Ultrasound-Guided Hip Procedures

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KEYWORDS

• Ultrasound • Injection • Hip joint • Iliopsoas bursa • Trochanteric bursa • Ischial bursa • Piriformis muscle

KEY POINTS

- The differential diagnosis for hip pain is extensive and includes intra-articular and extra-articular pathologic conditions, and referred pain from the lumbar spine and pelvis.
- Ultrasound (US) is commonly used to evaluate hip region pathologic conditions and to guide interventions in the hip region for diagnostic and therapeutic purposes.
- US confers many advantages compared with other commonly used imaging modalities, including real-time visualization of muscles, tendons, bursae, neurovascular structures, and the needle during an intervention.
- US-guided injection techniques have been described for many commonly performed procedures in the hip region, and many studies have been performed demonstrating the safety and accuracy of these techniques.

Video content accompanies this article at http://www.pmr.theclinics.com.

INTRODUCTION

The differential diagnosis for hip pain is extensive and includes intra-articular and extra-articular pathologic conditions, and referred pain from the lumbar spine and pelvis.[1] Ultrasound (US) is commonly used to evaluate pathologic conditions and to guide interventions in the hip region for diagnostic and therapeutic purposes.[2–15] Indications for performing interventions with image guidance include the proximity of neurovascular structures, lack of palpable anatomic landmarks, large body habitus, deep location of target, and the heightened need for accuracy when performing a diagnostic injection. In comparison with computed tomography (CT) and fluoroscopy, US does not produce ionizing radiation, has no absolute contraindications, does not require contrast agents, and is able to be performed with less expensive and more portable

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equipment.[9] US can identify bony acoustic landmarks and provides high-resolution soft tissue imaging, allowing for real-time visualization of muscles, tendons, and fascial planes.[7,8] US also allows for visualization of important neurovascular structures to assist in the prevention of injection-related complications.[7,8] This article describes the techniques for performing US-guided procedures in the hip region, including intra-articular hip injection, iliopsoas bursa injection, greater trochanter bursa injection, ischial bursa injection, and piriformis muscle injection. In addition, the common indications, pitfalls, accuracy, and efficacy of these procedures are addressed.

ULTRASOUND-GUIDED HIP JOINT INJECTION

Diagnostic Criteria

Intra-articular causes of hip pain include osteoarthritis, acetabular labral tears, femoroacetabular impingement, loose bodies, and ligamentum teres tears.[1] Hip osteoarthritis is most often symptomatic with weight-bearing activities but may also cause pain at night. Management options include activity modification, weight loss, analgesics, physical therapy, intra-articular steroids, viscosupplementation, and total hip arthroplasty.[16]

Patients with intra-articular pathologic conditions may not have signs and symptoms clearly localized to the hip joint. Often, patients will have concomitant knee or spine conditions, making a definite diagnosis difficult. In these patients, an intra-articular injection of local anesthetic can be useful in confirming hip pathologic conditions and has been associated with predicting a good surgical outcome.[14,15] Hip joint corticosteroid injections have been shown to decrease pain, stiffness, and disability in patients with hip osteoarthritis.[17] Intra-articular hip injections with hyaluronic acid products have also been performed in patients with hip osteoarthritis.[18,19]

Intra-articular hip injections have been performed with palpation guidance using anatomic landmarks, as well as with image guidance using fluoroscopy, CT, and US.[20–28] Hip joint injections are technically challenging to perform because of the deep location of the joint, variable body habitus, and the adjacent femoral neurovascular bundle. Therefore, image guidance has been recommended to ensure safety and accurate needle placement.[20] Sonography can identify the femoral neurovascular bundle, reveal intra-articular fluid collections, and visualize needle passage into the hip joint.[26] Byrd and colleagues[23] reported that patients found in-office US-guided hip injections more convenient and less painful than the same procedure under fluoroscopy. US-guided hip joint injections have been shown to have an excellent safety profile. Sofka and colleagues[28] reported no major complications with 358 US-guided hip joint aspirations or injections, including no inadvertent vascular or femoral nerve puncture. Also, Migliore and colleagues[19] performed 4002 intra-articular hip injections with hyaluronan products and reported no major complications.

Several studies have been performed confirming the accuracy of US-guided hip joint injections.[10,18,26,29] A recent meta-analysis revealed that US-guided hip joint injections are significantly more accurate than landmark-guided intra-articular hip injections.[30] In addition, a systematic literature review for a position statement by the American Medical Society for Sports Medicine found four level 1 studies of US-guided hip injections with a mean accuracy of 99%.[31] Two level 2 studies were identified for landmark-guided hip injections with a mean accuracy of 73%.[31]

Several studies have evaluated the efficacy of US-guided hip joint injections.[18,27,32,33] Micu and colleagues[27] found that US-guided hip intra-articular corticosteroid injections are efficacious in achieving pain control in patients with hip osteoarthritis. Furtado and colleagues[33] compared the short-term effectiveness of

US-guided versus fluoroscopy-guided intra-articular hip injections in patients with synovitis caused by autoimmune or degenerative disorders. For almost all variables that they evaluated, including pain, they found no statistically significant difference between the fluoroscopy-guided and US-guided hip injection groups.[33]

Injection Technique

In preparation for performing a US-guided hip joint injection, the patient is placed in the supine position with the hip in neutral rotation.[6] Preprocedure US evaluation of the anterior hip is usually performed with a low-frequency curvilinear-array transducer. The transducer is placed anteriorly in the oblique sagittal plane, parallel to the femoral neck. This allows visualization of the femoral head-neck junction as well as the overlying hyperechoic iliofemoral ligament and joint capsule.[6] This image is also optimal to evaluate for an effusion in the anterior joint recess.[13] The anterior capsule extends inferiorly from the acetabulum and labrum to inserts on the intertrochanteric line, although some fibers are reflected superiorly along the femoral neck to attach at the femoral head-neck junction.[34] Both the anterior and posterior layers measure between 2 to 3 mm in thickness. A normal amount of fluid between the layers should be less than 2 mm and, in the absence of a hip joint effusion, the 2 layers of the capsule are visualized together as a hyperechoic line.[5] A thin layer of hypoechoic hyaline articular cartilage is visualized covering the hyperechoic surface of the femoral head.[5] The anterior acetabular labrum is visualized as a hyperechoic, compact, triangular structure.[35] After identification of the hip joint, the transducer is then rotated into the transverse plane and moved medially to identify the femoral neurovascular bundle.[6] Special consideration should also be taken to also identify the ascending branch of the lateral femoral circumflex artery because this may be in the path of the planned trajectory of the needle (**Fig. 1**). After confirming the position of the neurovascular structures, the transducer is again placed in the oblique-sagittal plane to optimize visualization of the femoral head-neck junction (**Fig. 2**). At this point, the skin at the inferior end of the transducer is marked with a marking pen and the area is prepped in the usual sterile manner.[6] Following the delivery of local anesthesia, a 22-gauge 64-mm to 89-mm needle is advanced under direct US visualization into the anterior joint recess at the junction of the femoral head and neck (**Fig. 3**).[6] The needle can be felt to pass through the iliofemoral ligament and enter the hip joint (Video 1).[6] The injectate is then delivered while visualizing the injectate flow with real-time sonographic imaging.

