Review Article

Ultrasound-Guided Hip Injections

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Abstract

The diagnosis of hip pain can be difficult to isolate because the discomfort can originate from several locations and compensatory pain patterns. Pain generators can include the intra- and extra-articular hip structures, the lumbar spine, the pelvic floor, or a combination of these. It can also be referred as pain from the bowel, bladder, or reproductive organs. Injections into and around the hip have become an important part of both diagnostic and nonsurgical treatment algorithm for hip pain. The proximity of the hip to important neurovascular structures, lack of palpable anatomic landmarks, and deep location of targets can make use of ultrasonography-guided injections ideal. These injections have been growing in popularity in the orthopedic community because ultrasonography allows for a real-time visualization of dynamic anatomy without any radiation exposure to the patient and physician. The use of ultrasonography has allowed for in-office image guidance with improved accuracy for more targeted and advanced procedures. The patient's response to these injections can help guide patient selection for surgery and allow for better pain control of the soft-tissue pathology that often accompanies intra-articular pathology. This article highlights the diagnostic and therapeutic value of ultrasonography-guided hip injections for an orthopedic practice. The focus is on sonographic anatomy, introduction to technique, common indications, and pearls and pitfalls of these procedures.

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The differential diagnosis for patients presenting with hip pain can include both intra- and extra-articular hip structures, such as the labrum, chondral surface, or psoas tendon, all of which can present similarly. Additionally, pain generators can originate from the lumbar spine and surrounding hip musculature. As a result, intra- and extra-articular hip injections have become an important part of both diagnostic evaluation and therapeutic treatment for these patients.[1]

The proximity of the hip to important neurovascular structures, lack of palpable anatomic landmarks, and deep location of targets make use of ultrasound (US)-guided injections ideal for improved accuracy and directed advanced procedures. Also, US-guided injection is far superior in accuracy than landmark-guided hip joint injections.[2] This office-based procedure allows for immediate assessment of injection response, which can help isolate the pain source and guide treatment plans. Real-time visualization of dynamic anatomy without any radiation exposure to the patient and physician are added benefits. This article highlights the diagnostic and therapeutic value of ultrasonography-guided hip injections for an orthopedic practice. The focus is on sonographic anatomy, introduction to technique, common indications, and pearls and pitfalls of these procedures.

Table 1

Useful Ultrasonography and Procedural Terms

Ultrasonography Term	Description
Echo	A reflection of a sound wave off an object, which is measured by the transducer and analyzed to create the image.
Echoic	There are three-echoics: hyperechoic, hypoechoic, and anechoic. Hyperechoic: a bright area that corresponds to a structure that reflects sound well and returns a strong echo, such as bone or fascia. Hypoechoic: a darker area that corresponds to a structure that does not reflect sound well, such as fat. Anechoic: a black area that is indicative of no returning echo, from material that does not reflect sound, such as fluid.
Amplitude	A measurement of the intensity or loudness of the returning echo. The higher the amplitude, the brighter the correlating appearance on the screen.
Acoustic shadow	The anechoic shadow deep to a structure impenetrable to sound, such as bone. Makes it difficult to see deep to calcifications and impossible to see deep to bone.
Anisotropy	A common ultrasonography artifact that occurs when the ultrasonography beam encounters a structure at a non-perpendicular angle, which results in a loss of echogenicity in a structure, so that a normally hyperechoic structure appears hypoechoic. We see anisotropy more commonly in tendons and ligaments. To determine if a hypoechoic area is real or anisotropy artifact, toggle the transducer to a more perpendicular angle to see if the area fills in.
Long axis	Also known as in-plane, these two terms are used for both the orientation of the transducer to the structure of interest, and the orientation of the transducer to a needle trajectory. When in-plane to a muscle, or in long axis, your transducer is in the same direction as the muscle, and the fibers appear as long fibrils on the screen. When in plane to the needle, the needle will be visualized as you move it toward the target (Figure 3).
Short axis	Also known as out of plane, this is in reference to both the structure being visualized and the orientation of a needle trajectory. When in short axis to a structure, it appears to be a cross section of the structure. With injections using an out-of-plane approach, a needle will appear as a dot. Care must be taken to know where the tip is of your needle when doing these procedures because the image will look the same whether you are getting a cross section of the needle tip or the shaft (Figure 3).
Hydrodissection	Procedural technique to use fluid volume, usually a combination of sterile water or saline with anesthetic, to fill potential spaces and separate tissues planes under direct ultrasound guidance to separate tissue adhesions that may be contributing to symptomatology. While injecting, fluid can be seen "dissecting" between tissue planes. This can aid both with visualization of pathology and with percutaneous dissection of nerve entrapments, such as sciatic nerve entrapment in piriformis syndrome.

Ultrasonography and Injection Preparation Basics

Ultrasonography has transformed the way one can evaluate and treat acute injuries and chronic conditions. The ultrasonography beam creates a two-dimensional image of sound waves emitted from the footprint of the probe.[3] The waves from the transducer generate an image by returning echoes from the structures encountered, which are identified by their different echogenicity. Table 1 summarizes common terminology for ultrasonography, which can be useful for image interpretation.[4] Two principle transducers are used for musculoskeletal ultrasonography: the linear array and curvilinear array transducers (Figure 1, A). The linear transducer typically uses higher-frequency waves, which gives a higher resolution image, but it has less depth penetration. For the hip and buttock, the curvilinear probe is often used because it has a deeper depth of penetration (Figure 1, B).[3,4] Also, the curved footprint allows the needle trajectory to be more parallel to the footprint of the transducer and therefore more perpendicular to the ultrasonography beam. This agreement allows for improved visibility on the sonographic image. Good patient and ultrasonography positioning are imperative to optimize visualization of both the procedure itself and sonographic image. Ideally, the ultrasonography is on the opposite side of the patient or toward the patient's head, so one does not need to turn away from the procedure to see the ultrasonography screen (Figure 2, left).

