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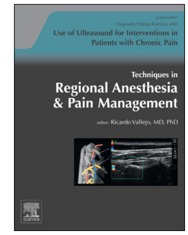

Ultrasound-guided interventional procedures for cervical pain

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ABSTRACT

Ultrasound is a particularly valuable imaging technique when performing nerve blocks at the cervical level. High-frequency probes provide high-quality resolution and are safe in skilled hands. Typically, interventions performed at the cervical level have been carried out with the help of x-rays, with the corresponding disadvantages such as the exposure to radiation and the inherent inability to observe radiotransparent structures such as blood vessels and nerves. Ultrasound allows us to visualize soft tissues and guide the tip of the needle to our target, without harming particularly delicate structures found in the path of the needle. This is important in nerve root blocks where the identification of periradicular nerves is crucial for the safety of the block itself. Likewise, ultrasound allows us to manipulate the needle with greater precision in the correct location; as is the case in cervical sympathetic nerve block where we can observe the injection of the liquid behind the prevertebral fascia and in front of the fascia of the longus colli muscle. In this article, we describe the most frequent techniques used in the pain clinic to treat headache and cervical pain, with special emphasis on the safety of the procedure.

The cervical structures that we can block for pain control are located at a more superficial level than those found in the lumbar spine. With the development of high-frequency linear probes, ultrasound enables us to visualize blood vessels and nerves that we could not otherwise locate with fluoroscope-guided techniques.

Sonographic identification of the brachial plexus at the interscalene level can be a starting point to become familiar with ultrasound-guided cervical blocks. It requires identifying the cervical muscles (scalene muscle and sternocleidomastoid muscle [SCM]), the large blood vessels (internal jugular vein and carotid artery [Ca]) and the small blood vessels (vertebral artery and transverse cervical artery), and the brachial plexus with its cervical roots. The anatomical differences between the transverse cervical apophyses allow us to identify the different levels of the cervical spine. It is therefore absolutely necessary to learn to recognize the shape of these transverse apophyses and their relationship with the different cervical roots so as to perform all the ultrasound-guided cervical blocks.

Cervical selective nerve root block

Cervical spinal nerves emerge from the intervertebral foramen over their corresponding vertebral bodies, except C8, which emerges between C7 and T1 and is located in the lower portion of the intervertebral foramen, closely related to the periradicular vessels.[1] The small periradicular arteries lead into the anterior spinal artery and the segmental medullary artery, which are of utmost importance in the nutrition of the spinal medulla and cerebral trunk.[2] The periradicular arteries are branches of the ascending cervical artery, the deep cervical, and the vertebral artery. The branches derived from

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the first 2 arteries are preferentially located in the posterior portion of the root, and those derived from the vertebral artery are located in the most anteromedial part of the intervertebral foramen. The periradicular veins usually are found passing along the upper portion of the radicular canal.

The infiltration of the cervical root is indicated in case of a diagnosis of cervical radicular pain, a therapeutic block with corticosteroids, or radiofrequency for the treatment of a foramen stenosis or cervicogenic headache (block of root C3).[3] The blocks at this level are contraindicated when there are coagulation disorders or when puncture in the vicinity of periradicular vessels is dangerous because of their anatomical location.

Sonoanatomy

The patient is placed in a lateral decubitus position with the side to be infiltrated facing upward. A high-frequency (6-13 MHz) linear probe is chosen and placed in an axial position above the lateral part of the neck, at the level of the cricoid cartilage. The transverse apophysis of the sixth cervical vertebra (C6) with its corresponding tubercles, both anterior (Chassaignac tubercle) and posterior, can be identified. The ultrasound image is similar to the image of a cup or a 2-humped camel. Between both the tubercles, the anechoic and oval shape of the C6 root is seen (Figure 1).

The level of C6 is confirmed by the characteristic protuberance of the anterior tubercle. If we move the probe in an axial plane in a caudal direction, the transverse apophysis of the seventh cervical vertebra (C7) becomes visible (Figure 2) along with its corresponding root. This transverse apophysis of C7 is characterized by the absence of an anterior tubercle and the presence of the vertebral artery. The ultrasound image of the transverse apophysis of C7 is merely a hyperechogenic line that is differentiated from the rest of the transverse apophysis with a cup-shaped image. At the level of C7, the vertebral artery, in 90% of cases, is located below the transverse apophysis and in a medial position from the root of C7 before it enters into the transverse apophysis of C6.

If we move the probe in a cranial direction from the C6 position, the transverse apophyses of the upper vertebrae appear similar, with the root located between the anterior and posterior tubercles (Figure 3).

Technique

Starting at C6 and moving the probe in a caudal or cranial direction, we can identify the different cervical roots (Figure 4).

Once we have identified the desired spinal root (from C3-C8), we change the exploration to the color Doppler mode to identify the position of the periradicular blood vessels in relation with the root (Figure 5). This step of the study is crucial considering the possibly fatal consequences of periradicular and vertebral artery injections.

We use a 22-gauge needle of 5-8 cm in size, depending on the patient's body constitution, or the SMK (Sluijter, Metha, Kanula)-type radiofrequency needle of 54 mm (active tip of 4 mm). We insert the needle in plane, in a posterior to anterior direction, and if possible, using intermittent color Doppler mode to control the position of the tip of the needle at all times with respect to the blood vessels (Figure 6). Once the target is reached, 1 mL of saline solution is injected to confirm the distribution of the liquid

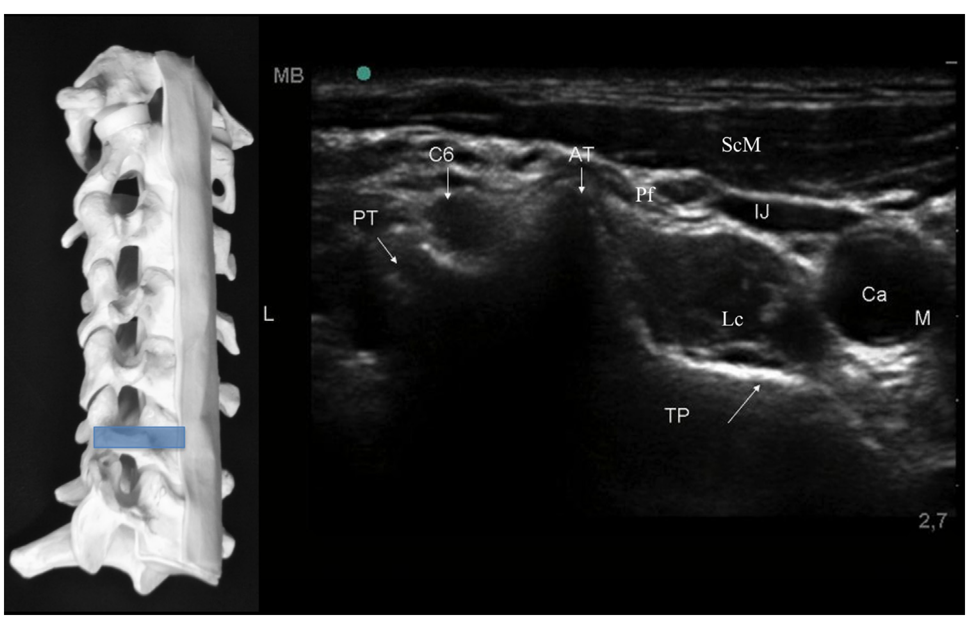

Fig. 1 – Probe placement (blue bar) at C6 (cervical spine model anterior oblique position). Short-axis transverse ultrasound image showing the anechoic and oval shape of the C6 root between both the tubercles. IJ, internal jugular vein; Ca, carotid artery; TP, transverse process of C6; AT, anterior tubercle; PT, posterior tubercle; C6, sixth nerve root; ScM, sternocleidomastoid muscle; Pf, fascia prevertebral; Lc, longus colli muscle; M, medial; L, lateral. (Color version of figure is available online.)

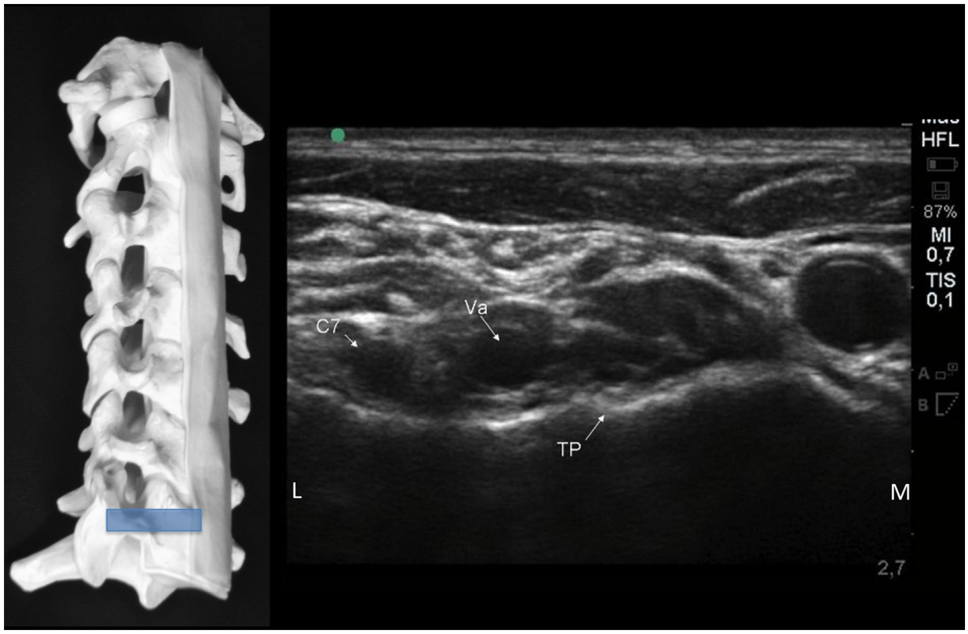

Fig. 2 – Probe placement (blue bar) at C7. The transverse apophysis of C7 is characterized by the absence of an anterior tubercle and the presence of the vertebral artery, it is merely a hyperechogenic line that is differentiated from the rest of the transverse apophyses with a cup-shaped image. TP, transverse process of C7; Va, vertebral artery; C7, seventh nerve root. (Color version of figure is available online.)

and rule out intravascular injection. If the tip of the needle is correctly visualized, but the diffusion of the injectate is not clear, an intravascular injection must be considered. Only after the administration of an intravascular injection has been discarded and a correct periradicular distribution of the injectate is verified, a nonparticulate steroid or low dose of local anesthetic is injected. Pulsed radiofrequency procedures follow their usual steps.