ULTRASOUND-GUIDED ILIOPSOAS BURSA INJECTION

Diagnostic Criteria

The main action of the psoas and iliacus muscles is to flex the thigh.[36] The main iliopsoas tendon inserts on the lesser trochanter, although the lateral fibers of the iliacus travel parallel to the iliopsoas tendon and insert directly onto the proximal femoral shaft without a tendon.[3,37] The iliopsoas musculotendinous unit and iliopsoas bursa are subject to mechanical stress with their close proximity to the acetabular rim and hip joint.[38] This can lead to iliopsoas tendinosis or tear. Iliopsoas tendon pathologic conditions may be accompanied by abnormal tendon movement and the source of internal snapping hip.[39] The tendon may be the cause of anterior hip pain after a total hip arthroplasty secondary to friction with the anterior margin of the acetabular cup or impingement on the collar of the femoral prosthesis.[40] With its location between the deep surface of the iliopsoas tendon and acetabular rim and hip joint, iliopsoas bursopathy may accompany iliopsoas tendon pain.[38] Because of the communication

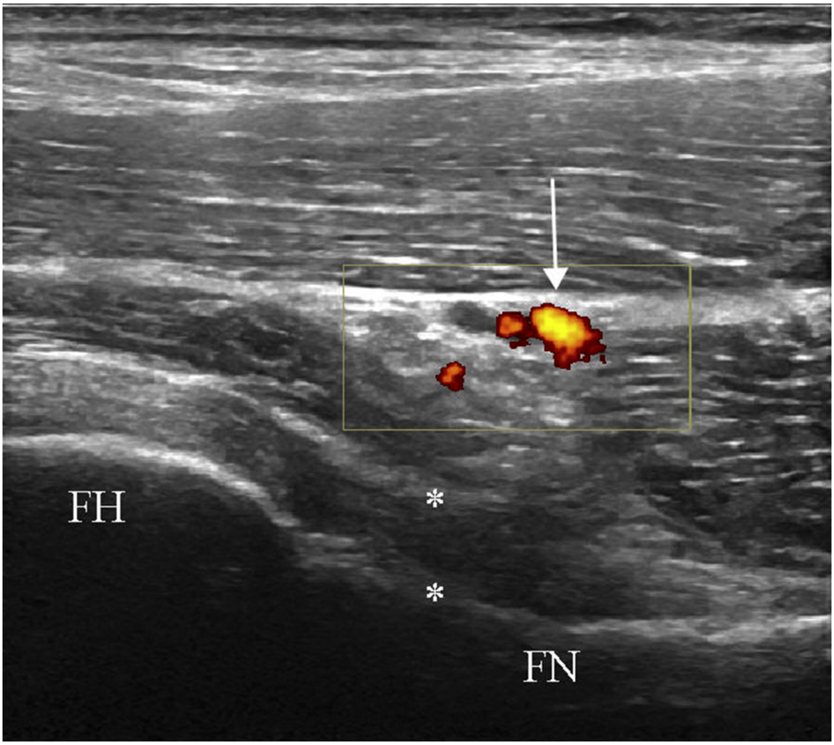

Fig. 1. Anterior oblique sagittal view of the anterior hip joint with lateral femoral circumflex vasculature indicated by the arrow. The asterisks show the anterior joint recess. FH, femoral head; FN, femoral neck. (*Courtesy of* Mayo Foundation for Medical Education and Research, Rochester, MN; with permission.)

between the hip joint and iliopsoas bursa in some individuals, iliopsoas distention is frequently related to hip joint pathologic conditions occurring from various causes, including rheumatoid arthritis, osteoarthritis, villonodular synovitis, synovial chondromatosis, and septic arthritis.[41] Iliopsoas bursitis may also represent a primary pathologic condition, typically related to a previous trauma or overuse syndrome.[41]

Image-guided injections can aid in the diagnosis and treatment of iliopsoas disorders.[38] It is important to be able to perform precise diagnostic iliopsoas injections to identify the source of pain. Iliopsoas injections have been performed with fluoroscopic guidance[42,43] and commonly with US guidance secondary to its excellent soft tissue resolution.[38] US-guided iliopsoas bursa injections have been shown to provide pain relief and predict a good outcome after surgical iliopsoas tendon release for those patients with anterior hip pain and a suspected snapping iliopsoas tendon.[44] Also, US-guided iliopsoas peritendon injections have been described in patients with anterior hip pain following total hip arthroplasty.[40,45,46]

Injection Technique

In preparation for performing a US-guided iliopsoas bursa injection, the patient is placed in the supine position with the hip in neutral rotation. Preprocedure US evaluation of the iliopsoas region is usually performed with a medium-frequency or low-frequency linear-array transducer. The transducer is initially placed in the transverse

Fig. 2. Anterior oblique sagittal transducer and needle position for an in-plane hip joint injection. (*Courtesy of* Mayo Foundation for Medical Education and Research, Rochester, MN; with permission.)

plane over the femoral head. The transducer is then translated superiorly and angled parallel to the inguinal ligament in the oblique axial plane.[2] At the proximal aspect of the femoral head, the bony contours of the femoral head and acetabulum, along with the iliopsoas muscle and tendon, can be visualized (**Fig. 4**). Toggling the transducer may be necessary to optimize visualization of the iliopsoas tendon secondary to anisotropy. Moving the transducer more superiorly allows visualization of the ilium at the level of the iliopectineal eminence and continued imaging of the iliopsoas muscle and tendon (**Fig. 5**). If a snapping iliopsoas tendon is suspected, a US examination of the iliopsoas tendon can be performed while the patient performs the maneuver that creates the snapping. If a patient cannot reproduce the snapping, a US examination can be performed as the hip is moved from flexion, external rotation, and abduction into full extension, adduction, and internal rotation.[44] Preprocedure scanning includes evaluation for anechoic or hypoechoic distention of the iliopsoas bursa and if present, assessment of a communication between the bursa and the hip joint.

