. Medium-term pain relief and improved function have been reported with the administration of intra-articular local anesthetic and steroid.[35,36] Imaging findings have been associated with the painful AC joint. Strobel and colleagues[36] described improved result of diagnostic block in patients who had capsular hypertrophy measuring more than 3 mm. Other investigators suggest that the presence of clavicular edema is an insensitive but specific sign for symptomatic degenerative changes.[37] Although these associations reach a statistical significance, no single imaging finding or group of imaging findings can accurately distinguish the symptomatic AC joint from the large prevalence of asymptomatic degenerative AC joint changes. For this reason, a diagnostic injection of lidocaine is usually performed to confirm that symptoms arise from the AC joint, before surgical treatment. Fluoroscopic-guided injection reduces the chance of inadvertent injection of the subacromial-subdeltoid bursa.

The accuracy of anterior blind injection of the shoulder is poor. Anterior glenohumeral injections have demonstrated an accuracy of 27% to 42%.[38,39] Accurate needle placement was associated with improved clinical outcome after injection with steroids. Improved accuracy has been described using a modified posterior approach without imaging guidance. In one study by Catalano and colleagues,[40] 125 of 147 (85%) patients were successfully injected on the first attempt. The posterior approach is also a common method for sonographic injection of the glenohumeral joint.[41,42] In one study, only 16 of 24 blind AC joint injections were purely intra-articular.[35]

Technique

Numerous techniques have been described in the fluoroscopic injection of the shoulder. Those used most often are the anterior, posterior, and rotator interval approaches. The anterior (Schneider) technique is the most commonly used and involves an anterior approach with the patient supine and with the arm partially externally rotated.[43] External rotation makes more articular surface available for the anterior approach. However, extreme external rotation should be avoided because it increases tension on the anterior capsule and increases the risk for extra-articular extravasation of injected contents. In the anteroposterior (AP) supine view, the anterior glenoid rim lies medial to the humeral head. A wedge may be used to achieve close to a Grashey view of the glenohumeral articulation. In either patient position, it is critical that the needle be placed at least a few millimeters lateral to the medial cortex of the humerus, to avoid inadvertent contact with the labrum (**Fig. 1**). The anterior method does have some disadvantages. It traverses the expected needle path of the glenohumeral ligaments and subscapular tendon, and the anterior labrum, and may penetrate these

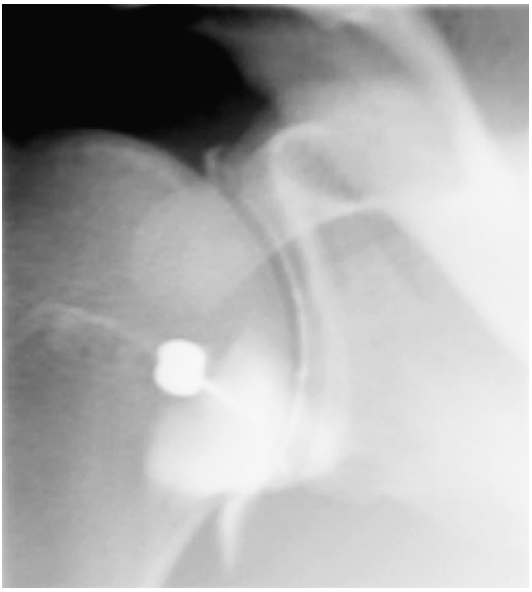

Fig. 1. Anterior approach to shoulder arthrogram. Patient is in supine position. Ideal needle position is a few millimeters lateral to the humeral cortex to avoid inadvertent contact with the glenoid labrum.

structures.[44] More often, inadvertent extravasation during injection makes diagnostic evaluation of these critical anterior structures more challenging.

A modified anterior approach is the rotator interval approach, performed with the patient supine.[45] A short (3.5-cm) needle is advanced to the medial upper quadrant of the humeral head (**Fig. 2**). It is important to avoid internal rotation of the arm, to avoid inadvertent puncture of the long head of the biceps. This technique is easily learned and avoids the glenohumeral ligaments and the labrum. However, it can also lead to diagnostic difficulties, especially with increasing interest in the imaging of the coracohumeral ligament and the rotator interval.

