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Ultrasound-guided interventional procedures for lumbar pain

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ABSTRACT

The possibility of performing the majority of the pain-control interventions in the lumbar spine without using fluoroscopy is a very promising alternative. A clear description of the most relevant sonoanatomy of the lumbar spine and the proposal for a systematic approach to perform principal lumbar spine blocks may help those that are beginning to use ultrasound and increase the interest of professionals that normally perform these blocks with x-rays. Therefore, the structures that are easily identifiable by ultrasound from the muscular blocks and the facet joints are first described.

Introduction

In daily medical practice, interventional techniques are used to treat lumbar pain, which are the most prevalent pathologies in pain clinics.[1] This causes the need to be in surgery and in permanent contact with the fluoroscope or x-ray equipment.

The interest in learning these blocks using ultrasound is hampered by the difficulties in ultrasound visibility of the vertebral spine at the lumbar level. Low-frequency probes must be used that have a much lower resolution than linear probes. These limitations are directly proportionate to body mass index (BMI), where the higher the BMI, the more visibility difficulty is encountered. Obesity is the principal limiting factor in using ultrasound for lumbar spine blocks, owing to the incapacity to see the intravascular or epidural diffusion of the substances administered.

Recent systematic reviews of the principal studies conducted on ultrasound-guided blocks in the lumbar spine clearly demonstrate these limitations and encourage others to conduct further studies that support the efficacy and safety of ultrasound-guided techniques.[2-4]

A clear description of the most relevant sonoanatomy of the lumbar spine and the proposal for a systematic approach to perform principal lumbar spine blocks may help those that are beginning to use ultrasound. The ultrasound guide and fluoroscope are complementary, especially when learning and interpreting ultrasound images of the lumbar spine.

For all spinal blocks, the 3 basic orientations of the ultrasound probe and beam must be mastered: transverse or axial, paramedian sagittal (PS), and paramedian sagittal oblique (PSo) (Figure 1). The steps described by Chin et al[5] to perform neuroaxial blocks guided by ultrasound are applicable to the interventional techniques that are mainly used to treat lumbar pain (Figure 2). For all ultrasound-guided neuroaxial lumbar blocks, the identification technique to mark intervertebral levels must be mastered. To do so, locating the lumbosacral junction must be done with the probe oriented in the PSo view showing the lamina. The probe is then moved in a caudal direction until a continuous hyperechoic line

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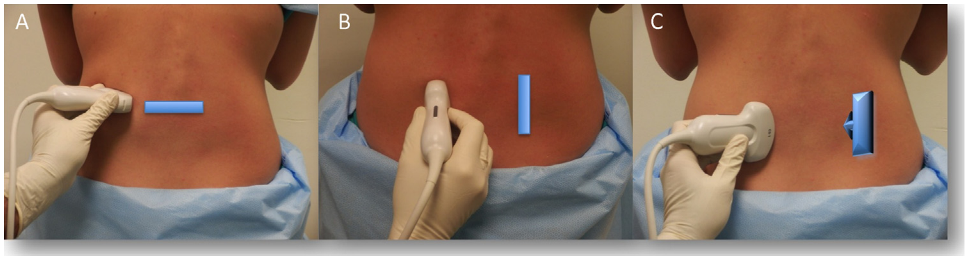


Fig. 1 – Probe orientations for spinal blocks: (A) transverse or axial; (B) paramedian sagittal (PS); and (C) paramedian sagittal oblique (PSo).

(the sacrum) and a short hyperechoic line (lamina L5) are identified. A space should be visible between these 2 lines. Once the L5-S1 space is located in the PSo view, the probe is moved in the cephalic direction, and the skin is marked at the midpoint of the probe that corresponds with each of the L5-L1 lamina. Marking the skin at the different lumbar levels in the PSo helps to avoid erroneous identification of the level while exploring the transverse view (Figure 3).

Lumbar muscles (quadratus lumborum and psoas muscle)

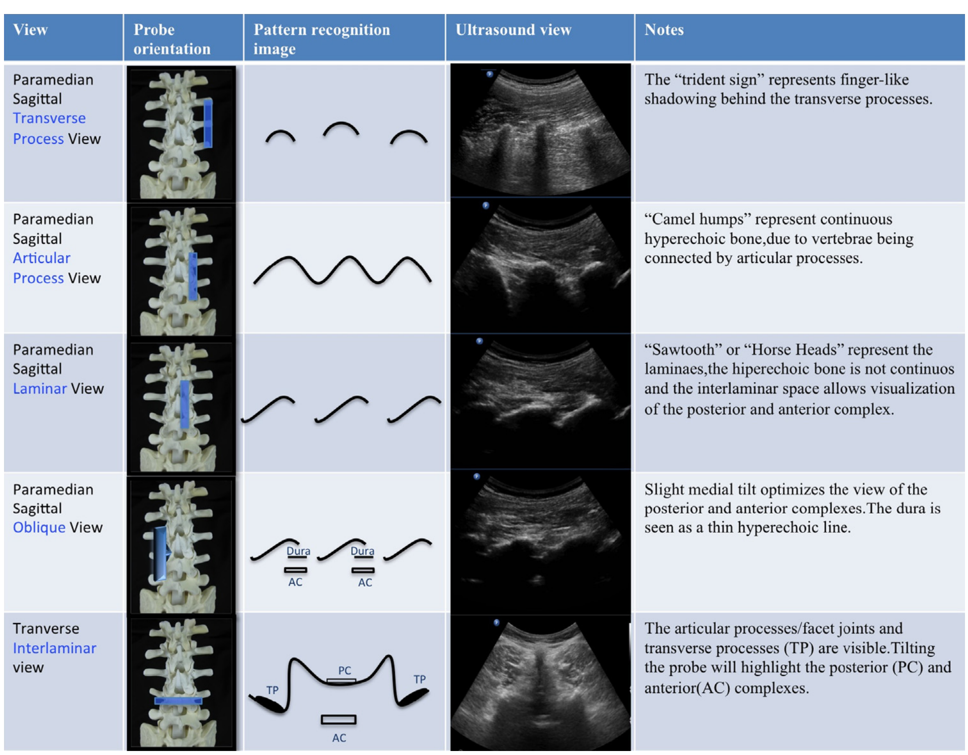
Anatomy and sonoanatomy

Professionals who only perform fluoroscope-guided interventional techniques may first be interested in identifying muscular structures surrounding the lumbar spine. Dysfunction of the lumbar muscles may cause acute and long-term lumbar pain, as well as a target point in the multidisciplinary treatment of lumbar pain.[6] The quadratus lumborum muscles and the psoas muscles are the only muscles of the spine with a moderate level of evidence for reproducing painful points and reflective pain.[7,8] They are also the only spinal muscles where a fluoroscope-guided infiltration procedure has been described, and where ultrasound could be used as an alternative. Myofascial pain derived from the quadratus lumborum or psoas muscles or both is a frequent and underdiagnosed cause of nonspecific lumbar pain.[9] In fact, these muscles together with the erector spinae muscles participate synergistically with the vertebrae to stabilize the vertebral spine.