Once preprocedure scanning is complete, the transducer is placed transverse to the iliopsoas tendon in the oblique axial plane, parallel to the inguinal ligament, and superior to the femoral head (**Fig. 6**). The skin at the lateral edge of the transducer is marked with a marking pen and the area is prepped in the usual sterile manner. Following the delivery of local anesthesia, a 22-gauge 89-mm needle is advanced in-plane with the transducer, using a lateral to medial approach.[2] The needle is then advanced under direct US guidance to the deep lateral portion of the iliopsoas tendon where it is directed between the deep surface of the iliopsoas tendon and the superficial surface

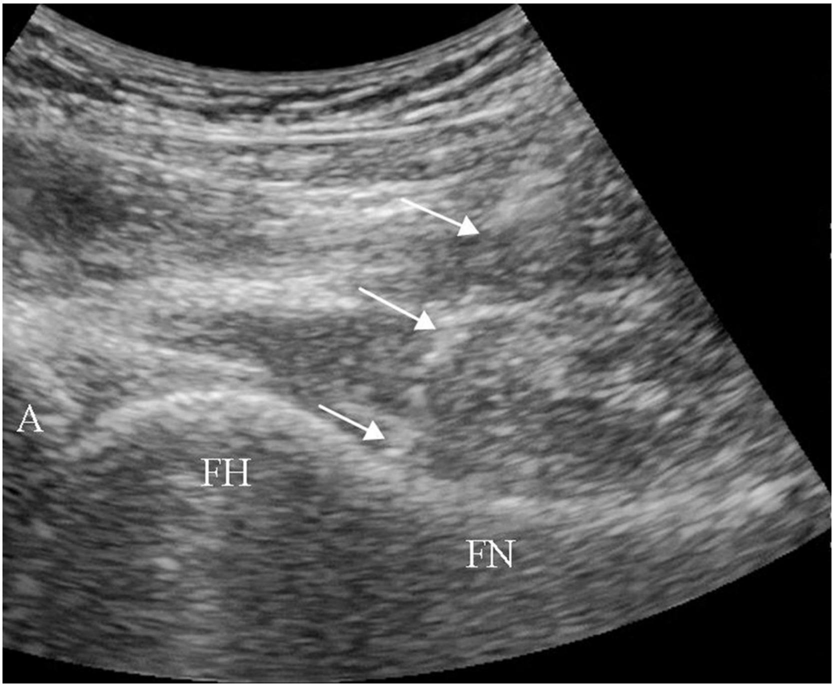

Fig. 3. Anterior oblique sagittal US image of an in-plane hip joint injection. The arrows indicate the needle. A, acetabulum; FH, femoral head; FN, femoral neck. (*Courtesy of* Mayo Foundation for Medical Education and Research, Rochester, MN; with permission.)

of the ilium at the level of the iliopectineal eminence, or alternatively between the iliopsoas tendon and acetabular rim (**Fig. 7**). As the injectate is delivered, fluid will be seen between the iliopsoas tendon and ilium, as well as on the medial side of the iliopsoas tendon (Video 2).[38] Hydrodissection may be useful to identify the plane deep to the iliopsoas tendon but superficial to the hip capsule to avoid inadvertent capsule penetration.[38]

ULTRASOUND-GUIDED GREATER TROCHANTERIC BURSA INJECTION

Diagnostic Criteria

The greater trochanter is a large protuberance that is part of the proximal femur and arises from the junction of the femoral neck and shaft.[47] Four distinct greater trochanter facets have been described: the anterior facet, lateral facet, posterior facet, and superoposterior facet.[48,49] Seven muscles attach to the greater trochanter. The gluteus minimus inserts on the anterior facet, the gluteus medius inserts on both the lateral and superoposterior facets, the piriformis inserts superomedially without a specific facet attachment, the obturator externus inserts medially in the trochanteric fossa, and the obturator internus and superior and inferior gemelli also insert more medially adjacent to the trochanteric fossa.[47–51] Three bursa in the region of the greater trochanter have been described.[47,50,52] The subgluteus minimus bursa is located between the anterior facet and gluteus minimus tendon, the subgluteus medius bursa is located between the lateral facet and gluteus medius tendon, and the subgluteus maximus (greater trochanteric) bursa is located over the posterior and lateral

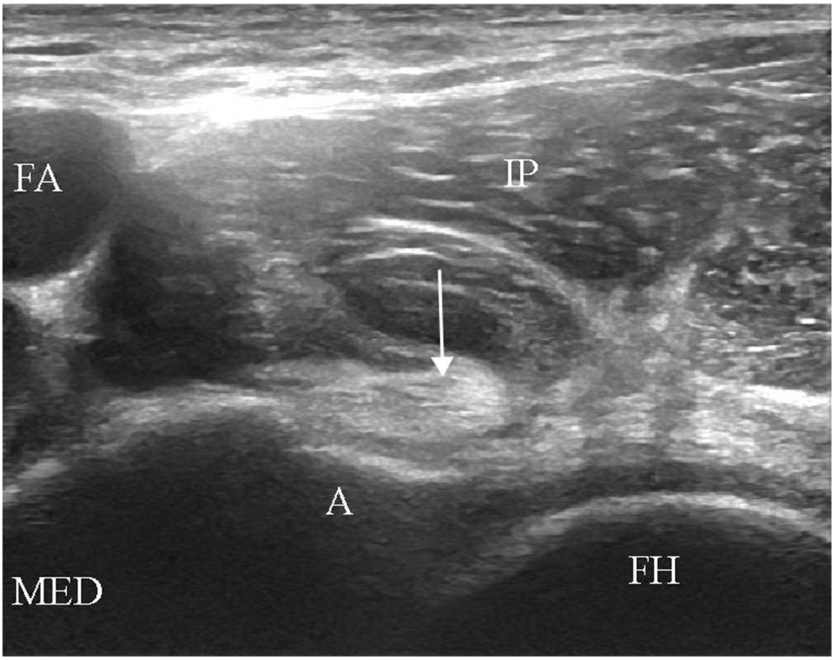

Fig. 4. Transverse oblique US image at the proximal aspect of the femoral head demonstrating the iliopsoas tendon (*arrow*). A, acetabulum; FA, femoral artery; FH, femoral head; IP, iliopsoas muscle; MED, medial. (*Courtesy of* Mayo Foundation for Medical Education and Research, Rochester, MN; with permission.)

facets.[48–50] **Fig. 8** illustrates the 4 greater trochanter facets, the attachment sites of the gluteus medius and minimus tendons, and the location of the regional bursae.[48]

Greater trochanter pain syndrome (GTPS) is a relatively common condition found to affect 17.6% of adults in a large observational study.[53] People with GTPS have high levels of pain, physical impairment, and decreased quality of life.[54] GTPS is a clinical entity that includes several disorders of the lateral hip, including greater trochanteric bursitis, gluteus medius and minimus tendinosis and tears, and snapping hip.[47,50] An anatomic dissection study supported the theory that the greater trochanteric bursa can develop from excessive friction between the greater trochanter and the gluteus maximus.[55] However, histologic analysis of greater trochanteric bursa tissue removed from patients undergoing total hip arthroplasty revealed no signs of acute or chronic inflammation, adding evidence that inflammation or bursitis plays a limited role in GTPS.[56] US and MRI can be used to evaluate the structures of the lateral hip in people with GTPS and most often reveal pathologic conditions involving the gluteus medius and minimus tendons, including tendinosis, calcifications, and tears.[49,50,57] Initial treatment of GTPS involves conservative measures and includes activity modification, ice, weight loss, and physical therapy to address strength and flexibility deficits.[50,52]

