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Ultrasound-Guided Blocks for Pelvic Pain

Chin-Wern Chan and Philip W.H. Peng

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S.N. Narouze (ed.), *Atlas of Ultrasound-Guided Procedures in Interventional Pain Management*,
DOI 10.1007/978-1-4419-1681-5_16, © Springer Science+Business Media, LLC 2011

Introduction

Chronic pelvic pain (CPP) is defined as noncylic pain of at least 6 months duration, severe enough to cause disability or seek medical attention, occurring in locations such as the pelvis, anterior abdominal wall at or below the umbilicus, lower back, or buttocks.[1] The pathophysiology of CPP is complex. The pain generator may include the viscera (e.g., bladder, bowel), neuromuscular system (e.g., pudendal neuralgia, piriformis syndrome), or the gynecological system (e.g., endometriosis). Pathophysiological processes, both peripherally and centrally combined with psychological factors most likely contribute to the clinical picture.[2] Therefore, a multidisciplinary approach to management is recommended.[2] As part of this management plan, neural blockade and injection of muscles within the pelvis play both a diagnostic and therapeutic role.[2]

The technique of neural blockade has changed considerably in the past several decades. In the past, clinicians were not able to reliably visualize nerves. The methods of choice in the past were either landmark-based (blind) or equipment-guided techniques. The latter are indirect methods providing surrogate markers (such as bony landmarks for the nerve in fluoroscopy) or electrophysiological changes (such as nerve stimulation or electromyography). Both of them have intrinsic limitations in precisely locating a soft tissue structure. The introduction and increasing use of ultrasound to assist in needle placement and injection have provided the pain clinician with many benefits compared to previous modalities. Among the advantages of ultrasound are improved visualization of the nerve and surrounding vascular, bony, muscular, and visceral structures, more precise deposition of medication in the vicinity of the nerve of interest, real-time guidance on needle advancement, thereby improving target and reducing inadvertent damage to surrounding neurovascular structures, and the ability to better identify intravascular and intraneuronal injection.[3] Furthermore, the relatively easy access, portability, and lack of radiation exposure make ultrasonography an attractive imaging modality for the interventional pain physician.[4–8]

This chapter concentrates on anatomy, sonoanatomy, and ultrasound-guided techniques for needle placement of the following structures associated with CPP: (1) ilioinguinal, iliohypogastric, and genitofemoral nerves; (2) piriformis muscle; and (3) pudendal nerve.

Ilioinguinal, Iliohypogastric, and Genitofemoral Nerves

The ilioinguinal (II), iliohypogastric (IH), and genitofemoral (GF) nerves are known as the “border nerves,” providing sensory innervation to the skin lying between the thigh and abdomen.[9] Due to their location and variable course, these nerves are susceptible to injury in surgical procedures involving the lower abdomen. Injury to the II and IH nerves is a known risk in open appendectomy incisions, postinguinal herniorrhaphy, low-transverse incisions (e.g., Pfannenstiel incision), and during trocar insertion for laparoscopic surgery of the abdomen and pelvis.[10–14] There are multiple mechanisms by which these nerves may be injured. Direct nerve trauma with or without neuroma formation, compression of the nerve with scar tissue or hematoma, and suturing of the nerve into fascial closure or mesh incorporation are several possible mechanisms.[15,16]

Patients presenting with pain secondary to irritation of these nerves usually complain of groin pain which may radiate to the scrotum or testicle in males, the labia majora in women, and the medial aspect of the thigh.[5] One review has identified chronic pain after inguinal repair to be as high as 54%.[17] Furthermore, one third of these patients report moderate to unbearable pain.[17] Blockade of the II and IH nerves are often performed to provide intra and postoperative analgesia for hernia repair.[18] In addition, blockade of these nerves serves a diagnostic and therapeutic purpose in patients complaining of chronic pain in this nerve distribution.[5,6,8]

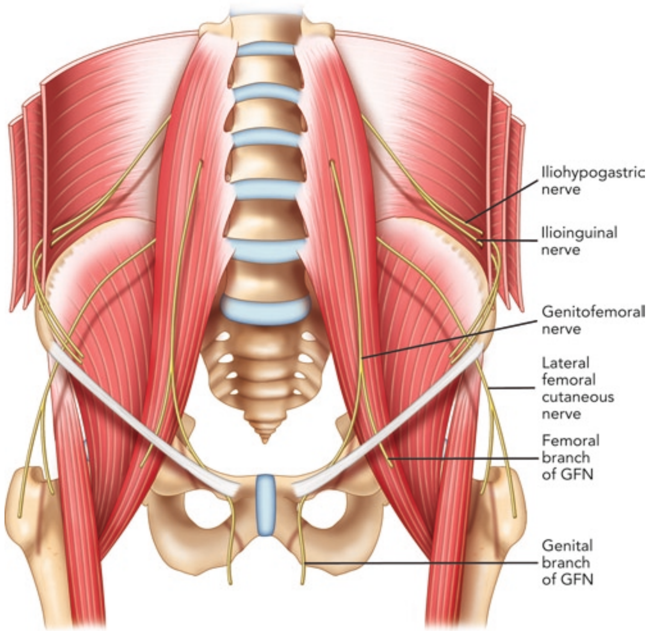

Figure 16.1. The pathway of ilioinguinal, iliohypogastric, and genitofemoral nerve (GFN) is shown. Reproduced with permission from USRA (www.usra.ca).

Anatomy

The II and IH nerves originate from the ventral rami of L1 with contributing filaments from T12.[9,19] The IH nerve emerges along the upper lateral border of psoas major (Figure 16.1). The nerve then crosses quadratus lumborum inferolaterally traveling to the iliac crest.[9] At a point midway between the iliac crest and 12th rib, the nerve pierces the transversus abdominis muscle superior to the anterior superior iliac spine (ASIS).[19] The IH nerve then runs inferomedially, piercing the internal oblique muscle above the ASIS.[19] From this point, the nerve runs between the internal and external oblique muscles, piercing the external oblique aponeurosis approximately 1 in. above the superficial inguinal ring.[9] As the nerve courses between the abdominal oblique muscles, it divides into lateral and anterior cutaneous branches.[12] The lateral cutaneous branch provides sensory innervations to the skin of the gluteal region.[19] The anterior cutaneous branch supplies the skin over the hypogastric region, including the skin over the lower region of the rectus abdominis muscle.[19] The II nerve emerges along the lateral border of psoas major, inferior to the IH nerve (Figure 16.1).[19] The II runs parallel and below the IH nerve. In contrast to the IH nerve, the ilioinguinal nerve pierces the internal oblique at its lower border, and then passes between the crura of the superficial inguinal ring, anterior to the spermatic cord.[9,19] The nerve provides sensory fibers to the skin over the root of penis and scrotum (mons pubis and labium majus) and superomedial thigh region.[19]