Complications

The success of a block is confirmed by the sensory deficit in the distribution area of the nerve root. The most severe complication is the injection of the periradicular blood vessels, which can be associated with fatal complications because of thrombosis of the anterior medullary artery and segmental arteries, especially when nonsoluble particulate

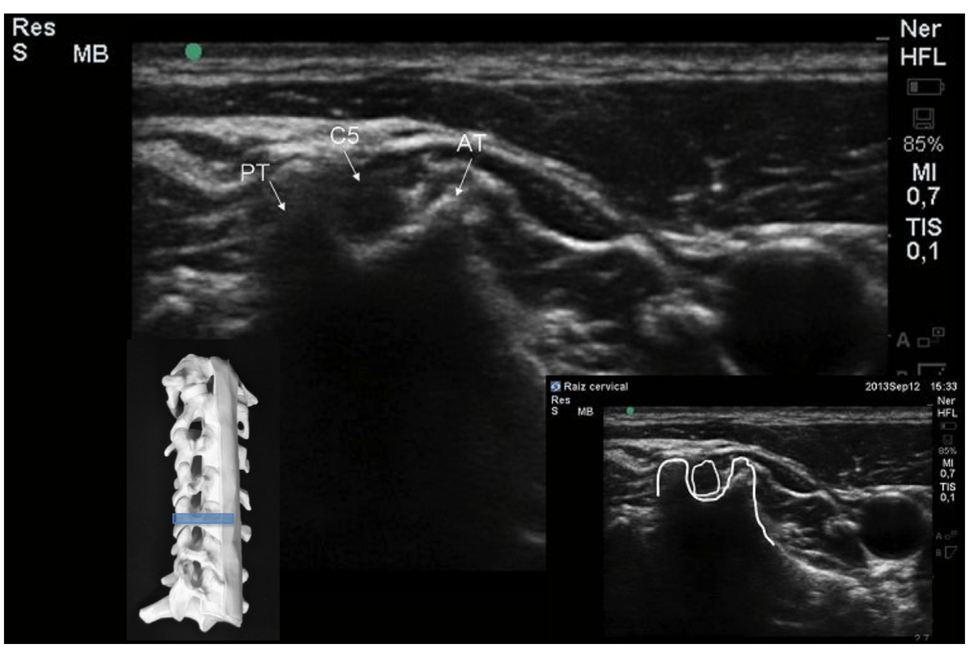

Fig. 3 – Probe placement (blue bar) at C5. Short-axis transverse ultrasound images showing the anterior tubercle (AT) and the posterior tubercle (PT) of the C5 transverse process as the "2-humped camel" sign. C5, fifth cervical nerve. (Color version of figure is available online.)

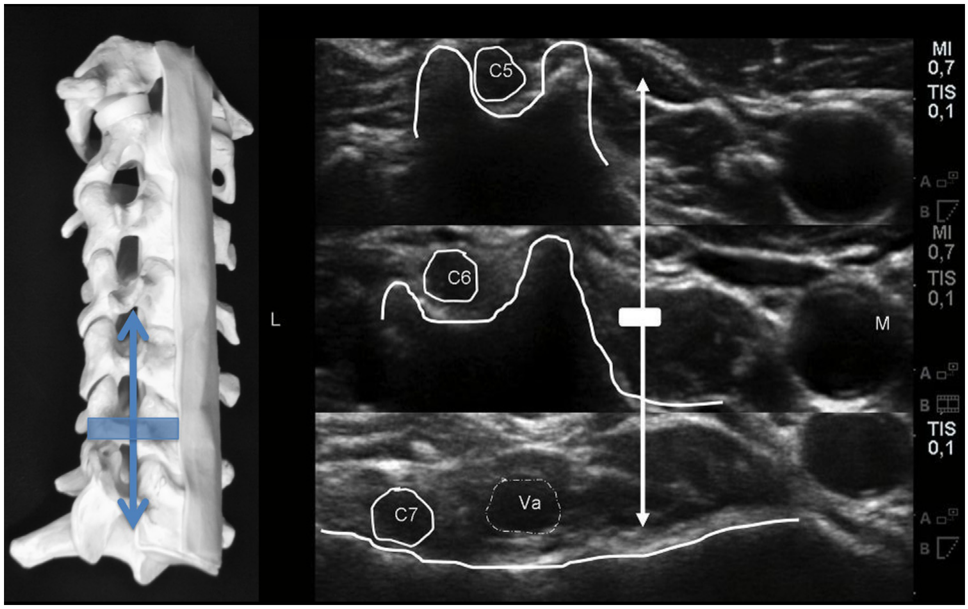

Fig. 4 – Probe placement (blue bar) at C6. The cervical level is determined by identifying the transverse process of the seventh and sixth cervical vertebrae (C7 and C6.) The seventh cervical transverse process (C7) differs from the levels above. Moving the transducer cranially, the sixth cervical vertebra (C6) with its corresponding tubercles, both anterior (Chassaignac tubercle) and posterior, can be identified. At higher levels than C6, the anterior tubercle becomes shorter and equal to the posterior. Va, vertebral artery.

steroids are injected.[4] The puncture or injection into the vertebral artery may cause a hematoma, transitory blindness, cerebral deficit symptoms, and even loss of consciousness. Other complications include puncture of the root, with or without damaging it, and complete spinal anesthesia after central diffusion of the local anesthetic.[5]

Efficacy and safety

Galiano et al[6] corroborated the utility of ultrasound in the block of the inferior cervical roots in cadavers with the tip of the needle located less than 5 mm away from the target. Narouze et al[7] showed the same results in real patients in addition to the real-time identification of possible blood vessels in the path of the needle. Yamauchi et al,[8] in an uncontrolled study, suggested that the injected solution in a root with ultrasound control primarily diffuses in an extra-foraminal direction when compared with the conventional infiltration performed with fluoroscopy, with the improvement of symptoms after 24 hours. Jee et al,[9] in a randomized study, showed that ultrasound-guided blocks are as effective as those guided by fluoroscopy as regards a greater alleviation of pain and functional improvement, with an added value of avoiding vascular puncture in real time without radiation.

Based on current literature, ultrasound-guided procedures allow for root infiltrations with similarly good results as those obtained from the classic fluoroscopy-guided procedures, with the advantage of real-time vascular puncture prevention

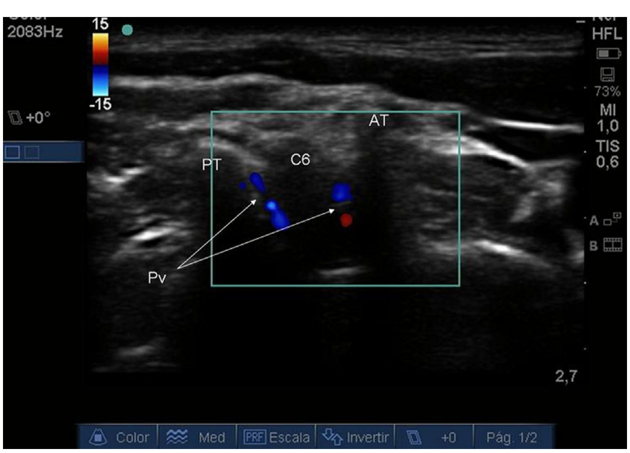

Fig. 5 – Short-axis transverse ultrasound image with color Doppler showing a small vessel (Pv) at the intravertebral foramen of C6. AT, anterior tubercle; PT, posterior tubercle, C6, sixth cervical vertebra.

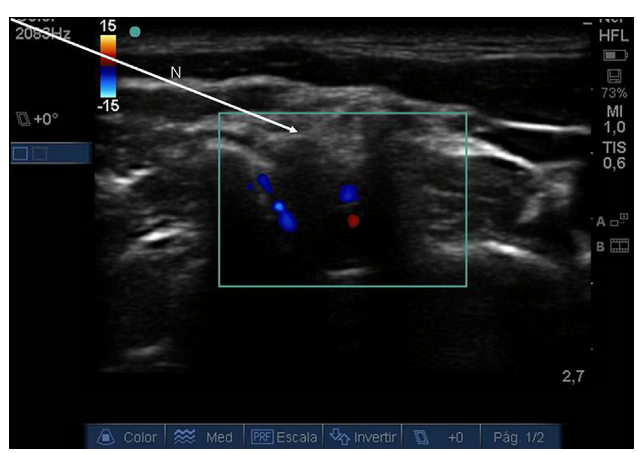

Fig. 6 – Short-axis transverse ultrasound image showing the needle path to the posterior aspect of the intervertebral foramen. N, needle path.