After the structure to be injected is identified and surrounding neurovascular structures are noted, skin markings can be made using a skin marker or pressure from a needle cap

Figure 1

A **B**

A, Collection of transducers used for musculoskeletal ultrasonography, from the largest footprint with the lowest resolution (low frequency, deep penetration) on the left to the smallest footprint with higher resolution (high frequency, shallow penetration). **B**, This is an example of the difference between the curved, low-frequency US probe image versus the linear, high-frequency probe image (subgluteal sciatic nerve). Note the difference in the shape and scope of the images, and the different depth and resolution. (1) Sciatic nerve; (2) gluteus maximus; (3) quadrates femoris; (4) femur. (Reproduced with permission from Ihnatsenka B, Boezaart AP: Ultrasound: Basic understanding and learning the language. *Int J Shoulder Surg* 2010;4:55-62.)

for probe and needle placement, and the area can be prepared. Although the use of sterile gel is the authors' recommendation when the injection site is adjacent to the probe, a recent study that cultured different ultrasonography-guided shoulder joint injection preparations indicated that both sterile and nonsterile gel had the same contamination rates. The authors cited skin flora as the likely source of contamination.[5] Given this finding, the use of a wide-field preparation with either chlorhexidine or a combination of iodinated products and alcohol is recommended to include the area of transducer placement because the movement of the probe during the procedure can bring skin flora to the needle entry site. It is also important to note that the transducer itself may contribute to the risk of infection, and therefore, precautions should be taken by using a sterile probe cover. More advanced practitioners may not worry about the transducer probe preparation because their technique limits the movement of the probe or gel into the field of the needle entry.

General Injection Options

Diagnostic Injection

A number of studies delineate the utility of diagnostic injection for both improvement of diagnosis and predictor of response to surgery, with relatively little morbidity.[6-8] A commonly used combination is short acting 1% to 2% lidocaine mixed with longer acting 0.25% to 0.5% bupivacaine or 0.1% to 0.5% ropivacaine. This combination provides relief for approximately 6 hours and allows the patient to determine if they have immediate relief in the office and with activity later that day. The authors recommend the patient to keep an activity/symptom journal after a diagnostic injection to determine the effect of the procedure.

Importantly, in vitro studies have proposed potential chondrotoxic effects of single-dose anesthetic use.[9,10] In a meta-analysis, Kreuz et al[10] found that lidocaine and bupivacaine were more chondrotoxic than ropivacaine and mepivacaine, and the chondrotoxicity was dose and time dependent. No study has showed a significant chondrotoxic effect in the very low concentrations of 0.0625% bupivacaine, 0.1 and 0.2% ropivacaine, and 0.5% mepivacaine,[10] nor have in vivo studies shown this same effect. Based on these findings, we recommend limiting the amount of anesthetic to the minimum effective volume for both intra-articular (IA) diagnostic injections and therapeutic injections, especially if repeated injections are expected.

Corticosteroid

Corticosteroid injection (CSI) is a widely used therapeutic option that is used in a vast array of ailments. Methylprednisolone and triamcinolone acetonide are the commonly used products with recommended IA dosages ranging from 40 to 80 mg for both products and 20 to 40 mg in soft tissue. It is important to note the risks of CSI, including fatty atrophy and skin discoloration for extra-articular injections, as well as septic arthritis after IA injections.[11] These injections can increase a patient's risk of periprosthetic infection if given within 90 days of surgery.[12,13] For joints, it

Figure 2

Anterior approach positioning. Left: appropriate positioning to allow the clinician to see the screen and the procedure site, without turning away from the patient. The ultrasonography unit can also be placed on the other side of the patient. Right: for an ultrasonography of the anterior hip, the patient lies supine with the hip in neutral rotation. The probe is held in a cephalad/caudad direction and slightly oblique in the expected trajectory of the femoral neck to allow for the visualization of the femoral head-neck in plane. The probe marker should point cephalad for proper orientation on the screen.

has been shown that corticosteroids may accelerate the rate of loss of total cartilage volume without reducing the overall pain levels with repeated injections over a 2-year period.[14] In addition, the use of steroid in chronic tendinopathy is controversial given the potential risks including local irritation, skin depigmentation, suppression of tenocyte activity and collagen synthesis, and tendon avulsion.[15] We recommend CSI be used in a limited manner, such as rescue for severe pain, to reduce these risks.

Hyaluronic Acid

Viscosupplementation, or the supplementation of hyaluronic acid (HA) into the IA space, aims to restore homeostasis in the joint, decrease pain, and improve function.[16] It is FDA approved and widely used in knee osteoarthritis (OA). Although not FDA approved for use in the hip, it is gaining popularity for off-label use in the hip as well. Actually, HA has been shown to be well tolerated, provide therapeutic benefit, and reduce pain in mild-to-moderate OA and femoroacetabular impingement (FAI).[17] No significant side effects are reported in the studies of HA in the hip, although local reactions of pain and transient synovitis can occur.[16]

Biologics

Recently, attention on biologic options is more in hopes of healing injuries faster with less scarring and the potential to reverse or decrease chondral loss. The most studied and available is platelet-rich plasma (PRP). Numerous systems are available to harvest and prepare PRP from the patient's blood. Typically, PRP concentrates platelets 3 to 5 times compared with whole blood, in addition to containing numerous growth factors necessary for healing.[18] It is common practice that leukocyte-poor PRP is preferred for IA injections, and leukocyte-rich PRP is better for tendon and muscle injections. However, no randomized trial has been published comparing the two preparations.[18,19] Although CSIs are not injected directly into the diseased tendon to avoid iatrogenic rupture, PRP should be injected directly into the areas of injury within the tendon to stimulate healing. No well-investigated protocol exists for the frequency of injections or post-procedure precautions. Long-term outcomes still have yet to be determined. Importantly, PRP itself is not FDA approved because it is currently considered exempt being a blood product. However, a number of FDA-approved commercial devices are available in the market to prepare PRP. Other biologics, such as mesenchymal stem cells, are outside the scope of this article.

