Use of ultrasound in chronic pain medicine—Part 2: Musculoskeletal and peripheral nerve applications

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Key points
The majority of patients seen in pain clinic present with a musculoskeletal complaint.
Ultrasound provides excellent resolution of musculoskeletal tissues and peripheral nerves, and is the tool of choice in a variety of musculoskeletal conditions for both diagnostic and therapeutic purposes.
The use of ultrasound to guide musculoskeletal and peripheral nerve interventions may offer greater accuracy and specificity compared with landmark techniques, and avoids exposure to ionizing radiation.
Ultrasound enables a dynamic and focused examination that may reveal pathology missed with static imaging.
Ultrasound may be useful to guide a wide variety of musculoskeletal and peripheral nerve interventions.

The previous article discussed the emerging role of ultrasound in chronic pain medicine, its potential advantages, and disadvantages, and placed particular emphasis on interventions related to the spine and sympathetic blocks. Many patients seen in the pain clinic present with a musculoskeletal problem and gaining skills in musculoskeletal ultrasound is a valuable acquisition for pain medicine specialists. This article gives an overview of the use of ultrasound in the diagnosis and treatment of painful conditions of the musculoskeletal and peripheral nervous system.

Musculoskeletal system
Ultrasound has a number of distinct advantages compared with other imaging modalities,1 and it is considered the diagnostic investigation of choice for a number of musculoskeletal problems.2

It is highly tolerable and acceptable to patients, there are no contraindications, and it is safe to use with MRI incompatible devices. It is highly portable, provides high-resolution images of soft tissue structures, and avoids exposure to ionizing radiation. Diagnostic and therapeutic interventions can be carried out during the same clinic visit, which benefits both patients and institutions.

Another significant advantage is the capability to perform a targeted and dynamic assessment. Static images produced by MRI or CT are usually interpreted at a remote site, whereas, with ultrasound, the sonographer can interact with the patient, and focus their examination accordingly. Images obtained during movement or against resistance may reveal occult pathology not apparent at rest, and whose symptoms may have been inadvertently attributed to ‘incidental findings’. This dynamic assessment is strengthened by the ability to alter the field of view, and make comparisons with opposite structures. In addition, the use of Doppler allows a real-time appreciation of blood flow.

Limitations include technical factors such as a reduction in resolution with increasing depth, poor penetration of bone, and a small viewing footprint. The technique is operator dependent, and a significant amount of time is required to gain expertise.

It is essential to have a working knowledge of the normal and abnormal ultrasound appearances of musculoskeletal structures, and these are outlined in Table 1. Structures can be broadly differentiated by their anatomical course, echogenicity, echotexture, compressibility, anisotropy, and Doppler flow characteristics.3

Ultrasound has been used to guide a wide number of interventions, the evidence for which has been summarized recently.4 The most commonly performed intervention involves the injection of local anaesthetic and steroid, but other procedures in which ultrasound may be useful include: percutaneous lavage of calcific tendonitis, pulsed radiofrequency, prolotherapy, and injection of botulinum toxin or sclerosants. In addition, ultrasound can be used to ensure the accurate placement of trigger point injections.5

Shoulder
Ultrasound has value in the assessment of bursitis, rotator cuff tears, calcific tendonitis, biceps tendon disease, and septic arthritis. It may also be used in the assessment of impingement syndrome. However, ultrasound is not considered useful for the assessment of adhesive capsulitis, rotator cuff atrophy, or stability of the glenohumeral joint.2
Because the biceps tendon is in continuity with the glenohumeral joint, effusions can spread into the tendon sheath, and mimic bicipital tenosynovitis.

Injections into the subacromial bursa or shoulder joint are usually performed when pain is severe or conservative measures have failed.

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In a small study of 50 ultrasound-guided glenohumeral joint injections, 94% were correctly placed.\textsuperscript{6} Compare this with the correct placement of landmark based injections, which varies, and is generally poor (quoted between 10 and 42%).\textsuperscript{7}

**Sub-acromial bursa**

With the patient sitting and their palm placed on the ipsilateral buttock, a high-frequency probe is placed in the coronal plane with its medial end positioned over the acromion process. The bursa can be approached in-plane from lateral to medial, and should be visible between the deltoïd muscle and the supraspinatus tendon, where it may be outlined by the peribursal fat pad (Fig. 1).