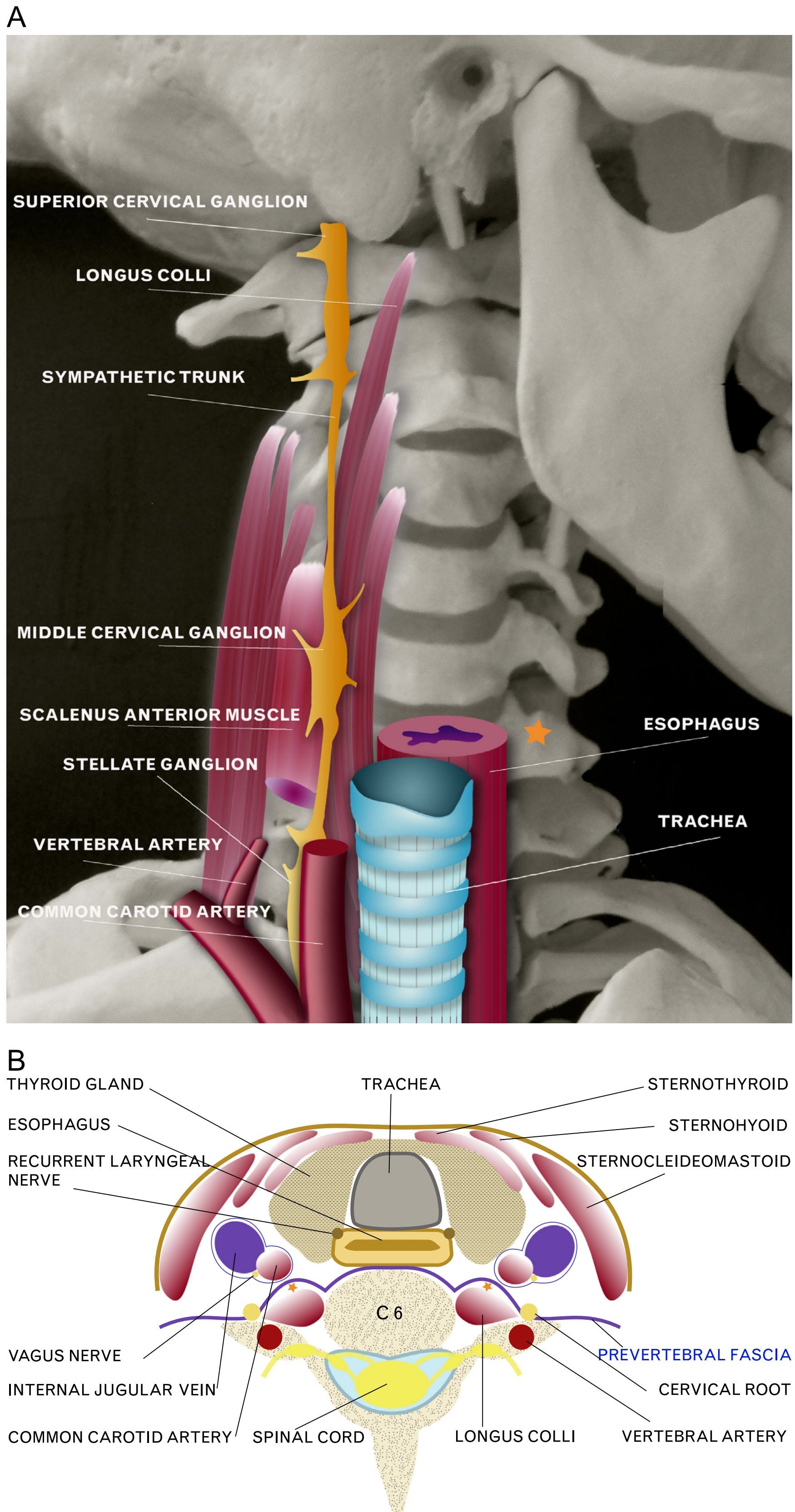

Fig. 7 – (A) Prevertebral region of the neck. The target site for the classical approach to the stellate ganglion is marked as orange star. (B) Cross-section of the neck at the sixth cervical vertebra level. The target site for ultrasound-guided stellate ganglion block is marked as orange star under the prevertebral fascia. (Color version of figure is available online.)

instead of diagnosis.[10] Even so, the identification of all the periradicular blood vessels can be a challenge in patients who are obese or in case of poor ultrasound visualization, in which case we must be especially cautious when injecting the local anesthetic and consider the use of fluoroscopy.

Stellate ganglion block

The sympathetic trunks are a pair of parallel cords that start at the base of the cranium and go to the coccyx. The sympathetic fibers can make use of branches of other nerves to reach their destination or they can travel directly, accompanying the blood vessels, forming sympathetic plexuses around them. The cervical part of the sympathetic trunk is located behind the prevertebral fascia (Pf) and above the longus colli muscle (lcom) on its lateral border (Figure 7A).[11]

The branches of the sympathetic trunk connect to each cervical spinal nerve by means of a gray ramus communicans as there are no white ramus communicans in the cervical region. In the trajectory of the sympathetic trunk at the cervical level, we can differentiate 3 ganglions: superior, middle, and inferior. The inferior cervical ganglion and the first thoracic ganglion form the cervicothoracic ganglion (stellate ganglion). This ganglion extends from the head of the first rib to the lower edge of the transverse apophysis of C7 and is sometimes found in a medial or posterior position with respect to the vertebral artery that is immediately adjacent to the cupula pleurae. The preganglionic sympathetic fibers ascend from these cervical ganglions, from the superior thoracic portion of the spinal medulla, to form synapses with postganglionic sympathetic fibers; the postganglionic fibers are distributed in branches from these ganglions. The branches of the stellate ganglion pass the spinal nerves C7-T1 along the gray ramus communicans and the vertebral artery, forming a plexus associated with said the aforementioned blood vessel and the heart (inferior cardiac nerves). This ganglion can also receive the white ramus communicans from the spinal nerve T1 and occasionally from the T2.[12]

The stellate ganglion block is indicated in the treatment of neuropathic pain or vascular insufficiency of the head, neck, and upper limbs. Other less frequent indications are hyperhydrosis, Meniere disease, posttraumatic stress disorder, menopausal flushes, and angina pectoris. The stellate ganglion block is contraindicated in case of recent myocardial infarction, contralateral pneumothorax, and atrioventricular block.

Sonoanatomy

There are 2 options for examining the patients: in a supine position with the neck in slight extension and contralateral rotation or in a lateral decubitus position with the side that will be infiltrated facing upward. The study starts at the cricoid cartilage, which usually corresponds with the cervical level of C6 (Figure 7B). A high-frequency (6-13 MHz) linear probe is placed in an axial position at the level of the cricoid cartilage and the probe moved from the medial to a lateral position to further confirm that we can see the “2-humped camel” image of the C6 transverse apophysis at this level and then in the caudal direction to verify that the inferior cervical level is C7 (Figure 4). The primary sonoanatomical references that we must identify are the SCM, the vascular compartment surrounded by the carotid sheath that contains the Ca which is located posterior and medial to the SCM, and the internal jugular vein. The Pf is identified posterior and lateral to the vascular compartment. It covers the muscle mass that corresponds to the lcom and longus capitis (lc) muscle. The hyperechoic line that corresponds to the transverse apophysis of C6 is found behind the lc muscle. As our target is the Pf, color or power Doppler modes are used to further identify the vascular structures around the fascia (Figure 1).

Technique

The block can be performed at the level of the C6 or C7 vertebrae. Diffusion studies using 5 mL of local anesthetic injected behind the Pf at the level of C6 corroborate that thoracic levels T2-T4 can be reached. Injection at C7 presents a greater risk of vascular puncture because of the presence of the vertebral artery and the inferior thyroid artery in the needle's trajectory. The stellate ganglion is just as accessible at C7 as at C6, and that is why the C6 approach is recommended. However, it is important to explore the most suitable planes around C6 in 2 dimensional and color Doppler modes to plan the needle trajectory (Figure 8). The probe is placed at the level of the cricoid cartilage in an axial position and the caudal-cranial inclination is adjusted until a good image of the transverse apophysis of C6 is obtained (Figure 1). The position at C6 is confirmed by moving the probe in a caudal direction until reaching the level of C7, which is identified by the presence of the vertebral artery and the absence of the anterior tubercle (Figure 4).

A 22-gauge needle of 5-8 cm in length is introduced at the lateral end of the probe, using an in-plane view, sliding it along the anterior tubercle of C6 until reaching the area

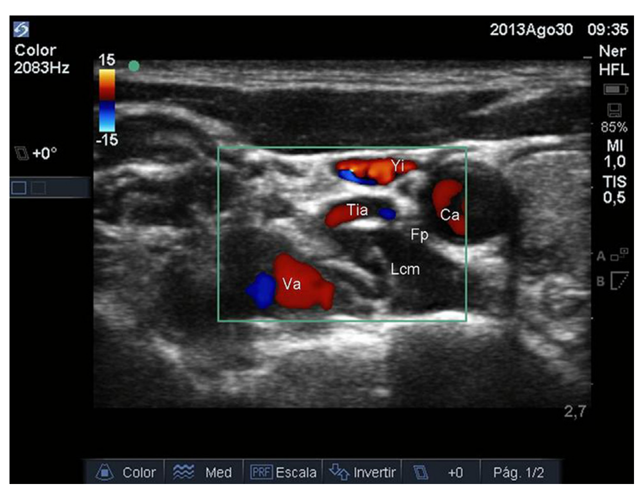

Fig. 8 – Ultrasonographic image with color Doppler showing the inferior thyroidal artery (ITa), prevertebral fascia (Fp), vertebral artery (Va), longus colli muscle (LC), internal jugular vein (IJ), and carotid artery (Ca). (Color version of figure is available online.)

posterior to the Pf and *anterior* to the lateral portion of the lcom (Figures 7B and 9) just behind the lc muscle.[13]

A small amount of saline is injected to confirm the correct location of the needle tip followed by 3-5 mL of local anesthetic. The success of the block at the level of the superior limb is determined by the 1.5°C temperature increase of the ipsilateral upper limb. The sympathetic block to the head, via the stellate ganglion, is evidenced by the presence of Horner syndrome, which is characterized by myosis, ptosis, and enophthalmos.[14]

Complications

Although the incidence of complications is low, subarachnoid or intravascular injection may have fatal consequences. There are several blood vessels that can be found in the trajectory of the needle, such as the vertebral artery, the thyroid artery, and the Ca (Figure 8). Just a small amount of local anesthetic injected into the vertebral artery may cause loss of consciousness, apnea, and convulsions. The injection of a small bubble of air in the same artery may cause a cerebral embolism.[15] The retropharyngeal hematoma may be severe enough to cause tracheal compression and lead to asphyxia.[16] If the infiltration is performed at the level of the C7 vertebra, the possibility of pneumothorax increases as the cupula pleurae is very close. The perforation of the esophagus, especially in the left side, may cause mediastinitis, particularly if there is a diverticulum that has not been identified previously. The needle trajectory in ultrasound-guided blocks is further away from the esophagus compared with that in fluoroscopy and blind-guided approaches.