Although GTPS is not typically caused by bursitis alone, many patients experience pain relief for a period of several weeks to months following an injection of corticosteroid and local anesthetic into the greater trochanteric bursa.[52] These injections have been performed using a landmark based technique,[52,58] fluoroscopic guidance,[59] and US guidance.[12] McEvoy and colleagues[12] demonstrated that US-guided corticosteroid injections into the greater trochanteric bursa may be more effective than

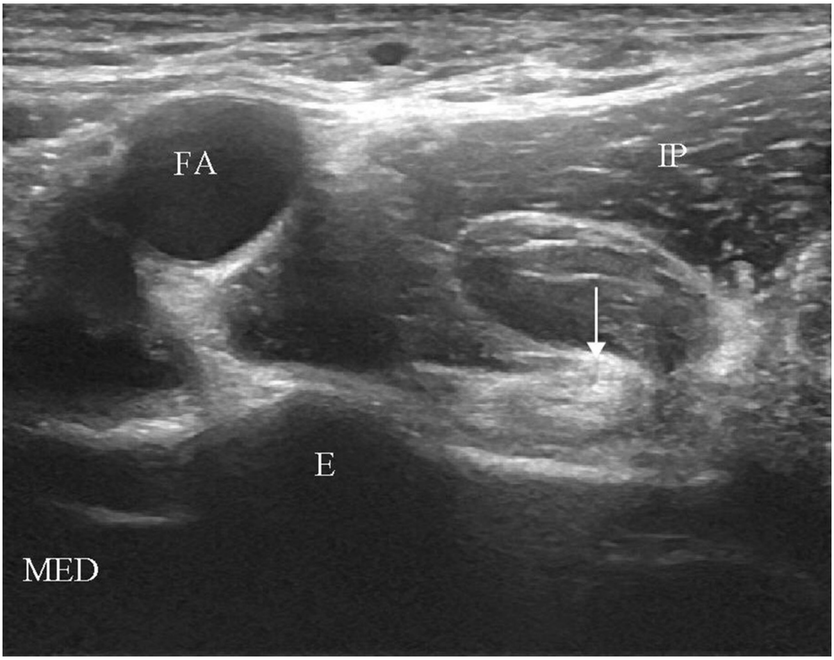

Fig. 5. Transverse oblique US image superior to the femoral head demonstrating the iliopsoas tendon (*arrow*). E, iliopectineal eminence; FA, femoral artery; IP, iliopsoas muscle; MED, medial. (*Courtesy of* Mayo Foundation for Medical Education and Research, Rochester, MN; with permission.)

US-guided corticosteroid injections into the subgluteus medius bursa for treatment of GTPS. Other US-guided treatments that directly target the area of the pathologic condition have been described and may be considered, including percutaneous needle tenotomy, injection of autologous platelet-rich plasma or whole blood, prolotherapy, and others.[50,60,61] Randomized controlled trials comparing the efficacy of these treatment options are needed to better determine their role in the management of GTPS.[50]

Injection Technique

The patient is placed in the lateral decubitus position on the contralateral hip, and the hips and knees are flexed in a comfortable position.[12,57,62] A high-frequency or medium-frequency linear-array transducer or low-frequency curvilinear-array transducer may be used depending on patient body habitus and desired field of view. The transducer is initially placed in the transverse plane over the lateral proximal femur. The transducer is then translated superiorly and the bony protuberance of the greater trochanter is identified. The apex of the greater trochanter is seen between the anterior and lateral facets (**Fig. 9**).[62] The gluteus minimus tendon is identified over the anterior facet and the gluteus medius tendon over the lateral facet. Evaluation should then be performed for subgluteus minimus and subgluteus medius bursal distention. The transducer is then moved posteriorly and the rounded posterior facet is identified posterior to the lateral facet. Greater trochanteric bursal distention may be identified between the gluteus maximus and posterior facet. The gluteus minimus and medius tendons and each trochanteric facet should be evaluated in both the transverse and longitudinal planes as indicated. When preprocedure scanning is

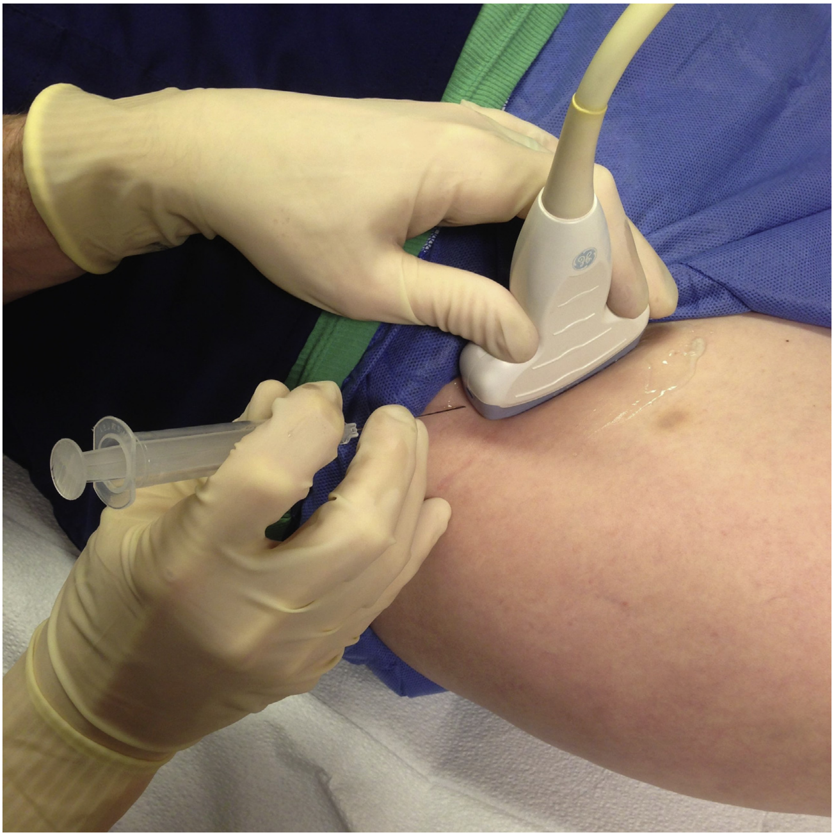

Fig. 6. Transverse oblique transducer and needle position parallel to the inguinal ligament for an in-plane iliopsoas bursa injection. (*Courtesy of* Mayo Foundation for Medical Education and Research, Rochester, MN; with permission.)

completed, the transducer is then again placed in the anatomic transverse plane over the greater trochanter (**Fig. 10**). The skin at the posterior edge of the transducer is marked with a marking pen and the area is prepped in the usual sterile manner. Following the delivery of local anesthesia, a 22-gauge 64-mm to 89-mm needle is advanced in-plane with the transducer using a posterior to anterior approach. The needle is then advanced under direct US guidance into the tissue plane between the superficial gluteus maximus-iliotibial band and the deep gluteus medius tendon, where the injectate is delivered (**Fig. 11**).