In patients with chronic lumbago, atrophy of the psoas and the paravertebral musculature has been documented by computed tomography as well as with asymmetrical images of the quadratus lumborum muscle.[10,11]

Identifying the erector spinae muscles, quadratus lumborum muscle, and psoas muscle may be the first step in understanding all of the lumbar spine sonoanatomy.

Anatomical knowledge of the quadratus lumborum muscle insertions and its integrated relationship with the peritoneum are the primary sonoanatomical references in locating the quadratus lumborum and psoas muscles.



View	Probe orientation	Pattern recognition image	Ultrasound view	Notes
Paramedian Sagittal Transverse Process View				The "trident sign" represents finger-like shadowing behind the transverse processes.
Paramedian Sagittal Articular Process View				"Camel humps" represent continuous hyperechoic bone,due to vertebrae being connected by articular processes.
Paramedian Sagittal Laminar View				"Sawtooth" or "Horse Heads" represent the laminaes,the hiperechoic bone is not continuos and the interlaminar space allows visualization of the posterior and anterior complex.
Paramedian Sagittal Oblique View		Dura AC Dura AC		Slight medial tilt optimizes the view of the posterior and anterior complexes.The dura is seen as a thin hyperechoic line.
Tranverse Interlaminar view		TP PC TP AC		The articular processes/facet joints and transverse processes (TP) are visible.Tilting the probe will highlight the posterior (PC) and anterior(AC) complexes.

Fig. 2 – Neuraxial ultrasound. Five sonographic views of the neuraxial spine.

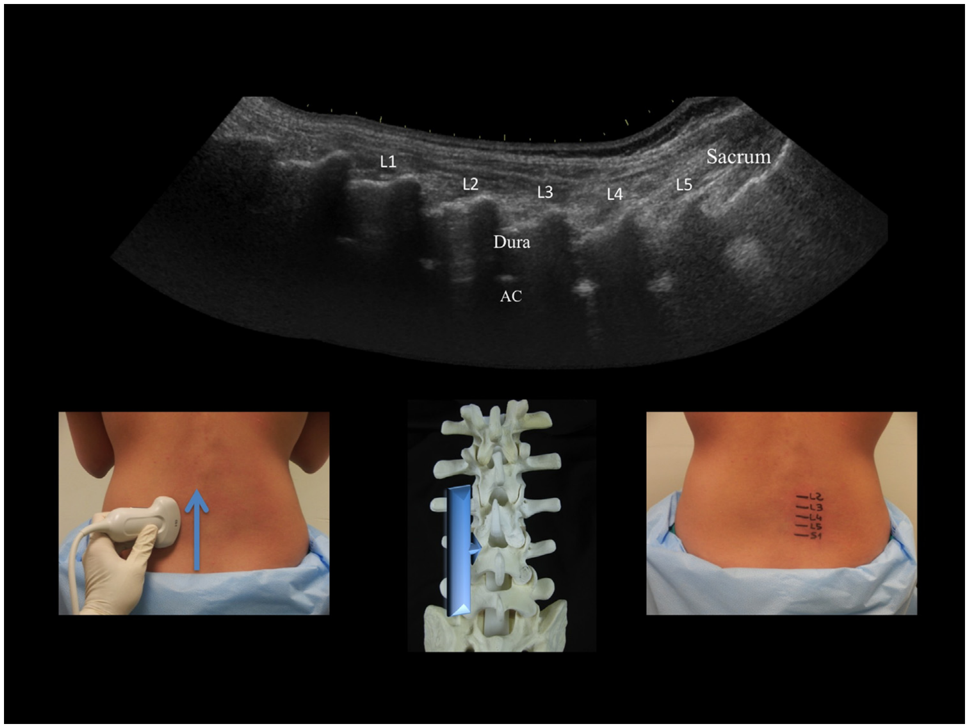


Fig. 3 – The technique to identify and mark the intervertebral levels. The lumbar interspaces are readily identified in the PS oblique view by counting upward from the lumbosacral junction (the gap between the line of the sacrum and the sawtooth of the L5 lamina). We can make a corresponding mark on the skin at the midpoint of the long edge of the probe. Panoramic ultrasound image of the laminaes, PSo view, and anterior complex (AC). (Color version of figure is available online.)

The quadratus lumborum muscle inserts from the iliac crest to the transverse process of the L1-L4 lumbar vertebrae and to the twelfth rib, always in a retroperitoneal position and with a close relationship to the kidneys in some portions. Transverse sections of the quadratus lumborum muscle show a greater thickness of the muscle at the L3-L4 level, coinciding with the lateral insertion in the iliac muscles.[12]

For correct ultrasound visualization of the quadratus lumborum muscle, the patient is placed in a decubitus or lateral decubitus position. The transverse process 3-4 cm from the midline is the target to be found in a PS view (PS transverse process view) with a low-frequency probe. The hyperechogenic images with posterior acoustic shadows that look like a trident in the PS view can be identified (Figure 2). On rotating the probe to a transverse view with slight lateral inclination (traverse paramedian view), a hyperechogenic linear image is observed that represents the entire length of the transverse process (Figure 4). The patient is asked to inhale to differentiate the retroperitoneal planes, and the quadratus lumborum muscle at the distal end of the transverse process becomes visible. If the probe is moved in a slight caudal direction, the transverse process image is lost and the muscle masses of the psoas and the quadratus lumborum muscles can be differentiated in 1 image (Figure 5). The psoas muscle inserts in a proximal position into the lateral side of the vertebral bodies and intervertebral discs. The interaction of the quadratus lumborum muscle with the iliac muscles can also be confirmed in a more lateral view.