Anterior Hip

Intra-articular Pathology

Intrinsic hip pathology reports can be nebulous, often presenting as groin, thigh, or buttock pain.[20] Patients with IA pathologic conditions usually have pain with prolonged sitting, going from sit to stand, and with athletic activities. In OA, patients often have pain with sitting, prolonged activity, or trouble tying their shoes. The physical examination helps differentiate intra- and extra-articular causes of hip pain. Common examination findings of IA pathology are pain and restriction with internal and external rotation, painful and restricted flexion, abduction, and external rotation (FABER) test, painful Scour maneuver, and painful Stinchfield test.[21]

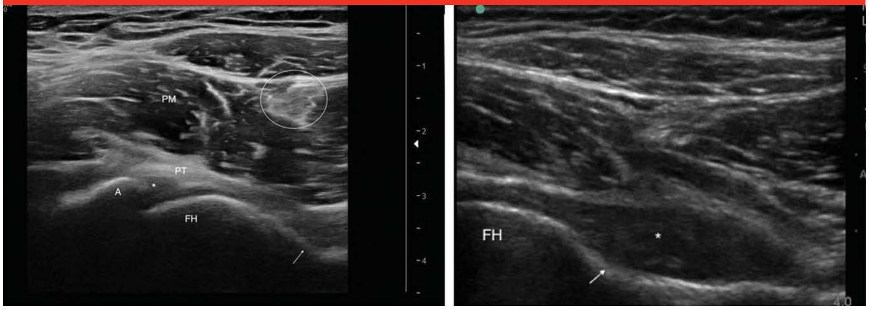
Ultrasonography of Anterior Hip

The anterior hip ultrasonography examination begins with the patient supine with hip in neutral rotation. In thinner patients, a linear array probe can be used for higher resolution of the image. The practitioner stands on the affected side and faces the head of the patient. The probe is held in the expected trajectory of the femoral neck, to allow for the visualization of the femoral head-neck in plane (Figure 2, right). In this view, one can visualize the acetabulum, femoral head, and femoral head-neck junction (Figure 3, A). If present, a joint effusion can be identified at the anterior synovial recess (Figure 3, right).

From this in-plane view, the probe is rotated 90° and glided slightly superior to bring into view the short axis psoas muscle and tendon at the level of the iliopectineal eminence. The psoas tendon can be traced in the short axis caudally to its insertion on the lesser trochanter. The iliopsoas bursa at the level the hip articulation is along the medial aspect of the joint, and it will appear as a thin hypoechoic line between the joint capsule and tendon. Presence of a fluid collection here would support the diagnosis of bursitis. The iliopsoas bursa is located deep to the insertion of the tendon, but just proximal to the lesser trochanter, and it can be best visualized over the level of the femoral head. Medial to the psoas tendon are the femoral nerve, artery, and vein (Figure 4). The psoas tendon can also be evaluated at this level in transverse and longitudinal views, to look for tendon pathology, such as hypoechoic areas, enthesophytes, and neovascularization.

For injections, using the technique described above, optimize your view of the femoral head-neck junction by adjusting the view and depth so that most of the needle trajectory will be visualized. Mark the skin at the inferior edge of the probe. It is important to locate the femoral nerve, artery, and vein, which should be medial to the femoral head-neck junction and can be confirmed with color flow. The ascending branch of the lateral femoral circumflex artery can often be found in the planned needle path, and care should be taken care to avoid piercing it (Figure 3, left).[22,23] After skin preparation, local anesthesia should be given by practitioners' usual technique. For needle selection, a 2- to 3.5-inch, 22-gauge needle is commonly used, but others are possible depending on body habitus, operator preference, and procedural goals. Using needle-in-plane with probe technique, advance the needle under the probe to the femoral head-neck junction. In larger individuals, inject local anesthetic deeper while the longer needle is advanced. The needle passing through the iliofemoral ligament, entering the hip joint, is often palpable (Figure 5). Flow over the femoral head can be visualized when the volume distends the joint capsule. Young et al[24] found that the overall volume of the injectate into the hip does not affect outcomes and recommends a volume between 3 and 9 mL.

Figure 3



Ultrasonographic images. Left: this depicts the in-plane view of the femoral head-neck junction. In this view, the acetabulum (A), femoral head (FH), and femoral head-neck junction (arrow) are in a sagittal oblique plane. The acetabular labrum can be visualized as a hyperechoic, triangular structure (*) deep to the iliofemoral ligament and psoas tendon (PT). The hyperechoic joint capsule extends to the femoral neck at intertrochanteric line, which is the distal attachment from the acetabulum, and allows for needle access to the intra-articular fluid at the anterior synovial recess. You can also see the psoas muscle (PM) and the lateral femoral circumflex vein, artery, and nerve (circle), which was larger than usual in this patient Also, the hypoechoic hyaline cartilage of femoral head can be examined to a limited extent in this view. Right: a hip joint effusion can be visualized in this image, as evidenced by the distension of the capsule with hypoechoic fluid (*). The femoral head (FH) is slightly irregular as can be seen in arthritis but still has a clear head-neck junction (arrow). In severe arthritis or CAM lesion, this head-neck junction can be obscured by squaring of the femoral head.