It should be noted from observation of the course of the nerves from imaging and cadaver studies, the most consistent area (90%) both II and IH nerves are found is at the point midway between the iliac crest and 12th rib, where the nerves are located between the TA and IO muscles.[19,20]

The GF nerve arises from the L1 and L2 nerve roots.[9] The nerve travels anteriorly, passing through the psoas muscle at the level of the third and fourth lumbar vertebrae.[9] It then runs on the ventral surface of the muscle, under the peritoneum and behind the ureter.[21] The nerve divides into the genital and femoral branches above the level of the inguinal ligament (Figure 16.1).[21] This point of division is variable. The genital branch passes through the deep inguinal ring providing motor innervation to the cremaster muscle and sensory fibers to the scrotum.[9,21] The course of this nerve in relation to the spermatic cord in the inguinal canal is varied, with ventral, dorsal, inferior locations[9,22] or as part of the cremaster muscle.[21] In females, the genital branch runs with the round ligament supplying mons pubis and labium majus.[9] The femoral branch follows the external iliac artery, passing through fascia lata providing sensory innervations to the skin of the femoral triangle.[9]

Success, consistency, and reliability in blockade of the border nerves with blind techniques have been poor.[23,24] This is likely due to the high degree of anatomic variability in not only the course of the nerves but also their branching patterns, areas of penetration of the fascial layers, and dominance patterns.[8] The above description of the II and IH nerve anatomy may only be consistent in 41.8% of patients.[25] Furthermore, the sites at which the II and IH nerves pierce the abdominal wall muscle layers are significantly variable.[14] However, by far the most consistent location of the II and IH nerves is lateral and superior to the ASIS where the nerves are found between the transversus abdominis and internal oblique muscular layers.[5,6,8,19]

Literature Review on the Injection Techniques for Ilioinguinal, Iliohypogastric, and Genitofemoral Nerve Block

A number of injection techniques for II and IH nerves have been described and virtually all are landmark-based.[26–28] Unfortunately, all these techniques suggest a needle entry anterior to the ASIS (Figure 16.2), where the anatomy of these nerves is highly variable. Thus, the failure rates with those techniques range between 10% and 45%.[18,23,24,29] Furthermore, the misguided needle may result in femoral nerve blockade[30] and bowel perforation and pelvic hematoma.[31–33]

There are two key elements contributing to the improvement in success rate. One is to perform the injection cephalad and posterior to the ASIS, where both the II and IH nerves (>90%) can be consistently found between the TA muscles at this point.[19] The

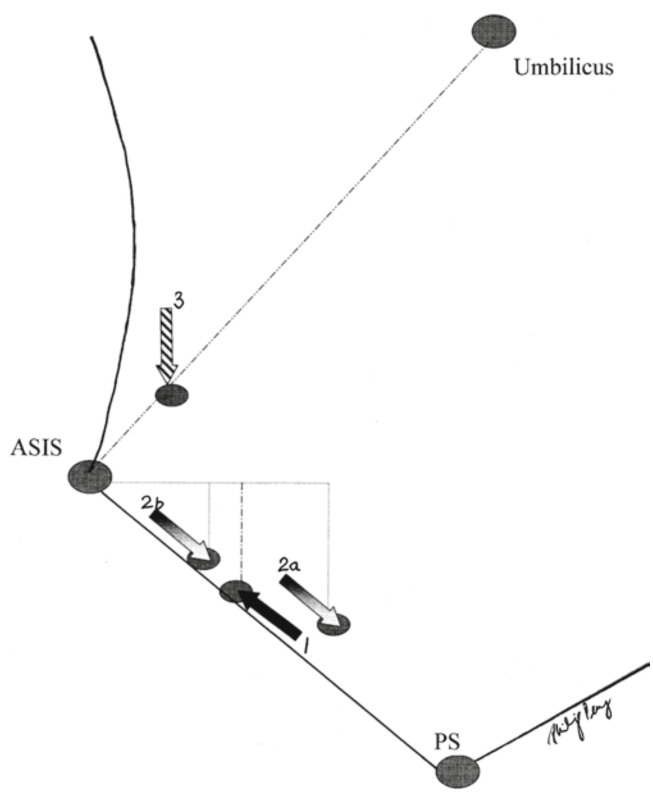

Figure 16.2. The three methods (four landmarks) described for ilioinguinal and iliohypogastric nerves injection are given in references[26–28]. *PS* pubic symphysis, *ASIS* anterior superior iliac spine. Reproduced with permission from American Society of Interventional Pain Physician.

other, is the use of ultrasound for the guidance of injection. Techniques utilizing ultrasound to inject the II and IH nerves have been published.[5,8,34,35] The accuracy of ultrasound guidance has been validated in a cadaver study with the injection site superior to ASIS and the block success rate was 95%.[34] The success of using ultrasound to guide II and IH nerve blockade has been replicated in the clinical setting. Based on visualization of the abdominal muscles, fascial planes, and the deep circumflex iliac artery, the authors were able to demonstrate a clinically successful block in all their cases based on sensory loss corresponding to the II and IH nerves following injection.[35,36] The ease and importance of identifying the abdominal muscle planes before attempting to visualize the nerves have been supported by a study assessing the training of anesthesiologists with little experience in using ultrasound to assist in needle placement.[37]

Neural blockade of the GF nerve is not commonly performed. Review of the literature yields that techniques described in the past were blind and rely on the pubic tubercle, inguinal ligament, inguinal crease, and femoral artery as landmarks.[38,39] One of the blind methods involves infiltration of 10 ml local anesthetic immediately lateral to the pubic tubercle, caudad to the inguinal ligament.[40] In another method, a needle is inserted into the inguinal canal to block the genital branch.[39] The latter method can only be reliably performed during surgery.[39] The blind techniques described are essentially infiltration techniques and rely on high volumes of local anesthetic for consistent results.[40]

Ultrasound-guided blockade of the genital branch of the GF nerve has been described in several review articles.[5,6,8] The genital nerve is difficult to visualize and blockade is achieved by identification of the inguinal canal.[5,6,8] In males, the GF nerve may travel within or outside the spermatic cord. Thus, the local anesthetic and steroid are deposited both outside and within the spermatic cord.[5,6,8]