In patients with obesity, the focus, gain, and depth parameters of the ultrasound device must be optimized, and the ultrasound planes that divide the peritoneum must be carefully differentiated. In thinner patients, it is possible to distinguish more hyperechogenic images from inside the psoas muscle corresponding to the posterior lumbar plexus and locate the foramen and lumbar root. In a study that included 30 young volunteers to demonstrate the sonoanatomy of paravertebral structures of the roots and lumbar plexus in the lumbar region L3-L4-L5, 57% of the volunteers showed good visibility of these structures.[13] This study also established a strong correlation between the age and echointensity of the muscles. There is a reduction in skeletal muscle mass in elderly people (sarcopenia), a substitution of the contractile elements in the muscles for fat and connective tissue, and an increase in extracellular water content in the muscles. The ultrasound images of the paravertebral lumbar region in elderly people appear to be whiter and shinier showing decreased contrast between muscle and adjacent structures. Muscle mass is also substituted for fat in patients with obesity, making ultrasound exploration in the lumbar area more difficult to evaluate.

Block technique

Locating the quadratus lumborum muscle as previously described with a low-frequency ultrasound probe of 3-8 MHz, the block can be performed in a short axis view with the patient in a decubitus position (Figure 5) or along the long axis, if the patient is in a lateral decubitus position (Figure 6). It is recommended in plane technique in which the whole-needle path is under control at any time to avoid

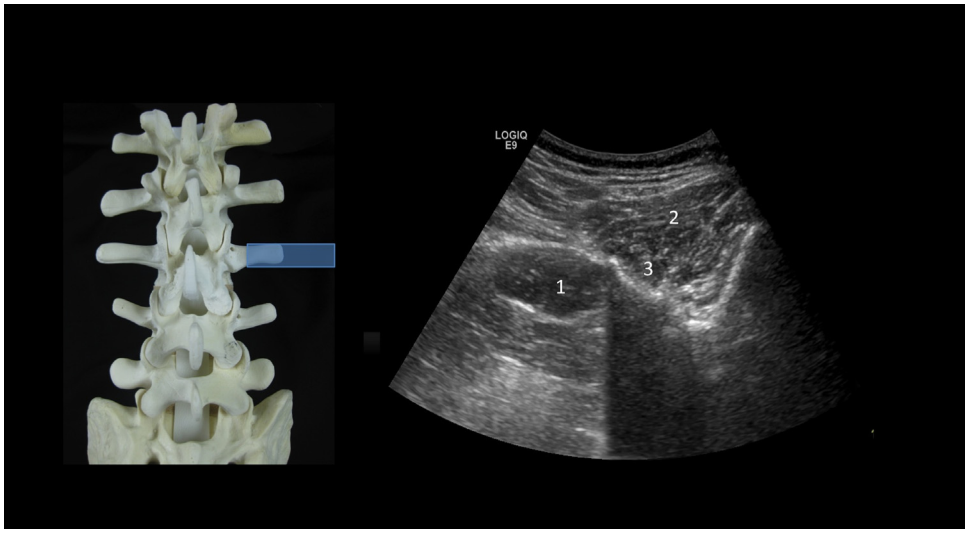


Fig. 4 – Transverse view showing a hyperechogenic linear image that represents the entire length of the transverse process (3), section of the quadratus lumborum muscle (1), and paraspinal muscles (2). (Color version of figure is available online.)

retroperitoneal puncture. The short axis view of the quadratus lumborum muscle allows for the infiltration to be performed in 1 puncture of both the psoas and the quadratus lumborum muscles.

The dry puncture technique of the “trigger points” has been used in treating myofascial pain at the lumbar level, as well as the injection of local anesthetic substances, corticosteroids, or botulinum toxin.[14,15]

Intra-articular: lumbar facet (L1-L4)

Anatomy and sonoanatomy

Zygapophyseal (facet) joint syndrome is a common diagnosis in patients with long-term back pain. After epidural corticosteroid injection, the lumbar facet block is the second most performed intervention for treating long-term pain and has probably been the first application where the use of ultrasound guidance was described for interventional treatment of lumbar pain.[16,17] The lumbar facet joint capsule and the surrounding structures are innervated, and, therefore, chemical, electrical, or mechanical stimulation of the lumbar facet joint causes reflective back pain. Repetitive stress on the lumbar facet joint may lead to osteoarthritis, where inflammation and stretching of the joint capsule cause axial lumbar pain that irradiates to the leg.

The L3-L5 lumbar vertebrae are those that are most frequently involved in spinal pathologies as these vertebrae carry the majority of the body weight and support the greatest tension of the entire vertebral column. With the exception of the fifth lumbar vertebra, L1-L4 show similar anatomical characteristics.

Each vertebra is connected to the adjacent level by the anterior intervertebral disc and the zygapophyseal or facet joints in the posterior portion. The vertebral body is a dense cortical bone and the pedicles are 2 short, round processes that extend from the lateral posterior margin of the dorsal vertebral body. The laminas are 2 flat plates of bone that extend in a medial direction from the pedicles to form the posterior wall of the vertebral foramen. Anatomical variations of the lumbar spine, including scoliosis, sixth lumbar

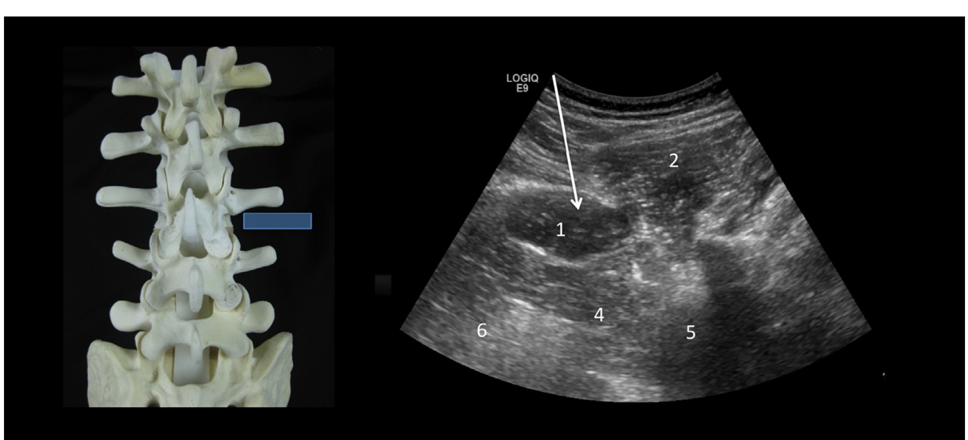


Fig. 5 – Transvese view under lumbar transverse process: the quadratus lumborum muscle (1), paraspinal muscles (2), psoas muscle (4), vertebral body (5), and peritoneum (6). The arrow marks the needle path for quadratus lumborum muscle block (short axis view). (Color version of figure is available online.)