Outcomes With Intra-articular Injection

In general, IA hip, local anesthetic, diagnostic injections are used to help guide the surgeon and predict whether a patient with FAI should pursue arthroscopy of the hip.[25,26] Lynch et al[25] showed that a negative response to IA injection with local anesthetic or corticosteroid has a strong negative predictive value for surgical intervention. Although failure to improve with injection can be useful to exclude arthroscopy as a treatment option for the patient with FAI, a positive response will not predict a positive outcome with arthroscopic FAI surgery.[26] Khan et al[17] reported improved patient satisfaction scores in the domain of diminished pain (pain rating, 5.6 versus 3.0;

Figure 4

Ultrasonographic image. From the in-plane view of the femoral head, rotate 90° and will become parallel to the inguinal crease (be sure to keep the probe marker on the same side at the screen). In this short-axis view of the psoas tendon (PT) and muscle, the iliopsoas muscle (PM) has a marbleized appearance and will be superficial and lateral (L) to the tendon. The psoas tendon will be superficial to the femoral head with the iliopsoas bursa visible as a thin hypoechoic line when fluid is present, such as in iliopsoas bursitis. In normal physiology, the bursa is not visible. In this image, the Doppler function is being used to confirm the femoral artery (FA) and vein (FV), which lie medial (M) to the psoas muscle.

$P < 0.1$) and improved convenience with ultrasonography-guided injections compared with fluoroscopic injections.

In fact, CSIs have been a mainstay of treatment for FAI, labral tears, and OA. Robinson et al[27] showed that methylprednisolone in hip OA improved pain and stiffness at 6 weeks after the injection, but this response only persisted in the higher-dose group at 12 weeks. Usually, short-term relief of less than 3 months can be achieved with CSI. The lack of longer-term pain relief and risk of further chondral injury with repeated injection using corticosteroid should be considered.[17] This should prompt a shared, decision-making discussion with the patient and caution in a longer-term strategy.

It was also found that FAI can be treated by ultrasound-guided HA injection, which exhibited a statistically significant improvement in both the visual analog scale and the Harris Hip Score, lasting at least 12 months.[17] In a meta-analysis by Conrozier and Vignon,[16] it was found that among nine studies on HA for hip OA, there was significant improvement in pain and function in most patients for more than 3 months with the authors favoring ultrasonography-guided injection over fluoroscopic injections. It is important to note that the patient selection is important to have the best response to HA injections. Patients with good range of motion (ROM) and mild-to-moderate arthritis respond best to this procedure.

Figure 5

Image of needle trajectory (arrows) for an intra-articular hip injection. You can see the joint space between the acetabulum (A) and femoral head (FH) and the joint space deep to the psoas tendon (PT).

For hip osteoarthritis, IA HA has mixed results in the current literature. In one randomized controlled study, no difference in Western Ontario and McMaster Universities (WOMAC) pain scores between a single injection of HA and placebo was shown.

No published studies of the use of in-office PRP in acetabular labral tears secondary to FAI exist to date; however, during hip arthroscopy for FAI and labral injuries, PRP did not improve outcomes and increased pain scores.[28] Biologic injections are also showing promise as a treatment modality for OA of the hip; also, PRP injection was shown to diminish pain in OA of the hip and improve function.[29]

Risk of Infection of Arthroplasty After Steroid Injection

Increased risk of surgical site infection after arthroplasty is an established concern in the total knee arthroplasty literature. Timing of injections should also be assessed and considered before scheduling total hip arthroplasty. In a review of injections administered fewer than 3 months before the surgery, CSI increased the risk of infection, and multiple injections conferred more of a risk than a single injection.[12,13] Although there is a need for further investigation in this area, currently, we recommend waiting at least 12 weeks after injection with corticosteroid for a total hip arthroplasty.

Extra-articular Pathology

Psoas tendinitis and iliopsoas bursitis can be reactive to IA pathology in patients with hip OA, FAI, or other IA pathology. Overuse is also a consideration in active patients engaged in sports associated with increased loads and/or inadequate rest with explosive sports such as sprinting, soccer, and American football. There is pain at the level of the femoral acetabular joint with passive stretch and resisted hip flexion. The location of pain with the maneuver helps to differentiate the psoas tendon insertion and bursa pathology from these conditions. Snapping hip can be evaluated with direct visualization of the psoas tendon just proximal to the femoral head/acetabulum junction, in transverse plane, with circumduction of the hip.

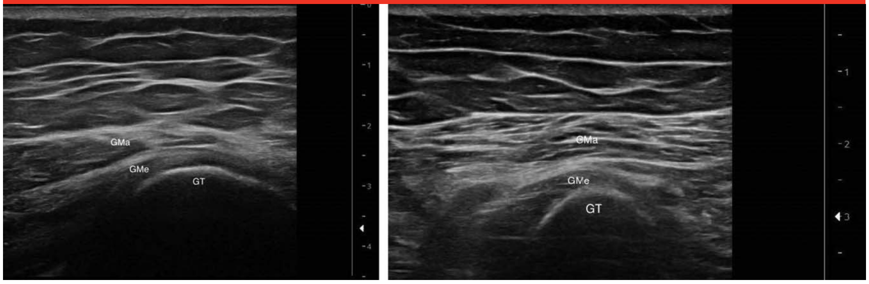
Iliopsoas Technique

Optimize the short-axis view of the muscle and tendon at the level superior to the femoral head. Approach the tendon and/or bursa from lateral edge of probe in plane, so that the neurovascular structures are visualized

Figure 6

The patient is lying in the lateral decubitus position, with hip flexed to 30° and the probe held in the longitudinal plane (cephalad/caudad) at the level of the palpated greater trochanter. The cephalad portion is rotated slightly anterior to view the gluteus minimus tendon in long axis and slightly posterior to view the gluteus medius in long axis.