Ultrasound-Guided Technique of Ilioinguinal, Iliohypogastric, and Genitofemoral Nerve

Ilioinguinal and Iliohypogastric Nerves

When performing II and IH nerve blockade under ultrasound guidance, it is important to clearly identify the abdominal wall muscle layers: EO, IO, and TA. The patient is placed in the supine position. Both nerves are relatively superficial, thus a high-frequency (6–13 MHz) linear probe will provide optimal visualization. The recommended area for initial scanning is posterior and superior to the ASIS. The probe should be placed perpendicular to the direction of the II and IH nerves (which is usually parallel to the inguinal ligament) with the lateral edge on top of the iliac crest (Figure 16.3). At this position, the iliac crest will appear as a hyperechoic structure adjacent to which will appear the three muscular layers of the abdominal wall (Figure 16.4). Below the TA, peristaltic movements of the bowel may be detected. The probe may need to be tilted either caudad or cephalad to optimize the image. Once the muscular layers are identified, the II and IH nerves will be found in the split fascial plane between the IO and TA muscle layers. Both nerves should be within 1.5 cm of the iliac crest at this site, with the II nerve closer to the iliac crest.[34] The nerves are usually in close proximity to each other[25] and located on the "upsloping" split fascia close to the iliac crest. In some cases, the nerves may run approximately 1 cm apart.[8] The deep circumflex iliac artery which is close to the two nerves in the same fascial layer can be revealed with the use of color Doppler (Figure 16.4). A neural structure within the fascial split may also be seen medial and on the flat part of the IO and TA muscle junction. This is the subcostal nerve and if mistaken for the II and IH nerve, the nerve blockade will result in aberrant distribution of anesthesia.

Once satisfied with visualization of the nerves, a 22-guage spinal needle is advanced to the nerves under real-time guidance. Either an out-of-plane or in-plane technique may be used although an in-plane technique is favored by the authors. The needle is advanced so the tip lies in the split fascial plane between the IO and TA muscles and adjacent to the II and IH nerves (Figure 16.4). At this point, hydrodissection with normal saline can

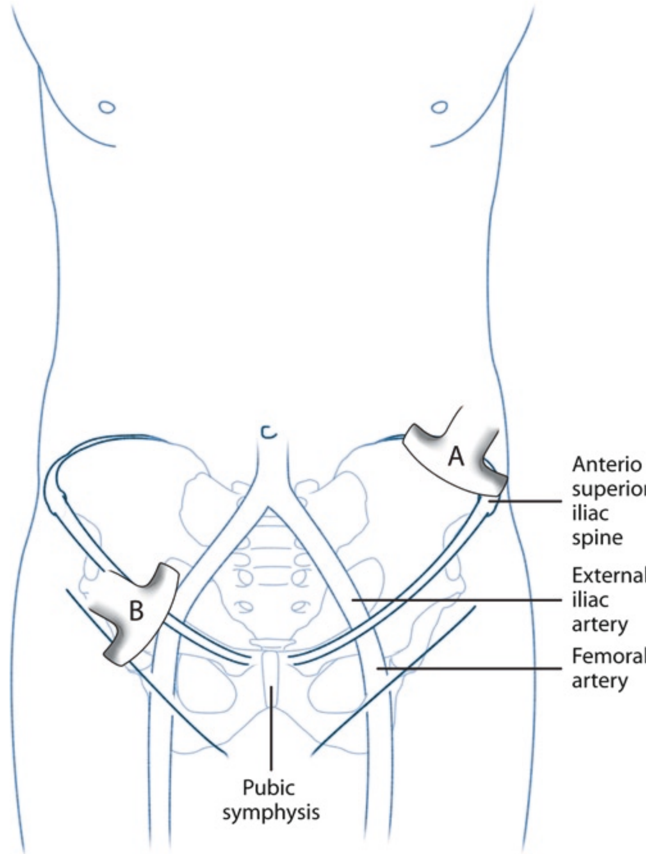

Figure 16.3. The position of the ultrasound probe is shown. The probe A is placed above and posterior to the anterior superior iliac spine and is in the short axis of the course of ilioinguinal nerve. The probe B is placed in the inguinal line in long axis of femoral and external iliac artery. Reproduced with permission from USRA (www.usra.ca).

confirm adequate position of the needle tip and spread within the fascial plane. In some cases, the nerves may be difficult to visualize. In this situation, injectate may be deposited in the fascial plane between the TA and IO muscles, ensuring satisfactory medial and lateral spread.[36] The injectate usually consists of 6–8 ml of local anesthetic (bupivacaine 0.5%) and steroid (depo-medrol 40 mg). The desired result is observation of spread of the solution in the split fascial plane to surround both nerves.

Genital Branch of Genitofemoral Nerve

The genital branch of the GF nerve cannot be visualized directly. The major structure that is sought on scanning is the inguinal canal and its content (spermatic cord in males or the round ligament in females).

The patient is positioned supine and a linear US probe with high frequency (6–13 MHz) is used. Initially, the probe is placed in the transverse plane below the inguinal ligament. In this plane, the femoral artery is identified and positioned in the middle of the screen. The probe is then rotated so that the artery lies in the long axis (Figure 16.3). The ultrasound probe is then moved cranially to trace the femoral artery until it dives deep into the abdomen to become the external iliac artery (Figure 16.5). At this point, an oval or circular structure may be seen superficial to the femoral artery. This structure is the inguinal canal and contains the spermatic cord in men and the round ligament in women. The probe may be moved slightly medial to trace the spermatic cord or round ligament. In males, arterial pulsations may be visible within the spermatic cord. These pulsations rep-

