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Ultrasound-guided pain interventions in the pelvis and the sacral spine

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ABSTRACT

Ultrasound guidance of infiltrations in the management of chronic pain allows us to visualize in "real time" the advance of the needle and the diffusion of the analgesic agent in and around the pain-generating anatomical structures. It also enables us to avoid important structures, blood vessels, for example, located in the path of the puncture, thus, avoiding complications. The pelvic area has many pain-generating zones, including joints, muscles, and certain specific points, where nerve structures can be compressed. The involvement of these structures can produce pelvic or lower back pain along with pain that radiates to the lower limbs. Owing to its inability to penetrate bone, ultrasound is unable to visualize, and therefore infiltrate, a number of important nerves located on the anterior face of the sacrum, including the ganglion impar, inferior hypogastric plexus, and superior hypogastric plexus. In this article, we describe different techniques for the ultrasound-guided infiltration in the pelvic region, including the sacroiliac joint, pudendal nerve, coccygeal nerves, transsacral block, lateral branches of the posterior sacral roots, dorsal branch of the L5, caudal epidural infiltration, infiltration of the piriformis and gluteus medius muscles, infiltration of the iliolumbar ligament, ganglion impar block, and superior hypogastric plexus block.

Introduction

The posterior surface of the sacrum is relatively easy to explore using ultrasound (US). The most important sonoanatomical landmarks are the sacral crests, foramina, and sacral cornua. Unfortunately, structures, such as the ganglion impar and the superior and inferior hypogastric plexus located on the anterior surface and sacral promontory, cannot be visualized using US directed from the posterior face of the sacrum owing to acoustic shadowing of the sacral bone.

The application of US as an imaging tool to guide a needle toward a specific tissue represents a great advance in the treatment of chronic pain. The existence of portable devices with therapeutic and diagnostic capabilities, the absence of

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ionizing irradiation, and the "real-time" imaging of the advance of the needle and the diffusion of the analgesic agents are the primary advantages of US-guided techniques. Also, in regions close to a bone surface, the infiltration of small volumes of local anesthetic is particularly useful as a technique to confirm diagnoses. Nonetheless, US-guided puncture can be a dangerous technique if certain basic principles are not followed, such as continuously visualizing the distal tip of the needle to avoid vital structures in the needle's path. The presence of acoustic shadowing in the sacral area requires extra caution and a detailed knowledge of the anatomy of this region.

The hydrodissection technique using saline solution enhances the localization of the distal end of the needle before injecting the analgesic agent. The use of a short piece of extension tube prevents small movements of the needle caused by changing the syringe, which could affect the position of the needle tip and thus enhances the safety and precision of the puncture and administration of the analgesic agent.

Nevertheless, on occasion, US-guided puncture must be combined with the use of fluoroscopy, for example, when the position of the needle tip must be monitored on the anterior surface of the sacrum where bone acoustic shadowing makes US visualization impossible. The use of fluoroscopy may also be necessary if the patient is significantly obese, or if a tumor mass exists that may significantly alter the normal anatomical relationships of the area to be punctured.

This article describes a series of puncture techniques for pelvic region structures, including the sacroiliac joint, pudendal nerve, the coccygeal nerves, transsacral block, lateral branches of the posterior sacral nerve roots, the dorsal branch of L5, caudal epidural infiltration, infiltration of the piriformis and gluteus medius muscles, infiltration of the iliolumbar ligament and blocking of the sympathetic structures, the ganglion impar, and the superior hypogastric plexus.

The same sterility measures used in neuraxial puncture are required to perform an US-guided puncture in the sacral area. A sterile probe cover is used (Sterile Kit made by Bard Access Systems, Salt Lake City, UT) and sterile gel (Aquasonic 100 made by Parker Laboratories, Inc, Fairfield, NJ).

The techniques are performed in the operating room of a pain unit and all patients receive basic hemodynamic monitoring. We use a SonoSite M-Turbo US (Bothell, WA) equipped with a linear probe (13-6 MHz) and a convex probe (5-3 MHz) to perform the procedures.

The needles used for local infiltration (skin) were 25 G of 16 mm and 21 G of 40 mm (BD Microlance Becton Dickinson, Franklin Lakes, NJ). The short bevel needles used for US-guided puncture were 22 G of 90 mm and 50 mm (Quincke de Vygon, Écouen, France). Radiofrequency needles CR 23 G 10 cm (Cosman Medical, Inc, Burlington, MA) were used for pulsed radiofrequency.

Sacroiliac joint infiltration

The 2 sacroiliac joints join the sacrum and the ilia, and thus they provide support to the spine by distributing the weight of the body over the pelvis. The sacroiliac joints are frequently a cause of lower back pain, especially if there is a history of lumbar spine surgery.[1,2] The sacroiliac joints are also involved in a number of rheumatic disorders. The injection of a local anesthetic and corticosteroids into the sacroiliac joint area may be useful when pharmacological treatment is not effective.

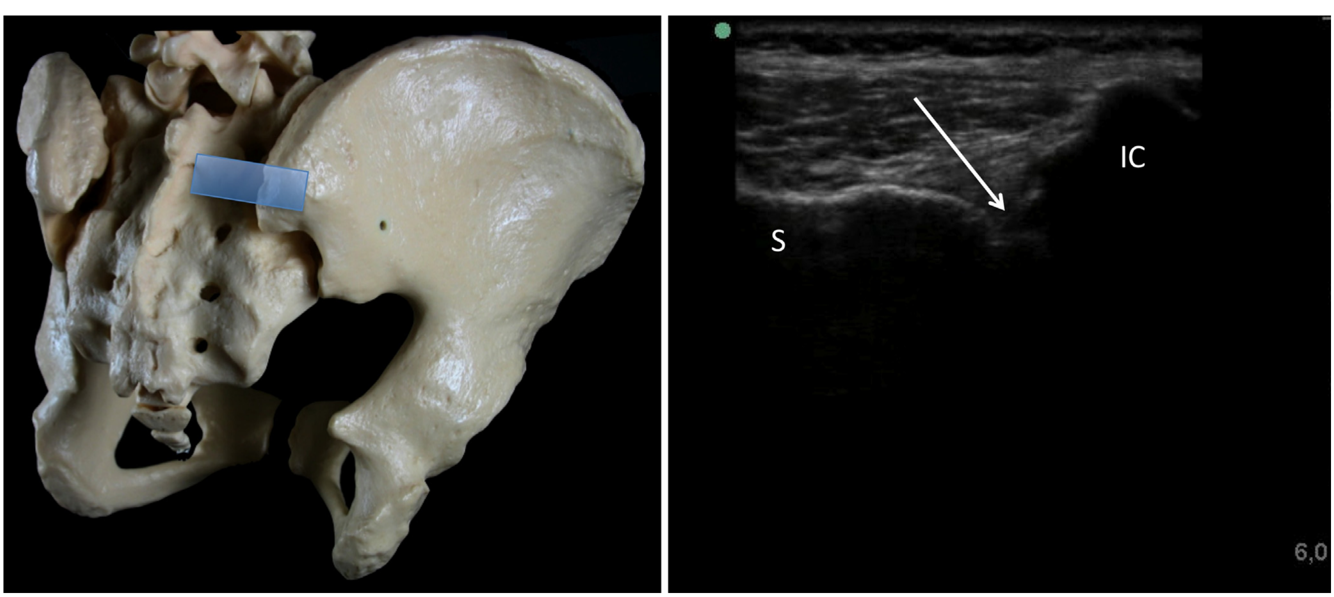

Fig. 1 – Sacroiliac joint injection. (Left) Anatomical diagram showing probe position (blue rectangle). (Right) Transverse US view corresponding to probe position in the left image. The arrow indicates the direction of the needle as it advances toward the cleft of the sacroiliac joint. IC: iliac crest; S: acoustic shadowing of the posterior sacrum. (Color version of figure is available online.)

Probe type

Convex: A linear probe (with or without the software known as "virtual" convex) can be used in slim patients.

Patient position

Prone decubitus.

Sonoanatomical references

Acoustic shadowing of the posterior-superior iliac spines and the sacral cornua, S1-S3 foramina, acoustic shadowing of the posterior surface of the sacral bone (Figure 1).

US exploration

A convex probe is positioned between the posterior-superior iliac spines in a transverse position. The probe is moved (and inclined slightly) distally until the bone contour of the posterior wall of the sacrum can be seen between the first and second sacral foramina. Next, the probe is moved laterally toward the side to be blocked until we observe the bone surface of the ilium and the notch between these 2 bones that corresponds to the sacroiliac joint. On occasion, the joint notch is not visualized owing to the morphology of the ilium and the presence of anatomical variations.

Technique

A 22 G, 90-mm spinal needle is introduced, after anesthetizing the skin with 1% lidocaine, at the medial aspect of the transverse positioned probe. Needle advance is performed in plane until the sacroiliac joint "notch" is reached (Figure 2). After piercing the interosseous (dorsal sacroiliac) ligaments, contact is made with the bone surface inside the joint (Figure 3). After a negative aspiration for blood, 3-5 ml of the analgesic agent of choice is injected. Generally, a combination of a local anesthetic solution and a relatively insoluble crystalline corticosteroid suspension are used.

Complications

Potential complications include the puncture of pelvic structures, such as the rectum, injury to a sacral root, or unintentional vascular injection of the analgesic agent.

Pudendal nerve block

Pudendal nerve syndrome is typically produced by an injury of the pudendal nerve along its path through the ligamentous and muscular structures of the pelvis. Compression or entrapment of the pudendal nerve is manifested as neuropathic pain in the genital, anal, and perineal areas. This pain usually appears when sitting down and is alleviated when standing up or lying down. It is more common in women and the causes of this syndrome may include repeated trauma, history of pelvic surgery, parturition, and chronic constipation.[3]

The pudendal nerve is formed by the anterior division of the S2, S3, and S4 spinal nerves. The nerve, accompanied by the pudendal artery, emerges from the greater sciatic notch at the level of the ischial spine and reenters the pelvis through the lesser sciatic notch, between the sacrotuberous and sacrospinous ligaments. Then it runs in the fascia found on the medial surface of the lower fibers of the obturator internus in a space referred to as pudendal, or Alcock, canal.[4,5] Finally, it runs forward to divide into the following 3 branches: the inferior rectal branch, perineal nerve, and dorsal nerve of the penis or clitoris. At the ischial spine level,

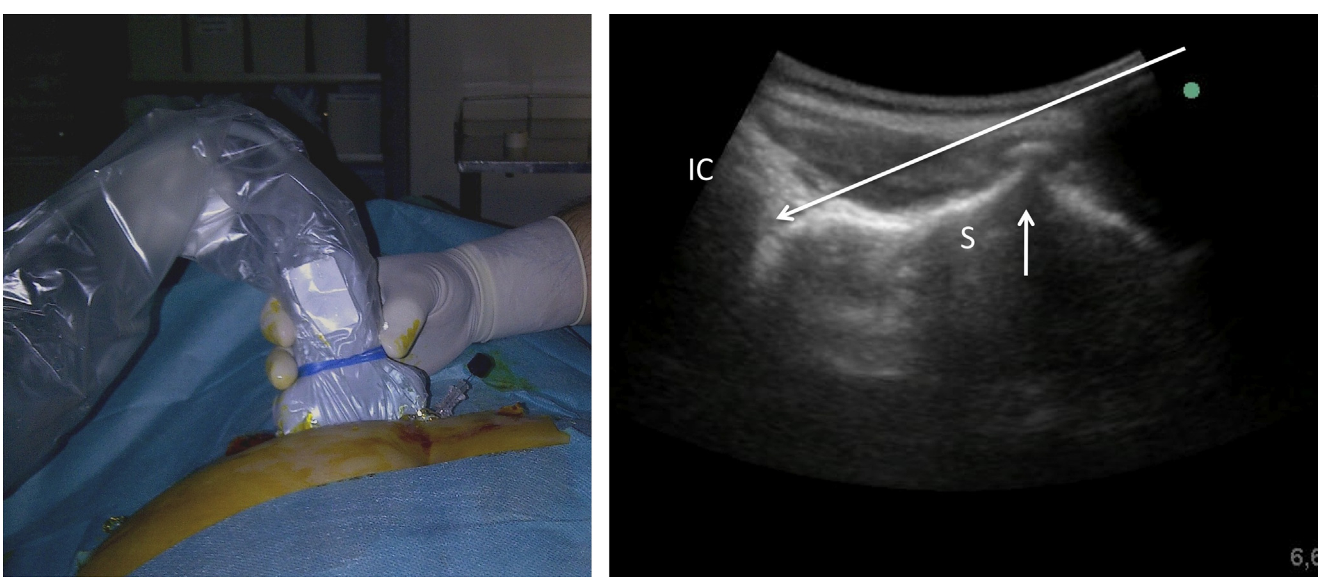

Fig. 2 – Sacroiliac joint injection. (Left) Clinical image showing probe position and needle placement. (Right) Transverse US view corresponding to probe position in the left image. The large arrow shows the trajectory of the needle into the sacroiliac joint and the small arrow points to the sacral spine. IC: iliac crest; S: acoustic shadow of the posterior sacrum. (Color version of figure is available online.)

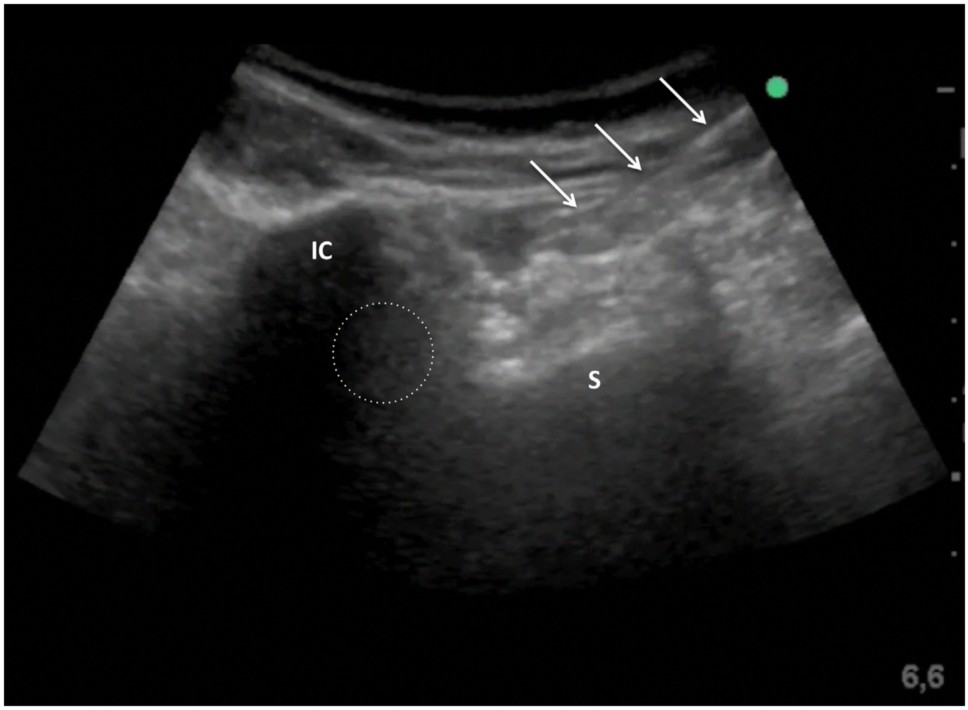

Fig. 3 – Sacroiliac joint injection. Transverse US view showing the trajectory of the needle (arrows). The articulation location (circle) is not visualized because of the acoustic shadowing of the iliac crest. To advance the needle into the joint, it is necessary to penetrate the posterior sacroiliac ligament. IC: iliac crest; S: acoustic shadowing of the posterior sacrum. (Color version of figure is available online.)

the pudendal nerve is medial to the pudendal artery in a 76%-100% of the cases.[6,7]

Entrapment of the pudendal nerve may occur in the area located between the sacrotuberous and the sacrospinous ligaments (70%), at the Alcock canal (20%), or simultaneously in both regions (20%). The dorsal nerve may be entrapped at the level of the urogenital diaphragm.[8]

The injection of analgesic agent in the space between the sacrotuberous and sacrospinous ligaments or even at Alcock canal may alleviate the symtoms of the pudendal nerve syndrome.[7] In fact, one of the diagnostic criteria for "pudendal nerve syndrome" is a response to infiltration of the pudendal nerve.[7,9]

Probe type

Convex for posterior exploration: A linear probe may be used in the US exploration of the pudendal nerve between the ischial tuberosity and the ischial spine.