Figure 7



Ultrasonographic images. Left: this image shows a long-axis view of the gluteus medius muscle and tendon (GMe) inserting onto the lateral facet of the greater trochanter (GT), and the overlying gluteus maximus (GMa). The arrow points to the potential space of the subgluteus maximus or greater trochanteric bursa in between the two tendonous layers. Right: with the probe held in transverse over the greater trochanter, the anterior facet and lateral facets can be brought into view. Both the gluteus minimus and gluteus medius tendons will be in short axis (transverse plane) and will appear as fibrillar, hyperechoic structures adjacent to their corresponding facets. The gluteus medius has an anterior and posterior band, with the anterior band having a broad attachment on the lateral facet and the posterior having a thicker band on to the superoposterior facet.

and considered throughout the procedure.[22] With the acetabulum rim in view and the psoas tendon overlying, skin markings can be placed for the probe placement and needle entry point. Prepare the skin and give local anesthesia in usual fashion. A 2- to 3.5-inch, 22-gauge needle can then be advanced in plane laterally to the tissue plane deep to the psoas tendon. Lidocaine can be used to hydrodissect the tissue planes to avoid IA injection.

The injectate is delivered just under the tendon with visualization of bursal swelling, which can be deep to and extend medial to the tendon at this level above the joint capsule.[22] If the plan is to deliver PRP to the psoas tendon or attempt percutaneous needle tenotomy (PNT) (Table 1), the injection target is going to be based on the area of visible injury.

Outcomes With Psoas Tendon Injection

The nonsurgical management of psoas tendinopathy includes the previously reviewed injectates. In a case series, 29 of 38 patients who received 40 mg of triamcinolone into the bursa by ultrasonography had good improvement in pain.[30] The psoas tendon can be approached in plane, or in transverse plane pending the preference of the operator. At the time of publication, no studies were found on the use of PRP with or without PNT on psoas pathology.

Lateral Hip

Ultrasonography of the Lateral Hip

The ultrasonography of the lateral hip is performed with the patient in the lateral decubitus position with hip flexed and ultrasonography probe over the palpated greater trochanter (Figure 6). The gluteus muscle attachments onto the greater trochanter are analogous to the rotator cuff of the shoulder and appear similarly on

Figure 8

Ultrasonographic image showing a greater trochanteric bursa injection. The needle (solid arrows) enters the bursal space (*) between the gluteus maximus (GMa) and gluteus medius (GMe) tendons. Changes of chronic tendonopathy, including fragmentation of tendinous attachment (dashed arrow) onto the greater trochanter (GT), can also be seen.

ultrasonography as well. In this regard, the supraspinatus/infraspinatus would resemble the gluteus medius/minimus.[31] The gluteus minimus can be seen from its origin at the ilium to its tendinous insertion on the anterior facet of the greater trochanter.[23] The trochanteric attachments

Figure 9

Patient positioning for ultrasonography of the posterior hip. The ischial tuberosity serves as the initial landmark to start your posterior hip ultrasonography. In this position, you can seen the proximal hamstring conjoined tendon attachment.

should be evaluated in both the long and the short axis (Figure 7, left and right). In partial and complete tendon tears, a disruption of the fibrillar pattern can be seen, creating hypoechoic areas that do not disappear with adjustment of the probe, correcting for anisotropy.

There are several bursae of the lateral hip, which are seen as hypoechoic or anechoic tissue planes in the normal patient. These potential spaces may appear more prominently when fluid filled or inflamed. The most commonly suspected and treated is the subgluteus maximus bursa, commonly referred as the greater trochanteric (GT) bursa. The GT bursa can be found anatomically by bringing the greater trochanter into view in short axis, mainly over the lateral facet where the gluteus medius inserts. The gluteus maximus will be found overlying the gluteus medius tendon, and the tissue plane between these two structures is the GT bursa[22,23] (Figure 7).

Greater Trochanter Pain Syndrome

Patients with greater trochanter pain syndrome (GTPS) present with pain laterally that worsens with direct pressure, such as when lying down. Physical findings include pain with direct palpation, pain with passive stretch, and manual resistance of external rotators. Most commonly, the GT, or subgluteus maximus, bursa is the source of pain and has had the best response to treatment comparative to other injection locations in patients presenting with GTPS.[31] Associated pathologies include tendinopathy of the gluteus minimus and medius, tensor fasciae latae (TFL) syndrome, and indirect causes such as radiating pain from other sites.

Injection Techniques

Optimize the view of the gluteus medius using the previously described technique. The area can be palpated with sonographic imaging to confirm the pain generator. The bursa can be approached superiorly, inferiorly, or posteriorly depending on the preference of the practitioner. Prepare the skin and give local anesthesia in usual fashion. Depending on patient body habitus, a 2- to 3.5-inch needle is used for injection. The needle tip is advanced to the tissue plane between the gluteus medius tendon and the overlying gluteus maximus, and the injectate can be seen expanding the bursa between the tendons (Figure 8).

Outcomes

Although CSI can alleviate symptoms to allow for appropriate rehabilitation, the GTPS is analogous to subdeltoid bursitis in that it often requires a change in mechanics to give lasting improvement.[23,31] Relatively, CSIs are safe and have good short-term outcomes in regard to reduction in pain during rest and activity compared with physical therapy alone; but, those effects do not last with injection alone in the long term.[23] Some authors support the use of corticosteroid to facilitate pain control when the patient undergoes physical therapy to address the underlying mechanics.

Although there is limited evidence for the use of biologics in GTPS, a recent registry study of 21 patients with moderate-to-severe gluteus medius tendinosis refractory to conventional therapy who underwent ultrasonography-guided leukocyte-rich PRP injection and PNT of the gluteus medius showed statistically significant improvement in all hip score measures.[32] A case series of PNT of various areas of chronic tendinitis of 14 patients showed no adverse events and a statistically significant pain reduction that lasted at least 12 weeks.[33]

Posterior Hip

Ultrasonography of Posterior Hip

The posterior hip includes the gluteal muscles, the short external rotators, and the hamstrings. To allow for examination of the posterior structures, the patient should lie prone, with their feet hanging off the end of the table and the hip in neutral position (Figure 9). A low-frequency linear or curvilinear probe may be needed to image larger patients because of the depth of the pertinent structures.