The posterior approach is performed with the patient prone, with the arm in external rotation. The palm should be facing down, and a bolster is placed under the symptomatic shoulder to obtain a Grashey view.[46] The needle is advanced to the medial aspect of the humeral head, approximately 5 mm lateral and 10 mm superior to the inferomedial cortex (**Fig. 3**). External rotation of the arm results in laxity of the posterior capsule, which enhances the ease of intra-articular placement. Most important, continuous downward pressure while the needle tip abuts the bone is gradually released during the test injection, which allows the injectate to find the potential space between the humerus and the posterior joint capsule. If injection is made without downward pressure on the needle initially, injection into the posterior rotator cuff is a frequent result. Although slightly more technically challenging, the posterior approach is preferred at the author's institution. The posterior shoulder anatomy is less variable and less commonly affected by pathology, and it has fewer stabilizing structures than the anterior aspect of the shoulder. A rotator interval or conventional anterior approach is performed if posterior labral pathology is clinically suspected.

Fig. 2. Rotator interval approach to shoulder arthrogram. Patient is in supine position with arm externally rotated to move the biceps tendon out of the needle path. Needle target is the superomedial aspect of the humeral head.

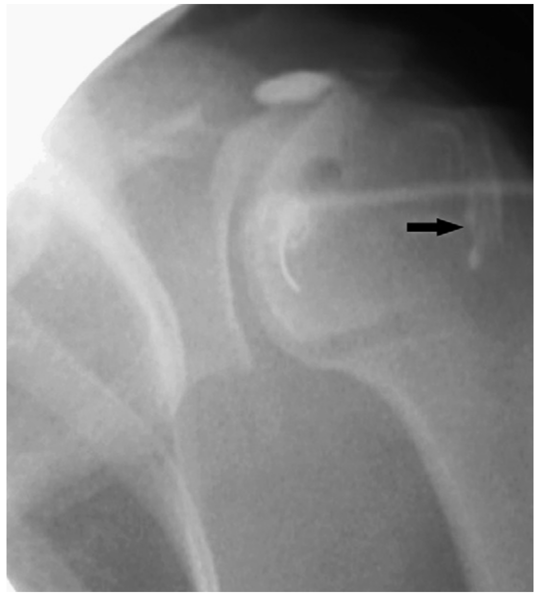

Fig. 3. Posterior approach to shoulder arthrogram. Patient is in prone position with arm in external rotation and bolster used to achieve Grashey view of glenohumeral joint. Needle target is the medial aspect of the humeral head, one centimeter above the inferior aspect of the joint. Intra-articular contrast commonly extends into the biceps sheath (*arrow*).

The AC joint is injected under fluoroscopic guidance, with the patient in a supine position. A 25-gauge needle is placed from either an anterior or superior approach. A small amount of contrast can be injected to confirm position before injection of local anesthetic.

ELBOW

Rationale

Although MR imaging examination of the elbow is most often performed without contrast, MR arthrography may provide additional information in some circumstances. Arthrography is most often used to distend the joint and aid in the diagnosis of osteochondral bodies. Ossific bodies near the joint may represent intra-articular bodies or periarticular ossification. MR or CT arthrography is also helpful in distinguishing them. Routine MR imaging demonstrates excellent accuracy for full-thickness, ligamentous tears but limited sensitivity for detecting partial tears. Partial tears of the anterior band of the ulnar collateral ligament at its insertion on the sublime tubercle of the coronoid process may be difficult to detect on routine MR imaging.[47] MR arthrography demonstrates high sensitivity and specificity in detecting partial tears and small avulsion fractures at this attachment.[48]

Technique

In elbow arthrography, the lateral approach is used most often. The patient is placed in a prone position, with the elbow placed above the head in 90° flexion. A lateral view of the elbow is obtained and the needle is placed within the radiocapitellar joint (**Fig. 4**). The primary disadvantage of this technique is the diagnostic dilemma that can occur with gadolinium extravasation around the radial collateral ligaments. A posteromedial approach avoids this drawback. The patient is positioned supine, with the elbow above the head, pronated and flexed to 30°. The medial epicondyle is palpated and the needle is placed between the medial epicondyle and the olecranon. The needle entry site is approximately 1 cm lateral to the medial epicondyle to reduce the chance of inadvertent contact with the ulnar nerve. The needle pathway has an anterolateral orientation, with the target being the olecranon fossa (**Fig. 5**).