Patient position

Prone decubitus.

Sonoanatomical references

The pudendal artery, ischial spine, greater sciatic notch, piriformis and obturator internus muscles, sacrotuberous and sacrospinous ligaments, and ischial tuberosity.

US exploration

The probe is positioned with one end along the lateral border of the sacrum and the other pointed toward the greater trochanter. The piriformis muscle and the sciatic nerve are visualized in this position. Next, the probe is rotated to the longitudinal axis and moved slightly in a distal direction to visualize the ischial spine on the lateral edge of the greater sciatic notch. The pudendal artery can be observed using color Doppler (Figure 4). The pudendal nerve is visualized as a fascicular structure at the level of the ischial spine. In this location, the nerve has a diameter of approximately 4-5 mm, and it is found at an average depth of about 5.5 cm. Its position with respect to the ischial spine may vary between 1.0 and 15 mm.[10-12] It may be hard to see because of the presence of fatty tissue, its depth, and the presence of possible anatomical variations.[10] Normally by means of US the pudendal nerve can be identified at this level.[11] In some cases, the pudendal nerve may have already divided into its terminal branches at this level.[7,10]

Tagliafico described a technique using a linear probe. The probe is placed longitudinal between the ischial tuberosity and the ischial spine. The pudendal nerve is visualized close to the ischial spine and at this shallower depth, a high-resolution linear probe can be effective.[11]

Technique

The skin is infiltrated with 1% lidocaine. Then a 22-G, 90-mm needle, connected to a small extension tube, is introduced in plane. The needle is inserted at the distal edge of the probe.

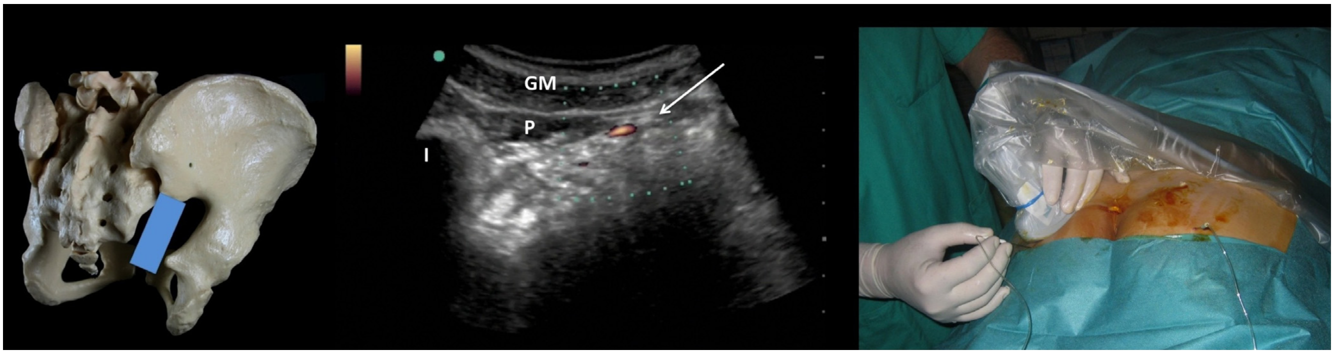

Fig. 4 – Pudendal nerve block. (Left) Probe positioning over the lateral border of the greater sciatic notch shown on an anatomical diagram (blue rectangle). (Middle) US view corresponding to probe position in the left image. The pudendal nerve (arrow) is located distal to the pudendal artery (Doppler signal). (Right) Image acquired during clinical practice. An US-guided puncture using a radiofrequency needle is observed. I: ilium; GM: gluteus maximus muscle; P: piriformis muscle. (Color version of figure is available online.)

In some cases, one may notice when the sacrotuberous ligament is pierced. The pudendal nerve is usually in a distal position with respect to the pudendal artery in the US image. The correct positioning of the needle tip between the sacrotuberous and sacrospinous ligaments is confirmed by hydrodissection, which ensures a safe injection of 4-5 ml of the chosen analgesic agent. Neurostimulation (22-G, 100-mm SonoPlex Stim cannula, Pajunk, Germany) may be useful to avoid damaging the sciatic nerve (Figure 5). Obviously, an absence of sciatic nerve response has to be confirmed before injecting the analgesic agent.[13] If contact is made with the pudendal nerve, a motor response involving the anal sphincter may be noticed.

Complications

Hematoma from vascular puncture, infection, nerve damage, and puncture of the rectum. These complications are very infrequent if continuous visualization of the distal tip of the needle is maintained at all times and sterility rules are followed.

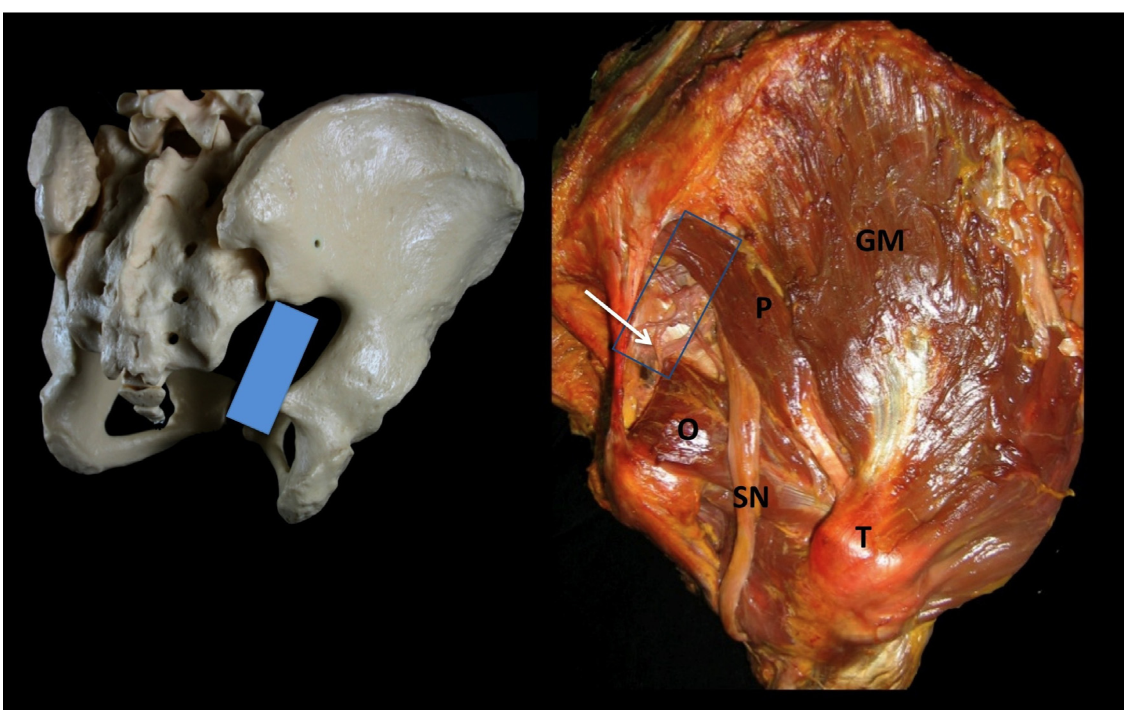

Fig. 5 – Pudendal nerve block. (Left) Anatomical diagram showing probe position (blue rectangle) over the lateral edge of the greater sciatic notch. (Right) Corresponding anatomical image with probe position (rectangle) superimposed over the greater sciatic notch. The pudendal nerve (arrow) is seen within the lower half of the rectangle. P: piriformis muscle; O: obturator internus muscle; SN: sciatic nerve; T: greater trochanter; GM: gluteus medius muscle. (Color version of figure is available online.)

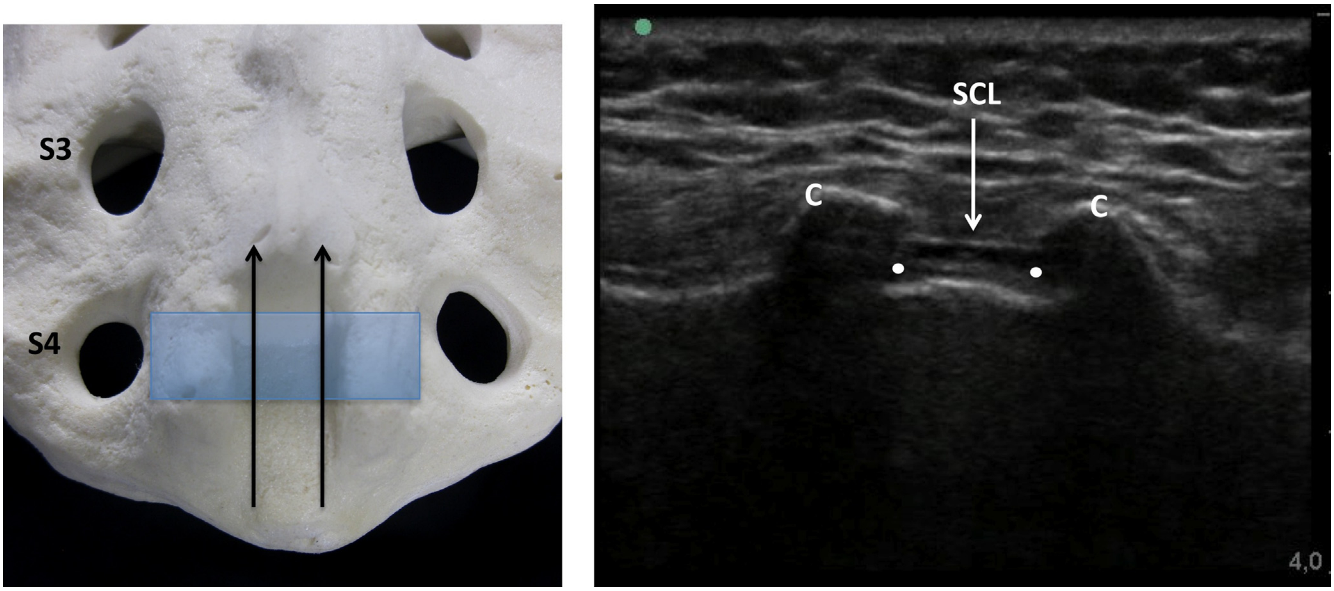

Fig. 6 – Coccygeal nerves. (Left) Anatomical diagram showing probe position (blue rectangle). The arrows mark the lateral borders of the sacral hiatus, which continues proximally as the sacral canal. It is important to maintain the tip of the needle between the S3 and S4 foramina to prevent dural puncture or hematoma. (Right) Transverse US view corresponding to probe position in the left image. The white dots correspond to the lateral borders of the sacral hiatus formed by the cornua (C) and covered by the sacrococcygeal ligament (SCL). (Color version of figure is available online.)

Coccygeal nerves block

The coccygeal plexus is formed by the ventral branches of the fourth and fifth sacral nerves and the coccygeal nerves. The coccygeal nerves emerge from the sacral canal together with the S5 nerve root into the gap referred to as the sacral hiatus whose lateral limits are referred to as the sacral cornua. Among other anatomical structures, the coccygeal plexus provides innervation to the sacrococcygeal joint.[14]

Coccydynia is characterized as pain in the coccyx area that increases when sitting and is usually more frequent in women. One of the most frequent causes of coccydynia is the instability of the sacrococcygeal joint due to local trauma. Other causes include postsurgery, tumors, and infectious processes, or it may be idiopathic.[15]

When conservative medical treatment, rehabilitation, and pharmacological treatment are ineffective, a coccygeal plexus block can be performed at the level of the sacral canal. However, involvement of the small sacrococcygeal joints must not be overlooked as a potential cause.[16,17]

Probe type

Linear.

Patient position

Prone decubitus (Kraske position).

Sonoanatomical references

Sacral cornua, sacrococcygeal ligament, S4 formina, and coccygeal cornua.

US exploration

The posterior surface of the sacrum is explored distal from S1 until the sacral cornua and the sacrococcygeal ligament are visualized.

Technique

After the subcutaneous (SC) infiltration with 1% lidocaine at the puncture site, a 22-G, 90-mm spinal needle is inserted into the sacral canal along the medial edge of each cornu. The needle should not pass cephalad beyond the level of the S3 foramina. At each point, 2-4 ml of local anesthetic, with or without corticosteroids, is administered. If the patient experiences more than 50% reduction of their pain, the result is considered positive. If successful, a pulsed radiofrequency (PRF) technique can be used at the level of the structures that form the coccygeal plexus inside the sacral canal to prolong the effect of the analgesia. In this case, 2 radiofrequency needles of 100 m are inserted in plane to the level of the sacral hiatus brushing against the medial edge of each cornu. The active tip of each needle should reach the medial edge of the sacral canal between S4 and S3 (Figure 6). The correct positioning of the needle tip is confirmed initially by sensory stimulation (50 Hz with 0.4-0.7 V). The patient should notice sensations (numbness and increased pain) in the coccygeal area. PRF is then applied according to the chosen parameters (Figure 7).

