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Ultrasound-Guided Cervical Nerve Root Block

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Anatomy of Cervical Nerve Root

The cervical spinal nerve occupies the lower part of the foramen with the epiradicular veins in the upper part. The radicular arteries arising from the vertebral, ascending cervical, and deep cervical arteries lie in close approximation to the spinal nerve.

Huntoon showed, in cadavers, that the ascending and deep cervical arteries may contribute to the anterior spinal artery along with the vertebral artery. Twenty percent of the foramina dissected had the ascending cervical artery or deep cervical artery branches within 2 mm of the needle path for a cervical transforaminal procedure. One third of these vessels entered the foramen posteriorly potentially forming a radicular or a segmental feeder vessel to the spinal cord, making it vulnerable to inadvertent injury or injection even during correct needle placement.[1]

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Hoeft et al,[2] in a single cadaver study, showed that radicular artery branches from the vertebral artery lie over the most anteromedial aspect of the foramen, while those that arise from the ascending or deep cervical arteries are of greatest clinical significance as they must course medially throughout the entire length of the foramen.

Indications

Cervical nerve root block/transforaminal epidural injections are indicated in cervical radicular pain not responsive to conservative therapy.

Cervical epidural injections can be performed using an interlaminar or a transforaminal approach. As cervical radicular pain is frequently caused by foraminal stenosis, transforaminal approach can maximize the concentration of steroid delivered to the affected nerve roots while reducing the volume of injectate required and was shown to be effective in relieving radicular symptoms.[3,4]

Limitations of the Fluoroscopy-Guided Techniques

Cervical transforaminal injections have been traditionally performed with the use of fluoroscopy or CT. However, there have been few reports of fatal complications in the literature as a result of vertebral artery injury[5,6] and/or infarction of the spinal cord and the brain stem.[7–11] The mechanism of injury was believed to be vasospasm or the particulate nature of the steroid injectate with embolus formation after inadvertent intra-arterial injection.[7,8]

Currently, the guidelines for cervical transforaminal injection technique involve introducing the needle under fluoroscopic guidance into the posterior aspect of the intervertebral foramen just anterior to the superior articular process in the oblique view to minimize the risk of injury to the vertebral artery or the nerve root.[12] Despite strict adherence to these guidelines adverse outcomes have been reported.[7,8] A potential shortcoming of the described fluoroscopic-guided procedure is that the needle may puncture a critical contributing vessel to the anterior spinal artery in the posterior aspect of the intervertebral foramen.[1] Here the ultrasonography may come to play, as it allows for visualization of soft tissues, nerves, and vessels and the spread of the injectate around the nerve, and thus it may be potentially advantageous to fluoroscopy. Ultrasound allows identification of vessels before they are punctured, while fluoroscopy recognizes intravascular injection only after the vessel has been punctured.[13]

Literature Review of Ultrasound-Guided Cervical Nerve Root Block

Galiano et al[14] first described ultrasound-guided cervical periradicular injections in cadavers; however, they were not able to comment on the relevant blood vessels in the vicinity of the vertebral foramen.

Narouze et al[15] reported a pilot study of ten patients who received cervical nerve root injections using ultrasound as the primary imaging tool with fluoroscopy as the control. The radiologic target point was the posterior aspect of the intervertebral foramen just anterior to the SAP in the oblique view, and at the midsagittal plane of the articular pillars in the anteroposterior view (the target point for transforaminal injection).

The needle was exactly at the target point in five patients in the oblique view and in three patients in the AP views. The needle was within 3 mm in all patients in the lateral oblique view and in eight patients in the AP view. In the other two patients, the needle

was within 5 mm from the radiologic target as the needle was not introduced into the foramen intentionally but rather just outside of the foramen as the goal was to perform selective nerve root injection and not a transforaminal injection.