**Glenohumeral joint**

Adducting the arm across the chest facilitates a posterior approach. A high-frequency transducer placed caudal and parallel to the spine of the scapula reveals the glenoid fossa and humeral head. The injection is then performed in plane from lateral to medial, targeting the space between the glenoid labrum and humeral head.

**Table 1** Characteristics of musculoskeletal structures seen on ultrasound.\textsuperscript{3} N, normal appearance; P, pathological changes; A, anisotropy; C, compressibility; D, Doppler flow; +, present; –, absent

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Transverse plane (T)</th>
<th>Longitudinal plane (L)</th>
<th>A</th>
<th>C</th>
<th>D</th>
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<tbody>
<tr>
<td><strong>Tendons</strong></td>
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<tr>
<td>N</td>
<td>Hyperechoic; (T) Stippled; (L) Fibrillar. Tightly packed collagen fibres, significant anisotropy</td>
<td>+++</td>
<td>–</td>
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<td>P</td>
<td>Tendinosis: enlargement, hypoechoogenicity, increased interfibrillar distance</td>
<td>+ – –</td>
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<td>Trauma: as above + loss of normal fibrillar pattern</td>
<td>+ – –</td>
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<td></td>
<td>Tears: focal anechoic areas; tendon gap. Demonstration may require dynamic scanning</td>
<td>+ – –</td>
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<td><strong>Ligaments</strong></td>
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<tr>
<td>N</td>
<td>Similar appearance to tendons but less compact and multidirectional pattern of collagen fibres</td>
<td>+ – –</td>
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<td></td>
<td>Identify by tracing anatomical insertions</td>
<td>+ – –</td>
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<tr>
<td>P</td>
<td>Enlargement, reduced echogenicity, fibre disruption</td>
<td>+ – –</td>
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<td><strong>Nerve</strong></td>
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<td>N</td>
<td>Mixed echogenicity. (Hypoechoic=nerve fascicles; hypoechoic connective tissue=epineurium/perineurium)</td>
<td>+ – –</td>
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<td></td>
<td>Proximal nerves have less connective tissue and may not demonstrate speckled pattern (e.g. brachial plexus)</td>
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<td></td>
<td>Often located in proximity to vessels. Speckled (T); Fascicular (L)</td>
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<td>P</td>
<td>Swelling (proximal if entrapped); diffuse echogenicity; loss of normal fascicular pattern</td>
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<td><strong>Muscle</strong></td>
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<td>N</td>
<td>Mixed echogenicity. (Hypoechogenic=muscle fascicles; Hyperechogenic=perimysium/epimysium)</td>
<td>+ – –</td>
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<td></td>
<td>Atrophy: loss of distinctive pattern and increased echogenicity; reduction in muscle fascicles; adipose and connective tissue deposition</td>
<td>+ – –</td>
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<td></td>
<td>Trauma: subtle hypoechoogenicity, loss of normal pattern, frank fibre disruption</td>
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<td><strong>Vessel</strong></td>
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<td>N</td>
<td>Hypo/anechoic tubular structures</td>
<td>– ++ ++</td>
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<td>P</td>
<td>Thrombus—non-compressible; reduction/absence of luminal flow</td>
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<td><strong>Bursae</strong></td>
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<td>N</td>
<td>Anechoic &lt;2 mm thick. Most bursa not visible unless distended (exceptions include subacromial bursa)</td>
<td>– ? –</td>
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<td>P</td>
<td>Enlarged (simple—anechoic; complex, e.g. calcium deposition—mixed echogenicity)</td>
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<td><strong>Joint</strong></td>
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<td>Cartilage</td>
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<tr>
<td>N</td>
<td>Anechoic and smooth</td>
<td>Hyperechoic and smooth border. Posterior acoustic shadowing</td>
<td>Not visualized with ultrasound</td>
<td></td>
<td></td>
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<tr>
<td>P</td>
<td>Reduced dimensions; irregular</td>
<td>Irregularities in smooth border</td>
<td>Increased vascularity (Doppler)</td>
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<td>Effusions: simple—anechoic; complex (non-specific)—mixed echogenicity</td>
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**Fig 1** Upper limb musculoskeletal ultrasound. (A) Patient positioning for subdeltoïd bursa injection. (B) Corresponding US image. (C) Positioning for posterior approach to glenohumeral joint, just caudal and lateral to the spine of scapula. DEL, deltoïd; SST, supraspinatus; BU, bursa; FP, peribursal fat pad; HUM, humerus.
Elbow
Ultrasound is used in the assessment of lateral and medial epicondylitis, synovitis, triceps tendon injury, olecranon bursitis, septic arthritis, effusions, and entrapment of the radial, median, and ulnar nerves. It may also have value in the assessment of ulnar collateral ligament injury.\(^2\) Effusions are best viewed and aspirated posteriorly (with 90° flexion), where the olecranon fossa is normally filled with an echogenic fat pad.