Efficacy and safety

To our knowledge, there are no data available comparing the efficacy of the stellate ganglion block guided with ultrasound with that of techniques that are not ultrasound guided.[17]

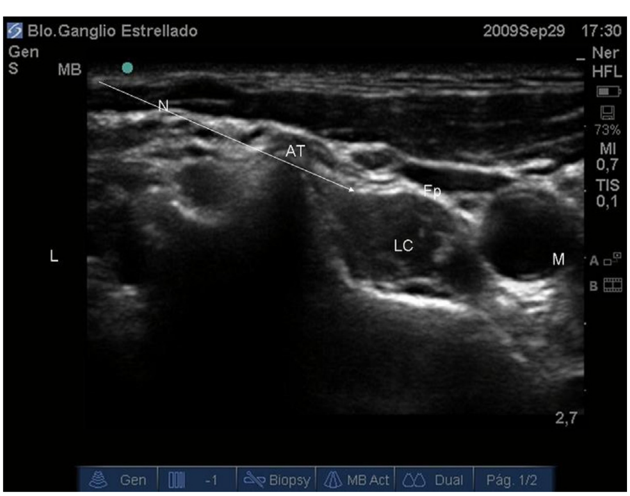

Fig. 9 – Short-axis transverse ultrasound image showing the needle path to the prevertebral fascia (Fp) for stellate ganglion block. N, needle path; AT, anterior tubercle; LC longus colli muscle; M, medial; L, lateral. (Color version of figure is available online.)

Kapral et al[18] showed the formation of a cervical hematoma in 3 of 12 patients when the infiltration was performed using external anatomical references, whereas there was only 1 case of hematoma in 12 patients when ultrasound was used to facilitate the block. Using ultrasound, Siegenthaler et al[19] showed that the trajectory of the needle in classic techniques of stellate ganglion blocks coincides with the arterial structures and the esophagus, despite the dislocation maneuvers used to avoid the large blood vessels.

Cervical medial branch nerve block

The zygapophysial joint is a diarthrodial joint, with a capsule and highly innervated synovial tissue. It is formed by the descending articular apophysis of a vertebra and the ascending apophysis of the inferior vertebra. It receives its innervation from the medial branch of the posterior division of each segmental cervical root.

The medial branches of the cervical nerves C4-C8 are anatomically similar to the medial branches of the thoracic and lumbar nerves. The medial branch heads posteriorly, toward the concavity that is formed between the junction of the superior and inferior articular processes, surrounding the ipsilateral articular pillar (Pa) and dividing into an ascending branch and a descending branch, which innervate the superior and inferior joints, respectively. Thus, each joint receives a double innervation that comes from the superior and inferior medial branches (Figure 10).

The medial branch of C3 differs from the medial branches of the lower levels. The medial branch of C3 divides into 2: one deep medial branch that surrounds the Pa of C3 in a manner similar to that which occurs at lower levels and innervates the joint of C3-C4 and a superficial branch known as the third occipital nerve (TON). This nerve travels around the lateral portion of the ipsilateral facet joint of C2-C3.

The block of the medial cervical branches is indicated in the treatment of cervical facet syndrome and cervicogenic headache.

Sonoanatomy

The patient is placed in a lateral decubitus position with the side to be infiltrated facing up, the head in a neutral position, and the neck slightly flexed laterally. A high-frequency (6-13 MHz) linear probe is chosen.

Overall, 2 probe positions are used for the medial branch block: coronal and axial. The first position allows us to locate the correct level and the second position allows us to perform the block.

With the probe placed in a coronal position, posterior to the transverse apophysis, the image of column of facets is obtained.[20] In this projection, the column of facet joints draws a sinusoidal image where the peaks represent the intervertebral facet joints and the valleys represent the central area of the junction of the ascending articular apophysis with the descending articular apophysis of a single cervical vertebra. The medial branch passes through these valleys and very close to the outline of the bone (Figure 11).

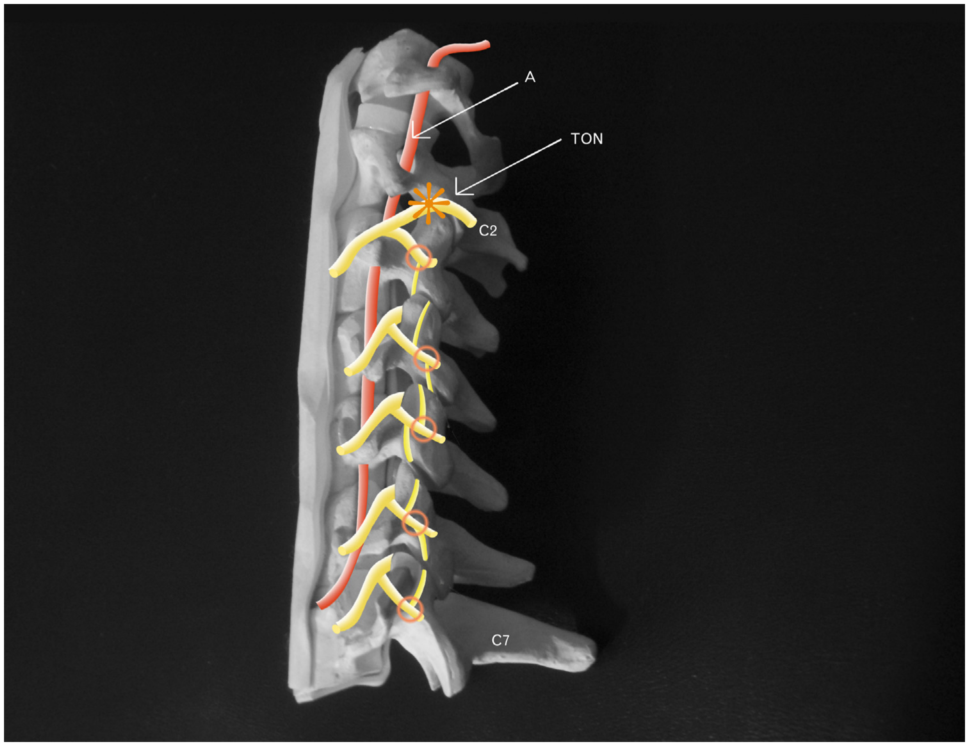

Fig. 10 – The cervical zygapophysial joints are innervated by articular branches derived from the medial branches of the cervical dorsal rami (orange circle). Cervical zygapophysial joint below C2-C3 has dual innervations, each joint receives a double innervation that comes from the superior and inferior medial branches The superficial medial branch of C3 is large and known as the third occipital nerve (TON). A, vertebral artery. (Color version of figure is available online.)

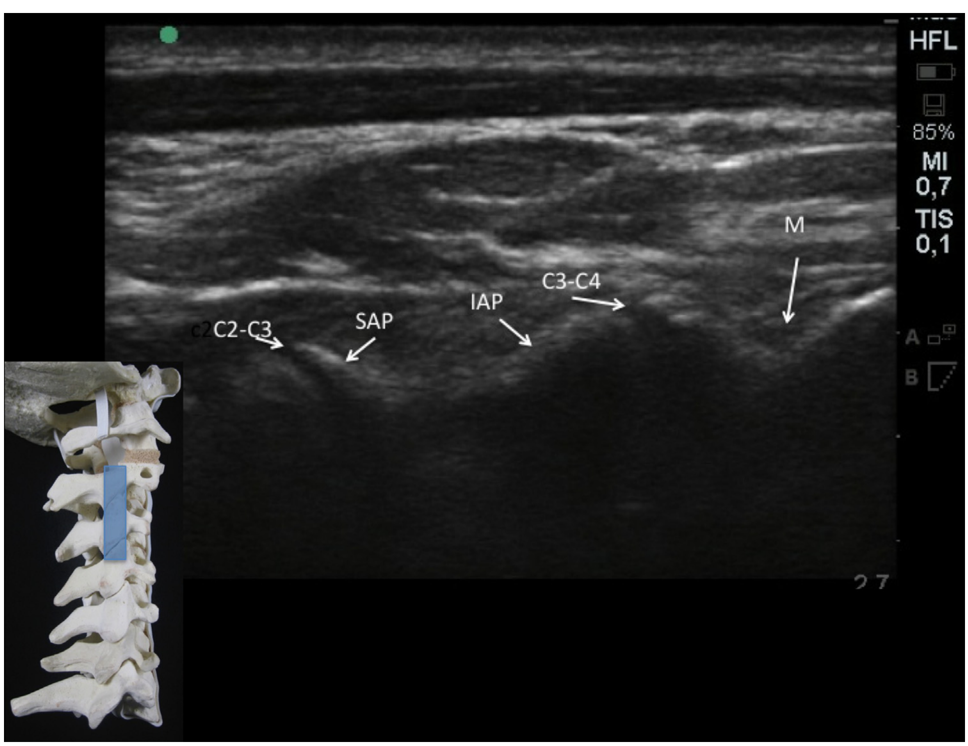

Fig. 11 – Probe placement (blue bar) at C2-C3 and C3-C4, Z-zygapophysial joints. SAP, superior articular process of C3; IAP, inferior articular process of C3; M, medial branch of C4. (Color version of figure is available online.)