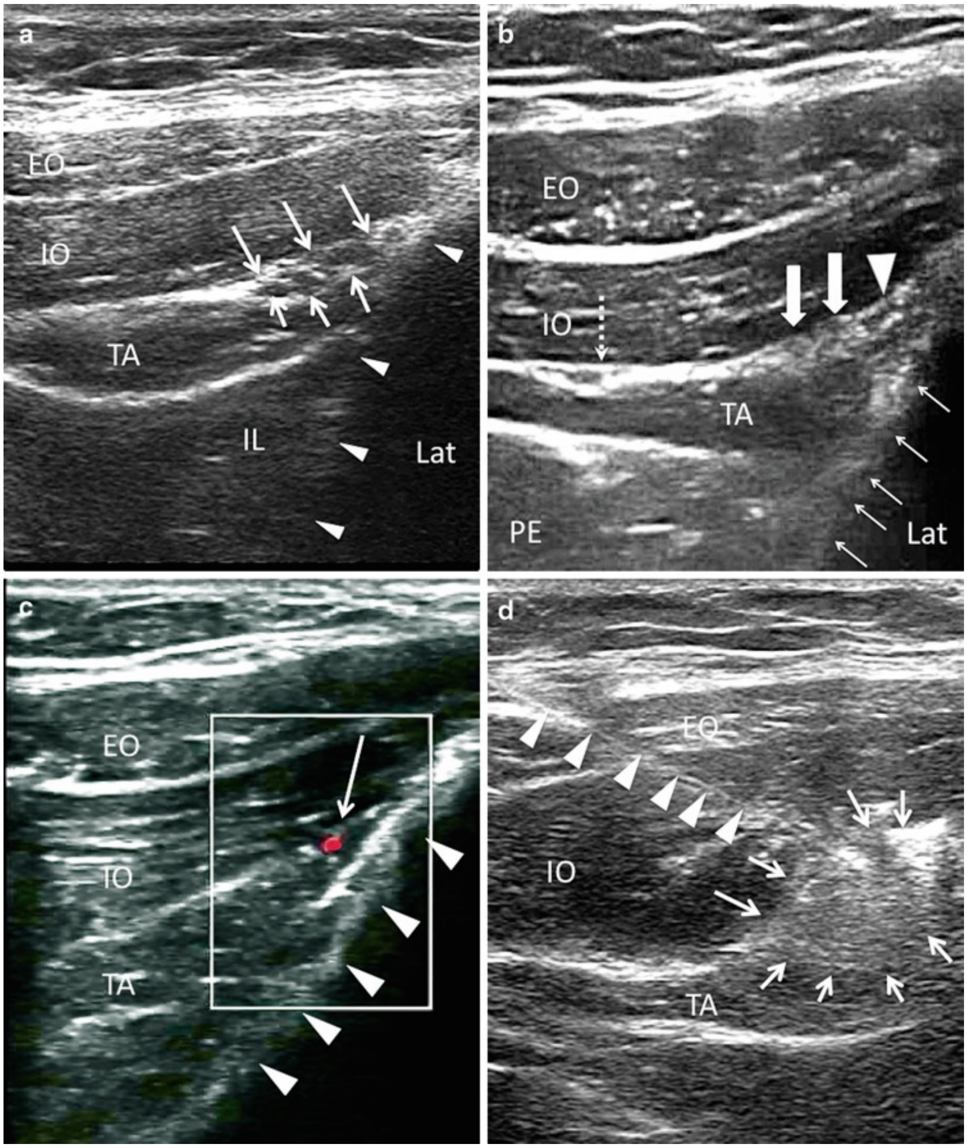

Figure 16.4. (**a**) Figure showing the three layers of muscles and the fascia split with the ilioinguinal and iliohypogastric nerves inside. *Solid triangles* outline the iliac crest. (**b**) Similar view as (**a**). *Solid arrows* show the ilioinguinal nerve (lateral) and iliohypogastric nerve (medial). *Solid triangle* shows the deep circumflex iliac artery. *Dashed line arrows* point to the fascia split with subcostal nerve (T12). Usually the fascia split for ilioinguinal and iliohypogastric nerves appears adjacent to the iliac crest. When it appears far away from the iliac crest like the one in this figure, one should suspect subcostal nerve. *Solid line arrows* outline the iliac crest. (**c**) Similar view as (**b**) with color Doppler. The deep circumflex iliac artery is shown in *red color*. *Line arrows* outline the iliac crest. (**d**) Figure showing the needle (outlined by *solid triangle*) inserted with in-plane technique and the *line arrows* outline the spread of the local anesthetic and steroid solution. *EO* external oblique muscle, *IO* internal oblique muscle, *TA* transverse abdominis muscle, *IL* iliacus, *PE* peritoneum, *LAT* lateral. Reproduced with permission from USRA (www.usra.ca).

resent the testicular artery and artery to the vas deferens. This may be confirmed by the use of color Doppler. The blood vessels may be made more prominent by asking the patient to perform a Valsalva maneuver, which increases blood flow through the pampiniform plexus. In addition to the arteries, a thin tubular structure within the spermatic cord may also be visible, which is the vas deferens. In females, the round ligament can be difficult to visualize and the target is the inguinal canal.