The ischial tuberosity should be identified by palpation and the ultrasonography probe placed over it in a transverse plane. Locate the hyperechoic ischial tuberosity with the attached conjoined tendon and semimembranosus tendon (Figure 10). The ischial bursa lies between the conjoined tendon and the gluteus maximus, and it is a potential space seen as tissue plane in normal anatomy on standard imaging unless distended.[23] Superior to the ischial tuberosity, the piriformis exits the pelvis through the greater sciatic foramen and runs laterally to insert on the greater trochanter deep to the attachment gluteus medius tendon. Adjust the medial edge of the probe slightly caudal to bring the piriformis into view (Figure 11, B). The lower leg can be internally and externally rotated to see the piriformis contraction relative to overlying gluteus maximus (Figure 11, A).

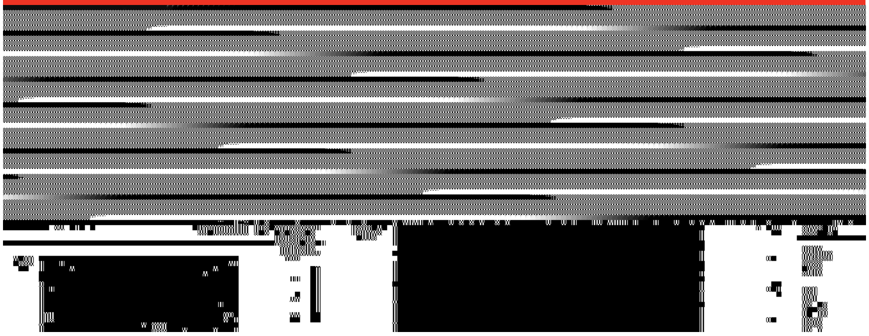
Piriformis Syndrome

Piriformis syndrome is a less common cause of sciatica, buttock, and thigh pain. Two components, somatic and neuropathic, contribute to the presenting symptoms. The somatic component is caused by a myofascial pain syndrome of the muscle itself, and the neuropathic component is caused by irritation of the sciatic nerve while it traverses near or through the piriformis. Pain associated with this condition is typically exacerbated by pressure to the piriformis, through prolonged sitting, muscle contraction, or direct palpation, and can radiate down the leg along the course of the nerve.[33,34]

Injection Technique

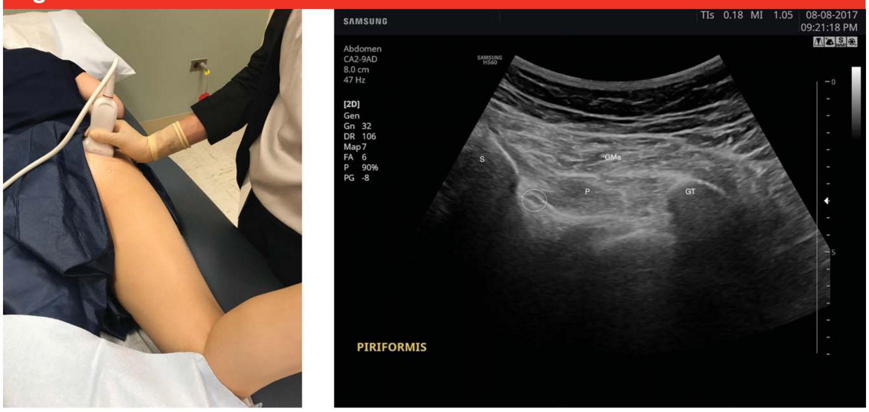
Injections can be administered as trigger point injections at the point of maximal tenderness, or as US-guided injections of the piriformis muscle or hydrodissection of the sciatic nerve. However, given the proximity of the piriformis to the sciatic nerve and the inferior gluteal artery and pelvic cavity, landmark-based injection is typically not recommended. Optimize the in-plane view of the piriformis to include the sciatic nerve using the technique described above. The intramuscular injection of the piriformis is best approached from the lateral side to avoid the sciatic nerve, although in some anatomic variants, the nerve will pass through the muscle body itself.[34] After preparing the skin and giving local anesthesia in usual fashion, approach the muscle belly with a 2- to 3.5-inch needle. Multiple passes through the muscle delivering the injectate is ideal.

Figure 10



Ultrasonographic images. **A**, The primary landmark for the posterior structures, the ischial tuberosity, is a hyperechoic structure deep to the gluteus maximus and the attachment of the conjoined tendon and semimembranosus tendon. The ischial bursa lies between the conjoined tendon and the gluteus maximus and is not usually able to be visualized. The sciatic nerve (circle) can be seen lateral to the ischial tuberosity. **B**, Obtain long-axis view of the hamstring tendon by rotating the probe 90°, so the probe marker is toward the patient's head and you will bring in the hamstring tendon in long axis. This is an ideal view for Percutaneous Needle Tenotomy (PNT) of the tendon, as long as the sciatic nerve is visualized first and avoided.

Figure 11



A **B**

A, This figure demonstrates the proper positioning to isolate the piriformis muscle. Using the greater trochanter as a landmark, position the transducer transverse to the patient and rotate the medial edge slightly superior to the sacral attachment of the piriformis. The lower leg can be internally and externally rotated to observe the movement of the piriformis muscle. **B**, Ultrasonographic image showing the piriformis muscle (P) extending from the sacrum (S) to the posterior facet of the greater trochanter (GT). Two muscle layers are visible over the posterior facet, with the gluteus maximus (GMa) laying superficial to the piriformis. The sciatic nerve (circle) is identified as an oval honeycombed structure and can be followed proximally until it dives beneath the piriformis and runs medially toward the sacrum.