In four patients they were able to identify vessels at the anterior aspect of the foramen, while two patients had critical vessels at the posterior aspect of the foramen and in one patient this artery continued medially into the foramen most likely forming a segmental feeder artery. In these two cases, such vessels could have been injured easily in the pathway of a correctly placed needle under fluoroscopy.

Sonoanatomy of the Cervical Spine and Identification of the Cervical Level

With patients lying in the lateral decubitus position, ultrasound examination is performed using a high-resolution linear array transducer. The transducer is applied transversely to the lateral aspect of the neck to obtain a short axis view of the cervical spine (Figure 8.1). One can easily identify the cervical transverse process with the anterior and posterior tubercles as hyperechoic structures "two-humped camel" sign and the hypoechoic round-to-oval nerve root in between[15] (Figure 8.2). First, 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 above levels as it usually has a rudimentary anterior tubercle and one prominent posterior tubercle[16] (Figure 8.3). Then by moving the transducer cranially the transverse process of the sixth cervical spine comes in the image with the characteristic sharp anterior tubercle (Figure 8.4), and then after the consecutive cervical spinal level can be easily identified. At higher levels than C6, the anterior tubercle becomes shorter and equal to the posterior tubercle with a shallow groove in between (Figure 8.2). Another way to determine the cervical spinal level is by following the vertebral artery, which runs anteriorly at the C7 level (Figure 8.3) before it enters the foramen of C6 transverse process in about 90% of cases. However, it enters at C5 or higher in about 10% of cases[17] (Figure 8.5).

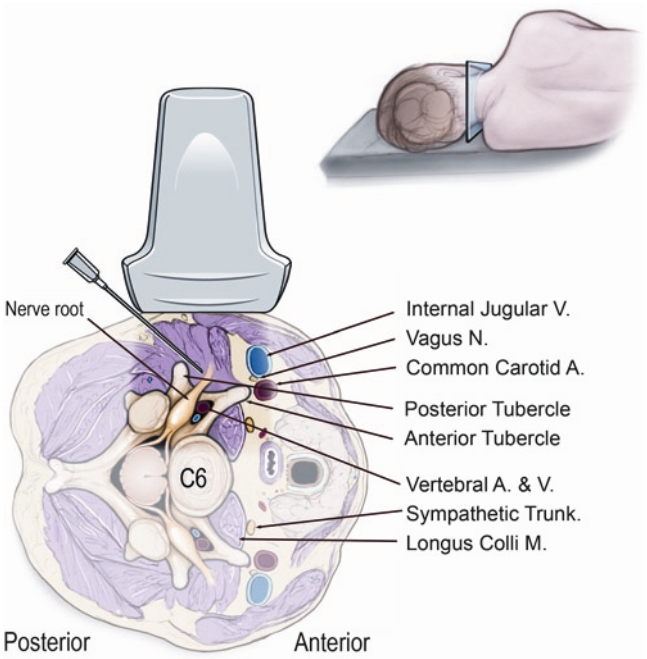

Figure 8.1. The orientation of the ultrasound transducer to obtain a short axis view at C6 level is shown. Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography© 2008–2010. All rights reserved.