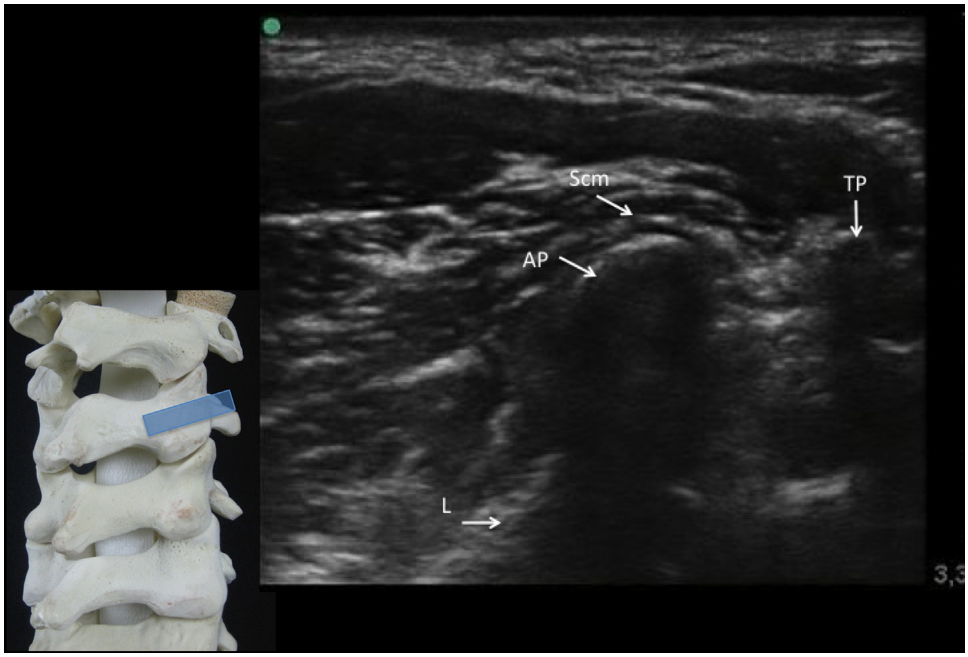

Fig. 12 – Probe placement (blue bar) at AP, articular pillar; L, lamina; Scm, semispinalis capitis muscle; and TP, transverse process. (Color version of figure is available online.)

With the probe placed in an axial position, at the level of the transverse apophysis (Figure 12), we can identify the posterior tubercle of the transverse process, the Pa, the lamina (La), and the semispinalis capitis muscle (Scm).[21]

Technique

We must first identify the correct level to be blocked. We have 2 techniques to locate the cervical level by ultrasound. The first is more useful to locate the upper cervical levels and the TON.

We place the probe in a coronal plane underneath the mastoid muscle looking for the pulsating image of the vertebral artery interrupted by the posterior acoustic shadow of the transverse apophysis (Figure 13B). Moving the probe posteriorly, the column of the facets becomes visible with its characteristic sinusoidal form (Figure 13A) represented by a continuous hyperechogenic line. Cranially, along the line of the facets, the C2-C3 joint is identified with the vertebral artery in its anterior portion (Figure 13C). Moving the probe in a caudal direction, we identify the following articular levels.

The second alternative to guide us in the cervical puncture level is to locate the cervical root that corresponds with the level desired with the probe in an axial plane, as previously described in the cervical root blocks. Once we have identified the posterior tubercle of the transverse apophysis, we move the probe posteriorly and slightly cranially until the image of the Pa appears (Figure 12). We can turn the probe again to the coronal plane to observe the sinusoidal ultrasound image of the peaks and valleys of the cervical facets.

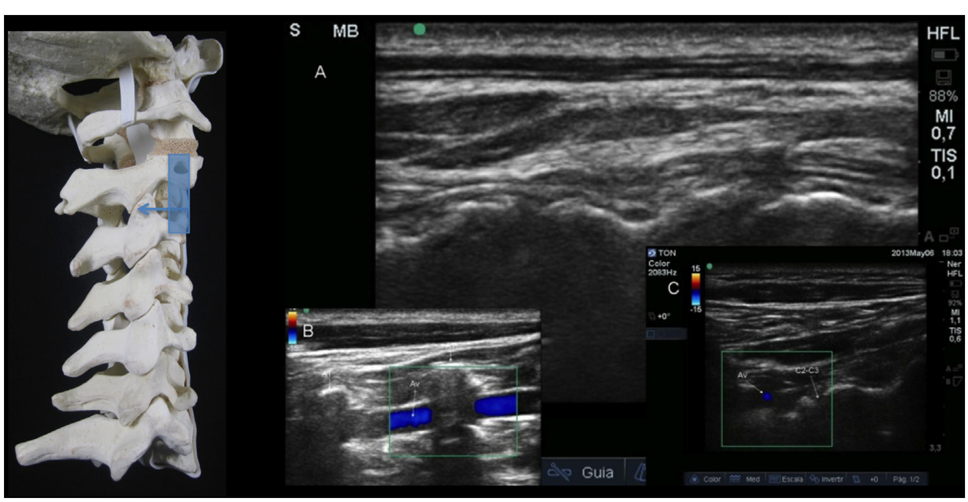

Fig. 13 – Probe placement (blue bar) coronal plane from (B) the transverse processes view to (A) the column of the facets and showing in (C) C2-C3 joint with the vertebral artery (Av). (Color version of figure is available online.)

Once we have identified the level, any of the methods described can be used to perform the block in the axial or transverse planes where the image of the Pa appears covered by the Scm. The target is located in the center of the Pa, right between the periosteum and the Scm. Before performing the block, it is important to carry out a thorough examination using the color Doppler mode to dismiss the presence of blood vessels in the trajectory of the needle. The needle is inserted in plane, in a posteroanterior direction, until the tip is in the middle of the Pa (Figure 14A). Once the tip of the needle has reached the target point, the probe is rotated to a coronal position to confirm that the tip is located in the center of the Pa (Figure 14B).

Complications

Although this is a technique that is associated with a low incidence of complications, there is always a possibility of vascular puncture, such as in the deep artery, and hematoma formation.[22] When the technique is performed in a posteroanterior direction, the needle tip, if uncontrolled, may have been placed in front of the pillar of the facets, thus puncturing the nerve root or the vertebral artery.

Efficacy and safety

There are no comparative data showing that the efficacy and safety of the medial branches blocks performed under ultrasonography is greater than with fluoroscopy.[17] The relevant studies published[21,23] report that the technique is accurately performed in more than 80% of cases, except at the level of the C7.[24]

TON block

The posterior division of the third cervical root leads to a medial branch that then divides into 2 branches: a deeper branch that partially innervates the zygapophysial joint of C3-C4 and a more superficial branch that is longer and known as the TON.

The superficial branch provides exclusive innervation to the zygapophysial joint of C2-C3. It borders its lateral and posterior portion before ascending to the suboccipital region where cutaneous branches stem off.[25] This block is performed for the diagnosis and treatment of cervicogenic headache.[26-28]

Sonoanatomy

The patient is in a lateral decubitus position with the side to be infiltrated facing upward and a high-frequency (6-13 MHz) linear probe placed in the coronal plane, the column of the facets are identified. In the upper portion, we identify the C2-C3 joint, easily recognized by the presence of the vertebral artery as we move the probe slightly in a cranial and anterior direction (Figure 15). In this position, the TON is identified as an oval hypoechoic structure with a hyperechoic flecking in a cranial direction or above the zygapophysial joint of C2-C3 (Figure 16). If we rotate the probe over the C2-C3 joint, to the axial position, the inferior Pa of C2 and the transverse apophysis of C2 can be identified (Figure 17).