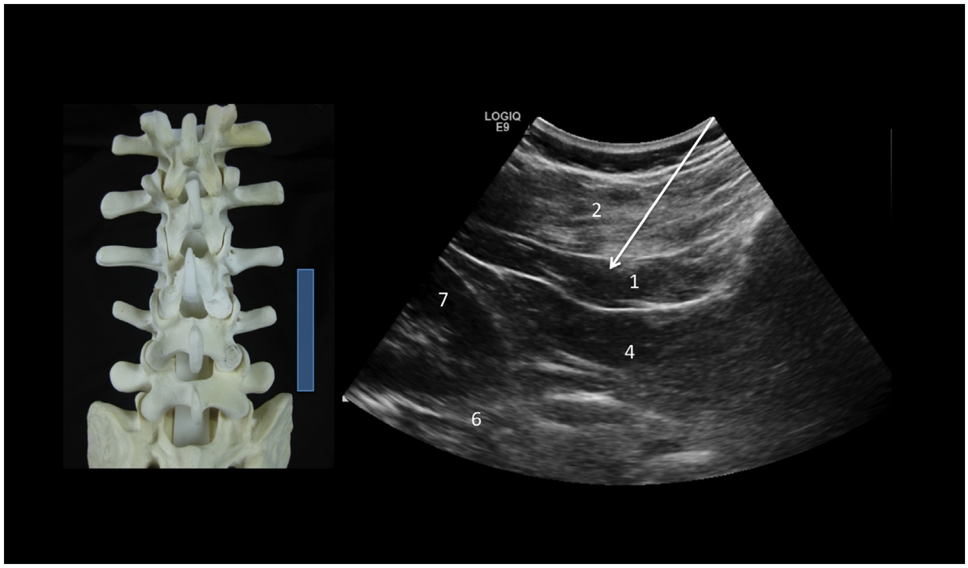


Fig. 6 – Paramedian sagittal view close the lumbar transverse process: the quadratus lumborum muscle (1), paraspinal muscles (2), psoas muscle (4), vertebral body (5), peritoneum (6), and kidney (6). The arrow marks the needle path for quadratus lumborum muscle block (long axis view). (Color version of figure is available online.)

vertebra, sacralization of the fifth lumbar vertebra, and pseudoarthrosis can make correctly identifying the intervertebral levels difficult, leading to incorrect needle insertion in an ultrasound-guided approach. The position of the facets varies greatly, with frequent asymmetry and angulations. Therefore, the imaging studies provided by the patient must be reviewed before planning an ultrasound-guided interventional procedure to decrease and prevent difficulties that may arise during an ultrasound-guided puncture.

It is important to understand that these are diarthrosis-type facet joints with a synovial membrane and an articular cavity between the bone endings, cramped by various tense ligaments (transverse capsular ligaments). It will, therefore, be difficult to perform *intra*-articular infiltrations and frequently only the *peri*articular area will be reached.[18]

The patient is placed in a prone position with a pillow under their abdomen to decrease lumbar lordosis. A convex probe of 3-8 MHz is used to perform the test. The vertebral spine is then explored after the sequence to obtain the images described in Figure 2 to identify and mark the intervertebral levels.

From the PS transverse process view, the probe is moved in a medial direction until a hyperechogenic line is observed that looks like a line of "camel humps" in the PS articular process view. In this view, each camel hump represents the facet articulation formed by superior and inferior articular processes of the successive vertebrae. This continuous line is located at a more superficial depth than the discontinuous line of the transverse processes. Once the view of the articular processes has been obtained, the probe is inclined to point the ultrasound beam in a lateral to medial direction toward the PSo view. A succession of "sawtooth" hyperechogenic lines is observed in this view that corresponds with the lamina of the lumbar vertebrae. Unlike the articular process view, the hyperechogenic line is discontinuous. With the PSo view, the probe is moved in a caudal direction until a continuous hyperechogenic horizontal line can be differentiated that corresponds with an ala of the sacrum. The L5 lamina can also be differentiated as it is narrower than the other lamina and becomes visible before the sacral line.

The cranial and caudal movements of the ultrasound probe in the PSo view allow for the localization of the spaces from S1-L1. Each of the levels that are examined can be marked on the patient's skin. To do so, the image is centered on the lamina on the screen of the ultrasound, making a mark that corresponds with the midpoint of the probe on the skin (Figure 3).

Once the vertebral levels and the vertebral structures are located in a parasagittal or longitudinal view (long axis view), each of the dorsal surfaces of the lumbar vertebrae can be observed to identify the facet joint in a transverse view or transverse interlaminar view. In this view, it should be possible to differentiate the linear hyperechogenic line of the sacrum, the image over the spinous process with 1 view of the hyperechogenic line with a large posterior acoustic shadow or the image of the intervertebral space, where the facet joint can be identified (transverse interlaminar view) (Figure 2). The sonoanatomical image of the L5-S1 face is different in that it is closely related with the sacrum.

Block technique

The intra-articular infiltration of the facet joint is not always possible owing to the presence of hypertrophy and being a very narrow joint with great tension between its ligaments and its capsule. Performing a periarticular block instead of an intra-articular block is frequently considered. Anatomical variations are an added difficulty for visibility. These include deformities of the spine, degenerative processes, obesity, with low-frequency probes also contributing to difficult visibility. For this reason, the different intervertebral levels and the line where the facets can be seen in a PS articular process view must be marked on the skin during the exploration technique previously described.

With the patient in a prone position, a pillow is placed under the abdomen to decrease lumbar lordosis. A convex probe of 3-8 MHz is selected, using routine sterility procedures for ultrasound-guided blocks (ultrasound probe covered with a sterile sheath and sterile ultrasound gel), and optimizing ultrasound parameters.

With the intervertebral reference levels already marked on the skin, an optimal ultrasound view of the facet joint to be blocked is sought in a transverse view, or transverse interlaminar view. The block is performed by inserting the 22-gauge needle in plane until establishing contact with the bone surface of the facet joint. A 1-2 mL of mixture of local anesthetic and depo-steroid is routinely used (Figure 7).

If visibility is poor in the transverse view, it is possible to perform the periarticular facet block in a longitudinal view, therefore, allowing for the interventional to perform the facet block at various levels with the same approach (Figure 8). The facet joint block from L5-S1 may be harder to perform in plane owing to the proximity of the iliac crest, meaning it must be performed out of plane.