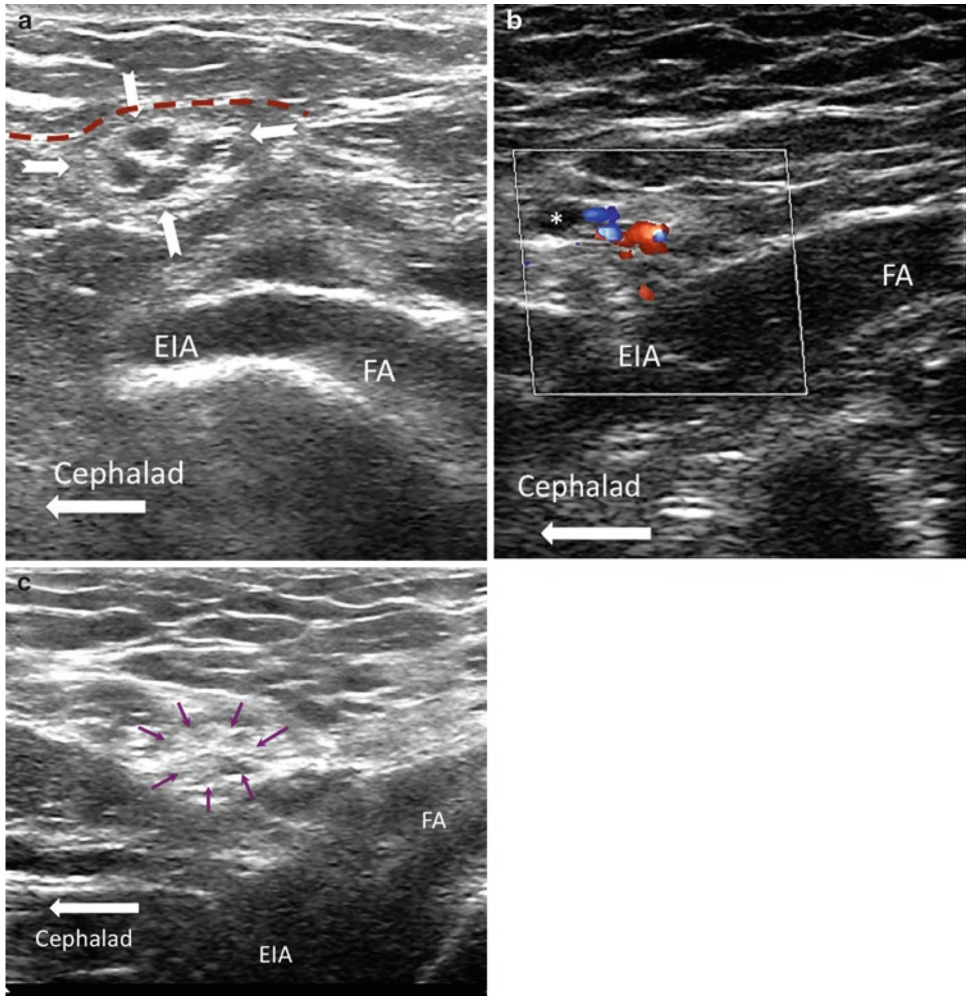

Figure 16.5. (**a**) Long-axis view of the femoral and external iliac artery showing the cross section of spermatic cord (outlined by *solid arrows*) in a male patient. The *red dashed line* outlines the deep abdominal fascia. (**b**) Similar view as (**a**) with color Doppler showing the vessels inside the spermatic cord. (**c**) Similar view as (**a**) but in a female patient showing the round ligament of uterus (outlined by *line arrows*). *EIA* external iliac artery, *FA* femoral artery. Reproduced with permission from USRA (www.usra.ca).

An out-of-plane technique is used to guide needle placement. The needle is inserted on the lateral aspect of the probe. The needle is directed to pierce the deep abdominal fascia and into the inguinal canal (Figure 16.5). Once the needle has pierced the fascia, hydrodissection with normal saline confirms spread within the inguinal canal. A volume of 4 ml of solution is deposited within the inguinal canal but outside the spermatic cord with another 4 ml deposited inside the spermatic cord. The reason for dividing the injection is due to the anatomic variability of the genital branch. The local anesthetic solution should not contain epinephrine as there is a risk of vasoconstriction of the testicular artery. In addition to local anesthetic, steroids may be added for cases with chronic pain. In females, 8 ml of the solution will be deposited into the inguinal canal.

Piriformis Syndrome

Piriformis syndrome is an uncommon cause of pain occurring in the back, buttock, or hip.[41–44] Typically, pain is felt in the region of the sacroiliac joint, greater sciatic notch, and piriformis muscle with radiation down the lower limb similar to sciatica.[45] The pain is exacerbated by walking, stooping, or lifting.[46] On physical examination, there may be gluteal atrophy and tenderness on palpation, pain on stretching of the piriformis muscle, and a positive Lasegue sign.[45,46] Often, it is a diagnosis of exclusion with clinical assessment and investigations necessary to rule out pathology of the lumbar spine, hips, and sacroiliac joint.[46,47]

Often, piriformis syndrome will improve with a conservative regimen of physical therapy and simple analgesic pharmacotherapy. For those patients not responding, more interventional therapy may be required in the form of muscle injections or surgery.[48] The piriformis muscle may be injected with local anesthetic and steroid[49] which will also aid in diagnosis if therapeutically successful. Furthermore, botulinum toxin has been injected into the piriformis muscle with evidence of longer periods of analgesia.[50,51] In those cases, in which there is failure to improve after three injections, surgical release of the piriformis muscle should be considered.[41]

Anatomy

The origin of the piriformis muscle is via fleshy digitations on the ventral surface of the S2 to S4 vertebrae (Figure 16.6).[44] Running laterally anterior to the sacroiliac joint, the piriformis muscle exits the pelvis through the greater sciatic foramen.[45] At this point, the muscle becomes tendinous inserting into the upper border of the greater trochanter as a round tendon.[47] The piriformis functions as an external rotator of the lower limb in the erect position, an abductor when supine, and a weak hip flexor when walking.[47]

All neurovascular structures exiting the pelvis to the buttock pass through the greater sciatic foramen.[47] The superior gluteal nerve and artery pass superior to the piriformis.[47] Inferior to the piriformis lie the inferior gluteal artery and nerve, the internal pudendal

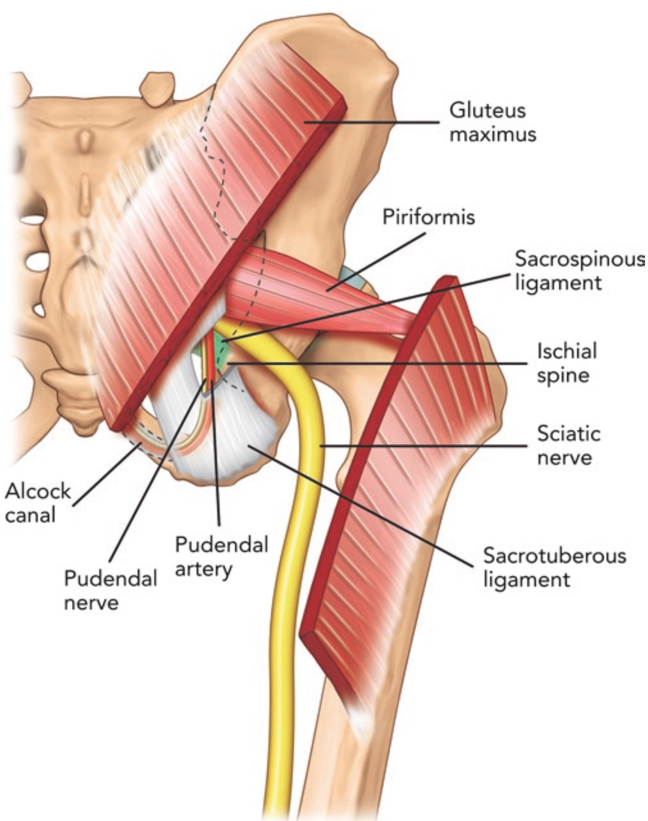

Figure 16.6. Posterior view of pelvis showing the pudendal neurovascular bundle and piriformis muscle. The gluteus maximus muscle was cut to show the deeper structures. Note that the pudendal nerve and artery run in the interligamentous plane between the sacrospinous and sacrotuberous ligament and subsequently into the Alcock's canal. Reproduced with permission from USRA (www.usra.ca).