WRIST

Rationale

Wrist arthrography is performed most often to assess the triangular fibrocartilage complex (TFC) or the intrinsic ligaments. Knowledge of the anatomy of these structures is critical to accurate interpretation of wrist arthrography. The intrinsic interosseous ligaments, the scapholunate (SL) and lunotriquetral (LT) ligaments, consist of strong volar and dorsal components composed primarily of type I collagen. A central component is composed of fibrocartilage. The TFC includes volar and dorsal components composed of type 1 collagen. An additional central portion is avascular and composed of weaker, obliquely oriented sheets of collagen fibers. The radial aspect of the TFC attaches directly to the cartilage of the ulnar aspect of the radius. The peripheral attachments include the proximal foveal attachment and a distal attachment near the meniscal homolog and adjacent lunate and triquetrum.

The key challenge in detecting clinically significant intrinsic ligament and TFC lesions is the high prevalence of degenerative attritional tears of these structures, which are often symptomatic. These attritional tears of the intrinsic ligaments and TFC are

Fig. 4. Lateral approach to elbow arthrography. The patient is prone with the arm above head and elbow flexed at 90°. The lateral side of elbow faces upward. Needle enters the radiocapitellar joint and contrast (*arrows*) is placed to confirm intra-articular position.

Fig. 5. Posteromedial approach to elbow arthrography. The patient is supine with arm above head and elbow flexed at 90°. Skin entry site is one centimeter lateral to the medial epicondyle to avoid contact with the ulnar nerve.

seldom present in teenagers but are found with a near 50% prevalence in older patients.[49] Differentiation of traumatic from attritional tears is best achieved with a careful history. A young patient who has recent trauma and a deficiency of an intrinsic ligament or TFC tear is more likely to suffer a symptomatic lesion. Imaging appearances may also help differentiate a traumatic from an attritional tear. Central perforations of the TFC tend to occur in asymptomatic patients, whereas radial or ulnar avulsions are usually traumatic.[50] Adjacent degenerative changes in the triscaphe or radioscaphoid joints suggest an attritional SL tear. Similarly, a chronic LT tear is often found in the setting of ulnar impaction and is associated with perforations of the TFC and lunate chondromalacia. Attritional tears most often involve the entire intrinsic ligament or only the central component. Isolated dorsal tears or joint space widening are more common with traumatic, symptomatic lesions.[51]

Wrist arthrography demonstrates moderate-to-strong sensitivity and excellent specificity in detecting TFC tears and tears of the intrinsic ligaments, when compared with arthroscopy as a gold standard.[52,53] Full-thickness tears of the SL ligament can be missed on triple-compartment arthrography, possibly because of a redundant torn ligament preventing the flow of contrast.[54] These types of false-negative arthrograms are uncommon when evaluating the LT ligament or TFC. The ability to distinguish attritional tears from symptomatic traumatic lesions relies on the visualization of the dorsal, central, and volar components of the intrinsic ligaments. Special conventional arthrographic maneuvers may evaluate these volar and dorsal components. This topic is beyond the scope of this article but an excellent discussion can be found in the review article by Linkous and Gilula.[55] MR imaging or CT following conventional arthrography may further delineate the components of the intrinsic ligaments and the TFC. In a study comparing conventional CT arthrography with arthroscopy, both correlated with high sensitivity and specificity for tears seen on arthroscopy.[56] However, CT arthrography was better able to ascertain the precise location of the tear, a quality that helps distinguish acute tears from attritional lesions. The superior sensitivity and improved interobserver reliability of CT arthrography, compared with conventional MR imaging, in the detection of dorsal tears of the SL ligament have been demonstrated.[56] A direct comparison of CT arthrography and MR arthrography has not been performed because it would likely require two different injections at different times to avoid diffusion of contrast into adjacent structures in the interval between studies.