Complications

The complications involving the sacral hiatus are the same as those for caudal epidural puncture. PRF is a relatively safe technique and no complications have been observed.[18]

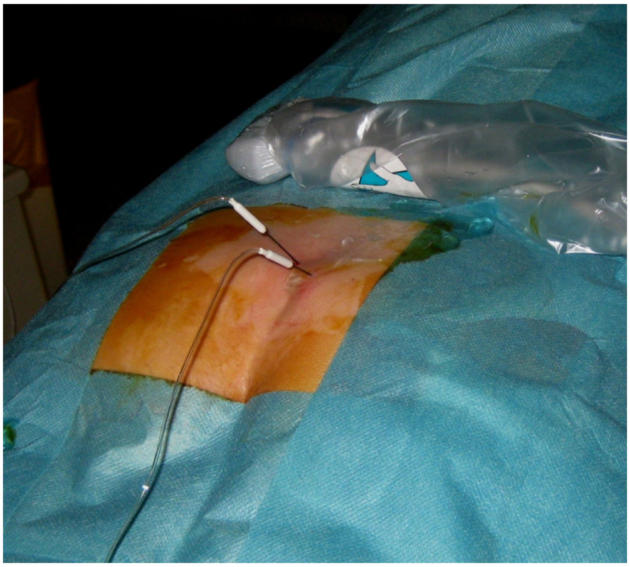

Fig. 7 – Coccygeal nerves. Image acquired during clinical practice showing parallel positioning of 2 neurostimulation needles along the inner aspect of the sacral cornua. When stimulating, correct positioning will result in a sensory perception over the coccygeal area. (Color version of figure is available online.)

Transsacral block

The block of the sacral roots can be a useful technique for the evaluation and treatment of perineal pain. Generally, we use this technique to treat oncologic pain.

Probe type

Linear.

Patient position

Prone decubitus: If the patient cannot tolerate prone positioning, lateral decubitus position can be used.

Sonoanatomical references

Medial sacral crest, sacral cornua and iliac crests, S3 and S4 foramina, sacrococcygeal ligament (Figures 8 and 9).

US examination

The probe is placed in a transverse position at the level of the sacral cornua. The S4 foramina are visualized lateral to the cornua, and the S3 foramina become visible when the probe is moved in a proximal direction. However, there may be anatomical variations regarding the number of foramina present (Figure 10).[19]

Technique

SC infiltration is performed at the puncture site with 1% lidocaine and then a 22-G, 50-mm needle connected to a short extension tube is introduced either in plane or out of plane. For more safety, bone contact is made initially with the anesthetizing needle at the medial edge of the foramen and then the 22-G needle is introduced. The S4 and S3 foramina are usually 10-mm and 15-mm deep, respectively, in adults. After a negative aspiration test, 2-3 ml of local anesthetic, with or without corticosteroids, is injected.

Complications

Puncture of the rectum, nerve injury, hematoma, infection, or the unintentional vascular administration of the analgesic agent.

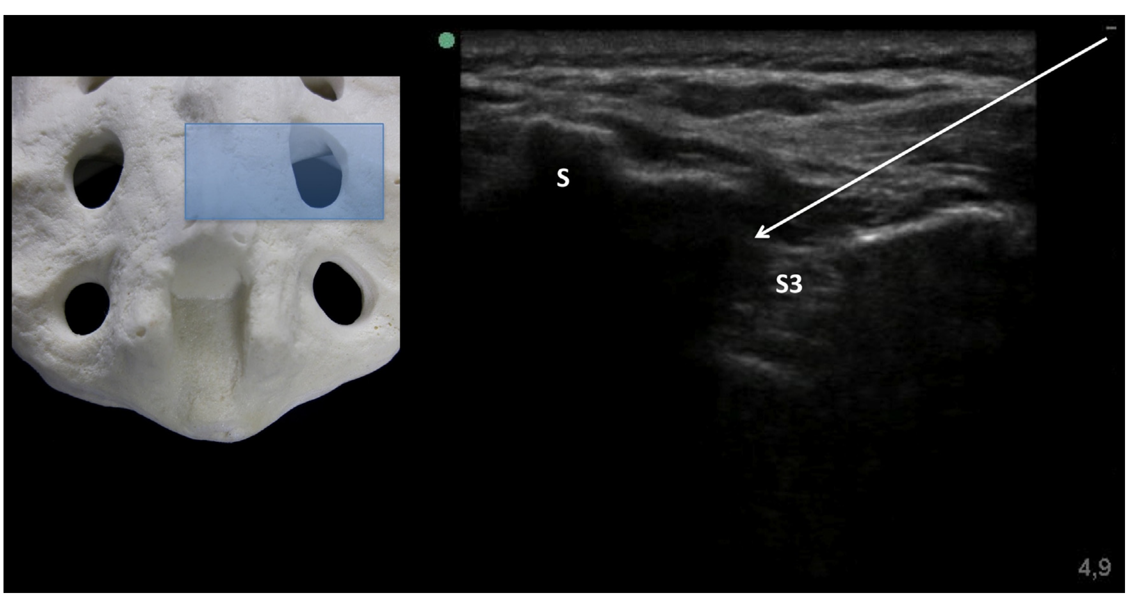

Fig. 8 – Transsacral block. (Left) Anatomical diagram showing probe position (blue rectangle). (Right) Transverse US view corresponding to probe position in the left image. Appropriate needle trajectory (arrow) at the level of the medial border of the S3 sacral foramen (S3) is shown. S: acoustic shadow of the sacrum. (Color version of figure is available online.)

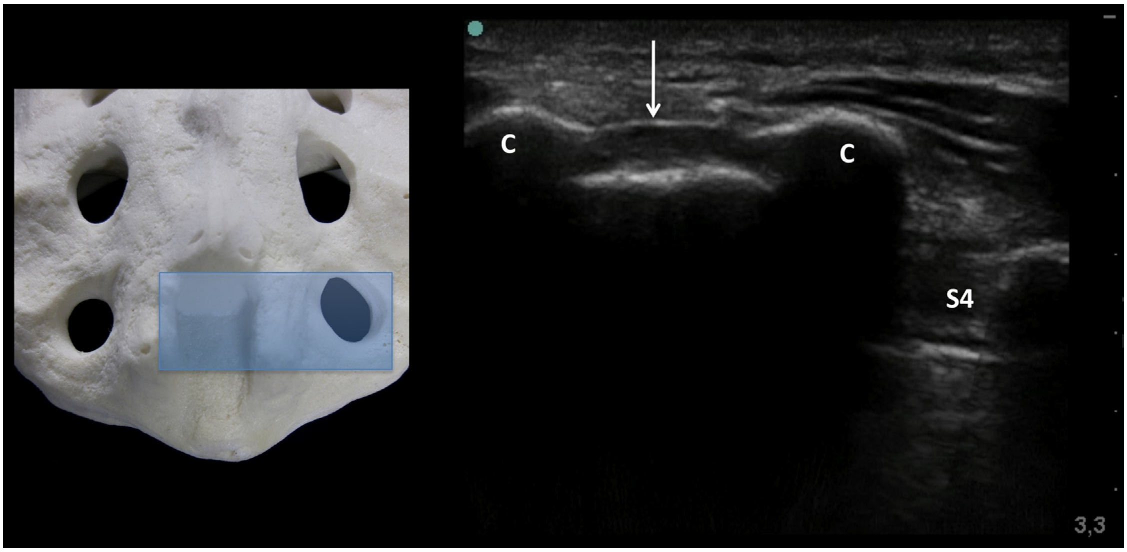

Fig. 9 – Transsacral block. (Left) Anatomical diagram showing probe position (blue rectangle). (Right) Transverse US view corresponding to probe position in the left image demonstrating that the S4 foramen (S4) is usually located at the same level as the sacral cornua (C). The sacrococcygeal ligament (arrow) is observed bridging the cornua. (Color version of figure is available online.)

Lateral branches of the posterior sacral rami

When infiltrating the sacroiliac joint with local anesthetics and corticosteroids has been effective, the patient may be a candidate for a denervation technique of the sacroiliac joint using radiofrequency. The sacroiliac joint is innervated by the lateral branches of the posterior rami of S1, S2, and S3 with contributions from the posterior ramus of L5.[20]

Probe type

Convex.

Patient position

Prone decubitus.

Sonoanatomical references

Iliac crests, posterior surface of the sacrum, sacral S1-S4 foramina.

US examination

The probe is placed on the longitudinal axis at the level of the sacral foramina on the affected side. The sacral foramina of

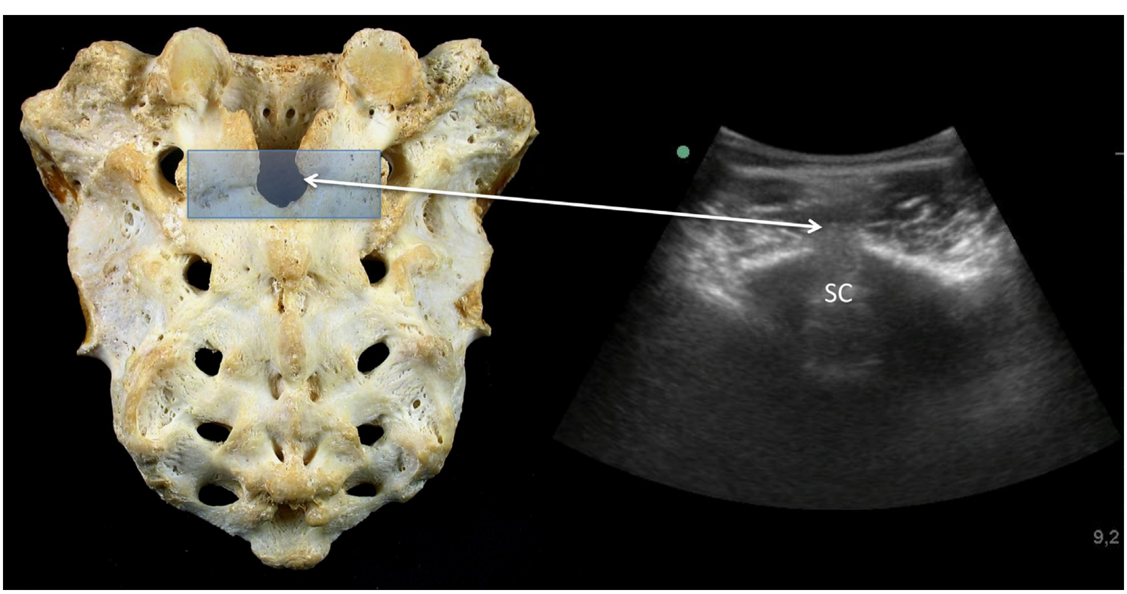

Fig. 10 – Transsacral block, anatomical variation. (Left) Anatomical diagram showing probe position (blue rectangle) over a fusion defect at the S1 level of a sacrum containing 5 pairs of foramina. (Right) Transverse US view corresponding to probe position in the LEFT image, demonstrating a fusion defect, which enables visualization into the sacral canal (SC). (Color version of figure is available online.)

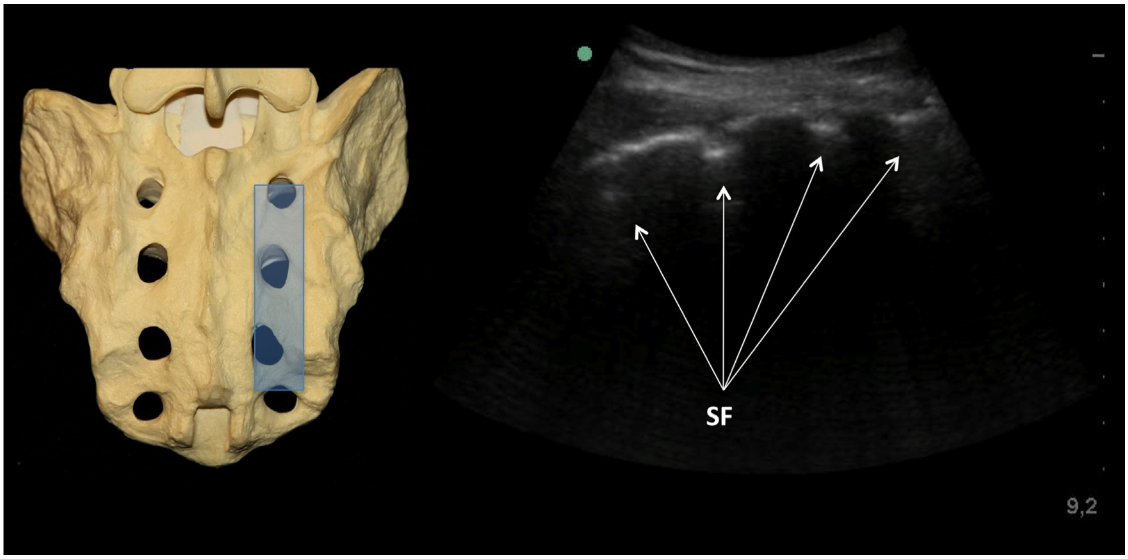

Fig. 11 – Lateral branches of the posterior sacral rami. (Left) Anatomical diagram showing probe position (blue rectangle) over the sacral foramina. (Right) Transverse US view corresponding to probe position in the left image showing the 4 sacral foramina (SF with 4 arrows). The dot indicates the proximal aspect of the image. (Color version of figure is available online.)

S1, S2, and S3 are visualized, and the probe is moved laterally between 5 and 10 mm, avoiding visualization of the posterior-superior iliac spine and the iliac crest (Figures 11 and 12).

Technique

SC infiltration are performed at the puncture sites with 1% lidocaine and 6-7 radiofrequency needles (100 mm) are introduced out of plane between the S1 and S3 foramina performing bone contact at the lateral edges of the foramina. In some cases, due to the acoustic shadow of the posterior-iliac spine out-of-plane puncture at the level S2 and S3, may be difficult. A needle is also introduced in the vertebral notch to aim for the posterior ramus of L5. It is important to perform a motor stimulation test, which should be negative (Figure 13).

Complications

The introduction of the needle into a sacral foramen should be avoided as this could potentially result in damage to a sacral root, vascular puncture, or rectum puncture.

L5 dorsal ramus block

The zygapophyseal joint between L5 and S1 is constituted by the superior apophysis of S1 and the inferior apophysis of L5.

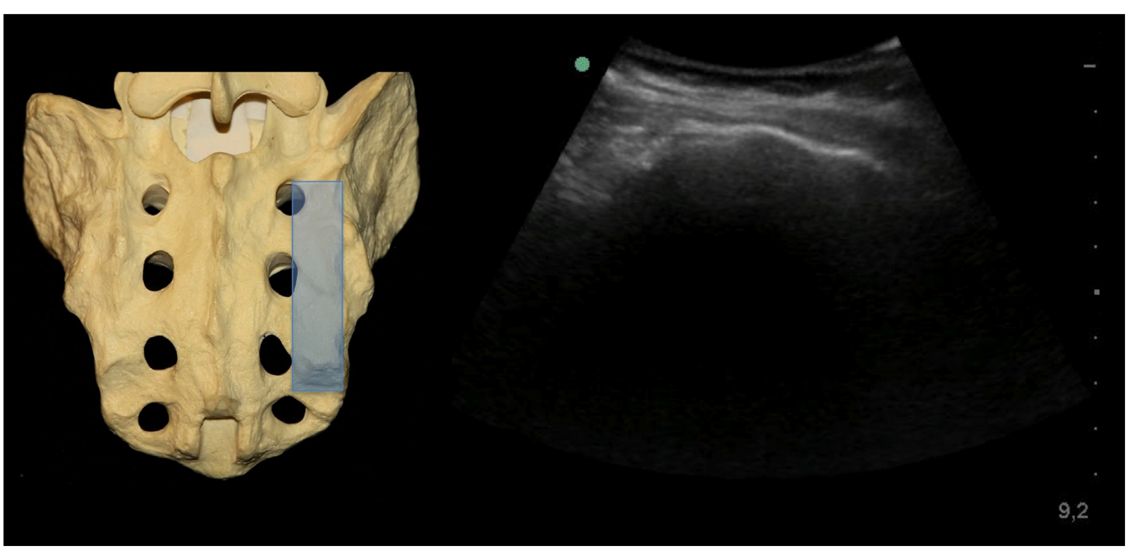

Fig. 12 – Lateral branches of the posterior sacral rami. (Left) Anatomical diagram showing probe position (blue rectangle) just lateral to the sacral foramina. (Right) Longitudinal US view corresponding to probe position in the left image, demonstrating the continuous bone surface of the sacrum just lateral to the foramina. The dot indicates the proximal aspect of the image. (Color version of figure is available online.)