ULTRASOUND-GUIDED ISCHIAL BURSAL INJECTION

Diagnostic Criteria

The hamstring muscle complex consists of the semimembranosus, biceps femoris, and semitendinosus, which originate from the ischial tuberosity.[63,64] The semimembranosus originates on the superolateral aspect of the ischial tuberosity beneath the semitendinosus muscle and anterolateral to the conjoint tendon of the biceps femoris and semitendinosus. The semimembranosus tendon origin becomes aponeurotic soon after its origin and has the largest proximal tendon of the hamstring muscles.[64]

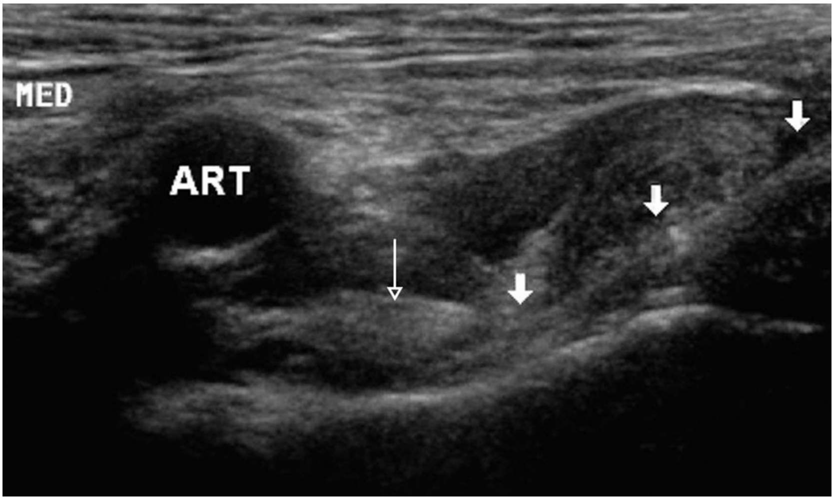

Fig. 7. US image of an in-plane iliopsoas bursa injection. The 3 solid arrows indicate the needle. The arrow with the open arrowhead indicates the iliopsoas tendon. ART, femoral artery; MED, medial. (*Courtesy of* Jay Smith, MD; with permission Mayo Foundation for Medical Education and Research, Rochester, MN.)

The ischial bursa is an inconstant (adventitial) bursa and, when not inflamed, is typically not visible on MRI or US.[65–67]

The differential diagnosis of gluteal region pain is broad and includes referred pain from the lumbar spine, sacroiliac joint disorders, piriformis syndrome, proximal hamstring tendinopathy, and ischial bursitis.[66,68,69] Inflammation of the ischial bursa most commonly occurs secondary to continuous and chronic irritation associated with sitting.[9,65–67,69] Ischial bursitis may also develop after a trauma to the buttocks or occur secondary to systemic inflammatory conditions such as systemic lupus erythematosus, ankylosing spondylitis, rheumatoid arthritis, or Reiter syndrome.[9,65,69] Ischial bursitis may present as a soft tissue mass, mimicking a tumor.[65,70,71] Patients with ischial bursitis most often experience pain in the buttocks and posterior thigh and, occasionally, in the lower leg that is worse with sitting and in the supine position.[9,72,73] Physical examination reveals tenderness to palpation over the ischial tuberosity.[67,72] Treatment options include oral analgesic or anti-inflammatory medications, avoidance of prolonged sitting, physical therapy to correct strength and flexibility deficits, and ice.[9,65,72] Diagnostic local anesthetic injections into the ischial bursa may be used when the diagnosis is uncertain. Corticosteroid injections have been performed for therapeutic purposes when other conservative treatments have been unsuccessful.[9,65,72]

A US-guided ischial bursa injection feasibility study and description of technique was performed by Wisniewski and colleagues[9] They performed cadaveric injections and demonstrated that US-guided ischial bursa injections can produce accurate ischial bursograms without overflow to adjacent structures or damage to surrounding neurovascular structures.[9] They also found that the sciatic nerve moves a significant distance laterally from the ischial tuberosity when the patient is in the lateral decubitus position with the hip flexed 90° in comparison with the prone position.[9] Therefore, placing the patient in the lateral decubitus position with the hip flexed 90° may decrease the risk of iatrogenic sciatic nerve injury during this procedure.[9]

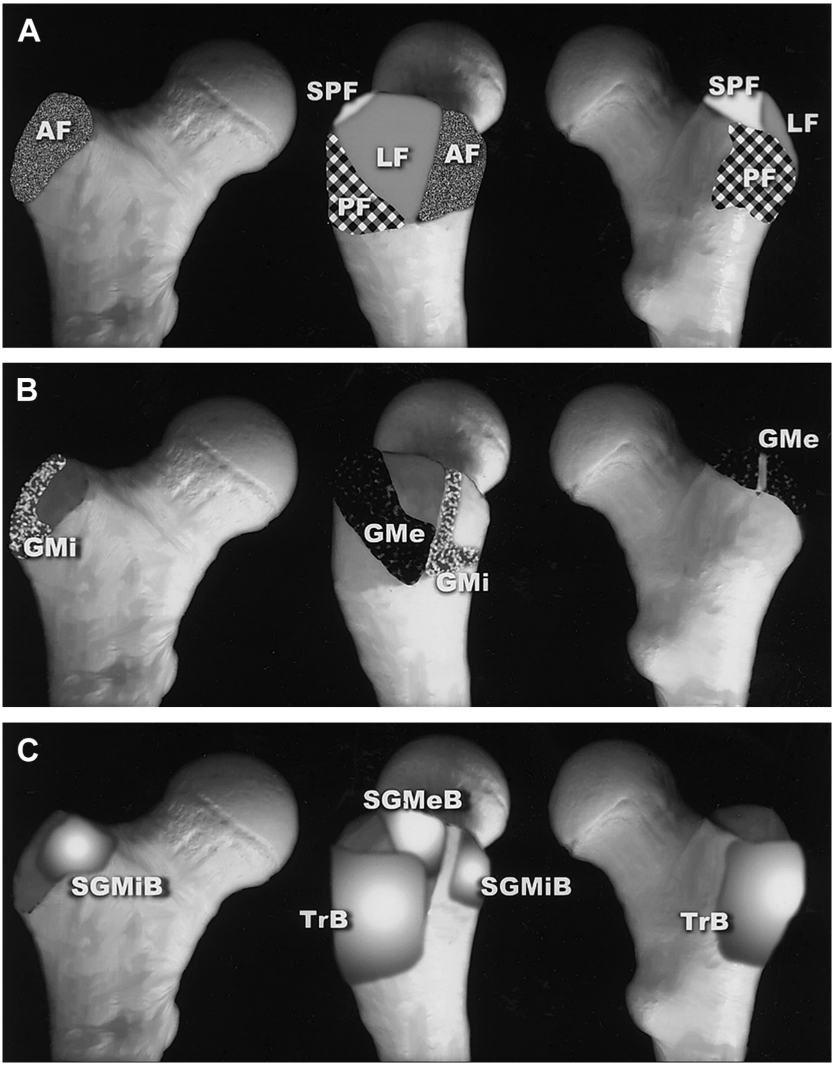

Fig. 8. (*A*) The proximal aspect of the femur in the anterior view (*left*), lateral view (*middle*), and posterior view (*right*) display the 4 facets of the greater trochanter: the anterior facet (AF), lateral facet (LF), posterior facet (PF), and superoposterior facet (SPF). (*B*) Osseous attachment sites of the gluteus medius (GMe) and gluteus minimus (GMi) tendons. (*C*) Locations of the bursae: trochanteric bursa (TrB), subgluteus medius bursa (SGMeB), and subgluteus minimus bursa (SGMiB). (*From* Pfirrmann CW, Chung CB, Theumann NH, et al. Greater trochanter of the hip: attachment of the abductor mechanism and a complex of three bursae-MR imaging and MR bursography in cadavers and MR imaging in asymptomatic volunteers. Radiology 2001;221:470; with permission.)