The clinical efficacy of the ultrasound-guided facet blocks is very high. Both Galiano et al[19] and Ha et al[20] achieved a midterm to long-term pain reduction in all patients. This data correlate with the high success rate (80%-88%) of the studies that validate the ultrasound-guided technique using fluoroscope or scanner or both in cadavers.[21,22] Although there are contradictory studies, it seems that both the injection of intra-articular corticosteroids or joint denervation with radiofrequency alleviate lumbar pain and functional improvement during a period of at least 6 months, without large differences between the different treatments.[23] Therefore, performing facet joint blocks using an ultrasound-guided technique must be mastered before learning to block the spinal nerves.

Nerves

Lumbar medial branch (L1-L4)

Anatomy and sonoanatomy

The lumbar nerve roots divide into ventral and dorsal branches when they emerge from the foramen. The dorsal branch produces 3 branches: the medial, intermediate, and lateral branches. The medial branch at the corresponding and superior levels innervates each facet joint. These medial branches pass through small tunnels formed by the corresponding superior articular process and the transverse process. During sonoanatomy exploration to block the medial branch, the same sequence should be followed as the one used to perform the facet joint block. The patient is positioned in a decubitus position and a low-frequency probe of 3-8 MHz is used. We mark on the skin lumbar levels L5-L1 in PSo view as we have described previously (Figure3).

An in-plane transverse exploration is performed on the level where the block will be carried out with a slight paramedian inclination to see a continuous hyperechogenic line from the spinous process, articular processes, and the transverse process. This image is similar to a staircase where the target point to locate the medial branch would be the angle of the inferior step formed by the transverse process and the superior articular process (Figure 9A).

To view this angle better, the probe can be moved in a lateral direction and make small angulation movements with the ultrasound probe that help to capture a better hyperechogenic line on the bone surface of the transverse process. The angle and placement of the probe are similar to those used to locate the quadratus lumborum muscle and its insertion in the transverse process. This point or target, where the medial branch travels in the transverse view, does not differentiate whether the probe is at the cranial or caudal level of the transverse process. Therefore although in the longitudinal view of the exploration, it must be double checked that the probe is in the cranial extreme of the transverse process (Figure 9B).

Block technique

Given that the medial branches cannot be seen with ultrasound, as occurs with the fluoroscope, it is of utmost importance that the target point of the bone reference previously described is located. In the transverse interlaminar view, in-plane approach is performed with a 22-gauge needle in the angle formed by the transverse process and the superior articular process. After establishing bone contact in the target point, the probe is rotated in the longitudinal axis

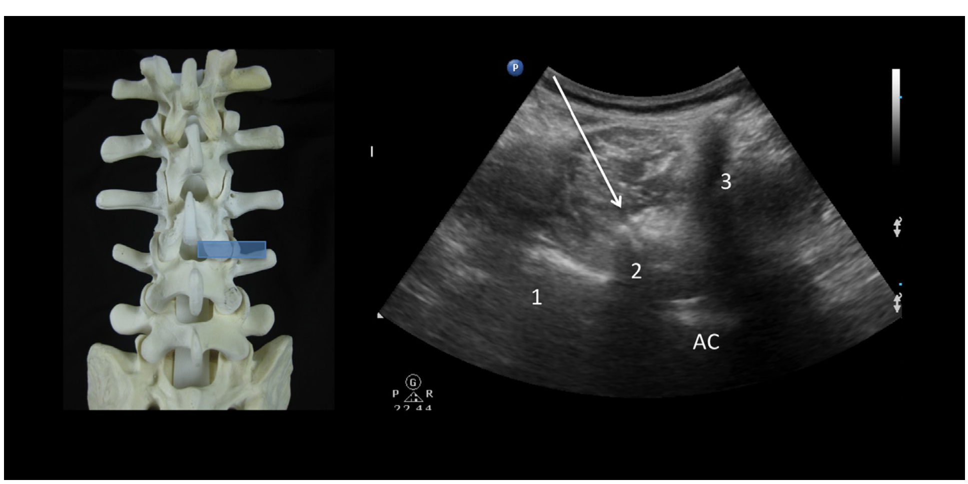


Fig. 7 – Transverse interlaminar view showing the facet joint to be blocked in plane (arrow needle). Transverse process (1), zygapophyseal (facet) joint (2), spinous process (3), and anterior complex (AC). (Color version of figure is available online.)

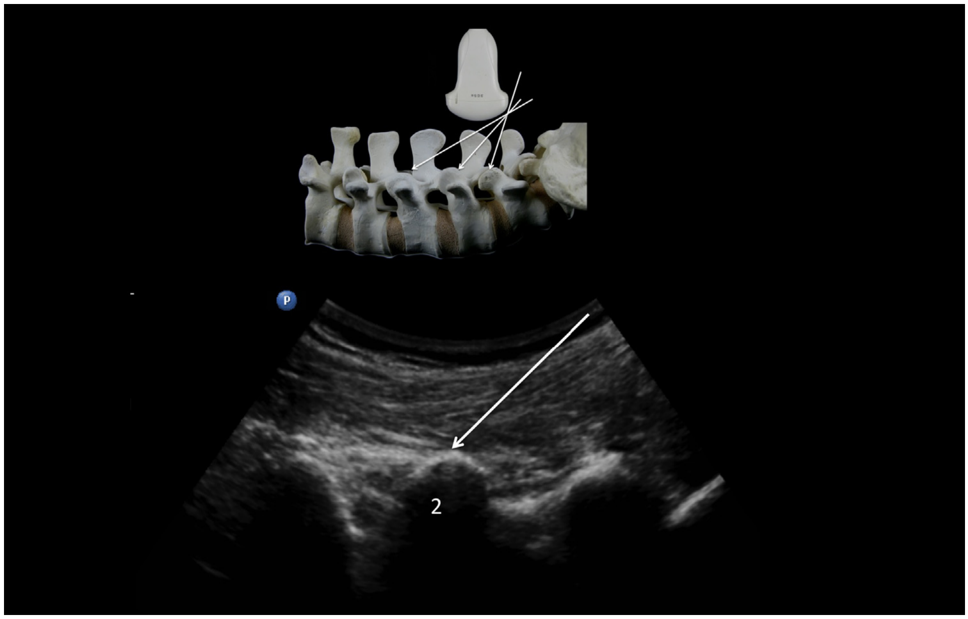


Fig. 8 – Paramedial sagittal articular process view allows us to perform the facet block at various levels with the same approach. Two facet joints. (Color version of figure is available online.)

of the spine to observe that the probe is located in the cranial extreme of the transverse process. At this level, the mix of the local anesthetic substance with the corticosteroid is deposited or neurolysis by radiofrequency is performed or both are performed.