Wrist
Because wrist structures are superficial, ultrasound has numerous indications in the evaluation of tendons, soft tissues, synovium, and nerves.\(^2\) In carpal tunnel syndrome, the proximal portion of the nerve becomes swollen while the portion passing through the tunnel is compressed. Although diagnostic criteria vary, quantification of the median nerve cross-sectional area with ultrasound may be considered diagnostic. In addition, anatomical information such as the presence of a bifid median nerve or persistent median artery is useful, as this may guide management and therapeutic intervention.\(^8\)

Hip
There is good evidence for the evaluation of synovitis, synovial cysts, effusions, high-grade muscle tears, and assessing an extra-articular cause of a snapping hip.\(^2\) Ultrasound is not currently considered first line in the assessment of trochanteric pain, although it may facilitate a guided injection. Fluoroscopy, CT, or landmark guidance is compounded by radiation exposure, high cost, heavy use of resources, the potential for neurovascular damage (femoral nerve, deep circumflex vessels), and technical failure. Studies evaluating the feasibility and accuracy of ultrasound guided hip injections with either CT or fluoroscopic confirmation have yielded favourable results (97–100%).\(^9,10\)

Technique
Using a low-frequency probe, identify the femoral nerve and vessels in their transverse plane at the level of the inguinal ligament. With the hip in the neutral position, the femoral head and acetabulum are visualized. Rotate the probe along the long axis of the femoral neck, keeping the femoral head and acetabulum in view. Doppler is used to identify vascular structures. Target the anterior synovial recess (which is at the junction of the femoral head and neck), with a 22G spinal needle inserted in plane from the distal end of the transducer. Needle and injectate visibility may be difficult because of depth (Fig. 2).

Knee
Ultrasound may be useful to guide diagnostic or therapeutic procedures, such as aspiration or injection. It is not useful in the assessment of cruciate ligaments, meniscal tears, or fractures.\(^2\) Ultrasound may be superior to landmark guidance for knee injections and, in one study, there was an improvement in success rate from 77.8% (137 of 176 injections) to 95.8% (181 of 189) \(P<0.001, \text{OR } 6.4, 95\% \text{ CI } 2.9–14.\)^11

Technique
One approach is via the lateral recess of the suprapatellar pouch. The knee is flexed and a high-frequency linear probe is positioned in the parasagittal plane, just lateral to the midline at the upper border of the patella. The quadriceps femoris tendon, shaft of femur, prepatella, and prefemoral fat pads are identified. The lateral recess is located between the fat pads and appears as an anechoic fluid filled space. To avoid puncture of the tendon, the probe is rotated into the transverse plane and the injection performed in-plane from lateral to medial. The volume of fluid in the lateral recess can be accentuated by either massaging the knee or by asking the patient to tense their quadriceps (Fig. 2).

Ankle
Ultrasound is an excellent imaging choice for the assessment of tendons, ligaments, effusions, synovium, ganglia, Morton’s neuroma, and plantar fasciitis. The assessment of bones or cartilage is not recommended.\(^2\) Morton’s neuroma appears as an ill-defined, hypoechoic, ovoid, or fusiform mass located between the metatarsal heads, on the plantar surface of the foot.

Plantar fasciitis
Ultrasound features of plantar fasciitis include increased thickness, vascularity, and hypoechoogenicity of the plantar fascia, usually at its origin from the calcaneum (enthesis). Corticosteroid injections can provide good short-term pain relief; however, the condition is usually self-limiting. In cases of refractory plantar fasciitis, ultrasound assessment may reveal atypical patterns of disease and facilitate a more targeted intervention with improved outcomes.\(^12\)

Technique
With the patient prone use a high-frequency linear transducer longitudinally over the heel. The plantar fascia can be identified as a linear, fibrillar, echogenic structure attached to the cortex of the calcaneum. The length of the fascia is traced to assess for tears or rupture, and its thickness measured at its proximal insertion. The plantar fascia can be approached from the most convenient location, and injectate deposited in or around the fascia.