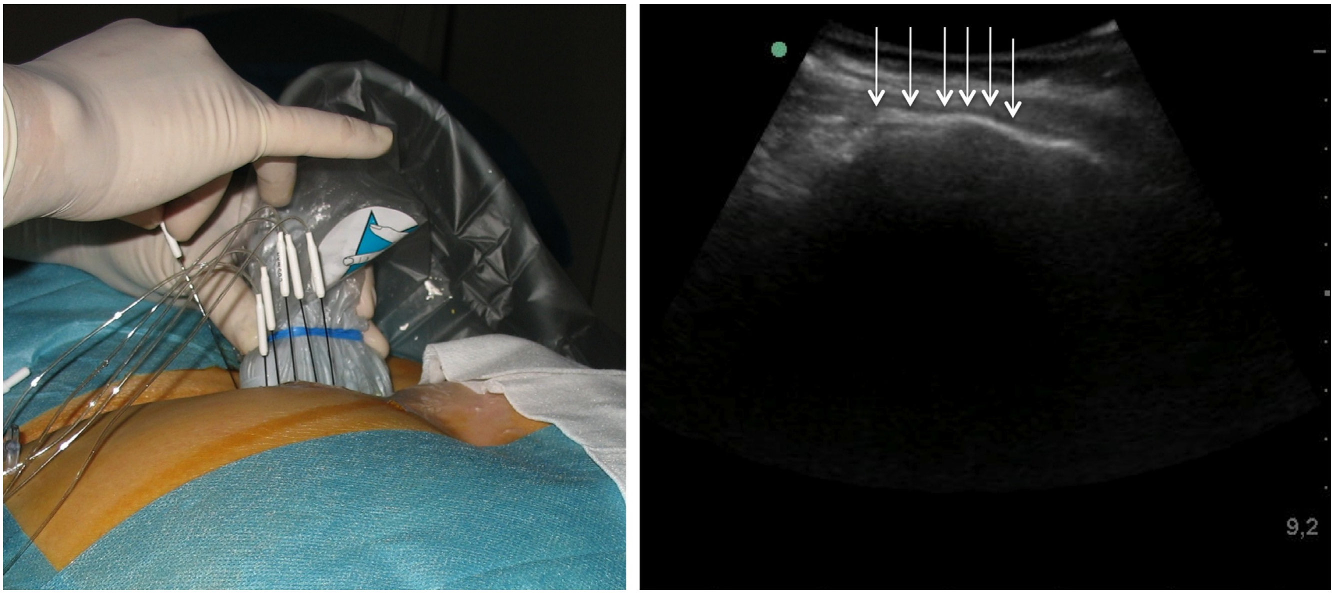

Fig. 13 – Lateral branches of the posterior sacral rami. (Left) Clinical image indicating position of the radiofrequency needles between the vertebral notch and S3. (Right) Longitudinal US view corresponding to probe position in the left image. The arrows represent the hypothetical placement of the radiofrequency needles on the hyperechoic surface of the sacrum, just lateral to the sacral foramina. (Color version of figure is available online.)

The medial branch of the posterior root provides sensory innervation to the lumbar zygapophyseal joint. The medial branch crosses the upper edge of the transverse apophysis at its confluence with the articular apophysis and then passes to the zygoapophyseal joint. A medial branch innervates the zygoapophyseal joint at the same level, and it also sends a branch to the zygoapophyseal joint directly underneath. The zygoapophyseal joint between L5 and S1 also receives a branch from the foramen of S1.[21]

Probe type

Convex.

Patient position

Prone decubitus with a pillow placed below the iliac crests.

Sonoanatomical references

The L5 spinal apophysis, L5 laminae, L5 inferior articular apophysis, S1 superior articular apophysis, and vertebral notch of the sacral ala and iliac crest.

US examination

The probe is placed on the transverse axis at the level of S1 and moved slightly in a proximal direction until the L5-S1 space becomes visible. In this position, the probe is then moved laterally until one visualizes the superior articular processes of S1 and the vertebral notch.[22]

Technique

SC infiltration is performed at the puncture site with 1% lidocaine and a 22-G, 90-mm spinal needle is inserted out of plane until bone contact is established on the vertebral notch (Figure 14). Next, the probe is rotated to a longitudinal axis to place the needle in plane and thus control the positioning of the needle in the vertebral notch. This is done because the position of the iliac crests may cause difficulty in the introduction of the needle in plane (Figure 15).

Complications

Complications may include hematoma formation, infection, paresthesia due to puncture of the L5 spinal root, or the unintentional intravascular administration of the analgesic agent.

Caudal block

The sacrum is constituted by the fusion of 5 vertebrae and the coccyx by the fusion 3 or 4 small vertebrae. The sacral hiatus is constituted by a natural defect in the fusion between S4 and S5, and it is covered by the sacrococcygeal ligament. Within the sacral hiatus and between the cornua pass the S5 roots and coccygeal nerves.

Low back pain with radicular symptomatology can be produced by mechanical compression, as well as the production of inflammatory mediators affecting one or more of the spinal nerve roots. The caudal epidural administration of corticosteroids is commonly used to treat pain produced by a herniated disc, discogenic pain, spinal stenosis, and the "failed back syndrome."[23]

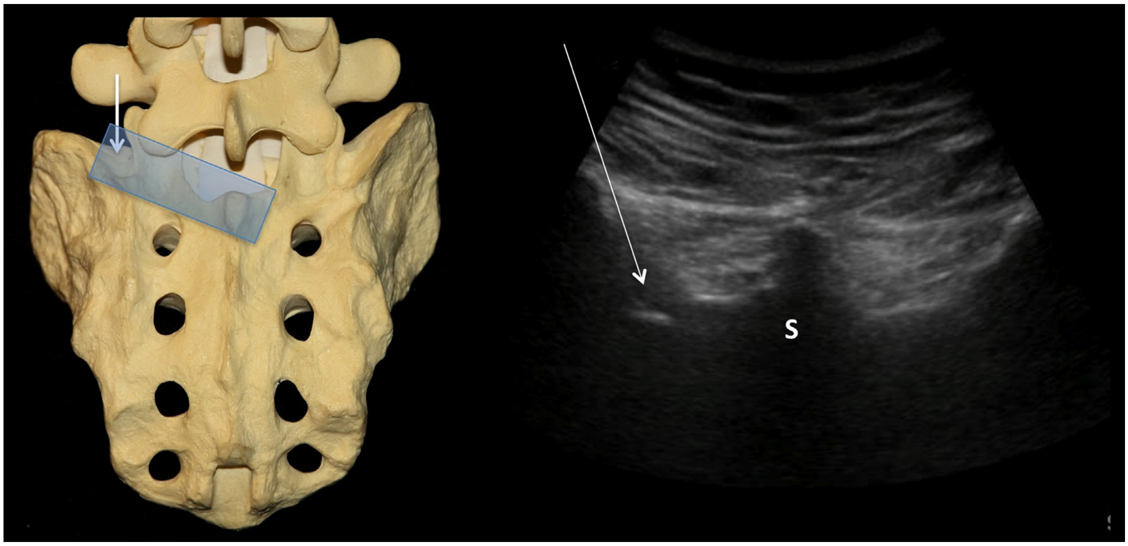

Fig. 14 – L5 dorsal ramus block. (Left) Anatomical diagram showing the probe in a transverse position on the examination site (blue rectangle) with its lateral aspect over the vertebral notch (arrow). (Right) Transverse US view corresponding to probe position in the left image, demonstrating the position of the vertebral notch (arrow) and to its right, the acoustic shadowing of the posterior surface of S1 (S). *Note*: the "shadowing" to the left of the needle is caused by the iliac crest. (Color version of figure is available online.)

Probe type

Linear: A convex probe may be needed in certain obese patients.

Patient position

Prone decubitus or in the Kraske position with the buttocks separated. The lateral decubitus position can also be used, if the patient cannot be placed in the prone position.

Sonoanatomical references

Sacral cornua, sacrococcygeal ligament. There may be anatomical variations regarding the number and disposition of the sacral cornua. These variations can be observed in up to 20% of cases and include the existence of a small canal diameter, lack of sacral hiatus, presence of only 1 cornu, or even a bone blockage of the sacral canal.[24]

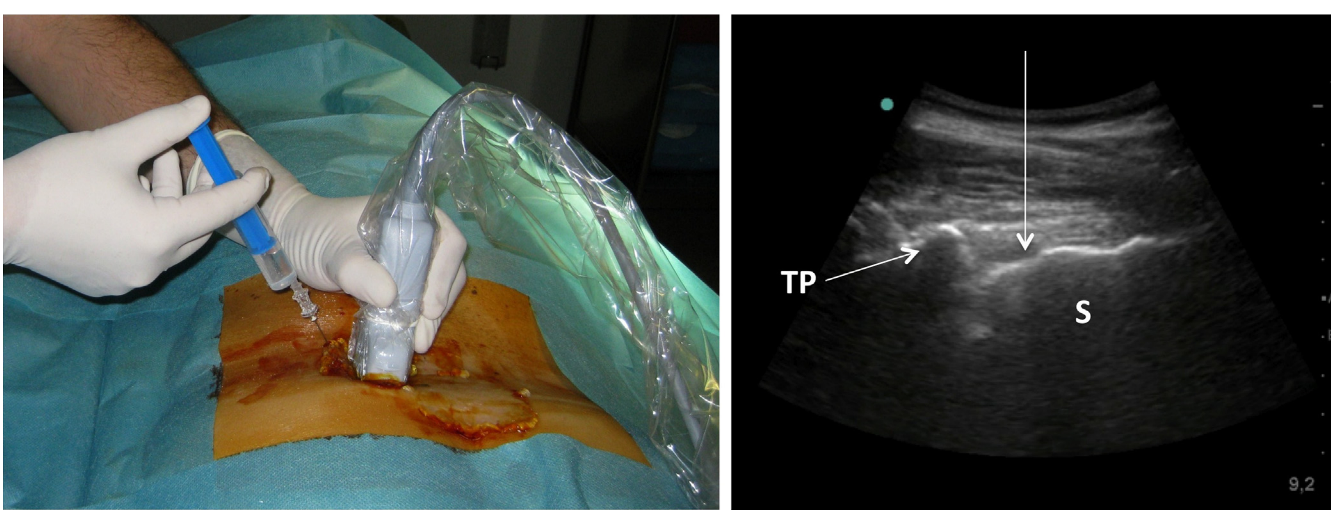

Fig. 15 – L5 dorsal ramus block. (Left) Image acquired during clinical practice. The probe was placed on the long spinal axis to visualize the needle out of plane, this was after the probe was rotated from the short spinal axis to perform the puncture in plane (see Figure 14). (Right) US view showing the point at the vertebral notch (arrow) where the bone contact has to be performed with the needle. The transverse process of L5 (TP) and the acoustic shadowing caused by the posterior aspect of the sacrum (S) are indicated. If the needle is placed slightly more proximal, irritation of the L5 nerve root could result in paresthesia. (Color version of figure is available online.)

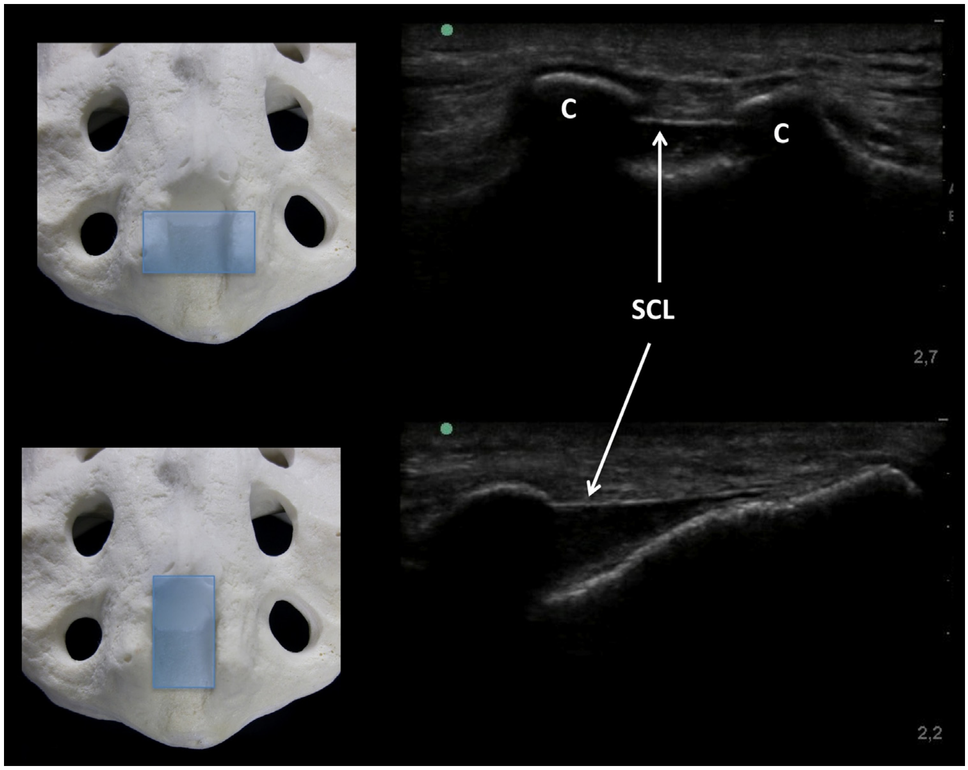

Fig. 16 – Caudal block. (Upper left) Anatomical diagram showing transverse probe position (blue rectangle) over the sacral hiatus. (Upper right) Transverse US view corresponding to probe position in the upper left image, indicating the sacral cornua (C) and sacrococcygeal ligament (SCL). (Lower left) Anatomical diagrams showing longitudinal probe position (blue rectangle) over the sacral hiatus. The dot indicates the left aspect of the image. (Lower right) Longitudinal US view corresponding to probe position in the lower left image, indicating the sacral cornua (C) and sacrococcygeal ligament (SCL). The dot indicated the proximal aspect of the image. (Color version of figure is available online.)