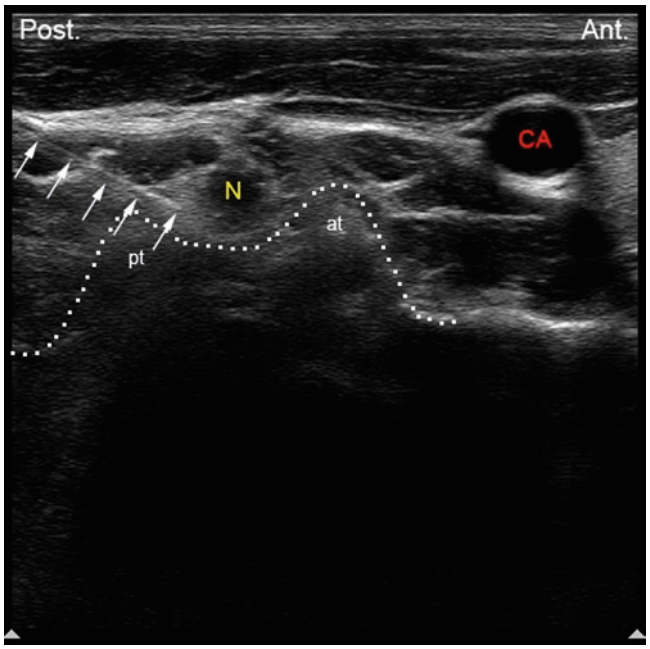

Figure 8.2. Sort-axis transverse ultrasound images showing the anterior tubercle (at) and the posterior tubercle (pt) of the C5 transverse process as the "two-humped camel" sign. *N* nerve root, *CA* carotid artery. *Solid arrows* are pointing to the needle in place at the posterior aspect of the intervertebral foramen. Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography© 2008–2010. All rights reserved.

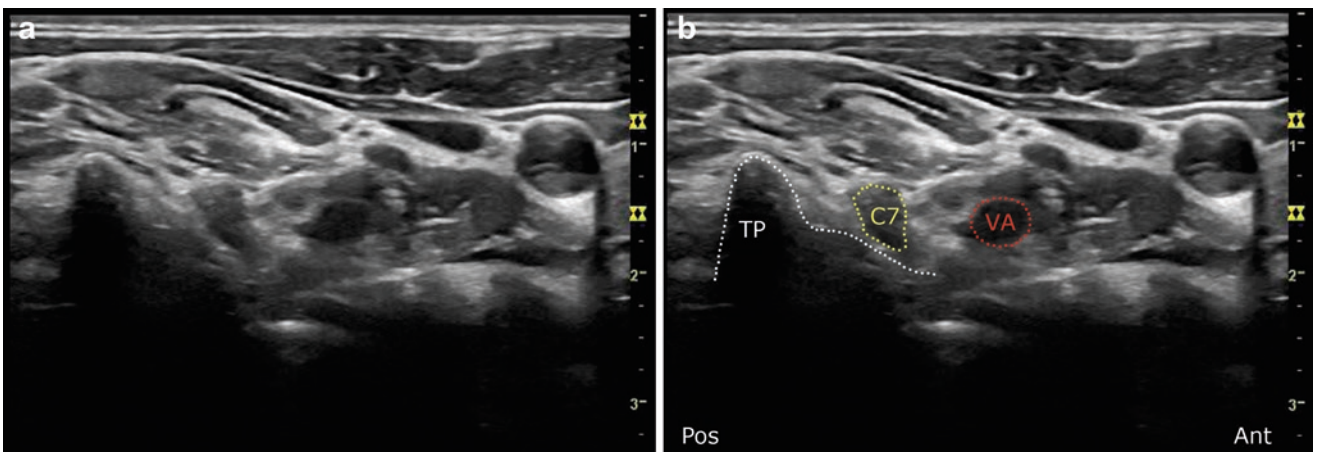

Figure 8.3. (**a**, **b**) Short-axis transverse ultrasound image showing the pt of the C7 transverse process. Note the vertebral artery (VA) is anterior to the C7 nerve root. No anterior tubercle. (Reprinted with permission from Ohio Pain and Headache Institute).

Ultrasound-Guided Technique for Cervical Selective Nerve Root Block

Once the appropriate spinal level is identified, a 22-gauge blunt-tip needle can be introduced under real-time ultrasound guidance from posterior to anterior with an in-plane technique to target the corresponding cervical nerve root (from C3–C8) at the external foraminal opening between the anterior and posterior tubercles of the transverse process (Figure 8.2). One can successfully monitor the spread of the injectate around the cervical nerve with real-time ultrasonography and the absence of such spread around the nerve root may suggest unsuspected or inadvertent intravascular injection. However, it is difficult to monitor the

