**Anomalous location of the vertebral artery in relation to the neural foramen. Implications for cervical transforaminal epidural steroid injections**.

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**Background**

Expert opinion suggests that the vertebral artery (VA) should never be encountered in a cervical transforaminal epidural injection (CTFESI),1 but Wells in 2010 suggested that the VA can sometimes be located in the posterior foramen.2

**Objectives**

Evaluate the prevalence of an anomalous posterior VA in the neural foramen and to see if any factors might correlate with proximity of the VA to needle location in a CTFESI.

**Study Design:**

Retrospective review of CT angiograms done on 198 consecutive patients

**Setting:**

University hospital

**Methods:**

A Neuroradiologist documented VA location in relation to the neural foramen on axial views of 198 consecutive CT angiograms done for various reasons. C2-7 were evaluated, where the VA courses within the foramen, with a focus on commonly injected levels of C4-7. The distance was measured from VA to ideal needle location for a CTFESI. Other data was collected including severity of foraminal stenosis, loss of disc height and medical history. Analysis was done to see if any factor correlated with VA proximity to the ideal needle location with CTFESIs.

**Results:**

The VA was located in the posterior foramen and within 2mm of ideal needle location in 19% of patients in at least one level from C4-7. Severity of foraminal stenosis correlated with VA proximity to typical needle location (p<0.0001).

**Limitations:**

This was a retrospective review on previously performed CT angiograms at a single academic center.

**Conclusion:**

The VA can sometimes be in close proximity to the typical target location of a CTFESI. This proximity correlates with the severity of foraminal stenosis. Physicians should be mindful of this and consider evaluating the T2 axial MRI before doing CFTESIs.

IRB approval from Emory University was obtained.

**Background**

In recent years, significant complications have been reported after cervical transforaminal epidural steroid injections (TFESIs). These have been catastrophic complications including spinal cord injury, stroke and death. (McMillin, Rozin, Tiso, Brouwer, Baker1-5) These complications are very unfortunate in an elective procedure such as a TFESI.

A survey of pain physicians revealed a total of 78 reported neurologic complications following cervical transforaminal injections. Among these were 16 vertebrobasilar brain infarcts, 12 cervical spinal cord infarcts and two combined brain and spinal cord infarcts. Thirteen cases resulted in death: five with brain infarcts, one with combined brain and spinal cord infarcts, one following high spinal anesthesia, one associated with seizure and five of unspecified etiology (Scanion 6)

Anatomical studies show that the size of particles in commonly used steroid preparations like triamcinolone (Kenalog), methylprednisilone (Depo-Medorl) and betamethasone (Celestone) equals or exceeds the caliber of many radicular arteries. (Tiso, Derby 7-8) These particulate steroids are larger in diameter than a red blood cell or tend to form aggregates larger than a red blood cell. This could lead to the potential for embolic microvascular occlusion.

Thus, injection of particulate steroids into the VA or spinal radicular arteries and resulting embolic infarcts is suspected to be a major cause of these catastrophic complications (Baker 5, Rathmel 9). Additionally, direct needle trauma to the VA has been reported as a cause of death with perforation of the VA. (Rozin 2)

It has been thought that the VA should not be encountered in cervical TFESIs when the needle is placed in an ideal location in the posterior aspect of the foramen. But, findings from (Wells 10) in 2010 suggest that the VA can sometimes be located in the posterior foramen which is the target point for these injections. This goes against expert opinion of (Bogduk et al. 11) who have stated, “The vertebral artery lies outside the cervical intervertebral foramina and should not be encountered in a carefully executed transforaminal injection. Yet it has often been implicated in cases of neurological complications.”

**Objectives**

The objective of this study is to evaluate and further clarify the prevalence of an anomalous posterior VA in the neural foramen and to see if any factors might correlate with proximity of the VA to needle location in a CTFESI.

**Methods:**

A radiologist with subspecialty training in Neuroradiology documented VA location in relation to the neural foramen on axial views of 198 consecutive CT angiograms done for various reasons at a university hospital. C2-7 were evaluated, where the VA courses within the foramen, with a focus on commonly injected levels of C4-7. If the VA was found to be in the mid to posterior aspect of the foramen, a distance was measured to the ideal needle location for a CTFESI. The ideal location for a CTFESI is defined by the International Spine Intervention Society (ISIS) Guidelines (Bodguk 12) is in the posterior foramen and “the tip of the needle should lie opposite the sagittal midline of the silhouettes of the articular pillars.”

