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Neck movement during cervical transforaminal epidural injections and the position of the vertebral artery: an anatomical study

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Abstract

Background: Cervical transforaminal epidural steroid injections (CTFESIs) are sometimes performed in patients with cervical radiculopathy secondary to nerve-root compression. Neck movements for patient positioning may include rotation, flexion, and extension. As physicians performing such procedures do not move the neck for fear of injuring the vertebral artery, we performed fluoroscopy and cadaveric dissection to analyze any movement of the vertebral artery during head movement and its relation to the foramina in the setting of CTFESI.

Purpose: To determine cervical rotational positioning for optimized vertebral artery location in the setting of cervical transforaminal epidural steroid injections.

Material and Methods: Four sides from two Caucasian whole cadavers (all fresh-frozen) were used. Using a guide wire and digital subtraction fluoroscopy, we evaluated the vertebral artery mimicking a CTFESI, then we removed the transverse processes and evaluated the vertebral artery by direct observation.

Results: After performing such maneuvers, no displacement of the vertebral artery was seen throughout its course from the C6 to the C2 intervertebral foramina. To our knowledge, this is the first anatomical observation of its kind that evaluates the position of the vertebral artery inside the foramina during movement of the neck.

Conclusion: Special caution should be given to the medial border of the intervertebral foramina when adjusting the target site and needle penetration for the injection. This is especially true for C6-C4 levels, whereas for the remaining upper vertebrae, the attention should be focused on the anterior aspect of the foramen. Since our study was centered on the vertebral artery, we do not discard the need for contrast injection and real-time digital subtraction fluoroscopy while performing the transforaminal epidural injection in order to prevent other vascular injuries.

Keywords

Epidural injection, cervicalgia, vertebral artery, neck rotation

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Introduction

Neck pain is a common pathology affecting the adult population. It is the fourth leading cause of disability with a prevalence in the range of 38–48%; the incidence of cervical radiculopathy is 83.2 per 100,000 (age-adjusted); there is a lifetime risk of 50% of the general population developing cervicalgia (1,2). Cervical transforaminal epidural steroid injections (CTFESIs) are relatively safe and efficient interventional procedures;

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however, adverse events can occur. Intravascular introduction of medication using the vertebral artery (VA) can result in catastrophic complications. Prior studies have been performed to assess the anatomical location of artery position in regard to spinal entry, as well as in the setting of degenerative disease (3). To our knowledge, there is no anatomical evidence evaluating safety in regard to arterial intraforaminal location based on the rotation of the cervical spine during a transforaminal procedure. This article aims to review, by dissecting cadaveric specimens, the original procedure of CTFESI and evaluate the location of the cervical VAs within the vertebral foramen during neck rotation to improve our understanding of the CTFESI procedure and its potential complications.

Material and Methods

The anatomical quality assurance (AQUA) checklist was used for this study. Four sides from two Caucasian whole cadavers (all fresh-frozen) were used. The specimens derived from one female and one male aged 67 years and 59 years at time of death, respectively. We performed a bilateral dissection of the sterno-clavicular junction, exposing both VAs at their origin on both male and female specimens. After exposing the right and left VA origin, we introduced a guide wire used for subclavian catheter placement into both arteries up to the level of the C1 vertebra. Oblique fluoroscopy images were taken with the head in a straight, supine position and rotated 45° and 90° contralateral to the injection site. We then evaluated the VA by direct observation by removing the transverse processes of the cervical vertebrae.

Results

Course of the VA following rotation of the neck with fluoroscopy

The course of the artery originated anteriorly as the first branch of the subclavian artery and entered the C6 foramen; it then coursed through the medial aspect of the foramina of the lower cervical vertebrae (C6-C4) and then to the anterior border of the remaining vertebral foramina. It remained in this position throughout, even when performing the abovementioned maneuvers (Fig. 1). We then introduced a spinal needle, aiming for the intervertebral foramina, imitating a transforaminal epidural injection. We noticed that the tip of the needle came in direct contact with the VA, even displacing the artery a few millimeters when driven deeper (Fig. 2).

Direct observation of the VA

By rotating the neck from the supine position to the right side, the V2 segment of the VA did not move; only the V3 segment moved slightly (1–2 mm) toward the face (Figs. 3 and 4). The same observation was made contralaterally.