artery, the pudendal nerve, nerve to obturator internus, posterior femoral cutaneous nerve, nerve to quadratus lumborum, and the sciatic nerve.[47] The anatomical relationship between the piriformis muscle and sciatic nerve is variable. Most commonly (78–84%), the sciatic nerve passes below the piriformis muscle.[52,53] Less frequently (12–21%), the nerve is divided, passing through and below the muscle.[53] Less common variations are the divided nerve passing through and above the piriformis; the divided nerve passing above and below the muscle; undivided nerve passing above piriformis; or undivided nerve passing through the muscle.[52,53] The close relationship of the piriformis muscle to the sciatic nerve explains why patients experiencing piriformis syndrome may also experience symptoms of sciatic nerve irritation.[43]

Literature Review on Piriformis Muscle Injections

There have been reports of different techniques utilized to inject the piriformis muscle, including fluoroscopy,[49] CT,[54] and MRI[55] to assist with accurate needle placement within the muscle. Electrophysiologic guidance has been used alone and in conjunction with the above modalities.[51,56,57] Irrespective of whether EMG guidance is used, fluoroscopically guided piriformis muscle injections depend on the presence of a characteristic intrapiriformis contrast pattern to confirm needle placement within the piriformis muscle (Figure 16.7),[49] which has been shown to be unreliable.[58] A validation study with cadavers suggested that the fluoroscopically guided contrast-controlled injection was only accurate in guiding an intrapiriformis injection in 30% of the injections.[58] In cases where the needle was incorrectly placed, the usual final position of the needle was within the gluteus maximus muscle, which overlies piriformis.

In contrast, ultrasound is seen as an attractive imaging technique as it provides visualization of the soft tissue and neurovascular structures, and allows real-time imaging of needle insertion toward the target.[59] Multiple reports of ultrasound-guided piriformis muscle injection have been published with similar techniques described.[4,5,58,60,61] The accuracy of needle placement with ultrasound was recently validated in a cadaveric study suggesting an accuracy of 95%.[58]

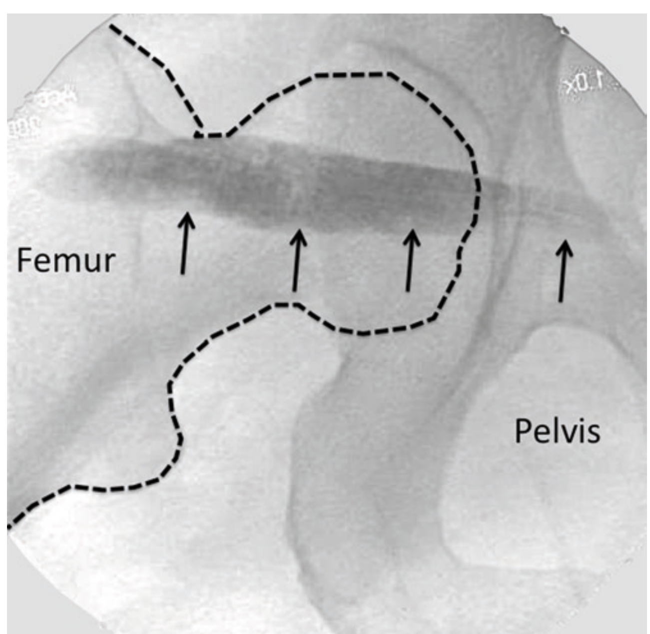

Figure 16.7. Radiographic contrast (indicated by *line arrows*) outlining the piriformis muscle. Reproduced with permission from USRA (www.usra.ca).

Ultrasound-Guided Technique for Piriformis Muscle Injection

The patient is placed in the prone position. A low-frequency (2–5 Hz) curvilinear probe is held in the transverse plane and initially positioned over the posterior superior iliac spine (PSIS). The transducer is then moved laterally to visualize the ilium, which will be identifiable as a hyperechoic line descending diagonally across the screen from the superomedial to inferolateral corners (Figure 16.8). Once the ilium is visualized, the probe