US examination

The probe is placed in a transverse position at the level of S1, and it is moved in a distal direction until the sacral cornua are visible. A hyperechogenic line, which corresponds to the sacrococcygeal ligament, is observed bridging the horns (Figure 16).

Technique

SC infiltration is performed at the puncture site with 1% lidocaine and a 22-G, 90-mm spinal needle is inserted out of plane until its distal tip is observed between the 2 sacral horns. The puncture point and the angle of introduction of the needle depend on the depth of the sacrococcygeal ligament and the longitudinal axis of the sacral canal (Figure 17). Next, the probe is rotated in a longitudinal axis and adjusted to observe the needle in plane. The needle is advanced through the sacrococcygeal ligament and into the sacral canal (Figure 18). It should be noted that the intradural space usually ends at the level of S2, and therefore the needle should not be introduced proximally past the posterior wall of the sacral canal (Figure 19). Anatomical variations may exist and the dural sac may end anywhere between L5 and S3 (Figures 20-22).[25] Under color Doppler mode, 2-3 ml of saline solution is then injected to assure correct positioning, and an aspiration test, which should be

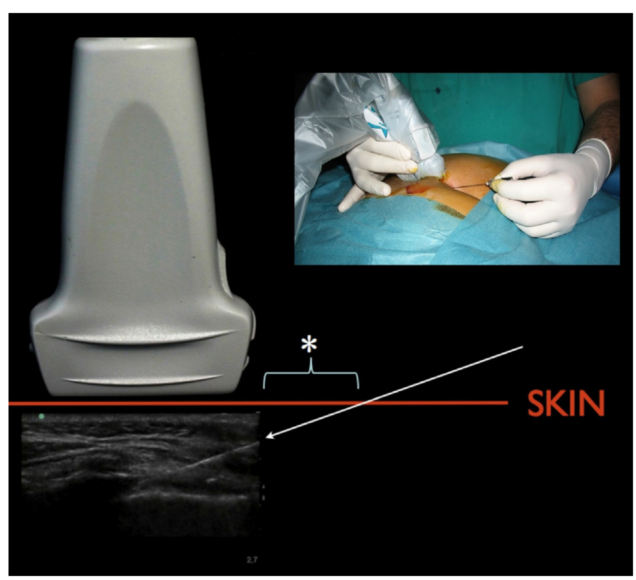

Fig. 17 – Caudal block. Longitudinal US view with superimposed probe showing the angle of needle insertion (arrow), which is readily estimated using US. The distance between skin puncture site and the probe is indicated (*). The sacral hiatus and canal are quite narrow and superficial requiring only a 22-G, 90-mm needle. (Inset: clinical image of puncture with the probe placed longitudinal.) (Color version of figure is available online.)

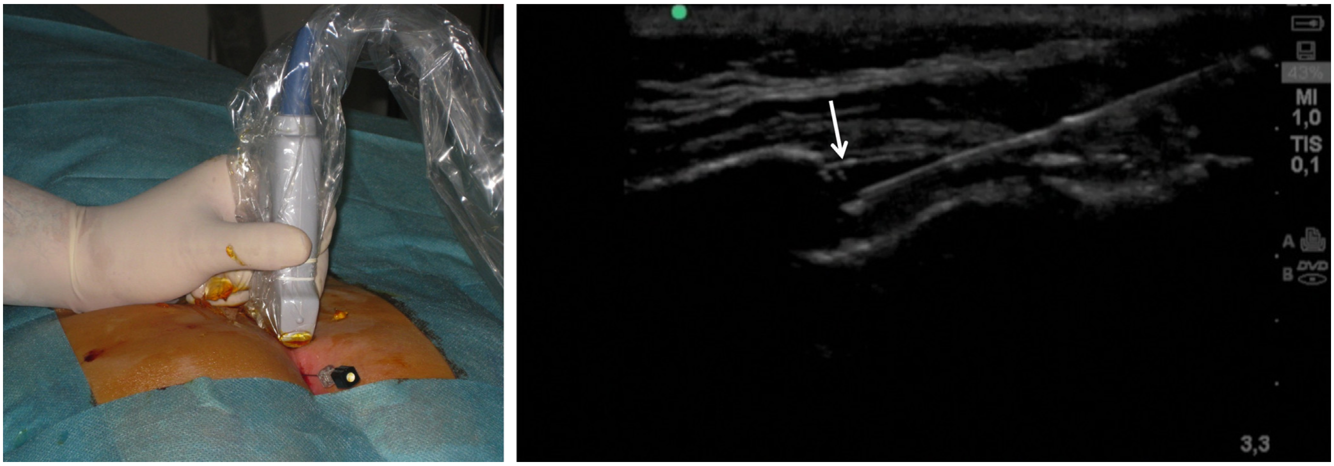

Fig. 18 – Caudal block. (Left) Clinical image showing longitudinal probe position to perform an in-plane needle insertion. (Right) Longitudinal US view corresponding to probe position in the left image. The needle is advanced through the sacrococcygeal ligament (arrow). Notice the correct upward position of the needle bevel (direct toward the probe). (Color version of figure is available online.)

negative for both blood and cerebrospinal fluid, is performed.[26] The analgesic agent is then administered (Figure 23).

Complications

Complications can include those associated with any neuraxial puncture: hematoma, abscess, unintentional vascular administration, local or systemic effects of the corticosteroids, and puncture of the intradural space.

Piriformis muscle infiltration

The piriformis muscle originates on the anterior face of the sacrum and inserts into the anterior-medial aspect of the greater trochanter. In most cases, the sciatic nerve emerges from underneath the inferior border of muscle (78%-84%), but it may emerge from the muscle belly or just above the superior border and cross the muscle in up to 10% of cases. The innervation of the piriformis muscle comes directly from the first 2 sacral roots.[27]

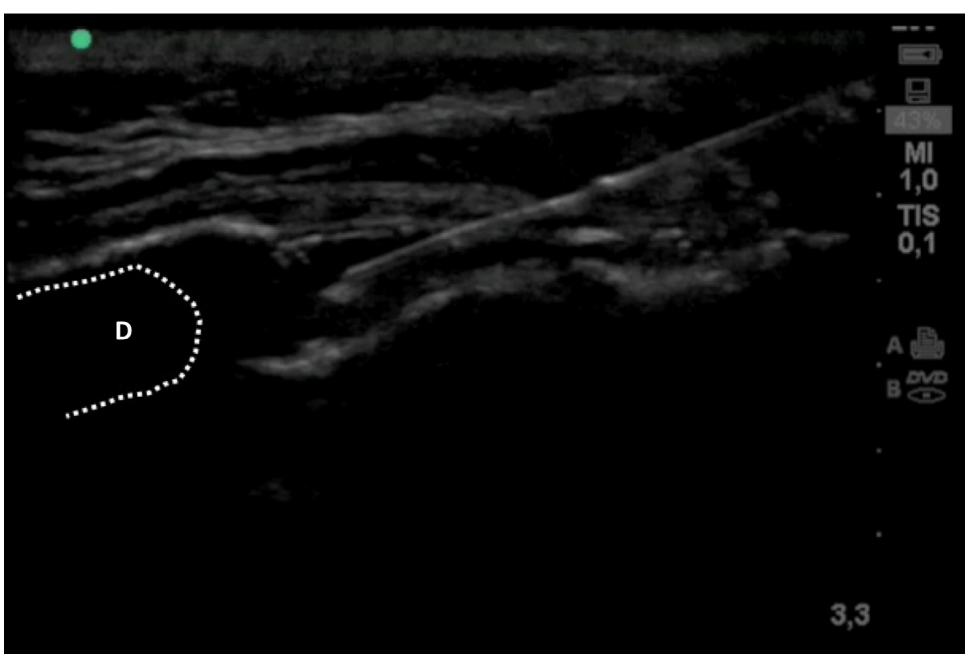

Fig. 19 – Caudal block. Longitudinal US view of the sacral hiatus with the normal distal extent of the dural sac indicated (dotted line). It is important not to advance the needle into the distal sacral canal. Although the dural sac usually terminates at the level of S2, there exists a significant variability with occasional termination of the dural sac at the level of S3. (Color version of figure is available online.)

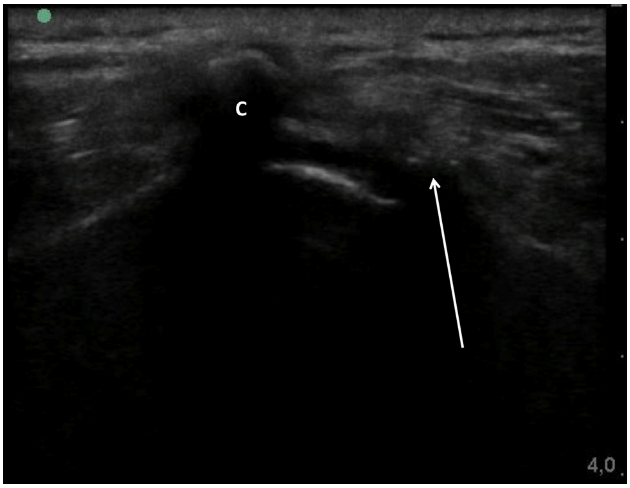

Fig. 20 – Caudal block. Transverse US view of an anatomical variant of the sacral hiatus, as it only has 1 sacral cornu (C). Notice how the right cornu is absent (arrow). (Color version of figure is available online.)

The etiology of the "piriformis syndrome" is controversial but may be caused by a shortening or contracture of the piriformis muscle. Changes in the muscle could result from severe or chronic muscle overload, small continuous traumas, alterations in gait, and poor posture habits. It has been suggested that the "piriformis syndrome" can produce sciatic nerve irritation or compression manifested as "pseudosciatica."[28] Clinical suspicion of the "piriformis syndrome" can be confirmed by means of provocative maneuvers and with a positive response to a diagnostic block by the infiltration of local anesthetic into the muscle at the lateral edge of the sacrum.

Probe type

Convex.

Patient position

Prone or lateral decubitus: In the lateral decubitus position, the involved side is placed superiorly, and the hip and knee are flexed.

Sonoanatomical references

Lateral edge of the sacrum, ilium, gluteus maximus and piriformis muscles, sciatic nerve, and superior gluteal artery.

US examination

With the patient in a lateral decubitus position, a convex probe is placed obliquely between the midpoint of the lateral edge of the sacrum and the greater trochanter. The piriformis muscle and the sciatic nerve can be visualized in this position (Figure 24).[29]

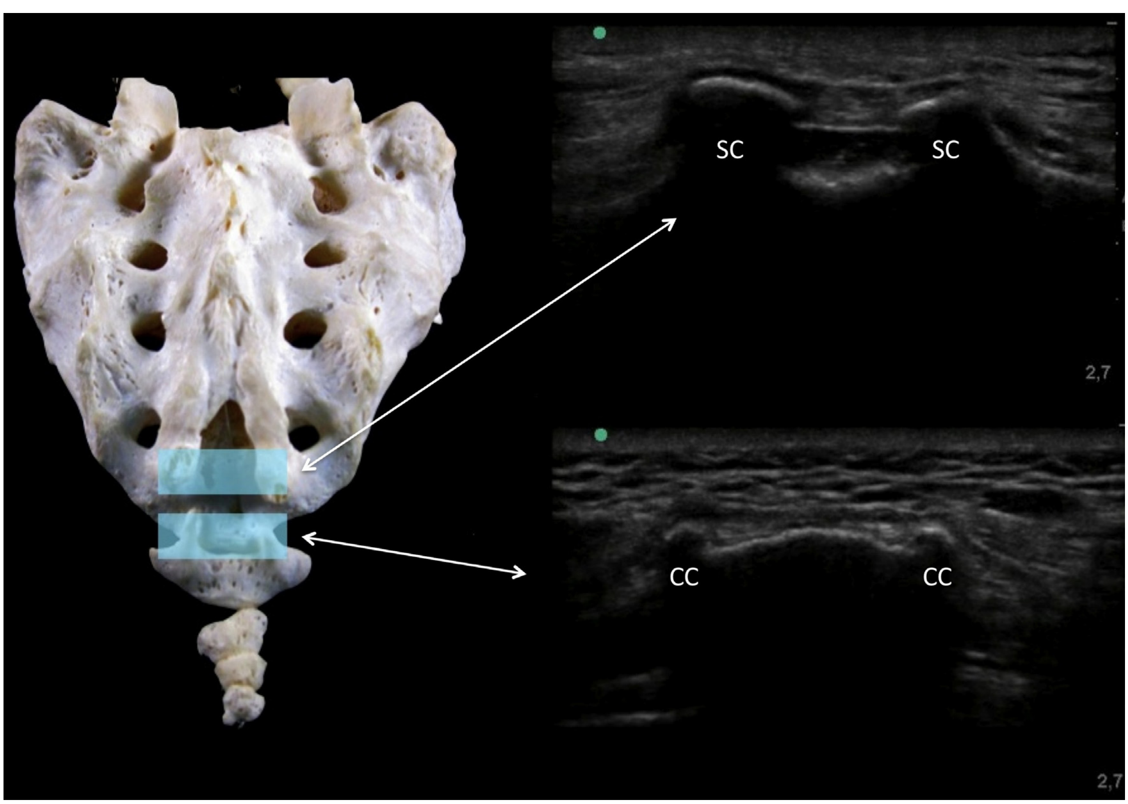

Fig. 21 – Caudal block. (Right) US view corresponding to probe position in the left image indicated with arrows. It is recommended to initiate the examination proximal and move the probe distal until the sacral cornua (SC) and sacrococcygeal ligament are identified (upper right image). Notice the difference between the sacral cornua (SC) and the coccygeal cornua (CC). (Color version of figure is available online.)