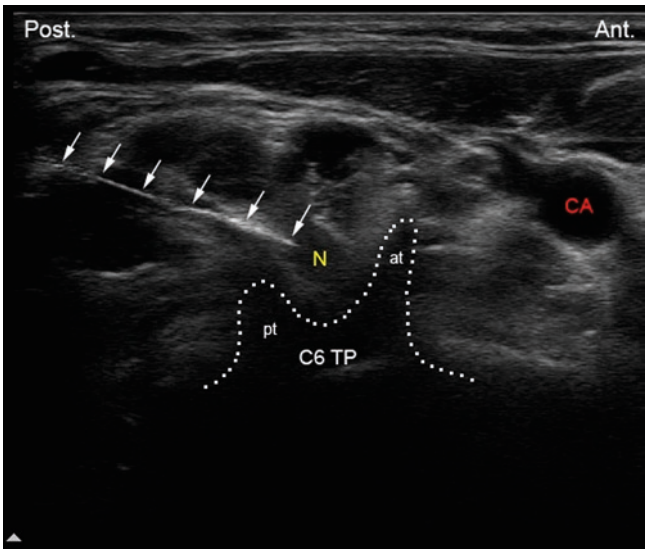

Figure 8.4. Short-axis transverse ultrasound image showing the sharp anterior tubercle (at) of the C6 transverse process (C6tp). *N* nerve root, *CA* carotid artery, *pt* posterior tubercle. *Solid arrows* are pointing to the needle in place at the posterior aspect of the intervertebral foramen. Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography© 2008–2010. All rights reserved.

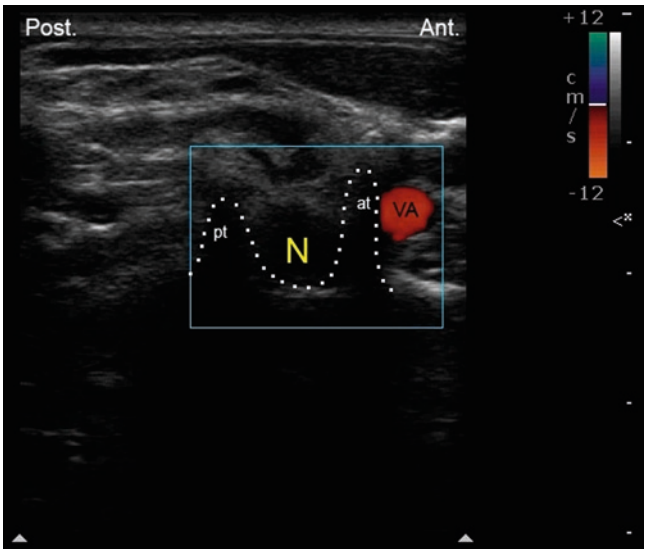

Figure 8.5. Short-axis transverse ultrasound image showing the sharp anterior tubercle (at) of the C6 transverse process and the vertebral artery (VA) is anterior. *N* nerve root, *CA* carotid artery, *pt* posterior tubercle. Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography© 2008–2010. All rights reserved.