Technique

Wrist arthrography is a complex procedure that should be tailored to answer the clinical question. The three main types of arthrography are midcarpal injections, radiocarpal injections, and distal radioulnar joint (DRUJ) injections. These are ideally performed with a C-arm, which can be rotated to profile the SL and LT joints in turn. A midcarpal injection is used at the author's institution to assess the integrity of the intrinsic ligaments. A midcarpal injection provides improved intrinsic ligaments compared with radiocarpal arthrography.[57] Contrast in the dorsal recess of the radioscaphoid joint may obscure visualization of these structures. TFC tears are diagnosed on radiocarpal injection. If this is unremarkable, an additional DRUJ arthrogram may detect partial tears and tears of the foveal attachment.[58]

The midcarpal injection is performed with a 1-inch 25-gauge needle with placement at the triquetrolunohamate space from a dorsal approach (**Fig. 6**). Normal midcarpal injection may extend to involve the carpometacarpal joints of the second through fifth digits. Extension between the SL and LT articulations is also noted. Communication with the radiocarpal joint is limited by the SL and LT ligaments along the proximal aspects of these joints. Extension into the radiocarpal joint suggests deficiency in one or both of these ligaments. After removal of the needle, the wrist is examined in radial and ulnar deviation with first, the SL, and then, the LT joint in profile. CT or MR imaging is performed after arthrography to characterize more fully the ligamentous defects and to

Fig. 6. Midcarpal injection. Patient is in prone position with arm above head, elbow flexed, and wrist pronated. Needle target is the joint space between the hamate, capitate, lunate, and triquetrum.

determine whether they involve the dorsal, volar, or central portions of the ligament.

The radiocarpal injection is performed most easily at the level of the radioscaphoid joint from a dorsal approach (**Fig. 7**). The dorsal lip of the radius overlaps the joint slightly, and a needle entry site a few millimeters distal to the joint is recommended to avoid this prominence. Care is also taken to avoid the region of the SL ligament. Communication with the DRUJ or midcarpal joint signals TFC and intrinsic ligament pathology, respectively. Injection of contrast is usually performed with cine fluoroscopy, which confirms the location of communication. In approximately 75% of cases, the radiocarpal joint communicates with the pisiform-triquetral joint.[59,60] In patients who do not have this communication, a diagnostic block may be required before surgery for treatment of pisiform-triquetral arthritis. In this setting, direct arthrography of this joint can be performed from an ulnar approach, with the hand pronated and in mild flexion.[60]

The key to successful DRUJ arthrography is needle placement. The needle should be placed adjacent to the ulnar, rather than at the center of the joint, a few millimeters proximal to the distal ulnar surface. Approximately 1 mL of contrast is injected (**Fig. 8**). The dorsal sensory branch of the ulnar nerve may be irritated by this approach[61] and the patient should be alerted to this possibility before the procedure.

HIP

Rationale

The hip is the most commonly injected joint under fluoroscopy at the author's institution. The spine, sacroiliac joints, and supporting soft tissues are common sources for hip pain and can present diagnostic uncertainty. A positive preoperative diagnostic block with local anesthetic is a reliable indicator of internal derangement and a good predictor of improvement after surgical intervention.[1,62,63] Intra-articular steroids may also provide weeks to months of relief in nonsurgical candidates or act as a temporizing measure before surgery.[5]

MR arthrography is commonly advocated for the evaluation of the hip. The key advantage of intra-articular gadolinium is the improved characterization of labral pathology. Czerny[64] reported a diagnostic accuracy of 91% using this modality, compared with conventional MR imaging, in the identification of labral tears. Improved visualization of chondral defects and loose bodies is also noted.[65] A diagnostic block with local anesthetic added to the MR arthrogram may suggest the presence of an intra-articular abnormality that is occult on imaging.[62]

Hip injection is also important in the postoperative hip. Aspiration identifies an infected prosthesis before revision, with sensitivity rates ranging from 83% to 98%.[66,67] Some investigators recommend aspiration before most hip revisions because unsuspected infection is not infrequently found.[66] Other investigators have found a 2% prevalence of unsuspected infection and a 13% incidence of false-positives on specimen cultures.[68] These investigators recommend aspiration only in selected patients. Bupivicaine injection into the pseudocapsule of the joint prosthesis also predicts a good outcome if the patient goes on to revision.[69]