Other data was collected including severity of foraminal stenosis, loss of disc height, side of VA dominance and medical history. Chi-square test was used to check the association between any two categorical variables. Wilcoxon signed-rank test (or Kruskal-Wallis test) was done to see if any numerical factor correlated with VA proximity to the ideal needle location with CTFESIs.

**Results:**

The VA was located in the posterior foramen and within 2mm of ideal needle location in 19% of patients in at least one level from C4-7. If looking at all levels where the VA courses through the foramen (C2-7) the VA was found in the posterior foramen and within 2mm of ideal needle location in 30% of subjects in at least one level. The most common levels for VA to be located posteriorly were C4-5(10%), C3-4(8.0%) and C5-6(8.0%). The least common level was C6-7 where only 1.1% of patients were found to have the VA in the posterior foramen within 2mm of needle target location.

Severity of foraminal stenosis correlated with VA proximity to typical needle location (p<0.0001). Looking at all levels without foraminal stenosis, only 4.4%(2.9% with a distance <2mm) of the time was the VA found posteriorly. If there was severe foraminal stenosis, 31%(27% with a distance <2mm) of the time the VA would be located posteriorly.

Furthermore, Loss of disc height (DDD score) is significantly correlated to posterior foramen (p=0.05, for patients with posterior foramen, the DDD score=4.8±3.4, while for patients without non-posterior foramen DDD=3.8±3.4) as well as the distance (p=0.0002, for patients with distance<2mm, the DDD score=5.5±3.3, while for patients with distance≥2mm, DDD=3.5±3.3). HTN is significantly correlated to the distance (p=0.03, 30% HTN patients have distance<2mm, while only 12% non-HTN patients have distance<2mm).

Other factors that were not associated with anomalous VA location include, body mass index, smoking status (pack years of smoking), diabetes, and side of vertebral artery dominance.

**Discussion:**

The VA can sometimes be in close proximity to the typical target location of a CTFESI. These findings are similar to prior findings of Wells (Wells 10) and warrant caution when doing CTFESIs. Expert opinion in the past has said that “the vertebral artery . . . should not be encountered in carefully executed transforaminal injections. Yet it has often been implicated in cases of neurological complications.”(Bogduk 11) This is appears to be incorrect and clinicians should be mindful of this.

The VA proximity to the typical target location for a CTFESI correlates with the severity of foraminal stenosis. It should be noted that this study looked at bony foraminal stenosis seen on CT scans. This did not evaluate disc herniations that lead to foraminal stenosis. Foraminal stenosis often correlates with the symptomatic level that is often injected by the interventionalist. Physicians should be aware of this and consider evaluating the T2 axial MRI to see the location of the VA before doing CFTESIs.

Other standard safety measure should still be employed. First, utilizing live fluoroscopy with contrast administration is key in picking up vascular uptake. Contrast should be administered in the AP view and keeping target area in the center of the screen. There has been more than one case of paraplegia after transforaminal injections when the needle was at the upper end of the screen making it difficult to pick up vascular flow (Glaser, Aprill 13, 14). Digital subtraction angiography has been shown to be more sensitive at picking up vascular flow of the small radicular arteries (Smuck 15), but the VA is large enough that it should be apparent on live fluoroscopy. Test doses of local anesthetics have been recommended. In one case report, a patient developed temporary quadriparesis following the injection of a test dose of local anesthetic despite appropriate needle placement. The injection was aborted and no permanent injuries occurred. (Karasek 16).

Use of a non-particulate steroid is probably the most important thing that can be done to prevent complications. This is supported by an animal study compared particulate and nonparticulate steroid injections into the vertebral arteries (VA) of pigs under general anesthesia. Those injected with particulate steroids never regained consciousness. Subsequent MRIs revealed upper cervical cord and brain stem edema and histological analyses showed ischemic changes. The animals injected with nonparticulate steroids did not have ischemic events and recovered without apparent adverse effects. MRIs and subsequent histological analysis were later normal in this group. (Okubadejo 17)

Limitations of this study includes that this is a retrospective study from a single academic center. These CT angiograms of the neck were done for various reasons, but primarily for patients who were being evaluated for a stroke. It is unknown if stroke patients may have a higher prevalence of anomalous VA locations.

**Summary**

The VA can sometimes be in close proximity to the typical target location of a CTFESI. This proximity correlates with the severity of foraminal stenosis. Physicians should be mindful of this and consider evaluating the T2 axial MRI before doing CFTESIs.

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