Failure to identify the needle tip or the diffusion of the local anesthetic or both indicates an improper needle placement or intravascular injection. The out-of-plane view can be used for orientation at the level of the transverse process. Agitation of the needle and hydrolocalization (rapid injection of a small quantity of liquid, 0.5-1 mL) will help to identify its position in this out-of-plane sonographic view.

Studies that have validated the use of the ultrasound-guided approach for performing the medial branch block

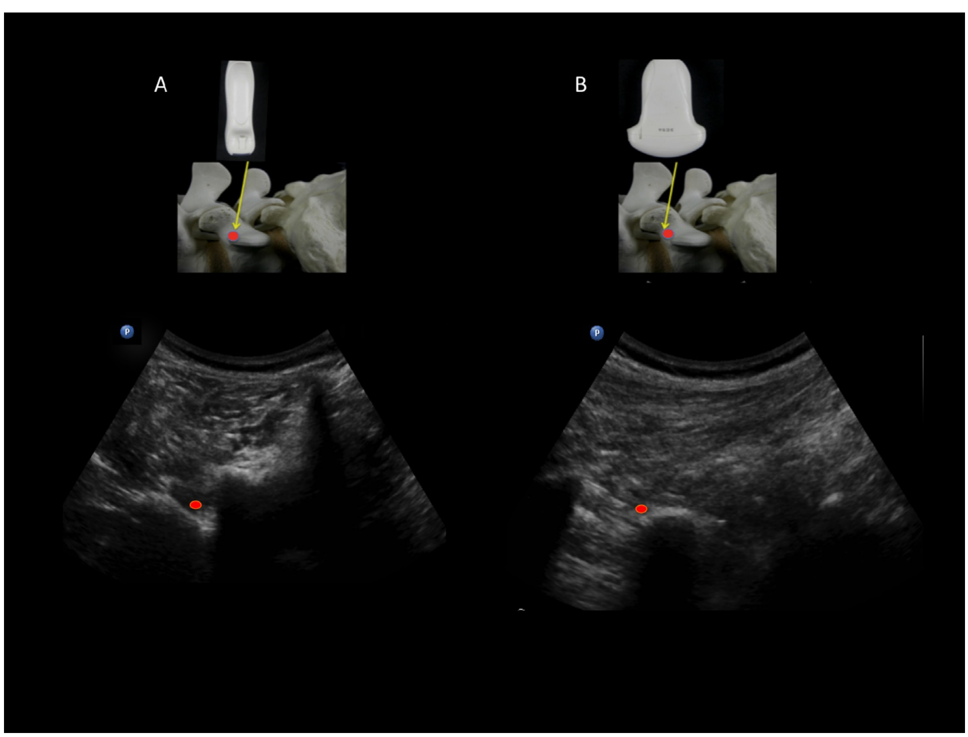


Fig. 9 – (A) Transverse view showing an image is similar to a staircase, where the target point to locate the medial branch would be the angle of the inferior step formed by the transverse process and the superior articular process (red dot). (B) Paramedial sagittal transverse process view, the target should be in the cranial extreme of the transverse process (red dot). (Color version of figure is available online.)

show that the precision of the block decreases in the lowest lumbar levels and in patients with a BMI >30 kg/m^2. Rauch et al[24] found that the accuracy rate decreased to 62% when an ultrasound-guided approach for lumbar medial branch blocks was evaluated in patients with obesity by using fluoroscopy as a comparator. Using volumes greater than 0.2-0.5 mL can increase diffusion at the paraforaminal level or epidural levels or both.[25] The precision needed to locate the target point, the tip of the needle, and the difficulties in viewing the diffusion of small volumes of the local anesthetic substance require a mixed learning curve between the ultrasound and fluoroscope that decrease the interpretation biases of the ultrasound images.

Selective nerve roots

The lumbar nerve roots can be especially difficult to visualize with ultrasound owing to their location in a deeper depth and the fact that they are surrounded by bone structures of the lumbar vertebral spine, making it very difficult for the ultrasound beam to penetrate. On the contrary, there is a rich vascularization around the lumbar roots that may lead to unintentional intravascular injection of the local anesthetic substance and the corticosteroids. All of the events published on permanent neurologic lesions were related to the injection of nonsoluble particulate steroids.[26] The current recommendations for transforaminal injections include increased certainty and precision as to the puncture location. A contrast substance must be administered before the corticosteroid to discard the subtraction of said substance by intravascular injection, as well as using water-soluble steroids and blunt-tip needles.[27] The limitations of the ultrasound-guided techniques are added to the controversy of the transforaminal lumbar injections among doctors that perform interventional pain techniques for the precise view of the tip of the needle, the diffusion of injected substances, and the prevention of intravascular injection. Although recent developments in ultrasound technology have achieved improvements in the images produced with low-frequency probes, viewing lumbar roots continues to be a challenge (Figure 10). The study by Chin et al[5] showed that using latest generation ultrasound probes in healthy, young volunteers with a BMI under 25 kg/m^2, lumbar roots were only able to be viewed in 57% of the cases. This also shows that the study could not be applied to elderly patients or patients with obesity.

The 4 studies[28-31] that describe the ultrasound-guided technique to locate lumbar roots base themselves on imaging tests (fluoroscope or computed tomography), and the only study conducted in patients required neural stimulation to identify the roots.

The studies conducted by Loizides et al[28] and Sato et al[29] used the PS transverse view as a reference. They searched for the hyperechogenic linear image between the 2 transverse processes that correspond with the intertransverse ligament and propose an in-plane or out-of-plane approach similar to the ultrasound-guided blocks described to block the lumbar plexus at the psoas level (psoas compartment block).[30] Galiano et al[31] propose an in-plane approach with the ultrasound probe in the transverse view (transverse interlaminar view) with a paramedian orientation that allows observation of the paravertebral zone underneath the transverse process (Figure 9). Gofeld et al[32] suggest that the technique described by Galiano et al regarding needle advancement underneath the transverse process toward the neural foramen, if applied in a clinical environment, could reach the neuroaxial compartment. For this, they propose, in a preclinical study, the most medial visible shadow of the vertebral body as the ultrasound target point. Spinal needles were inserted using the in-plane approach, aiming for the most medially visible shadow of the vertebral body. If the exiting nerve was seen, the transducer was shifted caudally to avoid trespassing the nerve root. When the needle is resting at the bone, no further advancement into the neuraxial compartment is possible. The contrast-spread pattern in this position of the needle tip resulted in the transforaminal epidural flow in most cases.