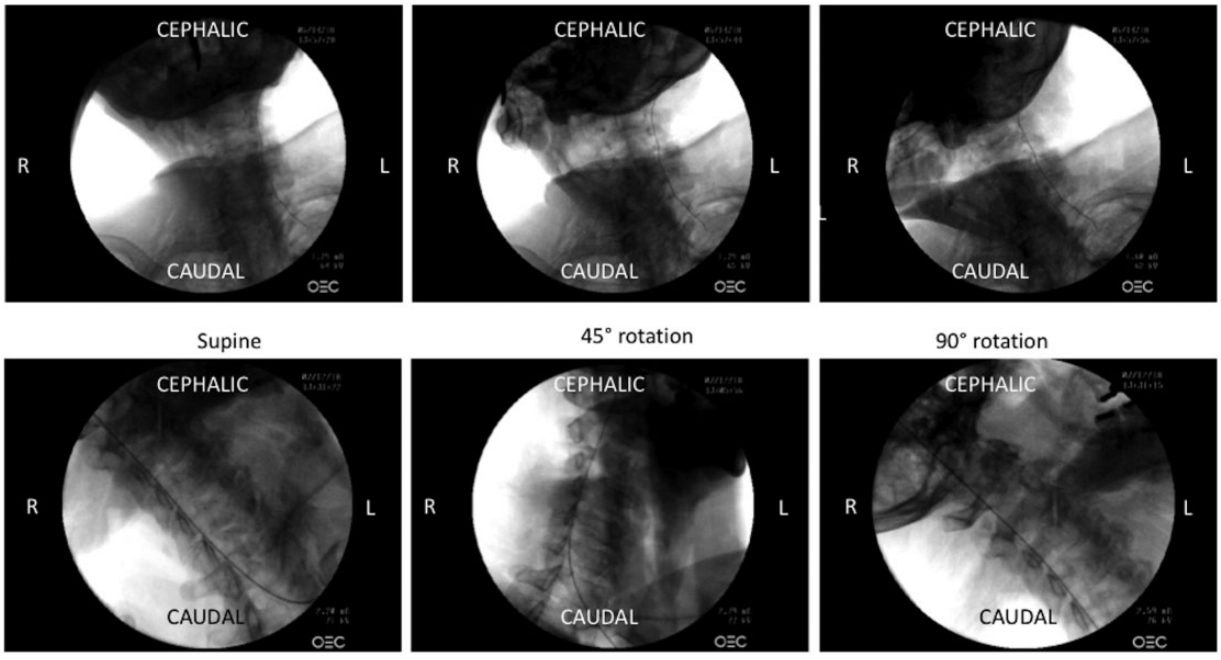

Fig. 1. Intraforaminal course of the VA. Note how the artery stays at the medial/anterior aspect of the foramina during all the maneuvers.

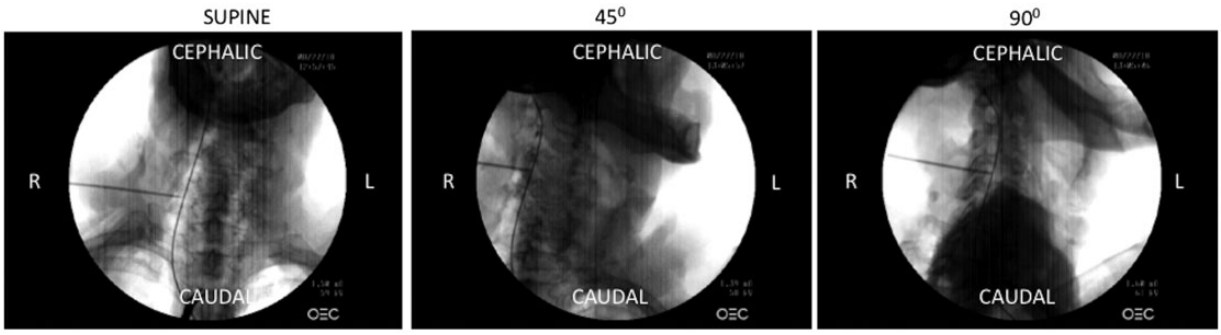

Fig. 2. Needle in direct contact with VA while performing transforaminal injection.