Injection Technique

The patient is placed in the lateral decubitus position on the contralateral hip, with the ipsilateral hip flexed 90°.[9] The ischial tuberosity is palpated and then the US transducer is placed in the transverse plane over the ischial tuberosity.[9]

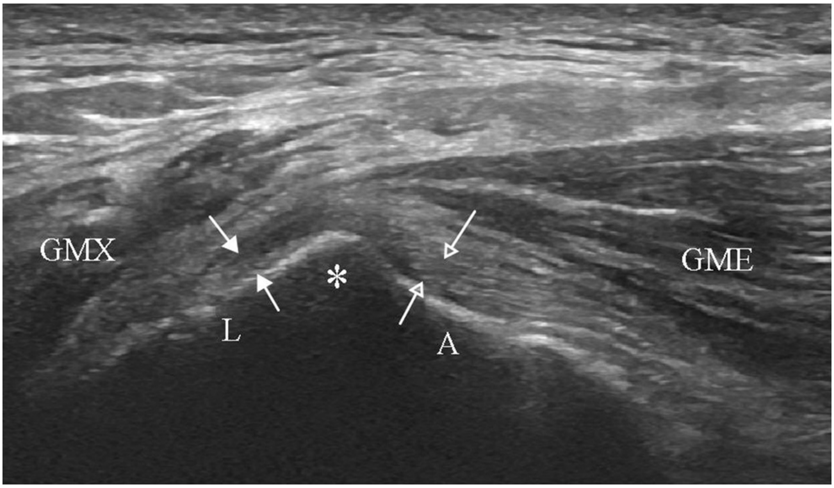

Fig. 9. Transverse US image over the greater trochanter demonstrating the bony apex (*asterisk*) between the gluteus medius (*arrows with solid arrowheads*) insertion on the lateral facet and the gluteus minimus (*arrows with open arrowheads*) insertion on the anterior facet. A, anterior facet; L, lateral facet; GME, gluteus medius muscle; GMX, gluteus maximus muscle. (*Courtesy of* Mayo Foundation for Medical Education and Research, Rochester, MN; with permission.)

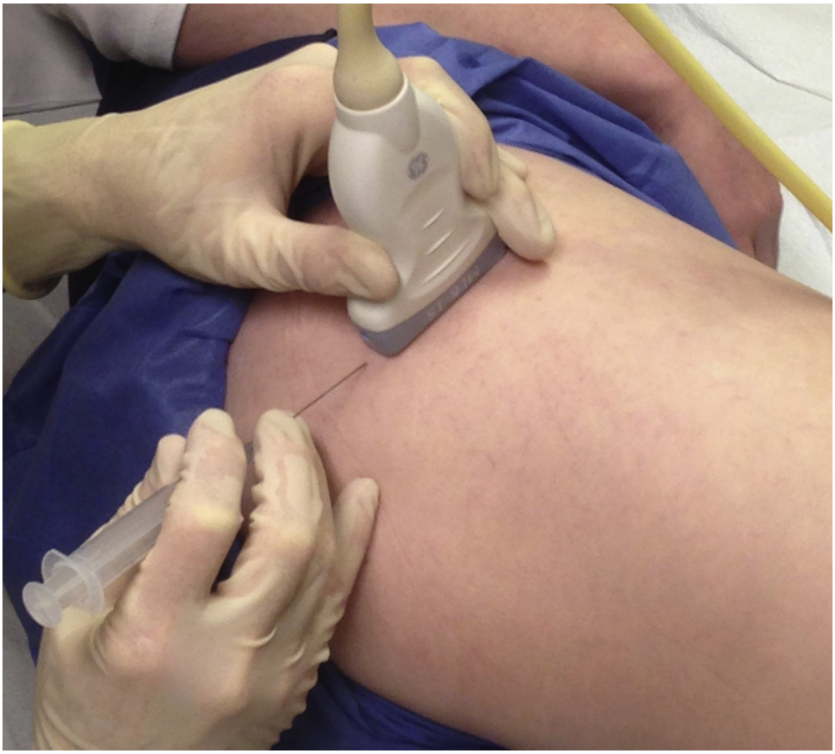

Fig. 10. Anatomic transverse transducer and needle position over the greater trochanter for an in-plane trochanteric bursa injection. (*Courtesy of* Mayo Foundation for Medical Education and Research, Rochester, MN; with permission.)

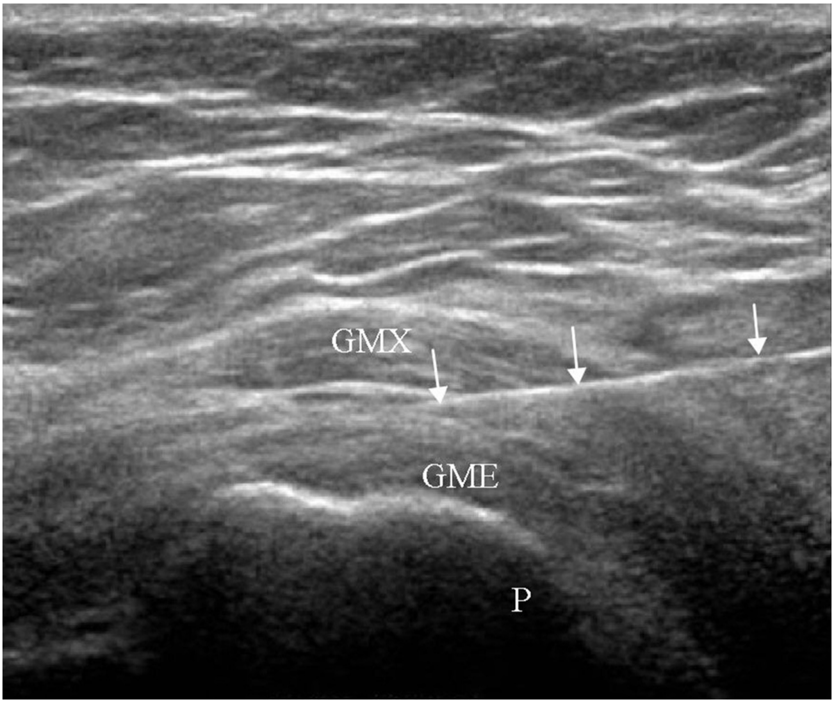

Fig. 11. US image of an in-plane trochanteric bursa injection. Arrows indicate needle. GME, gluteus medius tendon; GMX, gluteus maximus muscle; P, posterior facet. The right side of the image is posterior. (*Courtesy of* Jonathan T. Finnoff, DO; with permission Mayo Foundation for Medical Education and Research, Rochester, MN.)