Technique

The probe is placed in the coronal plane at the level of the column of the facets and the C2-C3 level is identified. Then the

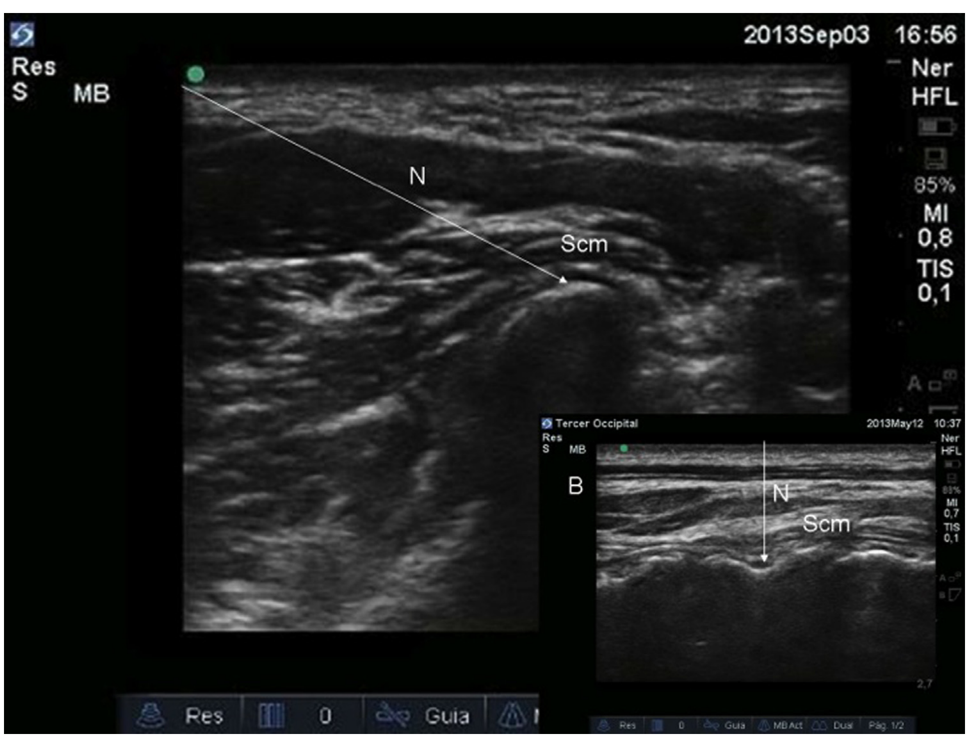

Fig. 14 – (A) Tranverse plane for cervical medial branch block in-plane approach. N, needle path; Scm, semispinalis capitis muscle. (B) Coronal plane of the cervical facets, out-of-plane approach. (Color version of figure is available online.)

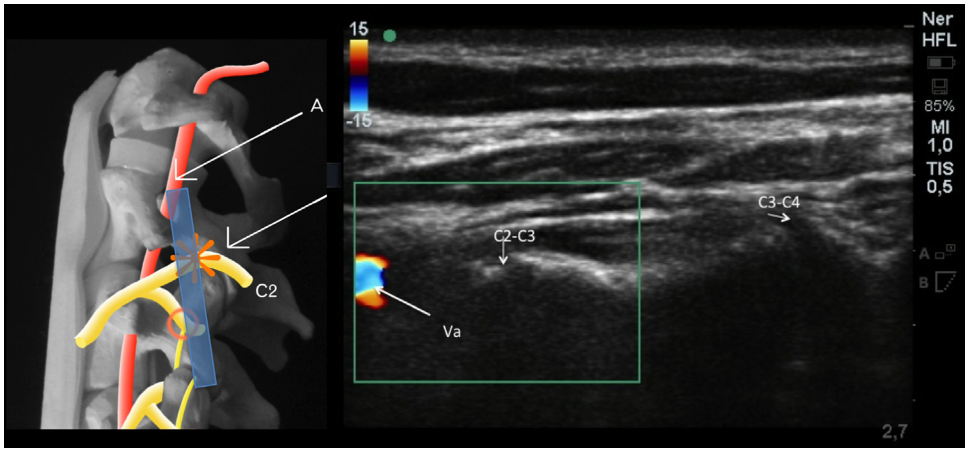

Fig. 15 – Probe placement (blue bar) C2-C3 and C3-C4 articulations in the center of the ultrasound picture, deeper pulsation of the vertebral artery can be seen. The use of Doppler sonography may facilitate the identification of this important landmark. Va, vertebral artery; C2-C3, zygoapophyseal joint C2-C3; C3-C4, zygapophysial joint C3-C4. (Color version of figure is available online.)

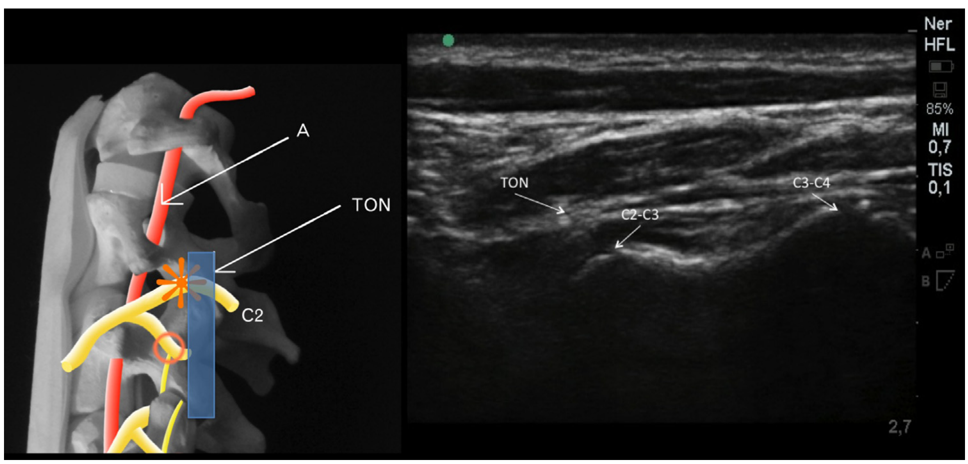

Fig. 16 – Probe placement (blue bar) at C2-C3. TON crosses the C2-C3 zygapophysial joint in this plane at an average distance of 1 mm from the bone, we search the typical sonomorphologic appearance of a small peripheral nerve. A, vertebral artery; TON, third occipital nerve. (Color version of figure is available online.)

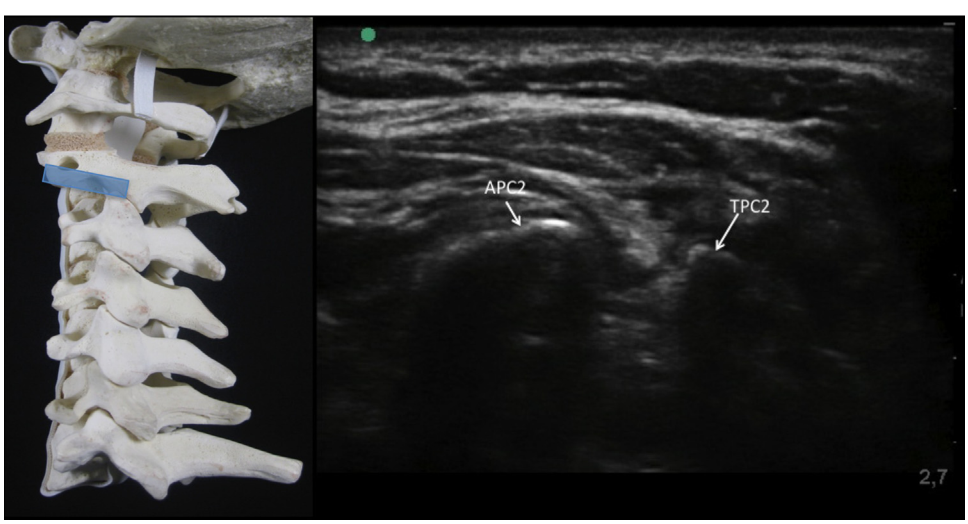

Fig. 17 – Probe placement (blue bar) at C2-C3 short-axis view at APC2, inferior articular process of C2; TPC2, transverse process of C2. (Color version of figure is available online.)

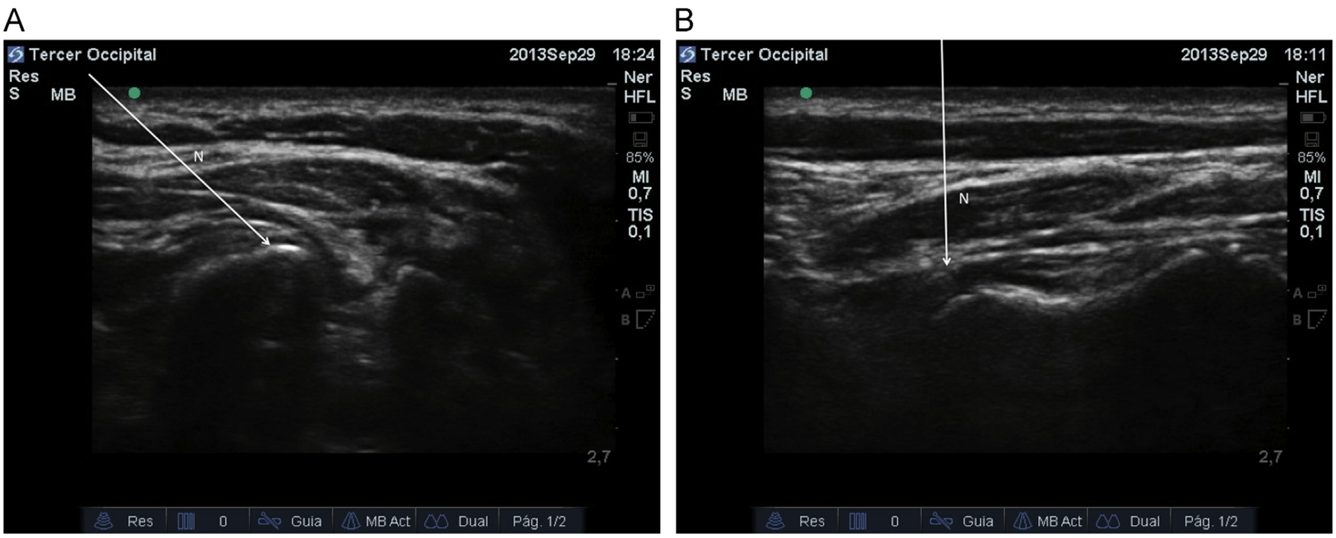

Fig. 18 – (A) Short-axis transverse ultrasound image at C2-C3 showing needle path in plane to the inferior articular process of C2. (B) Longitudinal ultrasound image at C2-C3 showing needle path out of plane to block TON. N, needle path; TON, third occipital nerve. (Color version of figure is available online.)

probe is rotated to the transverse position to show the C2-C3 joint (Figure 3). Doppler mode is then used to confirm that there are no blood vessels in the trajectory of the needle. The needle is inserted in plane through the lateral end of the probe until it makes contact with the periosteum of C2 (Figure 18A).