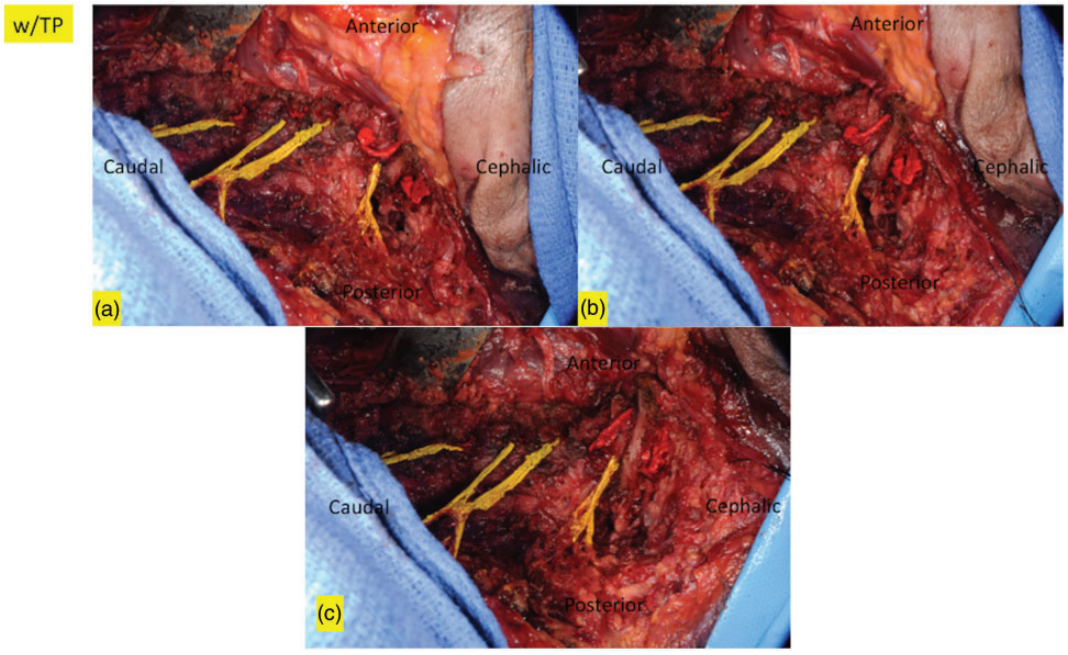

Fig. 3. Dissection displaying VA (red) and left cervical nerves from occiput to C6 while conserving the transverse processes. Movement of the left VA. Only the V3 segment of the VA slightly moved by rotating the neck. The neck rotating to the right side from 90° to the horizontal plane to 0°. (a) Supine; (b) 45°; (c) 90°.

Discussion

Cervical epidural injection is a non-surgical intervention procedure sometimes used by physicians around the globe to treat different causes of neck pain and cervical radiculopathy. Despite limited evidence, this procedure has been proven effective in patients with chronic function-limiting discogenic or axial pain (4). Most physicians prefer the transforaminal approach over the interlaminar because it can deliver medication directly to the nerve root and dorsal root ganglion, providing a greater incidence of ventral epidural spread of the medication, although recent studies have shown no significant difference in clinical efficacy and a slightly higher inclination for complications with transforaminal versus interlaminar techniques (5,6).

The VA arises as the first branch of the subclavian artery; it courses posterior to the inferior vena cava (ICA) through the foramina of C6 to C1 and pierces the dura mater. It consists of four segments: preforaminal or V1; foraminal or V2; atlantic or V3; and intradural or V4. Regarding its preforaminal segment, its most common relationships are: (i) anteriorly, it is associated with the common carotid, the vertebral vein, and the thoracic duct; (ii) posteriorly, it is usually accompanied by the ventral rami of the brachial plexus and the stellate ganglion; and (iii) anteromedially, it is limited by the inferior thyroid artery. In addition to supplying the spinal cord, the vertebral arteries also feed the brainstem and posterior regions of the brain. Anatomical variations—including lateral loops,