A medium-frequency linear-array transducer or low-frequency curvilinear-array transducer may be used depending on patient body habitus and desired field of view. The transducer is then moved laterally and the sciatic nerve is identified superficial to the quadratus femoris muscle.[9] Following this, the transducer is positioned so that the gluteus maximus muscle, hamstring tendons, ischial tuberosity, and sciatic nerve are all visualized simultaneously (**Fig. 12**).[9] The skin at the lateral edge of the transducer is marked with a marking pen and the area is prepped in the usual sterile manner (**Fig. 13**). Following the delivery of local anesthesia, a 22-gauge 64-mm to 89-mm needle is advanced in-plane with the transducer from a lateral to medial approach. The needle is then advanced under direct US guidance into the region of the ischial bursa, located deep to the gluteus maximus and superficial to the hamstring tendons, and the injectate is delivered (**Fig. 14**).

ULTRASOUND-GUIDED PIRIFORMIS INJECTION

Diagnostic Criteria

The piriformis muscle lies deep to the gluteus maximus muscle and its primary function is to externally rotate the hip.[8,74–76] It passes through the greater sciatic foramen and inserts on the medial surface of the superior greater trochanter, and may merge with the tendons of the obturator internus and gemelli muscles.[77] The sciatic nerve typically exits the pelvic cavity through the inferior portion of the greater sciatic foramen deep to the piriformis. However, multiple anatomic variations of the nerve have

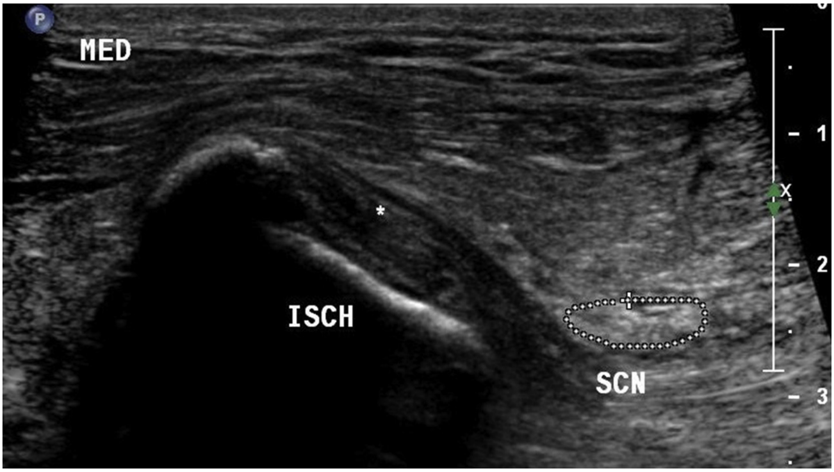

Fig. 12. US image demonstrating a short-axis view of the hamstring tendon origin (*asterisk*), ischium (ISCH), and sciatic nerve (SCN). The sciatic nerve is encircled. MED, medial. (*From* Wisniewski SJ, Hurdle MF, Erickson JM, et al. Ultrasound-guided ischial bursa injection: technique and positioning considerations. PM R 2014;6:58; with permission.)

been described. The undivided sciatic nerve may pass completely through the piriformis muscle or the nerve may divide, with the fibular division typically piercing the muscle and the tibial division traveling superiorly along the muscle.[75,77–79]

The symptoms of piriformis syndrome may vary and include pain in the low back, gluteal region, sacroiliac joint, and radicular leg pain.[75] It has been suggested that 6% to 8% of low back pain cases can be attributed to piriformis syndrome.[80] Piriformis syndrome often occurs after trauma to the buttocks.[74,77,81] Patients will often describe increased pain after sitting on the affected side.[77] Physical examination findings include tenderness over the piriformis muscle and pain with stretching of the piriformis muscle.[7,77,82] Piriformis syndrome is often a diagnosis of exclusion after other causes of buttock and lower limb pain have been eliminated.[8,75,76] Treatment options include stretching and strengthening exercises, physical modalities, oral analgesic or anti-inflammatory medications, and injections.[77,78,81]

Because piriformis syndrome is often a diagnosis of exclusion, a piriformis injection may be considered for diagnostic and/or therapeutic purposes. Piriformis injections, performed with local anesthetic, corticosteroid, and botulinum toxin type A, have been described.[74,83–86] Because of the deep location and small size of the piriformis muscle, and its close proximity to important neurovascular structures, image guidance has been recommended to improve safety and accuracy.[7] Piriformis injections have been described using fluoroscopy, US, CT scan, electromyography, and MRI guidance.[7,8,74,75,78,84,87,88]

Finnoff and colleagues[7] evaluated the accuracy of US-guided versus fluoroscopy-guided contrast-controlled piriformis injections in cadavers and found US-guided injections to be significantly more accurate (95%) than the fluoroscopy-guided injections (30%). A study by Fowler and colleagues[11] found no statistically significant difference in numeric pain scores, patient satisfaction, overall procedure time, or most functional outcomes when comparing US-guided versus fluoroscopy-guided with nerve-stimulation piriformis muscle local anesthetic and corticosteroid injections.

Fig. 13. Anatomic transverse transducer and needle position over the ischial tuberosity for an in-plane, lateral to medial ischial bursa injection. The subject is side-lying with the hip flexed to approximately 90°. (*Courtesy of* Mayo Foundation for Medical Education and Research, Rochester, MN; with permission.)

Injection Technique

With the patient in the prone position, the buttock region is scanned with a medium-frequency linear-array transducer or a low-frequency curvilinear-array transducer depending on body habitus and the desired field of view. The transducer is placed in the anatomic axial plane over the posterior superior iliac spine (PIIS).[8] The transducer is then moved inferiorly until the lateral sacrum is visualized medially and the PIIS is visualized laterally. The transducer is then moved inferior to the PIIS and the ilium will disappear from view, indicating the beginning of the greater sciatic notch.[7] The piriformis muscle is identified traversing from cephalomedial to caudolateral, deep to the overlying gluteus maximus muscle (**Fig. 15**).[8] In this orientation, the transducer is parallel to the course of the piriformis muscle. The piriformis muscle should be evaluated in both longitudinal and transverse views. Passive internal and external rotation of the hip can assist in identifying the piriformis muscle as it moves relative to the gluteus maximus (Video 3).[7,8,75] The sciatic nerve should then be identified and will most often be located deep to the piriformis muscle. Anatomic variations of the sciatic nerve course should be noted because it may necessitate adjustment in injection