The probe is then replaced in a coronal plane to confirm that the tip of the needle is near the nerve or above the C2-C3 joint[21] (Figure 18B). Only 0.25 mL of the local anesthetic substance is injected to avoid a false-positive result of the diagnostic test.[29]

Complications

Given the proximity of the vertebral artery, it is important to control the progression of the needle using the Doppler mode and to avoid puncture and possible intravascular injection.

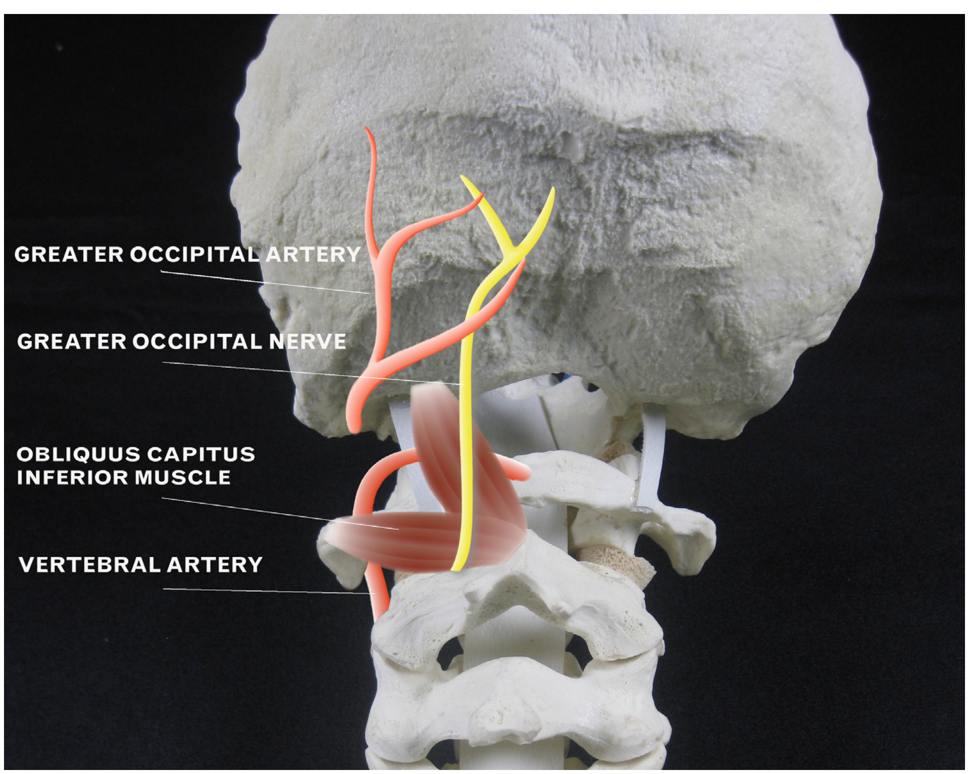

Fig. 19 – The greater occipital nerve (GON) arises from C2 dorsal ramus and curves around the inferior border of the obliquus capitis inferior muscle to ascend on its superficial surface next to the greater occipital artery. (Color version of figure is available online.)

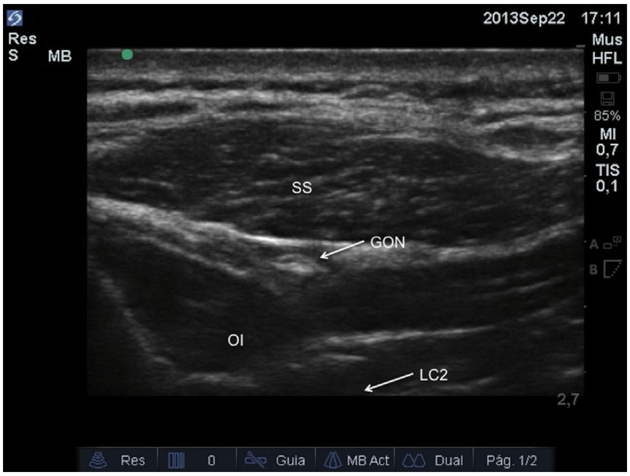

Fig. 20 – Probe placement at C2 level. SS, semispinalis capitis muscle; OI, obliquus capitis inferior muscle; LC2, lamina of the C2; GON, greater occipital nerve. (Color version of figure is available online.)

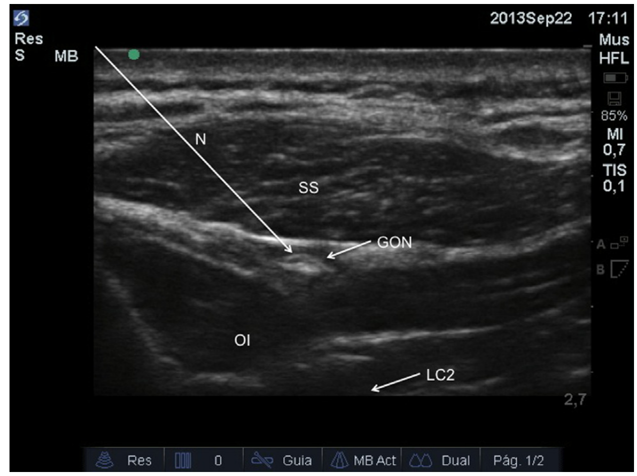

Fig. 22 – The arrow indicates the direction of the needle (N). SS, semispinalis capitis muscle; OI, obliquus capitis inferior muscle; LC2, lamina of the C2; GON, greater occipital nerve. (Color version of figure is available online.)

Efficacy and safety

Finlayson et al[30] demonstrated a similar efficacy of the third occipital block when comparing ultrasound and fluoroscopy; however, both the time required and the number of punctures are reduced when using ultrasound.

GON block

The greater occipital nerve (GON) is the dorsal branch of the second spinal nerve (C2). After bending around the inferior edge of the inferior oblique muscle, it ascends along its posterior portion to the interfascial space between the inferior oblique muscle and the rectus capitis major muscle on one side and the Scm on the other. In this situation and in its ascension, it perforates the Scm, the splenius muscle, and the trapezius muscle or its aponeurosis to become a purely sensitive nerve, innervating the skin and scalp of the posterior and superior portion of the occipital region. It is located in a medial position and at a variable distance from the major occipital artery in the occipital area[12] (Figure 19).

This block is performed for the diagnosis and treatment of occipital neuralgia or different types of headache or both.[31]

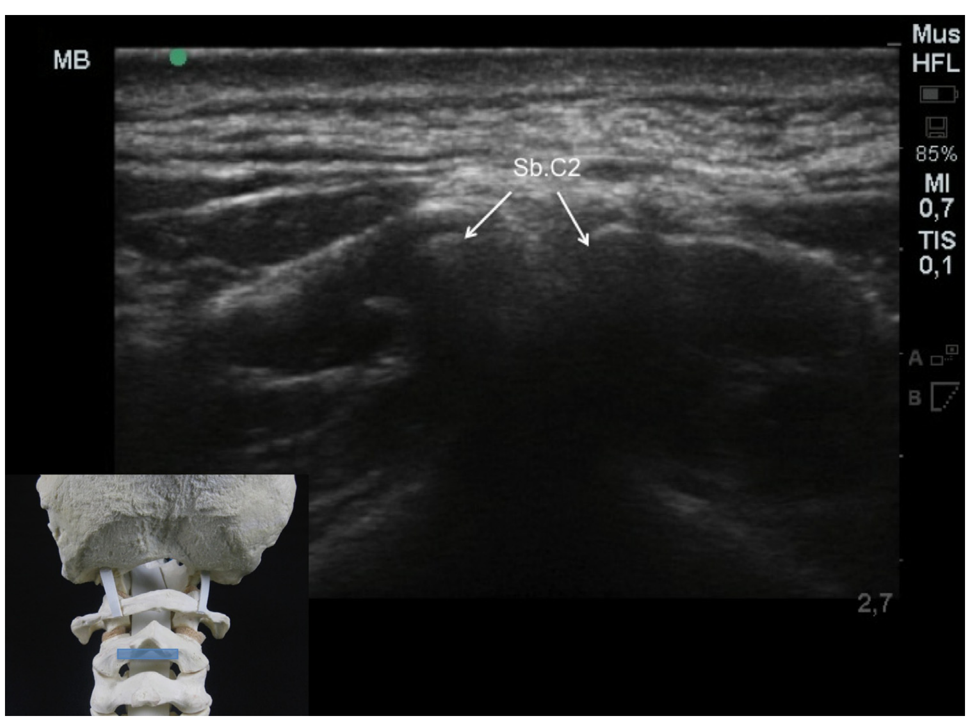

Fig. 21 – Probe placement (blue bar) at second cervical spinous process level. SbC2, spinous bifid process of C2. (Color version of figure is available online.)