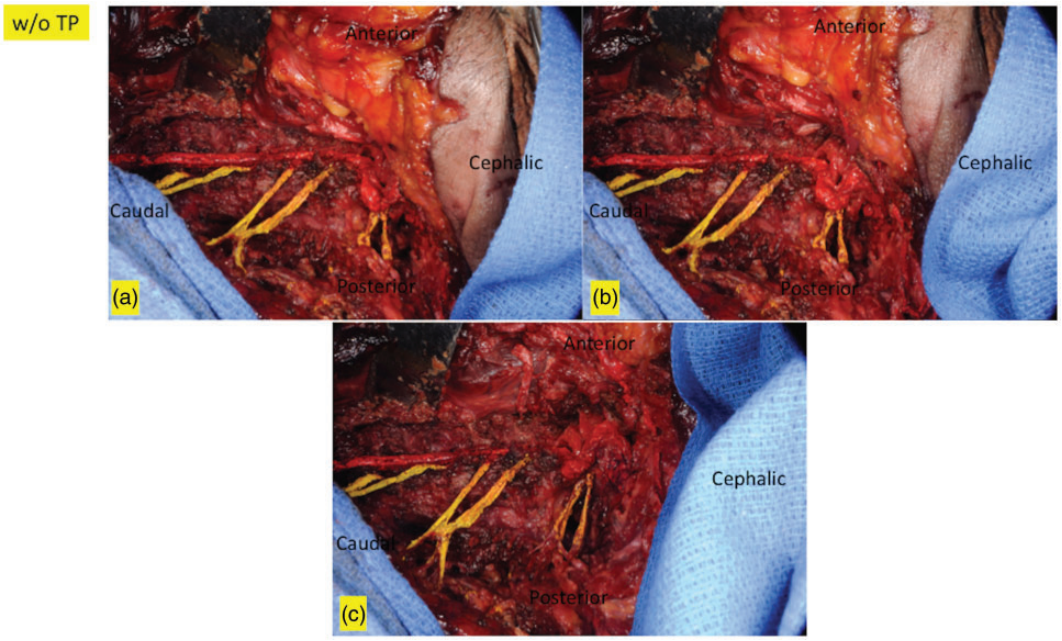

Fig. 4. Dissection displaying VA (red) and left cervical nerves from occiput to C6 after removing the transverse processes. Movement of the left VA. Only the V3 segment of the VA slightly moved by rotating the neck. The neck rotating to the right side from 90° to the horizontal plane to 0°. (a) Supine; (b) 45°; (c) 90°.

different origins, course variations through the craniocervical junction, and accessory vessels of the vertebral artery—have been previously reported in the literature with imaging techniques and anatomical dissections (7,8).

Because of its easy access and relatively safe procedure, epidural steroid injections have doubled (119% increase) among Medicare enrollees in the United States over the past decade (9).

Past studies assert that the optimal needle entry angle using the anterior oblique approach for CTFESI is approximately 50° to the horizontal in the supine position; this angle allows the best visualization of the neural foramen (10). Other more recent studies using CT guidance concluded that a 70° angle is safer when taking into consideration the injuring of such related vessels as the VA, internal carotid artery, and internal jugular vein (11). As we advance the needle into the foramen, contact with the spinal nerve or ventral ramus may occur, resulting in paresthesia and intense radicular pain, which usually resolves with a slight withdrawal of the needle. The procedure should be discontinued if these sensations do not resolve (12).

Complications regarding CTFESI can range from minor to major; the latter includes spinal cord infarction, seizure, brain infarction, bleeding, quadriparesis, and death (13,14).

In conclusion, after performing such maneuvers, no displacing of the VA was seen throughout its course from the C6 to the C2 foramina. To our knowledge, this is the first anatomical observation of its kind that evaluates the position of the VA inside the foramina during the classic maneuvers performed for CTFESI. As these locations have a juxtaposition to the VA, caution should be given to the medial border of the foramina when adjusting the target site and needle penetration for the injection. This is especially true for C6-C4 levels, whereas for the remaining upper vertebrae, the attention should be focused on the anterior aspect of the foramen. Since our study was centered on the VA, we do not discard the need for contrast injection and real-time digital subtraction fluoroscopy while performing the transforaminal epidural injection in order to prevent other vascular injuries.

Declaration of conflicting interests

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