Interlaminar epidural injection

Anatomy and sonoanatomy

The epidural injection of corticosteroids is the most commonly performed intervention in pain clinics in the United States and in the rest of the world.[33] Many times these techniques are performed in out-patient situations and without the use of image control. Locating the interlaminar epidural space with external references may have a failure rate of up to 42% in patients with obesity.[34] The use of the ultrasound at the spinal level has shown that it increases the success rate of the neuroaxial blocks in comparison with blind techniques. It allows better identification of the medial line and the intervertebral level, as well as the needle insertion angle and the required depth.[35] Thanks to the information that the ultrasound-guided technique provides, the number of puncture attempts can be decreased and performing the epidural puncture in the intervertebral spaces can be considered where external anatomical references (L5-S1) cannot be palpated.

The anatomy of the intervertebral space goes from more to less superficial in a transverse slice by the supraspinous and interspinous ligaments, ligamentum flavum, posterior epidural space, posterior dura mater, intrathecal space, anterior epidural space, posterior longitudinal ligament, and vertebral body. The ligamentum flavum and interspinous ligaments take on a triangular form as occurs with the posterior epidural space. This posterior epidural space narrows on the sides and establishes closer contact with the posterior dura mater. Inside the thecal sac, the medullary cone terminates at the first lumbar vertebral body (L1) level in adults. However, its location may vary from the center of the 12th thoracic vertebra (T12) to the upper one-third of the 3rd lumbar vertebra (L3).[36] The medullary cone continues with the cauda equina and the filum terminale. In ultrasound images of adult interlaminar spaces, it will not be possible to differentiate all of these structures. The ligamentum flavum, the epidural space, and the dura mater appear to be fused in a hyperechogenic line that is called the *posterior complex*. The intrathecal space is hypoechoic in a uniform manner and in some cases pulsing hyperechogenic images can be distinguished in its interior that correspond with the cauda equina and the filum terminale. The anterior dura mater, the posterior longitudinal ligament, and the vertebral body can be seen as a single hyperechogenic line that is called the *anterior complex* (Figure 2).

These 2 hyperechogenic lines of the anterior and posterior complexes can be seen in the transverse interlaminar view

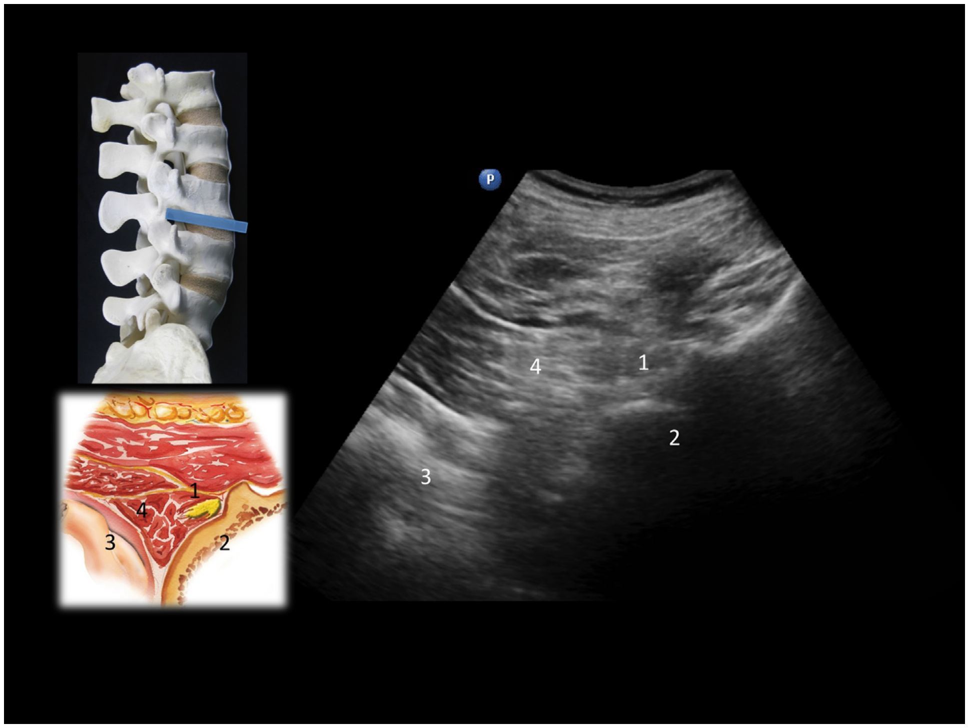


Fig. 10 – Paramedian oblique transverse scan of lumbar paravertebral region through the space between 2 adjacent transverse processes. Note the lumbar nerve root as it emerges from the intervertebral foramen (1), the posterior aspect of the psoas muscle (4), vertebral body (2), and retroperitoneal space (3). (Color version of figure is available online.)