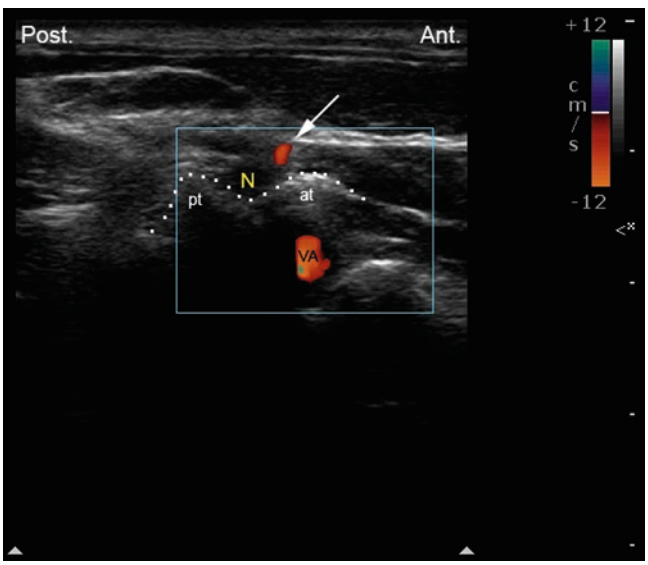

Figure 8.6. Short-axis transverse ultrasound image with color Doppler showing a small artery at the anterior aspect of the intravertebral foramen. *at* anterior tubercle, *pt* posterior tubercle, *VA* vertebral artery. (Reprinted with permission from Ohio Pain and Headache Institute).

spread of the injectate through the foramen into the epidural space because of the bony drop out artifact of the transverse process. We therefore refer to this approach as a "cervical selective nerve root block" rather than cervical transforaminal epidural injection.

The author believes that visualization of such small vessels (radicular arteries) may be very challenging especially in obese patients and requires special training and expertise. Real-time fluoroscopy with contrast injection and digital subtraction – when available – should still be used with ultrasound as an adjunct to help identifying blood vessels in the vicinity of the foramen (Figures. 8.6–8.8).

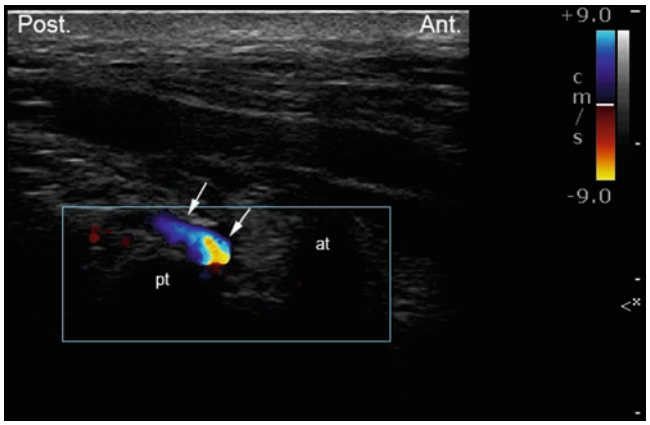

Figure 8.7. Short-axis transverse ultrasound image with color Doppler showing a small vessel at the posterior aspect of the intravertebral foramen. *at* anterior tubercle, *pt* posterior tubercle. (Reprinted with permission from Ohio Pain and Headache Institute).

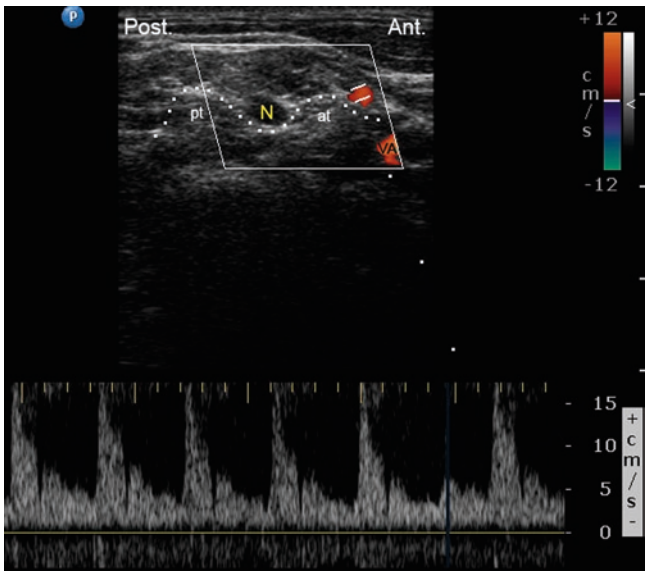

Figure 8.8. Short-axis transverse ultrasound image with pulsed-wave Doppler showing arterial perfusion in a small vessel at the anterior aspect of the intervertebral foramen. *N* nerve root, *VA* vertebral artery, *at* anterior tubercle, *pt* posterior tubercle. Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography© 2008–2010. All rights reserved.