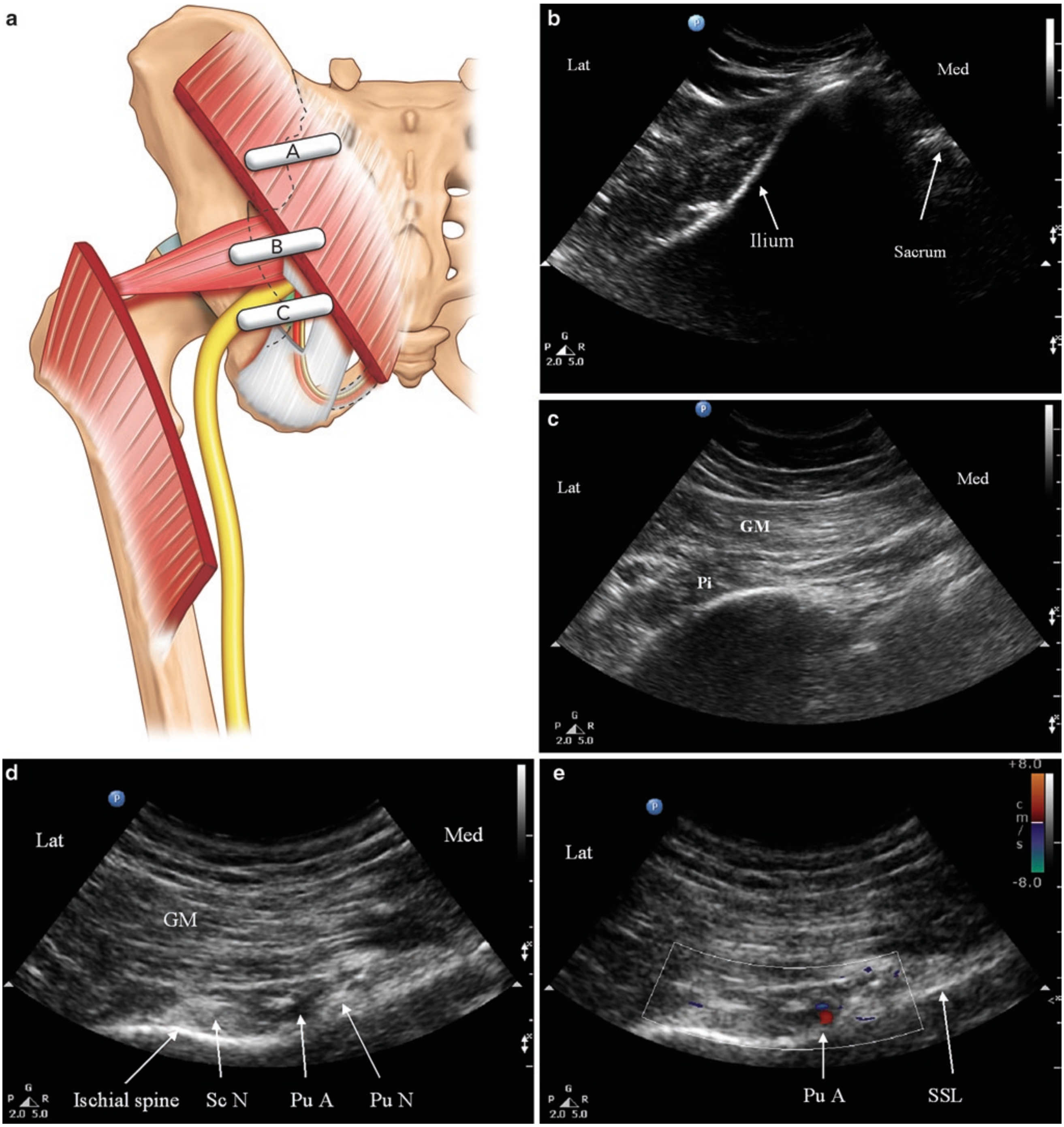

Figure 16.8. Ultrasonographic scan of the piriformis muscle and the pudendal nerve. (**a**) Three different positions of ultrasound probe. Reproduced with permission from USRA (www.usra.ca). (**b**) Ultrasound image at probe position A. (**c**) Ultrasound image at probe position B. (**d**) Ultrasound image at probe position C. (**e**) Color Doppler to show pudendal artery. *Pu A* pudendal artery, *Pu N* pudendal nerve, *SSL* sacrospinous ligament, *Sc N* sciatic nerve, *GM* gluteus maximus muscle. (**b**–**e**) From Rofaeel et al.[7] Reproduced with permission from Lippincott Williams & Wilkins.

is orientated in the direction of the piriformis muscle and moved in a caudad direction until the sciatic notch is found (Figure 16.8). At the sciatic notch level, the hyperechoic shadow of the bone will disappear from the medial aspect and two muscle layers will be visible: the gluteus maximus and the piriformis (Figure 16.8). Confirmation of the piriformis muscle can be made by having an assistant rotating the hip externally and internally with the knee flexed. This movement will demonstrate side to side gliding of the piriformis muscle on ultrasound. It is important to identify the sciatic notch, as failure to do so may lead the practitioner to mistakenly identify one of the other external hip rotators (e.g., the gemelli muscles) as piriformis.

Due to the depth of the muscle, a 22-guage, 120 mm nerve stimulating needle is used. The authors recommend the concomitant use of a nerve stimulator to avoid unintentional injection of the sciatic nerve, as the passage of the sciatic nerve in this territory is variable as described above. In addition, the use of a nerve stimulator also allows identification of the needle tip within the piriformis muscle by the visualization of piriformis muscle twitches on the monitor.

An in-plane technique is used with the needle being inserted on the medial aspect of the probe and passing laterally into the muscle belly of the piriformis in the sciatic notch. If intramuscular injection is the objective, the needle should be slowly advanced further until strong contractions of the piriformis muscle are evident on the monitor. A small volume of normal saline (0.5 ml) may be injected to confirm position within the muscle. Once satisfied with needle position, a small volume (1–2 ml) of medication (either a mixture of 1 ml of 0.5% bupivacaine and 40 mg depo-medrol or 50 units of Botulinum toxin A diluted in 1 ml of normal saline) may be injected into the muscle.

Pudendal Neuralgia

The pudendal nerve supplies the anterior and posterior urogenital areas (clitoris, penis, vulva, and perianal area).[62–64] Pudendal neuralgia refers to CPP where pain is experienced in these regions innervated by the pudendal nerve.[62] Typically, the pain is exacerbated by sitting and may be reduced by lying on the nonpainful side, standing, and sitting on a toilet seat.[65] On physical examination, there may be evidence of hypoesthesia, hyperalgesia, or allodynia in the perineal area.[65] The pain may be reproduced or exaggerated when pressure is applied against the ischial spine during a vaginal or rectal examination. Pudendal nerve block is an important tool in the diagnosis of this condition.[66]

Often the cause of the symptoms in patients suffering from pudendal neuralgia will not be readily identifiable. However, bicycle riding,[67] vaginal delivery,[68,69] countertraction devices in orthopedic surgery,[70,71] pelvic trauma,[70] and intensive athletic activity[72] are recognized risk factors in the development of pudendal neuralgia. There are two anatomical regions in which the pudendal nerve is susceptible to entrapment along its path: (1) the interligamentous plane, which lies between the sacrotuberous and sacrospinous ligaments at the level of the ischial spine[73]; (2) Alcock's canal.[74]

Anatomy

The pudendal nerve contains both motor and sensory fibers.[75] Relative to the major nerves of the extremities, the pudendal nerve is thin (0.6–6.8 mm) and is situated deep within the body, surrounded by fatty tissue.[76] The nerve arises from the anterior rami of the second, third, and fourth sacral nerves (S2, S3, and S4)[75] and passes through the greater sciatic notch.[76] Once out of the pelvis, the pudendal nerve travels ventrally in the interligamentous plane between the sacrospinous and sacrotuberous ligament at the level of the ischial spine (Figure 16.6).[62,77] At this level, 30–40% of pudendal nerves will be two- or three-trunked.[62,78,79] Within the interligamentous plane, the pudendal artery is located lateral to the pudendal nerve in the vast majority of cases (90%).[76] This region is of clinical importance as the nerve may be compressed between the sacrospinous and sacrotuberous ligaments.[73] Furthermore, elongation of the ischial spine due to repetitive muscular forces represents a potential source of microtrauma affecting the pudendal nerve.[72]

Following its passage between the two ligaments, the pudendal nerve swings anteriorly to enter the pelvis through the Alcock's canal of the lateral ischiorectal fossa.[78–80] Alcock's canal is a fascial sheath formed by the duplication of the obturator internus muscle, underlying the plane of levator ani.[78] At this site, the pudendal nerve is also susceptible to entrapment either by the fascia of the obturator internus or by the falciform process of the sacrotuberous ligament.[74]