Outcomes

The accuracy of US-guided piriformis injections has been validated in cadaver studies, with an accuracy of 95% in a 2008 study by Finoff et al.[35] In a study of 57 patients, US-guided anesthetic-only injection into the piriformis was shown to have a significant benefit in pain reduction. Corticosteroid did not provide additional benefit over lidocainealone.[36]

Proximal Hamstring

Another cause of posterior hip and buttock pain is injury to the proximal hamstring tendons. This can be the result of an acute injury, such as a hamstring strain; it can develop chronically from a poorly healed prior injury or as the result of long-term tendinopathy. Pain with proximal hamstring tendinopathy is typically described as a deep posterior hip or buttock pain that worsens with repetitive activities, sitting for long periods, when bending at the hip, or with acceleration/sprinting.[37]

Injection Technique

The probe should be positioned to visualize the tuberosity, tendons, and nerve simultaneously, and the needle inserted from lateral to medial in plane with the transducer, taking care to avoid the sciatic nerve (Figure 9, A). Alternatively, an inferior-to-superior approach can be used, viewing the tendon in long axis with the needle in plane to the transducer (Figure 9, B). The needle is directed into the ischial bursa and tendon sheath for diagnostic and CSIs and into the tendon itself for PRP injections.

Outcomes

In a retrospective cohort study, Zissen et al[38] found that 50% of patients who underwent US-guided CSIs reported moderate-to-complete resolution of symptoms for at least 1 month. However, the use of CSI in the treatment of chronic tendinopathy is controversial given the potential risk of tendon avulsion. A randomized controlled trial by Davenport et al[37] did show significant improvement in all outcome measures at 6 months in proximal hamstring tendinopathy with injections of PRP and whole blood, although no statistically significant differences between these two groups were observed. More research on treatment of proximal hamstring tendinopathy is needed.

Summary

Ultrasonography has been shown to be a safe, effective, and convenient tool that can add to an orthopedic practice. It can aid in-office diagnosis and improve efficacy of therapeutic injections without the radiation of fluoroscopy. Although not an exhaustive review of diagnostic and therapeutic hip ultrasonography, this article serves to demonstrate the utility of ultrasonography for common hip pathologies in an orthopedic clinical practice.

References

Evidence-based Medicine: Levels of evidence are described in the table of contents. In this article, references 24, 29, and 36 are level I studies. References 5, 10, 14, 26, 27, 28, 33, and 37 are level II studies. References 6-8, 13, 30, and 38 are level III studies. References 2, 12, 16, 17, 25, and 32 are level IV studies.

References printed in **bold type** are those published within the past 5 years.

1. **Lynch TS, Bedi A, Larson CM: Athletic Hip Injuries. *J Am Acad Orthop Surg* 2017;25: 269-279.**
2. **Hoeber S, Aly AR, Ashworth N, Rajasekaran S: Ultrasound-guided hip joint injections are more accurate than landmark-guided injections: A systematic review and meta-analysis. *Br J Sports Med* 2016;50:392-396.**
3. Stevenson JH: Tissue scanning, in Daniels JM, Dexter WW, eds: *Basics of Musculoskeletal Ultrasound*. New York, NY, Springer, 2013, pp 15-17.
4. Ihnatsenka B, Boezaart AP: Ultrasound: Basic understanding and learning the language. *Int J Shoulder Surg* 2010;4: 55-62.
5. **Sherman T, Ferguson J, Davis W, Russo M, Argintar E: Does the use of ultrasound affect contamination of musculoskeletal injections sites? *Clin Orthop Relat Res* 2015;473:351-357.**
6. Odoom JE, Allen GM, Wilson DJ: Response to local anaesthetic injection as a predictor of successful hip surgery. *Clin Radiol* 1999;54:430-433.
7. Yoong P, Guirguis R, Darrah R, Wijeratna M, Porteous MJ: Evaluation of ultrasound-guided diagnostic local anaesthetic hip joint injection for osteoarthritis. *Skeletal Radiol* 2012;41:981-985.
8. Deshmukh AJ, Thakur RR, Goyal A, Klein DA, Ranawat AS, Rodriguez JA: Accuracy of diagnostic injection in differentiating source of atypical hip pain. *J Arthroplasty* 2010;25(6 suppl): 129-133.
9. Dragoo JL, Braun HJ, Kim HJ, Phan HD, Golish SR: The in vitro chondrotoxicity of single-dose local anesthetics. *Am J Sports Med* 2012;40:794-799.
10. **Kreuz PC, Steinwachs M, Angele P: Single-dose local anesthetics exhibit a type-, dose-, and time-dependent chondrotoxic effect on chondrocytes and cartilage: A systematic review of the current literature. *Knee Surg Sports Traumatol Arthrosc* 2018;26: 819-830.**
11. **Chandrasekaran S, Lodhia P, Suarez-Ahedo C, Vemula SP, Martin TJ, Domb BG: Symposium: Evidence for the use of intra-articular cortisone or hyaluronic acid injection in the hip. *J Hip Preserv Surg* 2016;3:5-15.**
12. **Pereira LC, Kerr J, Jolles BM: Intra-articular steroid injection for osteoarthritis of the hip prior to total hip arthroplasty: Is it safe? A systematic review. *Bone Joint J* 2016;98-b:1027-1035.**
13. **Chambers AW, Lacy KW, Liow MHL, Manalo JPM, Freiberg AA, Kwon YM: Multiple hip intra-articular steroid injections increase risk of periprosthetic joint infection compared with single injections. *J Arthroplasty* 2017;32: 1980-1983.**
14. **McAlindon TE, LaValley MP, Harvey WF, et al: Effect of intra-articular triamcinolone vs saline on knee cartilage volume and pain in patients with knee osteoarthritis: A randomized clinical trial. *JAMA* 2017;317: 1967-1975.**
15. Wong MW, Tang YY, Lee SK, Fu BS: Glucocorticoids suppress proteoglycan production by human tenocytes. *Acta Orthop* 2005;76:927-931.
16. Conrozier T, Vignon E: Is there evidence to support the inclusion of viscosupplementation in the treatment paradigm for patients with hip osteoarthritis? *Clin Exp Rheumatol* 2005; 23:711-716.