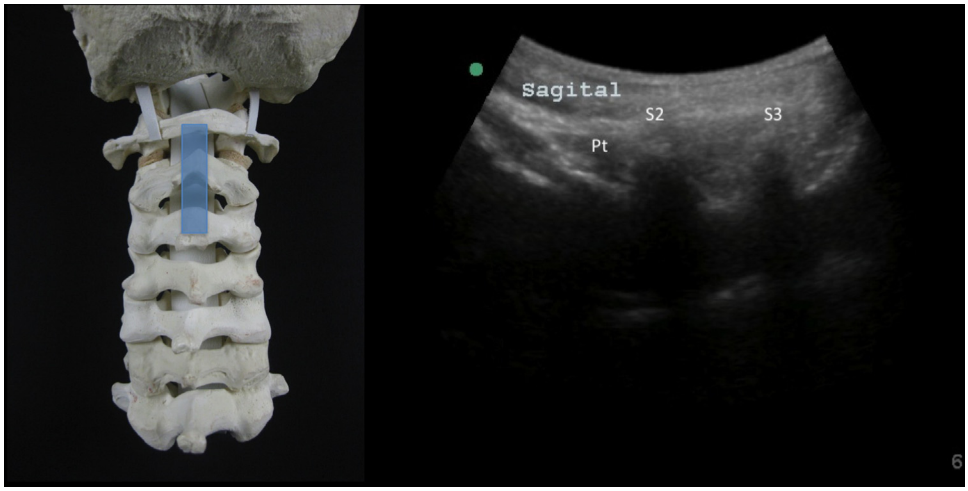

Fig. 23 – Probe placement (blue bar) at cervical spinous process. Pt, posterior tubercle of the C1; S2, spinous process of the C2 (bifid); S3, spinous process of the C3. (Color version of figure is available online.)

Although the mechanism by which pain relief is achieved is not clear, it seems that the occipital nerve block may cause a neuromodulating effect owing to a phenomenon of convergence with areas of nociception. A stimulation electrode can also be placed between the inferior oblique muscle and the Scm where the GON is located.

Sonoanatomy

The patient is placed in a decubitus position with the head in a neutral position and slightly flexed. A high-frequency (6-13 MHz) probe is placed in axial position at the level of the C2 (according to the localization technique to find the nearby cervical levels described in the medial cervical branch block). At this level, the sonoanatomical references identified are the spinal process of C2 and the Scm and posterior to this muscle, we find the inferior oblique muscle of the head that rests on the vertebral La of C2. The GON is located in the interfascial space between the semispinalis and inferior oblique muscles (Figure 20).

Technique

The probe is placed in an axial position until the spinous process of C2 is located, easily identifiable by its bifid processes (Figure 21). The probe is moved in a lateral direction with a slight cranial rotation of its lateral end.[32] The probe should be oriented toward the transverse apophysis of the atlas, following the direction of the inferior oblique muscle. The needle is inserted, in plane, toward the interfascial space, between the Scm and internal oblique muscle, to place the tip in the GON area (Figure 22). The efficacy of the block is evaluated by the sensory deficit in the cervical scalp and the skin of the posterior area of the neck.

Complications

Although the complications of this type of block are rare, given the proximity to structures, such as the vertebral artery

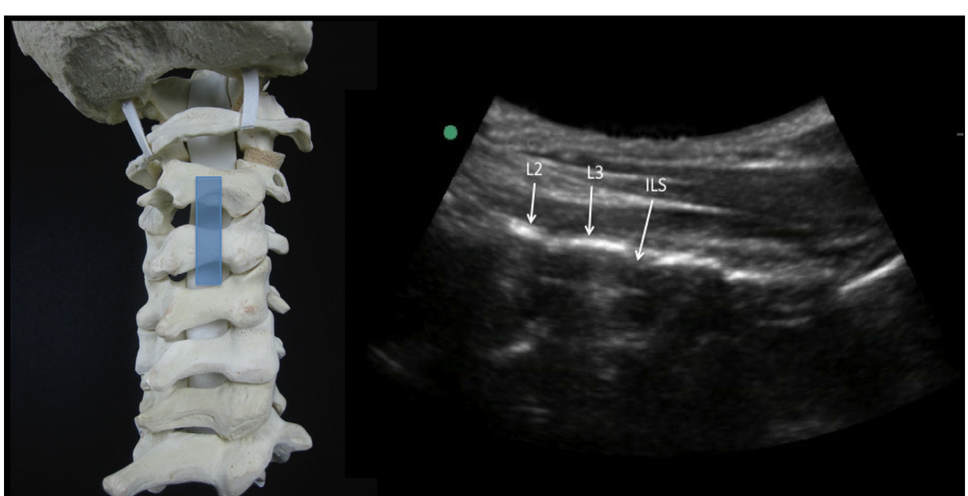

Fig. 24 – Probe placement (blue bar) at cervical lamina. L2, L3, lamina; ILS, interlaminar space. (Color version of figure is available online.)

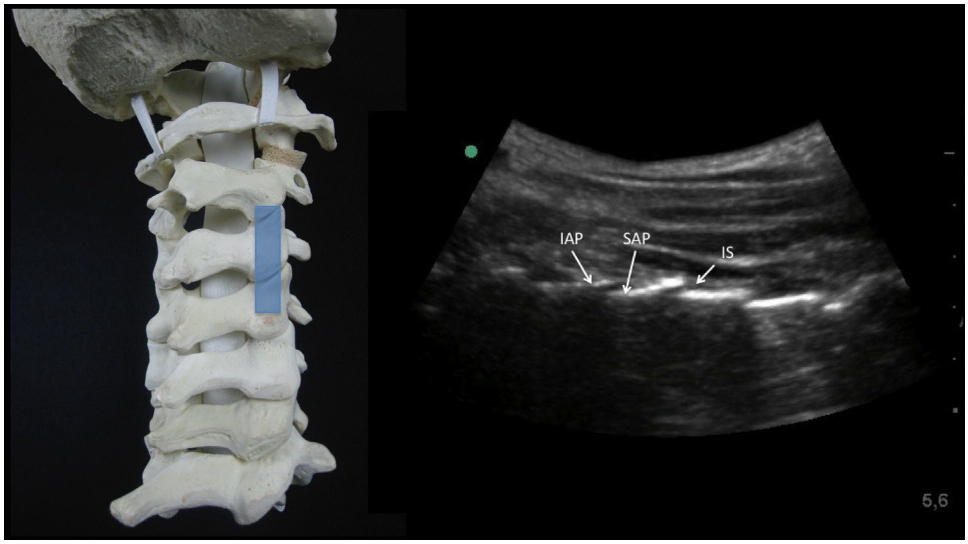

Fig. 25 – Probe placement (blue bar) at facet joints. IAP, inferior articular process; SAP, superior articular process; IS interarticular space. (Color version of figure is available online.)

or its branches, and the epidural space, it is important to control the position of the tip of the needle at all times so as to avoid puncture.

Efficacy and safety

Different studies have evaluated the efficacy of the GON block for the treatment of cervicogenic[33-35] and cluster headaches.[36] However, most of them lack a control group; in addition, they use different drugs such as local anesthetics or corticosteroids, or both, and different techniques are used to locate the nerve. These studies showed lasting effect beyond the duration of the local anesthetic, that is, various days or weeks. Regarding the ultrasound-guided technique, a recent study showed that the aforementioned proximal approach was associated with a greater rate of success in comparison with the traditional distal block performed in the superior nuchal line.[37]

Cervical facet joints block

The cervical zygapophysial joint is a diarthrodial joint, with a capsule and highly innervated synovial tissue. It is formed by the descending articular apophysis of a vertebra and the ascending apophysis of the inferior vertebra. It receives its innervation from the medial branch of the posterior division of each segmental root and from the level immediately above.[38] The prevalence of chronic pain after acute cervical pain in relation to the facet joint varies between 35% and 50%.[39]

The infiltration of the zygapophysial joint is indicated for the diagnosis and treatment of cervicogenic cephalgia of facet origin.[40] There is no clear evidence that the intra-articular infiltration of a local anesthetic and a corticosteroid relieves midterm to long-term pain.[41]

Sonoanatomy and block technique

The patient is placed in a decubitus position with the head in a neutral position and slightly flexed. A medium-frequency (10-5 MHz) linear probe or a low-frequency (2-5 MHz) probe, depending on the patient's body type, is suggested. Applying the probe in a sagittal plane over the spinous apophysis (Figure 23) helps to identify the level as we move the probe in a cranial to caudal direction. In a transverse plane, C2 spinous apophysis is characterized by its bifid shape (Figure 21). The apophysis of C1, which is rudimentary or even absent, is found rostral to C2. As we move the probe laterally in a parasagittal position, the image of the vertebral La is identified and seen as an hyperechoic line with small interruptions that correspond to the interlaminar spaces (Figure 24). If we move the probe further laterally, the column of the facets appears with its typical jagged-toothed image (Figure 25).

The needle is inserted in plane through the lateral end of the probe until reaching the selected intra-articular space (Figure 26).

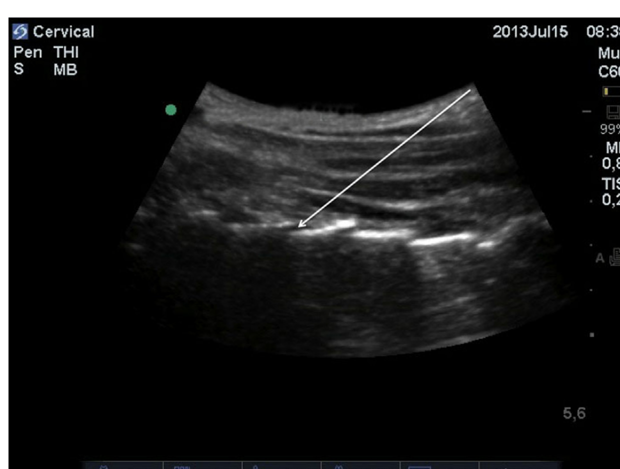

Fig. 26 – The arrow indicates the needle path in plane to block cervical facet joints. (Color version of figure is available online.)

Efficacy and safety

There are no studies that evaluate the efficacy and safety of the ultrasound-guided cervical facet blocks. A single study in cadavers with digital tomography confirmation has been published showing a success rate of 90%-100%.[42]

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