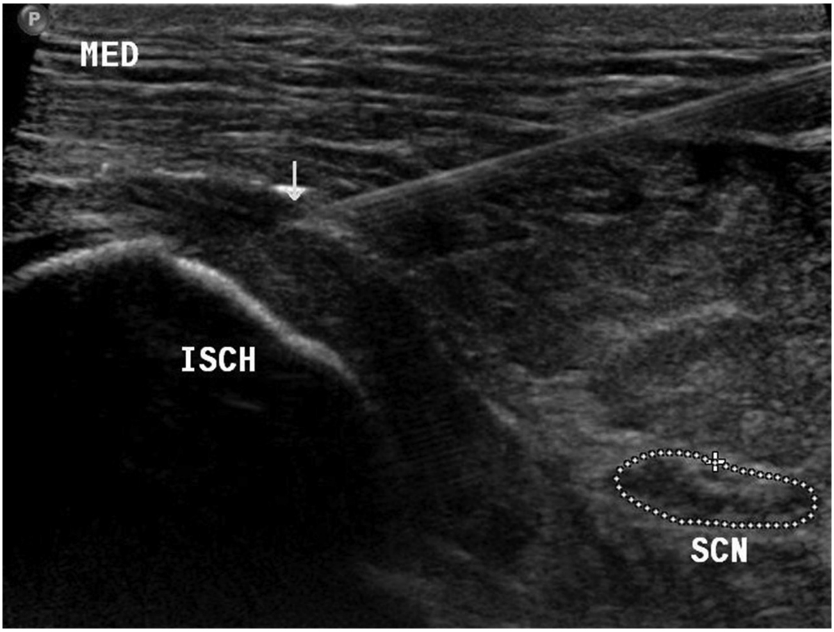

Fig. 14. US image demonstrating a needle within the ischial bursa. The gluteus maximus muscle is above the needle tip (*arrow*) and the hamstring tendon origin is below the needle tip. ISCH, ischium; MED, medial; SCN, sciatic nerve. (*From* Wisniewski SJ, Hurdle MF, Erickson JM, et al. Ultrasound-guided ischial bursa injection: technique and positioning considerations. PM R 2014;6:58; with permission.)

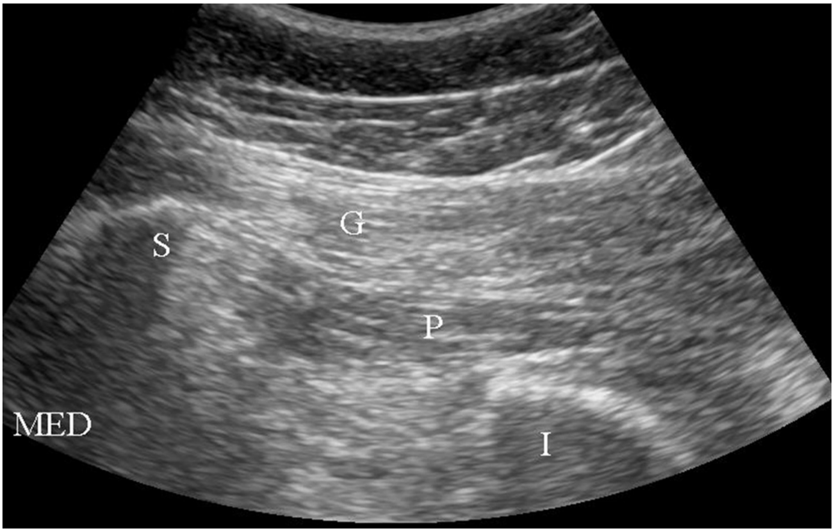

Fig. 15. Longitudinal US image of the piriformis muscle demonstrating the superficial gluteus maximus muscle (*G*) and piriformis muscle (*P*). I, ischium; MED, medial; S, sacrum. (*Courtesy of* Mayo Foundation for Medical Education and Research, Rochester, MN; with permission.)

technique and needle trajectory. The transducer is again placed in a cephalomedial to caudolateral orientation parallel to the piriformis muscle (Fig. 16). The skin at the lateral edge of the transducer is marked with a marking pen and the area is prepped in the usual sterile manner. Following the delivery of local anesthesia, a 22-gauge 89-mm needle is advanced in-plane with the transducer from a lateral to medial approach. The needle is then advanced under direct US guidance through the subcutaneous tissue and gluteus maximus until the piriformis muscle is entered, and the injectate is delivered (Fig. 17).

Fig. 16. US transducer and needle position over the piriformis muscle for an in-plane piriformis injection. Top of the picture is caudal and left side of the picture is lateral. (*Courtesy of* Mayo Foundation for Medical Education and Research, Rochester, MN; with permission.)

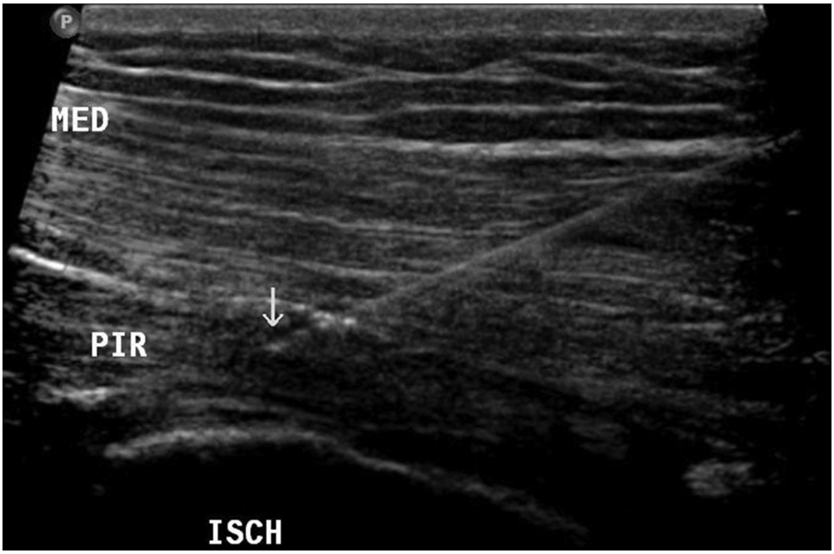

Fig. 17. US image demonstrating a needle placed within the piriformis muscle. Arrow indicates needle tip. ISCH, ischium; MED, medial; PIR, piriformis muscle. (*Courtesy of* Steve J. Wisniewski, MD; with permission Mayo Foundation for Medical Education and Research, Rochester, MN.)

SUMMARY

A variety of image-guided injections can be performed in the evaluation and treatment of hip pain. US confers many advantages compared with other commonly used imaging modalities, including real-time visualization of muscle, tendon, important neurovascular structures, and the needle during an intervention. US-guided injection techniques have been described for many commonly performed procedures in the hip region, and many studies have been performed demonstrating the safety and accuracy of these techniques. US guidance is, therefore, a highly recommended tool when performing procedures in the hip region.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.pmr.2016.04.004.

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