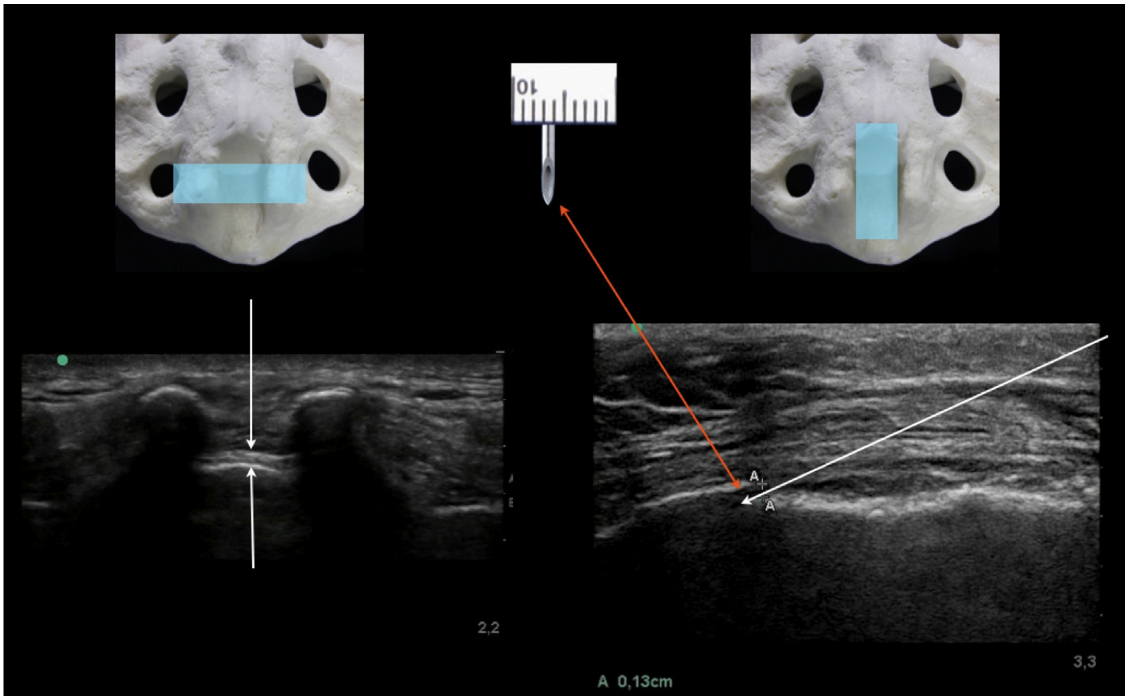

Fig. 22 – Caudal block. (Upper left) Anatomical diagram showing transverse probe position (blue rectangle). (Upper right) Anatomical diagram showing longitudinal probe position (blue rectangle). (Lower) US views corresponding to probe position in the upper left and upper right images. Note that the canal is quite narrow (vertical arrows), and thus it is important to pay attention to the needle trajectory angle. Inset: measure comparing the width of the canal (1.3 mm) with the width of the needle.

Technique

SC infiltration is performed with 2% lidocaine at the medial end of the probe and a 22-G, 90-mm needle connected to a small extension tube is introduced in plane from the medial aspect.[30] A neurostimulation needle can also be utilized. The tip of the needle is advanced toward the piriformis muscle located beneath the gluteus maximus muscle. Once the correct position of the needle tip in the muscle is confirmed, by means of hydrodissection, the analgesic agent is administered. Some sources suggest that the "trigger points" are located within the muscle at the lateral edge of the sacrum and also between the middle one-third and the lateral one-third of a virtual line established between the lateral edge of the sacrum and the major trochanter (Figure. 25).[31,32]

The use of a neurostimulating needle (22-G, 100-mm SonoPlex Stim cannula, Pajunk, Germany) provides greater safety confirming the location of the needle within the muscle when no motor response is observed in the affected limb. To perform a diagnostic block, the administration of 4-6 ml of local anesthetics is sufficient.

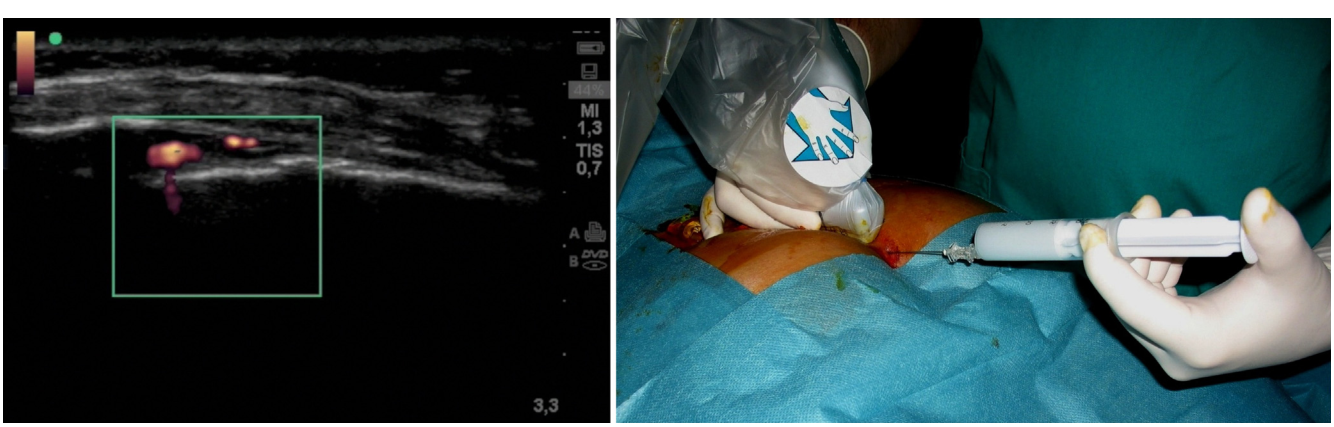

Fig. 23 – Caudal block. (Left) Longitudinal US view, with Doppler mode activated, during test injection to confirm correct needle position in the sacral hiatus (Right image). Note that visualization of the Doppler signal is possible only if the tip of the needle is in the hiatus and has not been advanced into the sacral canal.

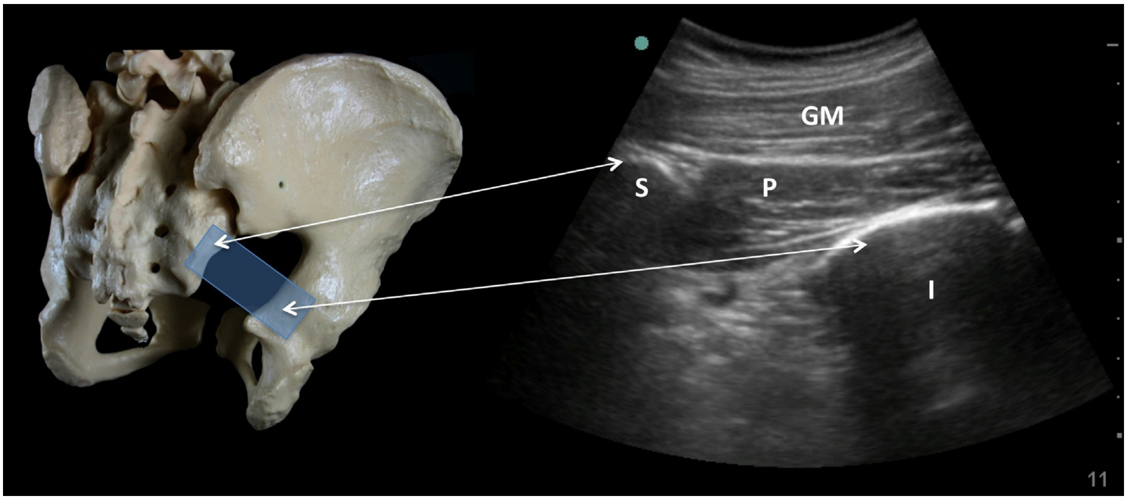

Fig. 24 – Piriformis muscle infiltration. (Left) Anatomical diagram indicating oblique-transverse probe position (blue rectangle) on a virtual line directed from the lateral border of the sacrum to the greater trochanter. (Right) US view corresponding to the probe position in the left image, showing the piriformis muscle (P), gluteus maximus (GM), sacrum (S), and ilium (I). (Color version of figure is available online.)

Complications

Damage to the sciatic nerve and vascular structures by the needle and the unintentional intravascular administration of the agent.

Gluteus medius muscle infiltration

The gluteus medius muscle is the primary hip abductor and also stabilizes the pelvis while walking. The gluteus medius muscle originates in the external surface of the iliac bone and inserts in the lateral and superior-posterior facet of the greater trochanter. The gluteus medius muscle is located beneath the iliac crest between the superior-posterior iliac spine and the anterior-superior iliac spine. The most posterior portion of the gluteus medius muscle is covered by the gluteus maximus muscle. The inferior portion of gluteus medius covers the gluteus minimus muscle. The gluteus medius muscle is innervated by the superior gluteal nerve, which arises from the L4, L5, and S1 spinal nerve roots.[31]

Lower back and sacrum pain are a common reason for consultation at pain units. In many cases, the pain may have a myofascial onset. Myofascial pain syndrome is one of the most frequent chronic pain forms of the musculoskeletal system.[33] Myofascial pain syndrome is defined as the presence of sensory, motor, and autonomic symptoms related to the presence of myofascial trigger points.[31]

The gluteus medius muscle can be damaged by repetitive minor trauma, sudden and forceful adduction, and, possibly, through extreme force transmitted via the iliotibial band and fascia lata.

The trigger points of the gluteus medius muscle are located near the iliac crest and between the posterior-superior and

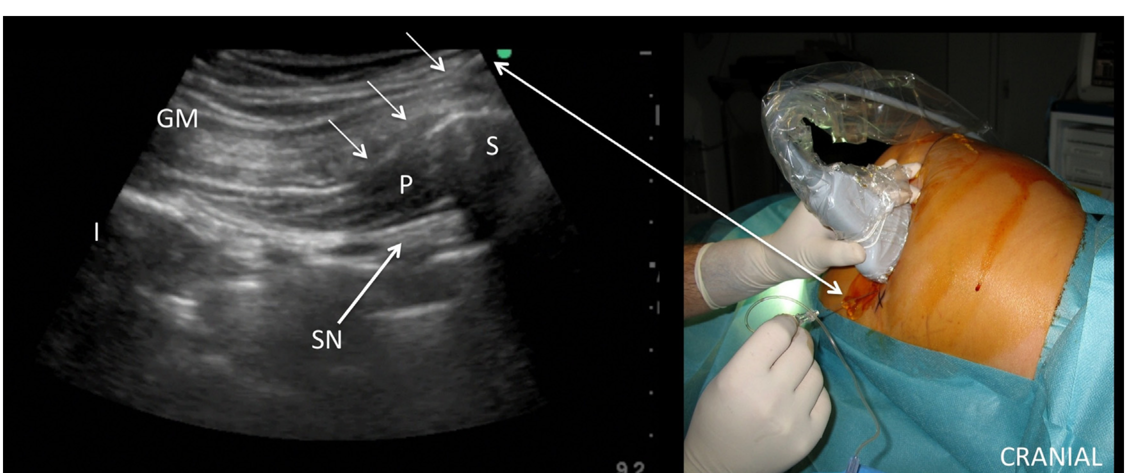

Fig. 25 – Piriformis muscle infiltration. (Left) Oblique-transverse US view of the hypoechoic piriformis muscle (P), the overlying gluteus maximus muscle (GM), and the underlying hyperechoic sciatic nerve (SN). The needle (arrows) is advanced from medial to lateral over the sacrum (S) into the piriformis muscle. The dot indicates the medial aspect of the image. I: ilium. (Right) Clinical image showing in plane medial to lateral needle insertion. (Color version of figure is available online.)

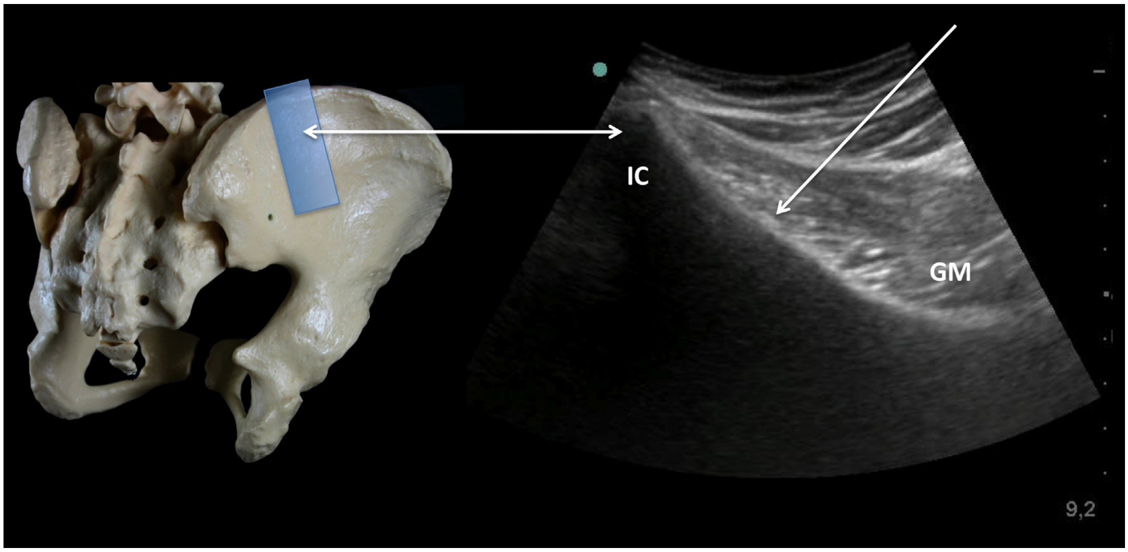

Fig. 26 – Gluteus medius muscle infiltration. (Left) Anatomical image indicating posterior longitudinal probe position (blue rectangle). (Right) US view corresponding to probe position in the left image, showing the acoustic shadowing of the iliac crest (IC), the ilium, the extensive origin of the gluteus medius muscle (GM), and the needle trajectory (arrow). The dot is positioned superior to the iliac crest. (Color version of figure is available online.)

anterior-superior iliac spines. The most active trigger points are located just below the line of the iliac crest. Pain worsens when walking and sitting. The pain is usually located at the level of the iliac crest, sacrum, buttocks, and posterior thigh.

Infiltration with a local anesthetic can be useful to differentiate the gluteus medius muscle syndrome from other processes, such as the facet syndrome, involvement of the sacroiliac joint, and myofascial syndromes involving other muscles in the pelvic area, such as the piriformis muscle.[34]

Probe type

Convex.

Patient position

Prone decubitus.

Sonoanatomical references

Anterior-superior and posterior-superior iliac spines, the upper edge of the iliac crest, the iliac bone, the gluteus medius muscle, and the quadratus lumborum muscle.

US examination

The probe is placed in a longitudinal position next to the posterior-superior iliac spine. The iliac crest should be visible. The probe is moved in a lateral direction, and appropriate puncture point(s) is chosen based on the location of the trigger point(s). If the probe is moved in a proximal direction, above the iliac crest, the quadratus lumborum muscle is seen on its longitudinal axis (Figure 26).

Technique

SC infiltration is performed at the puncture site with 1% lidocaine, and a 22-G, 90-mm needle connected to a small extension tube is introduced in plane. The needle is directed toward the most painful muscular zone. Bone contact with the iliac bone is not necessary. Between 3 and 5 ml of local anesthetic is injected (Figure 27).

Complications

Infection and hematoma.

Fig. 27 – Gluteus medius muscle infiltration. Clinical image of the in-plane needle insertion into the right gluteus medius muscle. (Color version of figure is available online.)

Iliolumbar ligament infiltration

Pain in the lumbosacral area is a frequent complaint in pain units. Many tissues, such as intervertebral discs, zygoapophyseal joints, various ligaments and fascia, the sacroiliac joints, muscles, peripheral nerves such as the cluneal nerves and the spinal nerve roots, in this area can cause pain.[35] However, the diagnosis of ligamentous involvement based exclusively on clinical signs and symptoms can be difficult. In these cases, US-guided puncture plays an important role in evaluating a potential ligamentous etiology.