As the pudendal nerve travels through the ischiorectal fossa, it gives off three terminal branches: the dorsal nerve of the penis, inferior rectal nerve, and the perineal nerve. The dorsal nerve of the penis runs lateral to the dorsal artery and deep dorsal vein of the penis, terminating in the glans penis.[77,81,82] The course of the nerve under the subpubic arch makes it susceptible to compression by the saddle nose of a bicycle.[83] The inferior rectal nerve supplies the external anal sphincter.[77,81,82] The remaining portion of the pudendal nerve trunk becomes the perineal nerve which continues to supply sensation of the skin of the penis (clitoris), perianal area, and the posterior surface of the scrotum or labia majora.[82] The perineal nerve also provides motor supply to the deep muscles of the urogenital triangle.[81,82]

Literature Review on the Pudendal Nerve Injections

There are two anatomical regions at which blockade of the pudendal nerve may be performed: the interligamentous plane[73] and Alcock's canal.[74]

The pudendal nerve has been blocked by various routes in the literature. These include the transvaginal[84], transperineal,[85,86] and transgluteal approaches.[87] The transgluteal approach is popular allowing blockade at the ischial spine and Alcock's canal. Traditionally, fluoroscopy has been used to guide needle placement, using the ischial spine as a surrogate landmark.[62] The needle is placed medial to the ischial spine which corresponds to the course of the pudendal nerve at this level.[87,88] The major limitation of fluoroscopy is that it cannot accurately demonstrate the interligamentous plane.[5,8] At the level of the ischial spine, the pudendal artery lies between the pudendal nerve and the pudendal artery in the majority of cases (76–100%).[7,76] Therefore, injectate may not spread to the pudendal nerve using this landmark. In addition, the potential proximity of the sciatic nerve at this level makes it susceptible to the anesthetic if spread of the injectate is not visualized in real time. Furthermore, the depth for needle insertion cannot be assessed with fluoroscopy.

Both ultrasound and computed tomography (CT) scan are ideal for visualizing the interligamentous plane as they identify all the important landmarks: ischial spine, sacrotuberous ligament, sacrospinous ligament, pudendal artery, and the pudendal nerve.[8] Furthermore, it also allows visualization of the sciatic nerve and other vascular structures, so more selective needle placement and blockade can occur. Ultrasound has the advantage of avoiding exposing the patient to radiation and is more accessible to clinicians. While early reports only described ultrasound visualization of the pudendal nerve,[76,89] the actual technique of blockade has been reported in greater detail recently.[5,7,8] A consistent feature of published techniques on ultrasound-guided pudendal nerve blockade is identifying the ischial spine and its medial aspect which contains the sacrotuberous and sacrospinous ligaments, internal pudendal artery, and pudendal nerve.[5–8]

At the level of Alcock's canal, ultrasound cannot accurately identify or guide needle placement. CT guidance is the only form of imaging which can accurately guide the needle into the canal.[90]

Ultrasound-Guided Technique for Pudendal Nerve Injection

Pudendal nerve blockade at the level of the ischial spine with ultrasound guidance is performed via the transgluteal approach with the patient in the prone position. The aim of scanning is to identify the ischial spine and therefore reliably identify the interligamentous plane which will appear on its medial aspect. A curvilinear probe (2–5 Hz) is recommended for scanning due to the depth of the nerve. Scanning begins with the probe held in the transverse plane over the PSIS, a technique similar to that of scanning the piriformis muscle (Figure 16.8). The probe is then moved caudad until the piriformis muscle is identified as described above for the piriformis muscle injection. At this level the ischium can be identified as a curved hyperechoic line. The probe is then moved further caudad to identify the ischial spine. The following four features will help to identify the level of the ischial spine (Figure 16.8):

The ischial spine will appear as a straight hyperechoic line as opposed to the ischium which is a curved hyperechoic line.

The sacrospinous ligament will be visualized as a hyperechoic line lying medial and in contact with the ischial spine. The sacrospinous ligament, however, does not cast an anechoic shadow deep to its image, as opposed to that casted by bone structures.

The piriformis muscle will disappear. Deep to the gluteus maximus lies the sacrotuberous ligament. Although it is difficult to differentiate between this ligament and the fascial plane of the gluteus maximus, the sacrotuberous ligament can be felt easily as the needle is advancing through this thick ligament.

The internal pudendal artery can be seen, usually situated on the medial portion of the ischial spine. This can be confirmed with color Doppler.

The pudendal nerve will lie medial to the pudendal artery at this level. However, due to the depth and the small diameter of the nerve it may be difficult to visualize. On dynamic scan, the sciatic nerve and inferior gluteal artery can be seen lateral to the ischial spine tip. Visualization of these structures is important because if these are mistaken for the internal pudendal artery, sciatic nerve blockade will result.

Once satisfied with the identification of the ischial spine, pudendal artery, and the interligamentous plane, a 22-guage, 120 mm insulated peripheral nerve stimulating needle is inserted from the medial aspect of the probe. The target is for the needle tip to be situated between the sacrotuberous ligament and sacrospinous ligament. Due to the depth of the pudendal nerve, it is helpful to insert the needle several centimetres medial to the medial edge of the probe to reduce the steepness of the needle path and therefore assist in visualization of the needle tip as it passes to the target site. The needle is advanced so that it will pass through the sacrotuberous ligament, on the medial side of the pudendal artery. As the needle is passing through the sacrotuberous ligament, increased resistance will be felt. Once the needle is through, the resistance will diminish. A small volume of normal saline is injected to confirm position within the interligamentous plane. The pudendal nerve itself will be difficult to visualize due to a combination of its depth,[7,76] small diameter,[62,76,79] and possibility of anatomical division into two or three trunks.[62,78,79]

If hydrodissection confirms adequate spread within the interligamentous plane and no intravascular spread, a mixture of local anesthetic and steroid may be injected. In the author's experience, a mixture of 4 ml of 0.5% bupivacaine and 40 mg of steroid (depomedrol) is commonly injected and clinical signs of pudendal nerve blockade are present shortly after. During injection, the clinician should ensure that there is a spread of the injectate medial to the pudendal artery and that the injectate does not pass too far laterally past the artery. Excessive lateral spread may result in inadvertent sciatic nerve blockade. It is recommended that the patient is assessed for signs of successful blockade following the procedure. This may be achieved simply by assessing sensation to pin prick and alcohol swab in the perineal area ipsilateral to site of blockade. Successful blockade will result in reduced sensation to both stimuli in this region.

Conclusion

Ultrasound is a valuable tool for imaging peripheral structures, guiding needle advancement, and confirming the spread of injectate around the target tissue, all without exposing healthcare providers and patients to the risks of radiation. In patients with CPP, the target structures for the interventional procedures can be well visualized with the use of ultrasound. Most of the ultrasound-guided interventional procedures in CPP have been validated and thus allow the accurate performance of these procedures.

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