17. **Khan W, Khan M, Alradwan H, Williams R, Simunovic N, Ayeni OR: Utility of intra-articular hip injections for femoroacetabular impingement: A systematic review. *Orthop J Sports Med* 2015;3:2325967115601030.**

18. Jo CH, Kim JE, Yoon KS, Shin S: Platelet-rich plasma stimulates cell proliferation and enhances matrix gene expression and synthesis in tenocytes from human rotator cuff tendons with degenerative tears. *Am J Sports Med* 2012;40:1035-1045.

19. **Kraeutler MJ, Garabekyan T, Mei-Dan O: The use of platelet-rich plasma to augment conservative and surgical treatment of hip and pelvic disorders. *Muscles Ligaments Tendons J* 2016;6:410-419.**

20. Martin RL, Enseki KR, Draovitch P, Trapuzzano T, Philippon MJ: Acetabular labral tears of the hip: Examination and diagnostic challenges. *J Orthop Sports Phys Ther* 2006;36:503-515.

21. **Trofa DP, Mayeux SE, Parisien RL, Ahmad CS, Lynch TS: Mastering the physical examination of the athlete's hip. *Am J Orthop (Belle Mead NJ)* 2017;46:10-16.**

22. **Payne JM: Ultrasound-guided hip procedures. *Phys Med Rehabil Clin N Am* 2016;27:607-629.**

23. Peng PW: Ultrasound-guided interventional procedures in pain medicine: A review of anatomy, sonoanatomy, and procedures: Part IV: Hip. *Reg Anesth Pain Med* 2013;38:264-273.

24. Young R, Harding J, Kingsly A, Bradley M: Therapeutic hip injections: Is the injection volume important? *Clin Radiol* 2012;67:55-60.

25. **Lynch TS, Steinhaus ME, Popkin CA, Ahmad CS, Rosneck J: Outcomes after diagnostic hip injection. *Arthroscopy* 2016;32:1702-1711.**

26. Ayeni OR, Farrokhyar F, Crouch S, Chan K, Sprague S, Bhandari M: Pre-operative intra-articular hip injection as a predictor of short-term outcome following arthroscopic management of femoroacetabular impingement. *Knee Surg Sports Traumatol Arthrosc* 2014;22:801-805.

27. Robinson P, Keenan AM, Conaghan PG: Clinical effectiveness and dose response of image-guided intra-articular corticosteroid injection for hip osteoarthritis. *Rheumatology (Oxford)* 2007;46:285-291.

28. **Redmond JM, Gupta A, Stake CE, Hammarstedt JE, Finch NA, Domb BG: Clinical results of hip arthroscopy for labral tears: A comparison between intraoperative platelet-rich plasma and bupivacaine injection. *Arthroscopy* 2015;31:445-453.**

29. **Dallari D, Stagni C, Rani N, et al: Ultrasound-guided injection of platelet-rich plasma and hyaluronic acid, separately and in combination, for hip osteoarthritis: A randomized controlled study. *Am J Sports Med* 2016;44:664-671.**

30. Blankenbaker DG, De Smet AA, Keene JS: Sonography of the iliopsoas tendon and injection of the iliopsoas bursa for diagnosis and management of the painful snapping hip. *Skeletal Radiol* 2006;35:565-571.

31. Dunn T, Heller CA, McCarthy SW, Dos Remedios C: Anatomical study of the "trochanteric bursa". *Clin Anat* 2003;16:233-240.

32. **Lee JJ, Harrison JR, Boachie-Adjei K, Vargas E, Moley PJ: Platelet-rich plasma injections with needle tenotomy for gluteus medius tendinopathy: A registry study with prospective follow-up. *Orthop J Sports Med* 2016;4:2325967116671692.**

33. Housner JA, Jacobson JA, Misko R: Sonographically guided percutaneous needle tenotomy for the treatment of chronic tendinosis. *J Ultrasound Med* 2009;28:1187-1192.

34. Kirschner JS, Foye PM, Cole JL: Piriformis syndrome, diagnosis and treatment. *Muscle Nerve* 2009;40:10-18.

35. Finnoff JT, Hurdle MF, Smith J: Accuracy of ultrasound-guided versus fluoroscopically guided contrast-controlled piriformis injections: A cadaveric study. *J Ultrasound Med* 2008;27:1157-1163.

36. **Misirlioglu TO, Akgun K, Palamar D, Erden MG, Erbilir T: Piriformis syndrome: Comparison of the effectiveness of local anesthetic and corticosteroid injections: A double-blinded, randomized controlled study. *Pain Physician* 2015;18:163-171.**

37. **Davenport KL, Akgun K, Palamar D, Erden MG, Erbilir T: Ultrasound-guided intratendinous injections with platelet-rich plasma or autologous whole blood for treatment of proximal hamstring tendinopathy: A double-blind randomized controlled trial. *J Ultrasound Med* 2015;34:1455-1463.**

38. Zissen MH, Wallace G, Stevens KJ, Fredericson M, Beaulieu CF: High hamstring tendinopathy: MRI and ultrasound imaging and therapeutic efficacy of percutaneous corticosteroid injection. *AJR Am J Roentgenol* 2010;195:993-998.