Peripheral nerves
Greater occipital nerve
A traditional landmark injection, medial to the occipital artery at the level of the superior nuchal line, lacks selectivity, and its success may be a result of adjacent spread to a multitude of other nerves or
tissues. A more selective greater occipital nerve block may be achieved more proximally at the level of C2 where the nerve overlies the obliquus capitis inferioris muscle (OCI). This muscle arises from the bifid spinous process of C2 and inserts into the transverse process of C1. A cadaveric study using ultrasound and a very small volume of dye (0.1 ml) yielded 100% success at this new location, vs 86% success at the traditional site.

**Technique**

Use a high-frequency transducer in the transverse plane. Start in the midline and scan caudally from the external occipital protuberance, to identify the bifid process of C2. Move the probe laterally, and then rotate the lateral end superiorly along the long axis of the OCI muscle. The greater occipital nerve should come into view between trapezius and OCI and can be blocked with an in-plane approach from medial to lateral. Caution must be exercised to avoid the vertebral artery, which is seen deep to OCI (Fig. 3).

**Suprascapular nerve block**

The suprascapular nerve innervates ~70% of the shoulder joint. Anatomically it arises from the C5 root, or superior trunk of the brachial plexus. It travels deep to the omohyoid muscle in the supraclavicular fossa and travels posteriorly to enter the supraspinous fossa through the suprascapular notch (which has a wide anatomical variation). The nerve and the suprascapular artery travel deep to the supraspinatus and infraspinatus muscles in their corresponding fossae, on the surface of the scapula.

The nerve is commonly targeted in the floor of the supraspinous fossa to avoid traversing the suprascapular notch and risking a pneumothorax. However, the nerve is difficult to visualize with ultrasound, and proximal articular branches may be missed. Alternatively, the suprascapular nerve may be traced from its origin at C5, and targeted more superficially in the supraclavicular fossa as it tracks beneath omohyoid. At this site in 60 volunteers, the median depth of the nerve was 8 mm and the nerve was visualized in 97 of 120 examinations (81%). This compares with a median depth of 35 mm and 36% visualization in the suprascapular fossa.

**Technique**

In the supraspinous fossa, a high-frequency linear probe is positioned parallel to the spine of the scapula inferior to the suprascapular notch. The trapezius and supraspinatus muscles should be visible.
and the lateral edge of the probe rotated superiorly to bring the nerve and artery into their short axis in the floor of the fossa. An in-plane approach is best performed from medial to lateral (Fig. 3).

**Ilioinguinal and iliohypogastic nerves**

Blind injections generally have a low success rate, which is attested to by the number of differing landmark techniques. In a study of 62 children having a landmark procedure, which was observed by ultrasound, 86% of injections were intramuscular, with an overall failure rate of 45%. A cadaveric study targeting the nerves with ultrasound at a more proximal location (5 cm cranial and posterior to the anterior superior iliac spine) returned a 95% simulated block success, using 0.1 ml of dye to completely colour the nerve in 33 of 37 injections. In two of the remaining four injections, the nerve was partially coloured.

**Technique**

Use a high-frequency linear probe with the patient supine. Scan ~5 cm cranial to the anterior superior iliac spine keeping the iliac crest in view at the lateral edge of the probe. At this level, all three muscle layers should be visible, and there is a high probability (90%) that the nerves will run between the internal oblique and transverses abdominus muscles. The nerves are hyperechoic, often accompanied by a blood vessel, and are usually visualized in a fascial split, typically passing 10 mm apart. Oblique rotation of the probe should bring the nerves into their short axis and the nerves can be targeted with either an in-plane or out-of-plane approach (Fig. 4).

**Genitofemoral nerve**

Genitofemoral nerve block may be useful in the diagnosis of genitofemoral neuralgia. It is mainly a sensory nerve with the genital branch supplying sensation to the scrotum or labia, and the femoral branch, supplying the skin overlying the upper part of the femoral triangle. The genital branch enters the inguinal canal via the deep inguinal ring, and the femoral branch follows the external iliac artery. A technique for ultrasound guided blockade of the genital branch has been described.