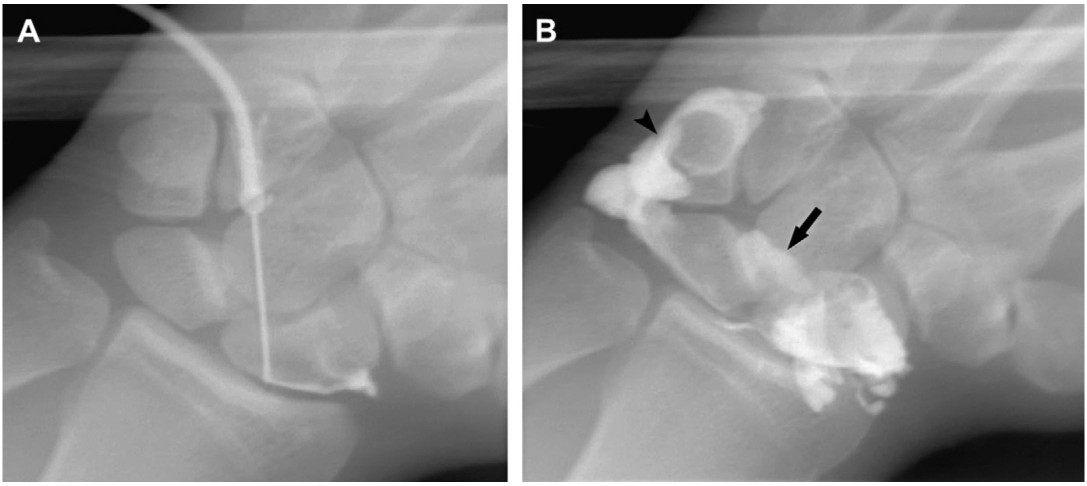

Fig. 7. Radiocarpal injection. (*A*) Skin entry site is a few millimeters distal to the joint space to avoid the dorsal rim of the radius. (*B*) Progressive injection of contrast fills the dorsal recess (*arrow*), which may obscure visualization of the intrinsic ligaments. Communication with the pisotriquetral joint (*arrowhead*) is commonly seen.

Fig. 8. DRUJ injection. Needle target is the lateral aspect of the ulnar cortex. Following contact, the needle is placed more radially, deeper into the joint. Note recent midcarpal injection.

If no frank infection is identified, conventional arthrography can demonstrate loosening, synovitis, and fistulae. Arthrographic studies of femoral cemented components are sensitive and specific tests in the evaluation of prosthetic loosening, especially when performed with digital subtraction arthrography.[70] Criteria to diagnose a loose femoral component include contrast extension past the intertrochanteric line in a standard component or halfway down the component of a long-stem prosthesis. Inconsistent literature is noted in regards to the acetabular component, with a specificity of only 58% in one study.[71] Maus and colleagues also found predicting acetabular loosening to be challenging. They recommended arthrographic criteria for acetabular loosening that included the presence of contrast extending underneath the middle third of the component, or the presence of 2-mm–thick contrast extending under the component.[70] A common cause of false-negatives in hip arthrography is the decompression of the hip capsule with extension into the greater trochanter or pseudobursae. In these cases, intra-articular pressure may be insufficient to force contrast underneath the loosened component. In the setting of recurrent infection, postarthrogram radiographs may demonstrate fistulae connecting to soft tissue abscesses.[72] These fistulae may become more conspicuous if the radiographs are obtained after the patient has ambulated for a brief period after the procedure.

Swan and colleagues[73] first identified the limitations of arthrography in detecting aseptic loosening in the noncemented prosthesis, and these limitations were corroborated in subsequent larger studies.[74,75] Arthrography has been shown to demonstrate only moderate accuracy in detecting loosening/infection of noncemented acetabular (68%) and femoral components (63%).[75] In one comparison study, plain radiography demonstrated better overall accuracy than conventional arthrography, nuclear arthrography, or scintigraphy in the detection of aseptic loosening in the noncemented prosthesis.[76] Diagnosis of aseptic loosening using conventional or nuclear arthrography is the absence of plain film findings should be made with care in the noncemented hip arthroplasty. Although the sensitivity will increase, the specificity of these modalities has been measured at 70%.[76]

Iliopsoas bursa injection may be requested in patients who have a clinical diagnosis of anterior snapping hip.[77] Opacification of the bursa with contrast shows the tendon in relief, and administering corticosteroids can help ameliorate symptoms at the same time. Ultrasound has become increasingly popular in the diagnosis and treatment of a snapping hip. Iliopsoas bursitis may be present in the absence of a snapping iliopsoas tendon. Aspiration may also be required to rule out septic bursitis. Relief with intra-articular local anesthetic within the iliopsoas bursa also confirms the clinical suspicion as a source for anterior hip pain.