The iliolumbar ligament provides stability to the lumbosacral union and the sacroiliac joint.[36,37] The iliolumbar ligament inserts on the transverse apophysis of L5 and on the iliac crest. Owing to its location, this ligament is under constant and elevated mechanical stress. Patients affected usually describe unilateral pain at the middle or posterior portion of the iliac crest, and they usually point to the painful spot with their finger. The pain increases during long periods of sitting or walking and with the lateral inclination toward the uninvolved side. Associated neurologic deficits are usually not observed. The ligament is located relatively deep between the transverse apophysis of L5 and the superior and internal portion of the iliac crest.[38]

Probe type

Convex.

Patient position

Prone decubitus with pillow placed under the abdomen.

Sonoanatomical references

Iliac crest, L5 transverse apophysis, and quadratus lumborum muscle.

US examination

The probe is placed on the transverse axis at the L5-S1 space and moved carefully until the transverse apophysis of L5 is visualized. Next, the probe is moved toward the affected side until both the iliac crest and the transversal apophysis of L5 are visible.

Technique

SC infiltration is performed at the puncture site with 1% lidocaine and a 22-G, 90-mm spinal needle is inserted in plane. The needle is directed laterally toward the hyperechogenic image located between the transversal apophysis of L5 and the iliac crest just below the erector spinae muscle. To perform a diagnostic block, the administration of 3-4 ml of local anesthetics with or without corticosteroids is sufficient (Figure 28).

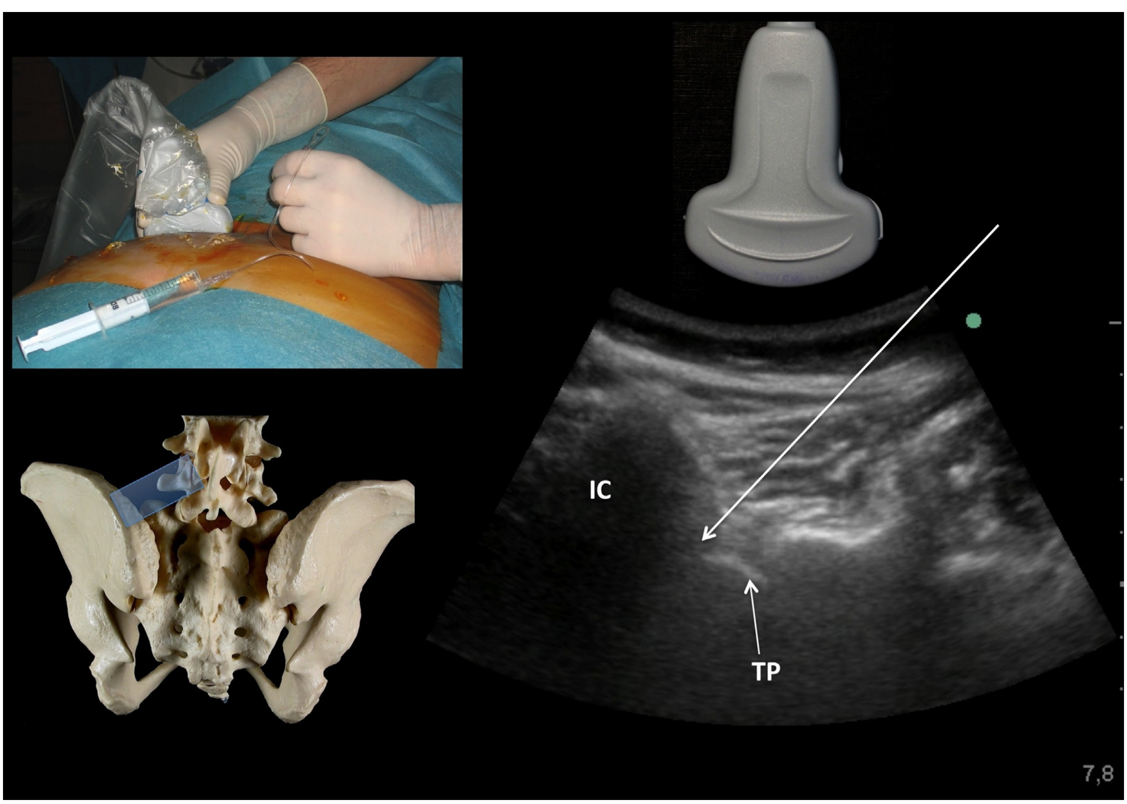

Fig. 28 – Iliolumbar ligament infiltration. (Upper left) Clinical image indicating an in-plane medial needle insertion. (Lower left) Anatomical diagram with the medial border of the probe (blue rectangle) positioned over the lateral border of the L5 transverse apophysis (TP). (Right) US view corresponding to probe position in the previous images. The acoustic shadowing of the iliac crest (IC), the L5 transverse apophysis, and the needle trajectory (arrow) are shown. (Color version of figure is available online.)

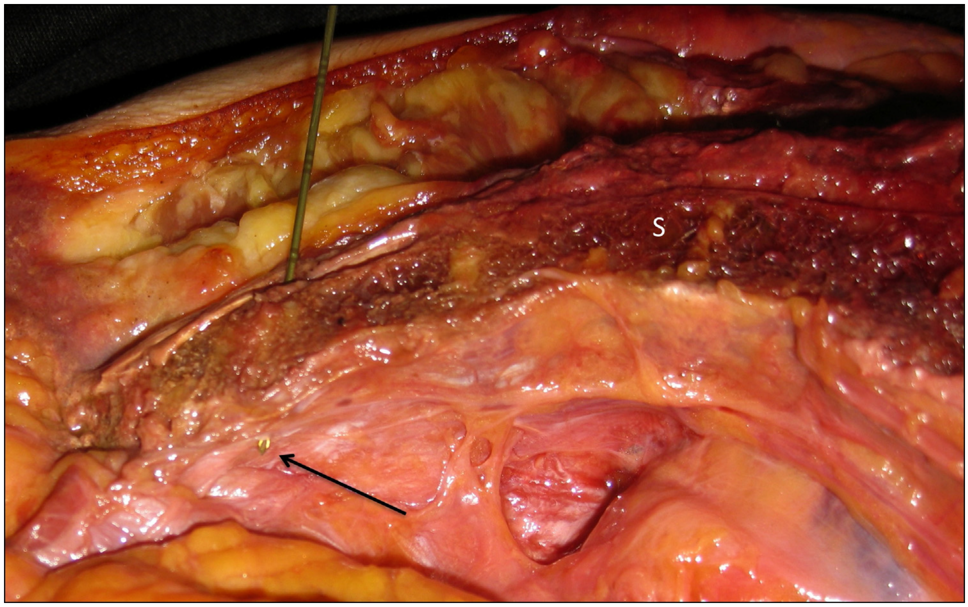

Fig. 29 – Ganglion impar block. Midline sagittal anatomical diagram of the sacrum. The right side represents the proximal aspect, and the skin overlying the posterior sacrum is at the top of the image. The sacral bone divides the image in half in horizontal fashion with the middle portion of the sacrum indicated by S. The short-beveled needle is projecting vertically through the sacrococcygeal joint with the needle tip in the presacral area (arrow). (Color version of figure is available online.)

Complications

Hematoma, infection, and damage to L5 spinal root.

Ganglion impar block

The ganglion impar is a small neural structure that is usually located anterior to the sacrococcygeal joint. The ganglion impar is the distal fusion of the 2 sacral sympathetic chains. The ganglion impar block is a useful technique to evaluate and treat pain of the distal area of the rectum, anus, scrotum, distal third of the vagina, and urethra.[39,40]

Fluoroscopy is the imaging technique of choice to perform the block as it allows direct visualization and confirmation of the position of the tip of the needle on the anterior aspect of the sacrum. However, to avoid exposure to harmful ionizing radiation, US can be used to locate the sacrococcygeal joint. Nonetheless, the anterior aspect of the sacrococcygeal joint cannot be observed and thus one cannot be

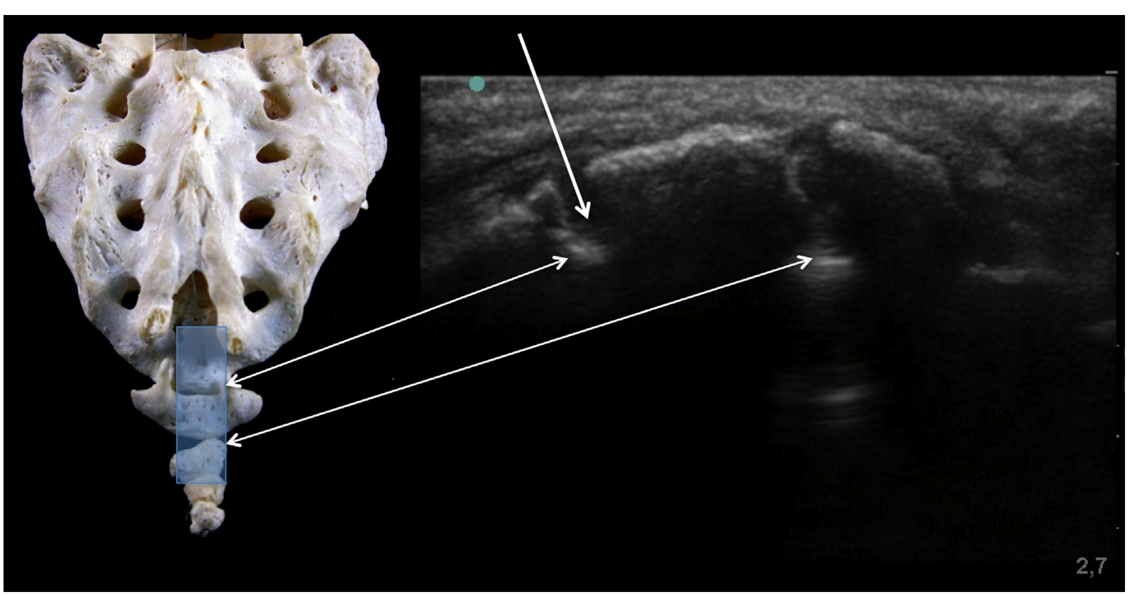

Fig. 30 – Ganglion impar block. (Left) Anatomical diagram showing the longitudinal probe position (blue rectangle) over the sacrococcygeal and first coccygeal joint. (Right) Longitudinal US view corresponding to probe position in the left image. The sacrococcygeal joint (vertical arrow) and first coccygeal joint are linked to their location on the anatomical image. (Color version of figure is available online.)

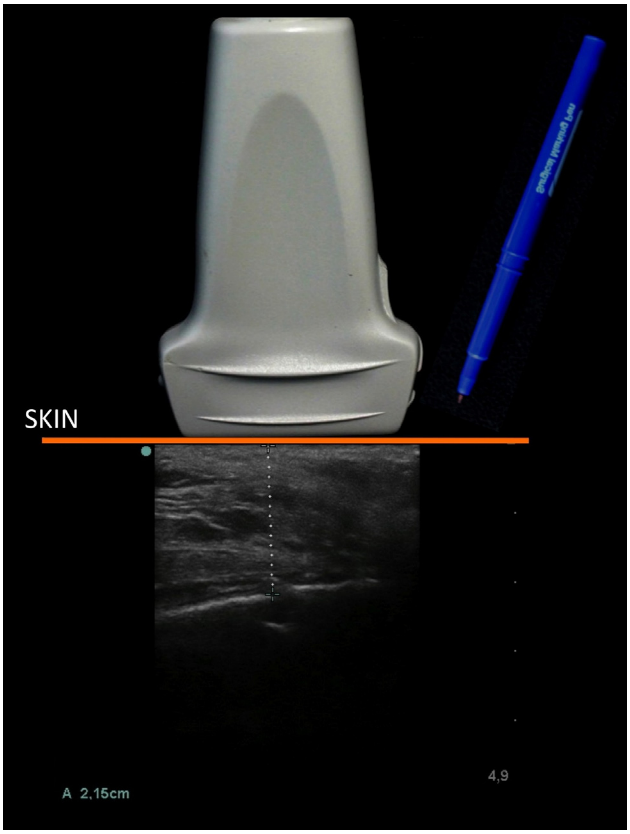

Fig. 31 – Ganglion impar block. Longitudinal US view over the distal sacrococcygeal joint enables the measurement of the distance between the skin and the joint represented by the dotted line (in this case 2.15 cm). The skin is then marked at the midpoint of the probe, and the needle is then advanced at this point according to the measured distance to the sacrococcygeal joint by US. The needle is then advanced slowly and carefully while attempting to inject saline solution until there is an obvious loss of resistance. (Color version of figure is available online.)

absolutely assured that the rectum has not been punctured (Figure 29).

Probe type

Linear.

Patient position

Prone decubitus with the buttocks separated.

Sonoanatomical references

Sacral cornua, sacrococcygeal ligament, and the fissure that corresponds with the sacrococcygeal joint.

US examination

The probe is placed in a transverse position at the level of the sacral cornua. Next, the probe is rotated longitudinal and moved in a distal direction. The first fissure that is observed is the sacrococcygeal joint, and the second fissure observed corresponds with the joint between the first and second coccygeal vertebrae (Figure 30).

Technique

The puncture can be performed in plane or out of plane depending on the angle and depth of the sacrococcygeal joint. However, the buttocks and the orientation of the sacrococcygeal joint may complicate the puncture. We believe that it is better to mark the puncture point and measure the distance between the joint and the skin. The puncture point is infiltrated with 1% lidocaine, and a short bevel 22-G, 50-mm needle is introduced until reaching the sacrococcygeal joint. The needle is then advanced very slowly while attempting to inject physiologic saline. When a loss of resistance is noted,

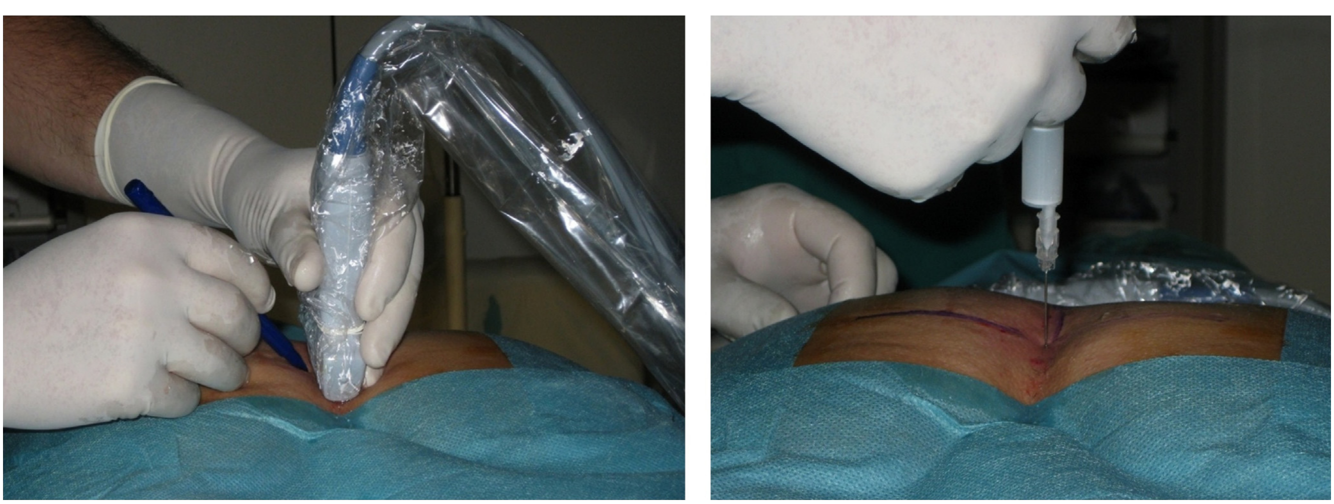

Fig. 32 – Ganglion impar block. (Left) Clinical image of the marking of the puncture point after US measurement of distance between skin and the sacrococcygeal joint. (Right) Clinical image of the needle advancement to the sacrococcygeal joint followed by penetration through the joint by the “loss of resistance” technique. (Color version of figure is available online.)