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**Fig 3** Peripheral nerve interventions. (a) Origins of the obliquus capitis inferioris muscle (OCI) and pathway of the greater occipital nerve (GON). Reproduced with permission. (b) Transverse view of the bifid C2 spinous process (C2-SP). (c) Corresponding US image along the long axis of OCI and showing GON. (d) Patient positioning and in-plane approach. (e) Pathway of the suprascapular artery and nerve. Note the muscular and articular branches. Reproduced with permission of usra.ca. (f) The nerve (N) is seen on the floor of the supraspinous fossa adjacent to the artery (A), deep to supraspinatus (SS), and trapezius (Tra). The probe is aligned obliquely from the acromion process (AC).
**Technique**

A high-frequency probe is placed perpendicular to the inguinal ligament and lateral to the pubic tubercle. In its short axis, the spermatic cord should be ovoid or spherical in shape, and visualized superficial to the femoral artery (seen in its long axis). The cord can be accentuated by asking the patient to cough or strain to increase the venous pressure, and one or two arteries may be seen within it. Injectate is then placed within and around the cord, as the location of the nerve can vary (Fig. 4).

**Lateral femoral cutaneous nerve**

The lateral femoral cutaneous nerve (LFCN) is sensory to the anterolateral thigh, and is traditionally blocked by a landmark technique for the treatment of meralgia paraesthetica. The nerve usually enters the thigh beneath the lateral edge of the inguinal ligament, and passes from medial to lateral over the sartorius muscle into the intermuscular space between sartorius and tensor fasciae latae. It then divides into anterior and posterior branches. Despite the description, anatomical variation is common such as passage of the nerve through the sartorius muscle or inguinal ligament. Landmark techniques consequently have low success rates. A cadaveric study of ultrasound guided needle placement showed a significant improvement in accuracy when compared with a landmark technique (84.2 vs 5.3%). Nevertheless, the nerve is small and can be difficult to differentiate from surrounding structures. There are a number of different techniques described to identify the nerve. Zhu et al. showed that in 240 scans of 120 healthy volunteers, the LFCN could be identified in the intermuscular space in a mean time of 7 s. In this cohort, the mean distance to the nerve from the anterior superior iliac spine was $15.6 \pm 4.2$ mm.

**Technique**

With the patient supine, identify the anterior superior iliac spine. In the transverse plane, scan distally 1–2 cm. The LFCN should appear located in the intermuscular space between sartorius and tensor fascia lata, which is most easily appreciated by dynamic scanning. The nerve appears as an ovoid hypoechoic structure with hyperechoic dots within it. Alternatively, the nerve maybe identified superficial to sartorius and passing from medial to lateral (Fig. 4).

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**Fig 4** Peripheral nerve applications. (a) Probe orientation for (1) ilioinguinal and iliohypogastric, and (2) genitofemoral nerve block. (b) Corresponding US image of position (1), and (c) annotated to demonstrate the relevant sonoanatomy. Ilioinguinal nerve (IIN), iliohypogastric nerve (IHN), transversus abdominus (TA), internal oblique (IO), external oblique (EO), anterior superior iliac spine (ASIS), subcostal nerve (SC), and iliac crest (IC). (d) Pathway of the lateral femoral cutaneous nerve (LFCN). Reproduced with permission of usra.ca. (e) Seen on US in the intermuscular space (IMS). SA, sartorius; TFL, tensor fascia lata; RF, rectus femoris. (f) The spermatic cord (SC) is seen in transverse section, perpendicular to the external iliac artery (EIA), and femoral artery (FA).
Piriformis muscle injection

The piriformis muscle is sometimes implicated as a cause of buttock and leg pain, and direct injection into the muscle is used as a therapeutic strategy. It is an external rotator and abductor of the hip. It originates from the level of S2–S4 and exits the pelvis via the greater sciatic foramen, inserting into the upper border of the greater trochanter.

Pitfalls of conventional injection techniques (fluoroscopy, and nerve stimulation) include poor endpoints, poor specificity, and failure to identify important adjacent structures that may be damaged (superior and inferior gluteal arteries and nerves, pudendal nerve, and sciatic nerve). Ultrasound readily identifies the piriformis muscle allowing real-time needle insertion and confirmation of placement. A cadaveric study of ultrasound vs fluoroscopically guided piriformis injections yielded a 95% (19 of 20 injections) vs 30% success rate (6 of 20), with most unsuccessful injections placed in the gluteus maximus.  