References

1. Huntoon MA. Anatomy of the cervical intervertebral foramina: vulnerable arteries and ischemic neurologic injuries after transforaminal epidural injections. *Pain*. 2005;117:104–111.
2. Hoeft MA, Rathmell JP, Monsey RD, Fonda BJ. Cervical transforaminal injection and the radicular artery: variation in anatomical location within the cervical intervertebral foramina. *Reg Anesth Pain Med*. 2006;31:270–274.
3. Kolstad F, Leivseth L, Nygaard OP. Transforaminal steroid injections in the treatment of cervical radiculopathy: a prospective outcome study. *Acta Neurochir*. 2005;147:1065–1070.
4. Slipman CW, Lipetz JS, Jackson HB, Rogers DP, Vresilovic EJ. Therapeutic selective nerve root block in the nonsurgical treatment of atraumatic cervical spondylotic radicular pain: a retrospective analysis with independent clinical review. *Arch Phys Med Rehabil*. 2000;81:741–746.

5. Wallace MA, Fukui MB, Williams RL, Ku A, Baghai P. Complications of cervical selective nerve root blocks performed with fluoroscopic guidance. *AJR Am J Roentgenol.* 2007;188:1218–1221.
6. Rozin L, Rozin R, Koehler SA, et al. Death during transforaminal epidural steroid nerve root block (C7) due to perforation of the left vertebral artery. *Am J Forensic Med Pathol.* 2003; 24:351–355.
7. Tiso RL, Cutler T, Catania JA, Whalen K. Adverse central nervous system sequelae after selective transforaminal block: the role of corticosteroids. *Spine J.* 2004;4:468–474.
8. Baker R, Dreyfuss P, Mercer S, Bogduk N. Cervical transforaminal injections of corticosteroids into a radicular artery: a possible mechanism for spinal cord injury. *Pain.* 2003;103:211–215.
9. Muro K, O'Shaughnessy B, Ganju A. Infarction of the cervical spinal cord following multilevel transforaminal epidural steroid injection: case report and review of the literature. *J Spinal Cord Med.* 2007;30(4):385–388.
10. Brouwers PJ, Kottink EJ, Simon MA, Prevo RL. A cervical anterior spinal artery syndrome after diagnostic blockade of the right C6-nerve root. *Pain.* 2001;91:397–399.
11. Beckman WA, Mendez RJ, Paine GF, Mazzilli MA. Cerebellar herniation after cervical transforaminal epidural injection. *Reg Anesth Pain Med.* 2006;31:282–285.
12. Rathmell JP, Aprill C, Bogduk N. Cervical transforaminal injection of steroids. *Anesthesiology.* 2004;100:1595–1600.
13. Narouze S, Peng PWH. Ultrasound-guided interventional procedures in pain medicine: a review of anatomy, sonoanaotmy and procedures. Part II: axial structures. *Reg Anesth Pain Med.* 2010;35(4):386–396.
14. Galiano K, Obwegeser AA, Bodner G, et al. Ultrasound-guided periradicular injections in the middle to lower cervical spine: an imaging study of a new approach. *Reg Anesth Pain Med.* 2005;30:391–396.
15. Narouze S, Vydyanathan A, Kapural L, Sessler D, Mekhail N. Ultrasound-guided cervical selective nerve root block: a fluoroscopy-controlled feasibility study. *Reg Anesth Pain Med.* 2009;34:343–348.
16. Martinoli C, Bianchi S, Santacroce E, Pugliese F, Graif M, Derchi LE. Brachial plexus sonography: a technique for assessing the root level. *AJR Am J Roentgenol.* 2002;179:699–702.
17. Matula C, Trattnig S, Tschabitscher M, Day JD, Koos WT. The course of the prevertebral segment of the vertebral artery: anatomy and clinical significance. *Surg Neurol.* 1997;48:125–131.