Injection of the hip using only anatomic landmarks has been reported. Studies boast a high accuracy in blind placement, as confirmed by visualization of the needle over the femoral neck on postprocedure fluoroscopy.[78] When injection of arthrographic dye is used to confirm placement after surface anatomy technique, accuracy is found to be around 80%.[79]

Technique

Numerous injection techniques of the hip have been described in the literature. The most commonly used fluoroscopic technique is a straight AP approach that parallels the radiograph beam. Needle placement along the lateral aspect of the cortex at the femoral head–neck junction is often advocated because it avoids the potential damage to the femoral vessels and anesthesia to the femoral nerve (Fig. 9). Advocates of needle placement along the medial aspect of the femoral neck suggest that injection and aspiration are easier in this area because of the more redundant capsule in this portion of the joint. Needle placement in the middle of the femoral neck has been shown to present a three-times-greater risk for contrast extravasation, and it should be avoided.[80] A lateral

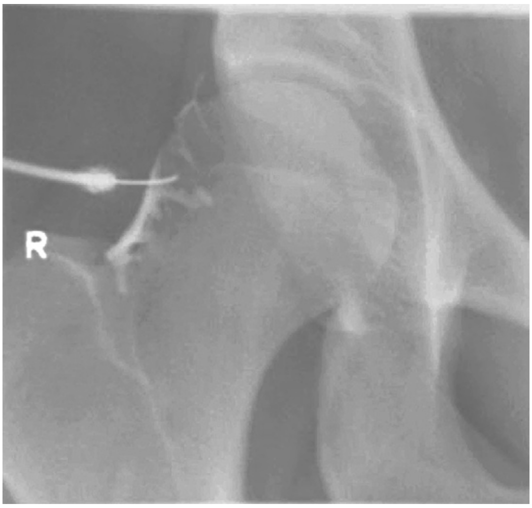

Fig. 9. Anterior approach to hip arthrogram. Patient is in supine position. Needle target is the lateral aspect of the femoral head–neck junction.

approach following standard arthroscopy portals can also be used.[81] This approach avoids the neurovascular structures but can be more challenging because the depth and position of the needle tip are more difficult to ascertain. Cranial angulation is used in obese patients to avoid pannus. AP positioning of the needle in this circumstance may inadvertently transgress the peritoneum in these patients (**Fig. 10**).

In patients who have already undergone hip arthroplasty, the AP technique can be modified. The skin entry site is placed just lateral to the neck of the prosthesis (**Fig. 11**), which allows

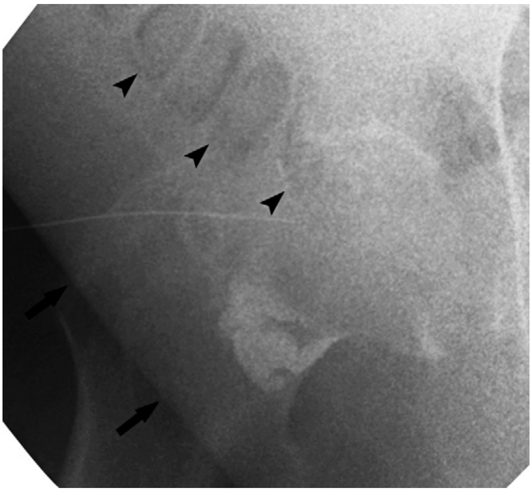

Fig. 10. Anterior approach in patient who has large body habitus. An oblique approach with long spinal needle is used to avoid pannus. A direct AP approach may transgress peritoneum and bowel (*arrowheads*).