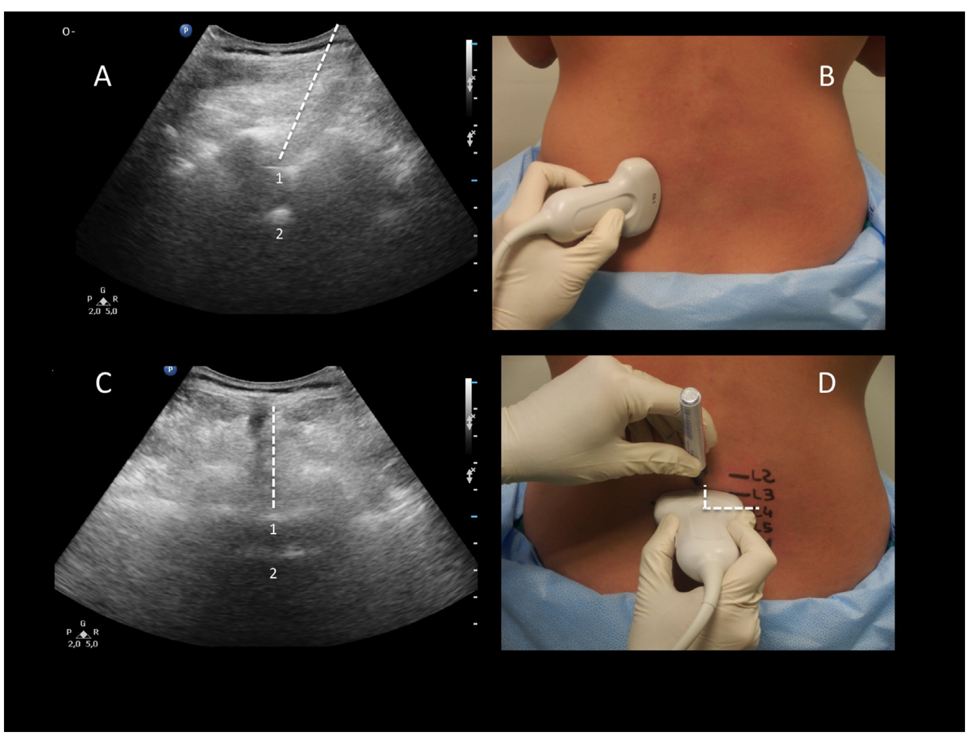


Fig. 11 – Surface marking to guide the needle insertion. In the paramedian sagittal PS oblique view, each interspace is centered in turn on the ultrasound screen (A) and (B). The probe is then turned 90° to obtain the transverse interlaminar view (C). The midline is centered on the ultrasound screen, and skin marks are made at the midpoint of the probe's long and short edges (D). The intersection of these 2 marks provides an appropriate needle insertion point for a midline approach to the epidural at that level. The distance is measured from the skin to the posterior complex with ultrasound measuring instruments. (1) Posterior complex and (2) anterior complex. (Color version of figure is available online.)

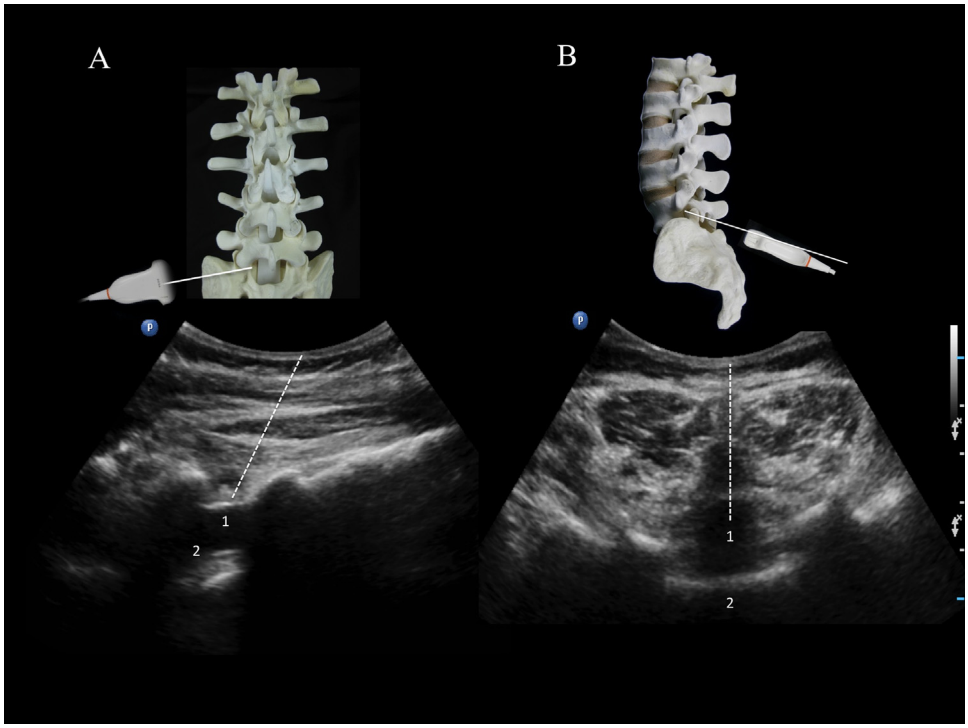


Fig. 12 – Ultrasound guide L5-S1 epidural injections. PS oblique view interspace L5-S1 is centered, in turn, on the ultrasound screen (A). The probe is then turned 90° to obtain the transverse interlaminar view (B), the inclination of the ultrasound probe that best distinguishes the posterior and anterior complexes will determine the inclination angle of the needle. The distance is measured from the skin to the posterior complex with ultrasound measuring instruments. (1) Posterior complex and (2) anterior complex. (Color version of figure is available online.)

and in the PSo view. However, owing to the triangular form of the interspinous ligaments and the posterior epidural space, the posterior complex has more anisotropy than the anterior complex. The result is that posterior complex cannot always be differentiated in the transverse view. Nonetheless, given that the posterior epidural space narrows on both sides and stays parallel to the dura mater, the 2 hyperechogenic lines separated by a hypoechoic image can be differentiated in the PSo view. These 2 hyperechogenic lines correspond with the ligamentum flavum and the posterior dura mater separated by the hypoechoic epidural space. This double vision in the 2 views (transverse and PSo view) allows for confirmation of the depth of the intrathecal or epidural spaces, which decreases interpretation errors of the ultrasound image.

Block technique

The steps to be followed for performing an ultrasound-guided interlaminar epidural block are described in Figure 2. The patient is placed in a seated position, a low-frequency (2-5 MHz) probe is selected, and the ultrasound parameters are adjusted for frequency, depth, focus, and gain according to the patient's dimensions. The previously described steps are then followed to obtain the images of the transverse processes, articular processes, lamina, and intervertebral levels are identified in the PSo view.

The desired level to perform the interlaminar puncture is identified and this level is examined in the PSo and transverse views to confirm that the hyperechogenic images of the posterior and anterior complex coincide at the same depth in the 2 exploration views. This maneuver helps to avoid confusion of the posterior complex with the anterior complex in the transverse approach. The distance is measured from the skin to the posterior complex with ultrasound measuring instruments. The symmetry is also confirmed between bone structures of the articular processes and the transverse processes, in the transverse plan, and the inclination of the probe that best distinguishes the 2 anterior and posterior complexes. This way the 4 midpoints of the long and short edges of the probe can be marked in the transverse view with the probe placed symmetrically in the midline. The probe is removed and a horizontal line is drawn that joins the 2 points of the long axis of the probe and a vertical line is drawn that joins the short axis. The optimal point for needle insertion is found where the 2 lines cross (Figure 11).

Antiseptic measures are applied to the area to be punctured, taking special care not to erase the marks on the skin. The epidural puncture is performed guided by the optimal puncture point marked on the skin and knowing at what distance the posterior duramater is found. The inclination of the ultrasound probe that best distinguishes the posterior and anterior complexes will determine the inclination angle of the needle (Figure 12).

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