Technique

Prone and with a low-frequency curvilinear probe, scan in the transverse plane with the medial edge of the probe on the posterior superior iliac spine. The contour of the ileum is visible laterally. As you scan caudally the ileum breaks away at the greater sciatic notch to reveal two layers of muscle; gluteus maximus and piriformis. Piriformis is deeper and darker in appearance. Rotate the probe into the long axis of the muscle. An assistant then performs external rotation of the hip with the knee flexed. This demonstrates piriformis muscle sliding, and helps with anatomical confirmation. The muscle can also be traced to and from its bony insertions. Although the sciatic nerve typically leaves the pelvis inferior to piriformis, anatomical variation is common, including passage through piriformis. A nerve-stimulating needle (typically 22G, 80–100 mm) is therefore recommended to identify the sciatic nerve, and prevent nerve damage (Fig. 5).

Fig 5 Piriformis and pudendal nerve. (a) The salient anatomy and sequential US probe positioning (A, ileum; B, piriformis; C, pudendal nerve). The SSL and IS are concealed under position C. Reproduced with permission from usra.ca. (e) Position A, the shadow of the ileum is seen sweeping anterolaterally. (c) Position B, the probe is aligned along the long axis of Pi deep to GM. (f) Patient positioning and in-plane approach to Pi or PN. (g) Rotation of the hip with a flexed knee reveals Pi muscle sliding. (For illustration only, an assistant is required in order to maintain a strict aseptic technique.) (h) Pudendal nerve. Position C, moving the probe caudal to Pi. The probe is aligned along the IS and SSL, demonstrating the PN and PA. STL is seen more superficially. Pi, piriformis; PN, pudendal nerve; PA, pudendal artery; GM, gluteus maximus; STL, sacrotuberous ligament; SSL, sacrospinous ligament; IS, ischial spine; SN, sciatic nerve.
Pudendal nerve

The pudendal nerve arises from S2 to S4, and passes through the greater sciatic notch and interligamentous plane to enter the pelvis through Alcock’s canal. There are three terminal branches: the dorsal nerve of the penis (clitoris), inferior rectal nerve, and perineal nerve. Entrapment can occur between the sacrotuberous and sacrospinous ligaments (interligamentous plane), or within Alcock’s canal (a fascial tunnel through obturator internus).

In interventional pain medicine, the pudendal nerve is usually targeted at the interligamentous plane, using either CT or fluoroscopic guidance. Fluoroscopy uses the ischial spine as a surrogate landmark, whereas ultrasound enables visualization of the ischial spine, sacral ligaments, pudendal vessels, and sciatic nerve. However, because of the small size and depth of the pudendal nerve, it is more difficult to visualize.

In a feasibility study with 17 patients, 100% developed a perineal sensory block using ultrasound,21 and a recent single-blinded, randomized, controlled trial of 23 patients undergoing bilateral nerve block showed comparable success rates to fluoroscopy, but with a significantly longer procedural time (428 vs 219 s).22

Technique

Prepare the patient similarly to that for the piriformis injection. Scan caudally, but keep the ileum/sciacum and notice its curvature as it contributes to the acetabulum. This curvature flattens out at the level of the ischial spine, which should be viewed along its long axis. At this point, the interligamentous plane is identified. The sacrospinous ligament is in continuity with the ischial spine, and the sacrotuberous ligament superficial to it. The neurovascular anatomy is identified within this plane, using Doppler. Care must be taken not to confuse the descending branch of the inferior gluteal artery with the pudendal artery, as the former runs with the sciatic nerve. A nerve-stimulating needle (typically 80–100 mm) is used, in plane from medial to lateral towards the medial aspect of the pudendal artery in the interligamentous plane (typically 80–100 mm) is used, in plane from medial to lateral towards the medial aspect of the pudendal artery in the interligamentous plane as the nerve is positioned here in the majority of patients. Lateral spread can result in sciotic nerve block (Fig. 5).

Conclusion

A variety of ultrasound-guided injections are rapidly emerging and evolving in the practice of interventional pain medicine. There may be an advantage in using ultrasound to increase procedural selectivity, specificity, and accuracy. It is hoped that this may lead to an improvement in patient outcomes, an accumulation of supportive evidence, and an expansion in the enthusiasm and number of clinicians competent in its performance. This article has given a broad overview of common procedures performed in the pain clinic. It must be stressed that the acquisition of skills to perform such procedures requires time, and should not be performed without thorough assessment and attainment of practical competence.

Declaration of interest

B.N. has received equipment loans from Philips and Sonosite. G.S. has no interest to declare.

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Please see multiple choice questions 25–28.