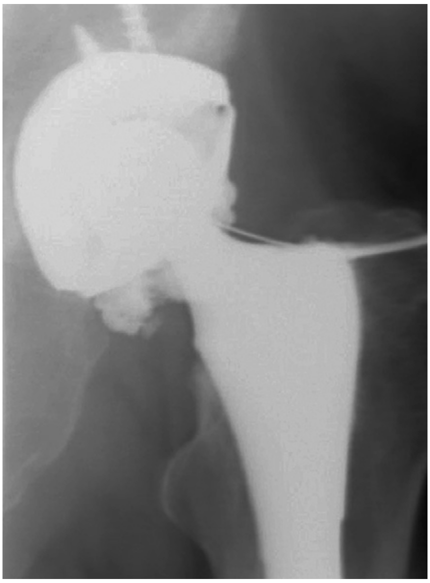

Fig. 11. Hip arthrography in patient who has hip arthroplasty. An anterior approach is performed with skin entry site slightly lateral to the prosthesis, allowing visualization of needle path.

visualization of the needle path as it is advanced to the lateral aspect of the prosthetic neck. Brandser and colleagues[82] describe a technique of spinning the bevel away from the neck to place the needle an extra 1 to 2 cm posterior to the lateral aspect of the femoral neck. The dry tap rate was only 2.4% using this method. Aspiration should be performed before the injection of additional material. If a strong concern exists regarding loosening or infection of a hip arthroplasty, dedicated postprocedure radiographs are performed after the patient has ambulated briefly, which allows the contrast to extend into areas of component loosening or soft tissue fistula (**Fig. 12**). Needle tip position at the midpoint of the intertrochanteric line will lead to the highest success rate when attempting to aspirate a hip with a Girdlestone arthroplasty (**Fig. 13**).[83]

Injection of the iliopsoas bursa is performed with the patient in a supine position. The ideal location for needle placement is along the anterior rim of the acetabulum, at a line drawn between the ipsilateral lesser trochanter and the inferior aspect of the ipsilateral sacroiliac joint (**Fig. 14**). The needle enters the iliopsoas bursa most easily while contrast is being injected because downward pressure of the needle on the bone is released.

KNEE

Rationale

Knee joint injections are often performed blindly with good success, especially in the presence of

Fig. 12. Hip arthrography in patient who has recurrent infections of total hip arthroplasty. AP radiograph performed after hip arthrography followed by patient ambulation. Contrast extends into two fistula connecting to soft tissue abscesses (*arrows*).

Fig. 14. Iliopsoas bursogram. Patient is in supine position. Needle target is the anterior rim of the acetabulum on a line drawn between the lesser trochanter and the inferior aspect of the sacroiliac joint.

a knee effusion. In patients who do not have an effusion, correct placement can be more difficult. Jackson and colleagues[84] found a 71% and 75% rate of accurate placement in those patients

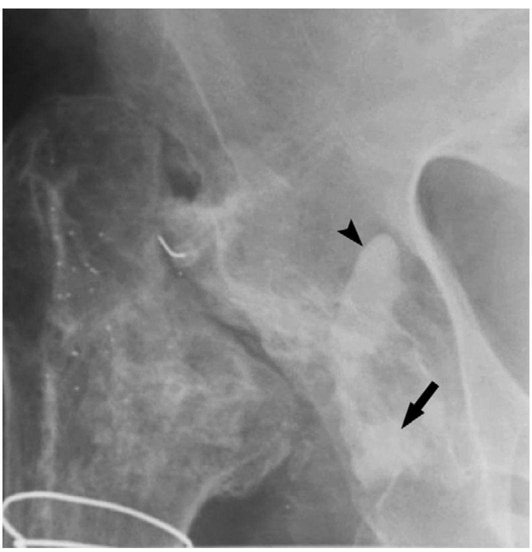

Fig. 13. Hip arthrography in patient who has Girdlestone arthroplasty. Patient is in supine position. Needle target is at a point bisecting the intertrochanteric line. Administration of contrast demonstrates contrast communication with the pseudocapsule at the level of the acetabulum (*arrow*) with extension into the iliopsoas bursa (*arrowhead*).

injected from the anterolateral and anteromedial approaches, respectively. A blind patellofemoral approach resulted in a higher accuracy (93%), a success rate that has been reproduced.[85] Patients who have inadvertent extra-articular injections have been shown to have decreased response, compared with those with proper placement. Although most procedures can be performed without imaging guidance, obese patients or patients who have patellofemoral arthritis may be sent for imaging-guided knee injection.