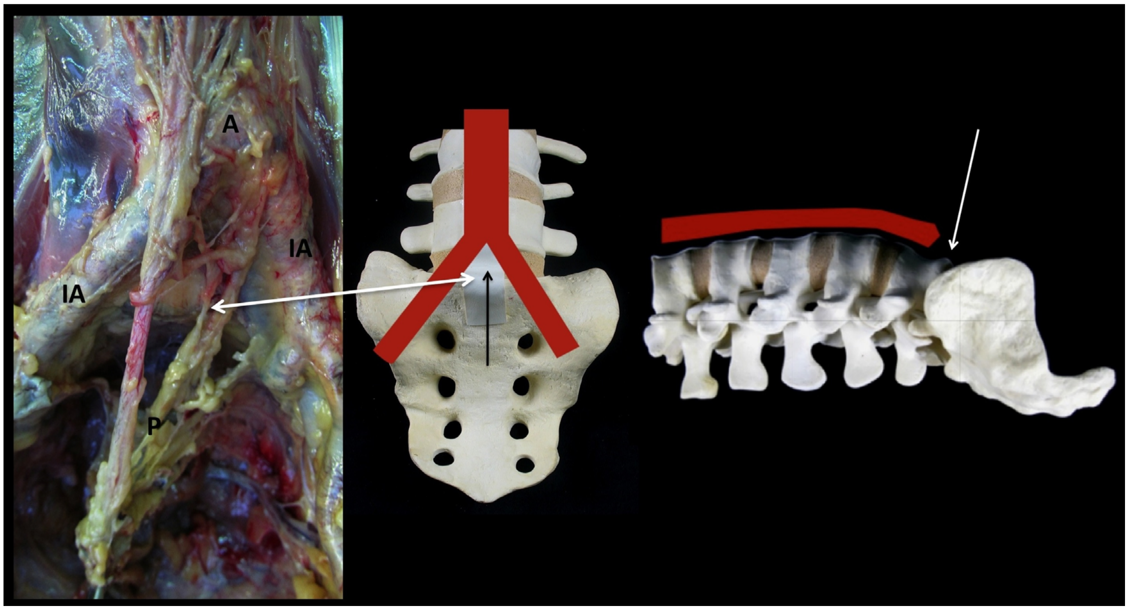

Fig. 33 – Superior hypogastric plexus block. (Left) Anatomical image of the plexus (white arrow) located in the retroperitoneal space immediately in front of the S1 prominence and between the iliac arteries (IA). (Middle) Frontal anatomical diagram showing the abdominal aorta and iliac arteries (inverted red "Y") and S1 prominence (black arrow). (Right) Lateral anatomical view indicating the abdominal aorta (red line) and position of the plexus in front of the S1 prominence (white arrow). The white arrow also indicates the needle trajectory. (Color version of figure is available online.)

the anesthetic is then injected with or without corticosteroids (Figures 31 and 32).

Our recommendation is to perform neurolytic blocks under fluoroscopic guidance only.[41]

Complications

Accidental perforation of the rectum, infection, or the unintentional vascular administration of the analgesic agent.

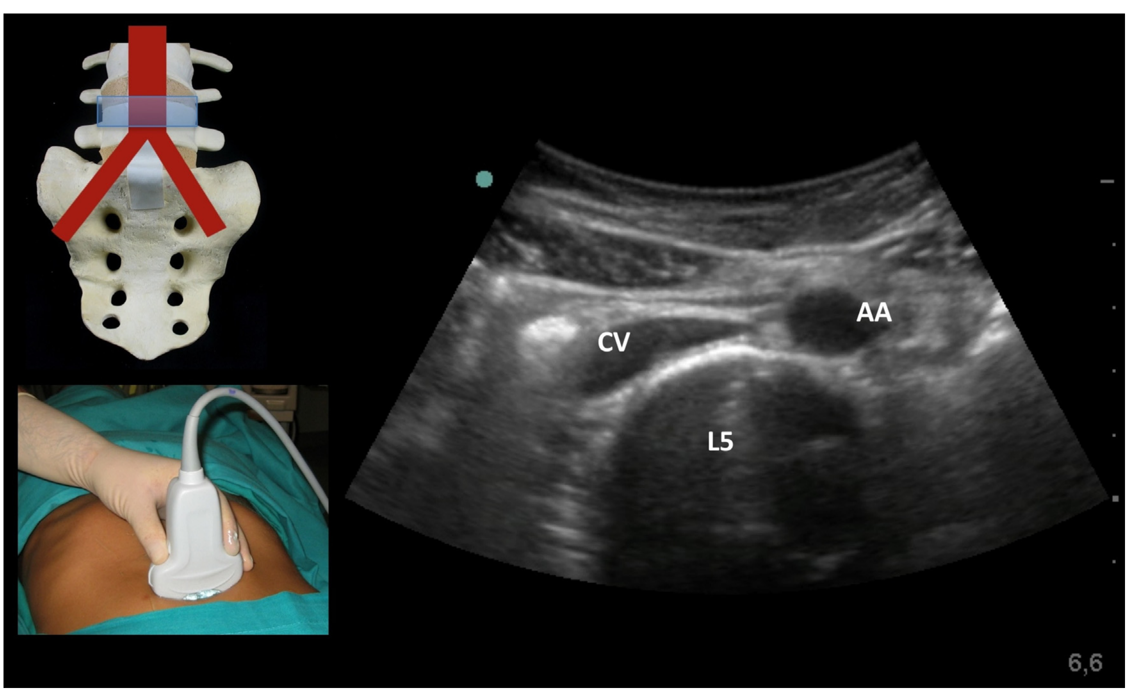

Fig. 34 – Superior hypogastric plexus block. (Upper left) Anatomical diagram with initial transverse probe position (blue rectangle) over L5 vertebral body. Note inverted red "Y" of aorta and iliac arteries. (Lower left) Clinical image with the probe over the midabdomen below the navel. (Right) Transverse US view corresponding to the probe position in the lower left image. The vena cava (CV), abdominal aorta (AA), and vertebral body of L5 (L5) are indicated. (Color version of figure is available online.)

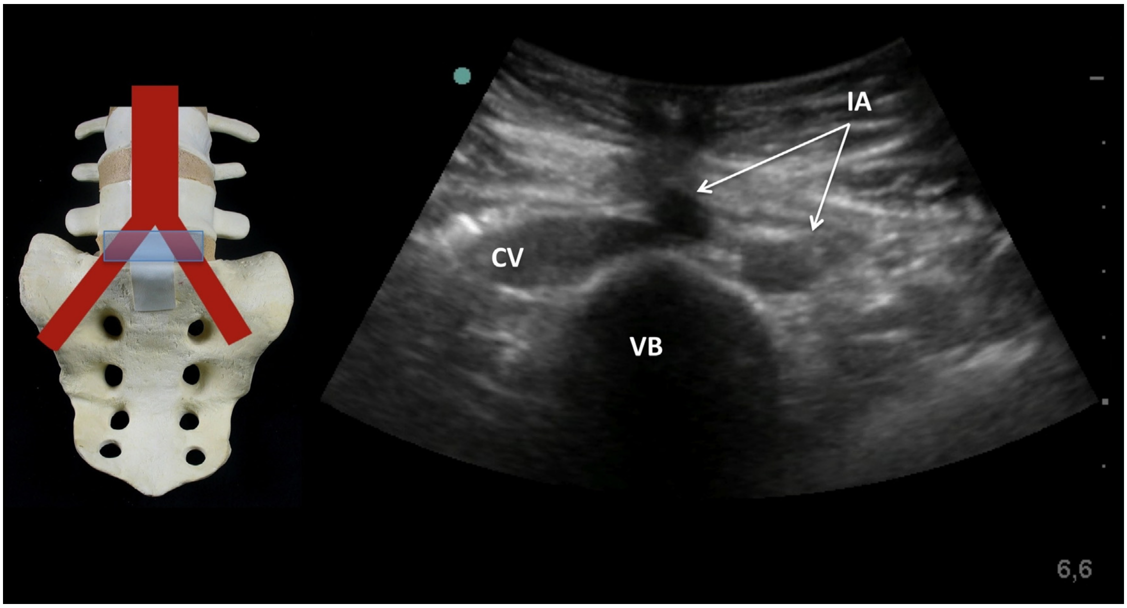

Fig. 35 – Superior hypogastric plexus block. (Left) Anatomical diagram with the probe moved slightly distal over the iliac arteries. (Right) Transverse US view corresponding to the probe position in the left image. The iliac arteries (IA), vena cava (CV), and vertebral body (VB) are shown. (Color version of figure is available online.)

Superior hypogastric plexus block

The superior hypogastric plexus is a retroperitoneal neural structure located between the lower one-third of the fifth lumbar vertebra and the upper one-third of the first sacral vertebra. It is constituted by the confluence of the lumbar sympathetic chain and the aortic plexus, and it contains parasympathetic fibers that originate in the dorsal roots from S2-S4.

The block of the superior hypogastric plexus is both a diagnostic and therapeutic intervention for pain syndromes

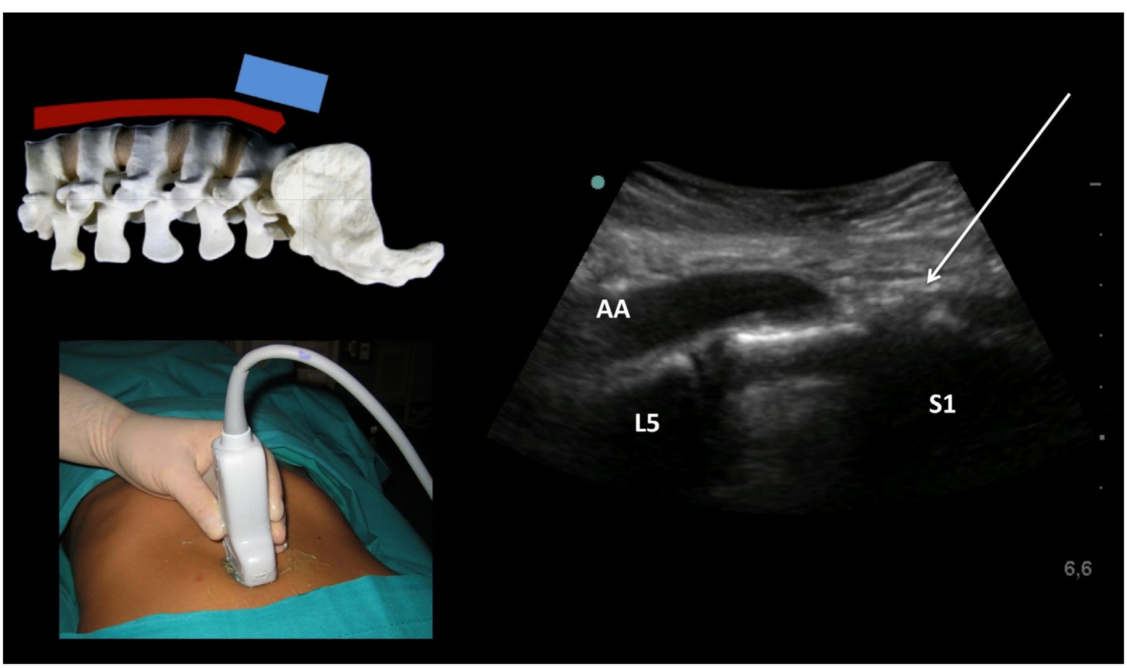

Fig. 36 – Superior hypogastric plexus block. (Upper left) Anatomical diagram showing probe position (blue rectangle) after rotating it longitudinal to the midline axis. (Lower left) Clinical image of the same probe position as in the upper left image. (Right) Midline longitudinal US view corresponding to probe position in the upper and lower left images. The anechoic abdominal aorta (AA) ending, as it bifurcates into the iliac arteries (not seen), the underlying L5 vertebra (L5), and the promontorium of the S1 vertebra (S1) are indicated. The arrow indicates needle trajectory. The puncture is not performed if the intestine is in the trajectory of the needle. (Color version of figure is available online.)

that originate in the testicles, prostate, ovaries, uterus, vagina, cervix, bladder, rectum, and sigmoid colon.

The block of the superior hypogastric plexus by US-guided injection is only possible through an anterior approach. Owing to the risk of puncturing the small intestine loops, it is recommended that antibiotic prophylaxis be initiated before the technique is performed.[42] The bladder should be emptied beforehand. It is also recommended and necessary that the patient fasts before the procedure. Finally, the possibility of pregnancy should be ruled out in appropriate patients.

Probe type

Convex.

Patient position

Prone decubitus.

Sonoanatomical references

Aortic artery, inferior vena cava, right and left iliac arteries, and L5-S1 anterior aspect (Figure 33).

US examination

The probe is placed transversal just below the navel and moved slowly in a distal direction until the division of the aorta into the 2 iliac arteries is visible. The probe is then rotated longitudinal and the anterior aspect of S1 should become visible along with the division of the aortic artery. It is essential that no large intestine structures are located in the path of the potential infiltration (Figures 34-36).[43,44]

Technique

SC infiltration is performed at the puncture site with 1% lidocaine, and a 22-G, 90-mm needle is inserted in plane at the distal end of the probe. Before introducing the needle, the patient must hold his breath after exhalation. The needle is then advanced toward the anterior longitudinal ligament until bone contact is made at the level of the upper edge of S1. Contact with the intervertebral disc between L5 and S1 should be avoided. The needle is withdrawn about 2-3 mm, and hydrodissection with a few ml of saline solution is performed to confirm appropriate diffusion. The lack of anechoic diffusion suggests intravascular location of the needle.

If correct hydrodissection is noted, 10-20 ml of the analgesic agent is injected. It is important to ensure that vascular structures, the bladder, or the large intestine is not in the path of the needle.

Complications

Intravascular administration of the analgesic agent, infection due to intestinal puncture, bleeding, nerve damage, and damage to the intervention discs L5-S1.

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