Knee joint injections may be diagnostic and therapeutic with the intra-articular placement of local anesthetic and steroid. In randomized trials, steroid has shown good short-term improvement in symptoms, compared with placebo.[6,86] Novel therapies, such as hyaluronic acid, are also used. Small amounts of these novel therapies are expensive, and imaging is often used to ensure correct intra-articular delivery.

Another use for knee injections is for MR or CT arthrography, most commonly used in the postoperative knee in an attempt to improve detection of meniscal tears after previous meniscectomy.[87] In patients who had prior resection of more than one fourth of their meniscus, MR arthrography increased accuracy by 10% to 20%, when compared with conventional arthrography, in one study.[88] Characterizing osteochondritis dissecans is another strength of MR arthrography.[89]

Technique

Knee arthrography is usually performed at the patellofemoral joint, from either a medial or lateral approach. This approach is usually straightforward, especially in the presence of an effusion. The patellar is manually displaced away from the needle with one hand while the other guides the needle (**Fig. 15**). This technique can be challenging in those patients who have patellofemoral arthritis or large body habitus. An anterior method may also be used, which may be achieved from either a lateral or a medial approach. The needle is placed just medial to the patellar tendon near the inferior patellar pole. The needle is advanced slightly cephalad until it abuts the medial femoral condyle (**Fig. 16**).[90] An anterolateral approach has also been advocated.[91] Less discomfort was noted with a needle target site of lateral femoral condyle rather than with an approach closer to midline. The investigators postulated that this difference was secondary to the increased innervation of Hoffa's fat pad.

ANKLE

Rationale

Therapeutic hindfoot injections provide valuable diagnostic information to the clinician. It is often difficult to differentiate pain arising from the tibiotalar joint, subtalar joint, or talocalcaneonavicular joint from an extra-articular cause. In general, the degree of arthritis on imaging does correlate to relief from local anesthetic.[92] Relief from injection localizes the abnormal joint and distinguishes the joint as a source of pain rather than an extra-articular source such as tenosynovitis, heel pad injury,

Fig. 15. Lateral approach to knee arthrogram.

Fig. 16. Anteromedial approach to knee arthrogram.

or plantar fascial injury. It is important to mix contrast with the diagnostic block. Subtalar and ankle joints communicate in 10% of the population.[93] Similarly, following trauma, capsular disruption may result in abnormal communications between joints of the hindfoot and midfoot. This communication occurred in 4 out of 32 patients in one series.[92] The recognition of these communications may alter surgical planning. For example, without the administration of contrast, the communication between the subtalar and talocalcaneonavicular joint would not be identified. Pain arising from the talocalcaneonavicular joint in this setting may be falsely localized after relief with subtalar injection. Relief of symptoms after diagnostic block correlates with significant pain relief after surgical management.[2]

Administration of intra-articular gadolinium may also be useful in selected indications. Direct MR arthrography improves the detection and characterization of cartilage abnormalities.[94] Visualization of osteochondral bodies is also improved because of distention of the joint. MR arthrography may improve the assessment of ankle impingement syndromes.[95,96] MR arthrography also improves the accuracy of detecting lateral ligamentous injury.[97,98]

Technique

Generally, 25-gauge needles are sufficient to interrogate the ankle joints. The tibiotalar joint is straightforward to inject. With the patient lying in a decubitus position, the needle is advanced into the anterior aspect of the joint. Care is taken to avoid anterior tendons and the dorsalis pedis

Fig. 17. Anterior approach to ankle arthrogram. Patient is in decubitus position with ankle bolstered to achieve true lateral position. Needle is inserted medial to anterior tibial tendon.

artery. Confirmation of correct placement with contrast is then obtained (Fig. 17).

The subtalar joint consists of an anterior and posterior portion. The posterior portion is injected from a lateral approach, just below the fibula. A slightly cephalad approach facilitates intra-articular placement (Fig. 18). Palpation of the peroneal tendons is performed before injection.

Fig. 18. Subtalar arthrogram. Patient is in a decubitus position with a slightly cephalad needle path.

SUMMARY

Joint injections remain a valuable modality in the detection and treatment of intra-articular pathology. Imaging guidance for joint injection generally increases accuracy in joint aspirations and diagnostic blocks. Confirming intra-articular placement with steroid injections improves efficacy and reduces local complications. Administering intra-articular contrast can improve the diagnostic performance of CT and MR imaging in many circumstances.

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