The V₃ segment of the vertebral artery

To the Editor: We read with great interest the paper by Özgen and colleagues (Özgen S, Pait TG, Çağlar YS: The V₃ segment of the vertebral artery and its branches. J Neurosurg Spine 1:299–305, October 2004).

Abstract

Object. The goal of this study was to demonstrate the origins, courses, anastomoses, and target tissues of the arterial branches that arise from the V₃ segment of the vertebral artery.

Methods. Ten adult cadaveric necks (20 V₃ segment specimens) were examined (magnification × 40) after injection of colored silicon. The branches at each cervical level were classified in a new system according to anatomical features and target tissues—antero- posterior, medial, and lateral. Incidence with which each branch category was observed at each cervical level was calculated.

Anterior branches were observed at C-3 in all 20 V₃ segment specimens. The incidence with which the posterior branch was present at C-4 was 45%, whereas the corresponding rates at segments superior and inferior were lower. The medial V₃ segment branches were assessed in four subcategories. The anterior spinal artery was present at C-3 in all specimens, whereas the mean incidence at the C₄–₆ level was 46.7%. The posterior spinal artery was most frequently detected at C-3 (60%). The anterior radicular artery (RA) was present at C-5 in 50% of the specimens, whereas the posterior RA was detected at C-5 in only 35%. Lateral branches were most frequently detected at C-3.

Conclusions. The authors provide detailed anatomical information about the origins, courses, anastomoses, and target tissues of the vessels that arise from the V₃ segment. This new classification allows for better understanding of the vasculature of the C₃–₆ region.

We have performed a similar study of the V₃ segment of the vertebral artery (VA) and, for the most part, so far our dissections of six cadaveric specimens (12 sides) have yielded results consistent with those of the authors. We would, however, like to share some findings that, in our opinion, could add to the authors’ description.

We wish to clarify the exact origin of the VA collateral vessels on the arterial circumference and their branching pattern (relationship between multiple arteries and the common trunk artery). When classified according to their sites of origin, the V₃ collateral vessels we found between C-4 and C-6 were either medial or posterior. Medial arteries are those coursing to the anterior surface of vertebral bodies (called “anterior branches” in Özgen and colleagues’ classification). These branches arise as a single trunk from the anteromedial aspect of the VA, usually close to the upper margin of each transverse bar.

More sizeable branches arise from the posterior surface of the VA, usually at the level of the inferior margin of the corresponding nerve root, as we found in 14 (39%) of 36 examined levels. These branches enter the neuroforamen with an ascendant course and follow the nerve root with a variable fate: they may nourish the nerve root only, give off a collateral vessel, or reach the spinal cord and become contributors to the anterior, or less frequently, to the posterolateral medullary axis. Hence, as shown in Fig. 6 in the article by Özgen, et al., most of the collateral vessels classified by the authors as being in the medial group (for example, the anterior spinal branches, the anterior and posterior radicular branches, and the dural branches) as well as some of the arteries in the lateral group (ganglionic and articular branches) usually originate from this single trunk and may reach up to 1.4 mm in diameter. Because of their obvious segmental pattern, we suggest that these collateral vessels be referred to as radicular trunks. However, as pointed out by the authors, although the level of origin and the actual behavior of these arteries are unpredictable, their origin is always at the posterior surface of the VA (Fig. 1). Because the timely identification of radiculomedullary arteries is a crucial step in preventing iatrogenic spinal cord ischemia,¹²⁴ this identification may have surgical implications in procedures involving manipulation of the VA. Unroofing the anterior aspect of the VA by resecting the anterior root of the transverse processes is insufficient to visualize radiculomedullary branches, as the term “medial” might suggest. The only way to visualize these branches is to expose the posterior aspect of the VA or, more distally, the nerve root on the medial deep aspect of the artery itself.

We also found that at C-3 (as defined by the authors, the VA segment between C-3 and the C-2 transverse foramen) the pattern of collateral branching is distinctly peculiar. At that level, a medial branch constantly arises from the deep medial side of the VA. This collateral vessel is always the most sizeable of the anterior spinal artery group (authors’ classification) and, as beautifully shown in Fig. 2 in the paper by Özgen and colleagues, it travels up into the retro- somatic space, eventually contributing to the odontoid arterial arch. At the same level (or within a 1–2 mm range), a second artery stems from the opposite lateral aspect of the artery. The branch is visible but is interrupted soon after it begins, as seen in the same figure. This collateral vessel was present in 11 (92%) of our 12 specimens, and although not mentioned by Özgen and colleagues, it is larger and demonstrates a behavior that differs from that of the other V₃ lateral branches. The vessel exits the foramen with the C-3 nerve root and follows a caudal recurrent course running on and nourishing the extrarapinal portion of the C-3 and C-4 nerve roots (Fig. 2). Eventually, this vessel anastomoses with the ascending cervical artery (which normally arises from the thyrocervical trunk or the inferior thyroid artery) and ascends along the anterior surface of the anterior scalene muscle. Hence, the lateral recurrent branch of C-3, along with its C-4 contribution, is part of an anatomic system between the thyrocervical trunk and the VA. This anastomosis can be occasionally visualized through selective angiographic injection of the ascending cervical artery and may serve as a source of collateral blood flow in stenoocclusive diseases of the VA.³ This artery may also account for the rare cases of anomalous entry of the VA at the C-3 or C-4 level.² In our dissections, this arterial arch received occasional contributions at its superior end from the radicular branches of the ascending pharyngeal and occipital artery.
References

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The authors documented that the the branches of the V₂ segments supplying the anterior spinal canal (defined as the anterior spinal artery [ASA]) were located dorsal to the posterior longitudinal ligament (PLL). I would like to add the benefit of my experience to their description. In several cadaver dissections in this region, I have found the ASAs to be present in the abundant anterior internal vertebral venous plexus, which is identified after blue dye is injected through the jugular vein. The venous plexus is formed between the double-layered PLLs—superficial (dorsal) and deep (ventral) layers—and the artery is situated just dorsal to the deep layer of the PLL (that is, the ventral aspect of the venous plexus cavity). I surmise that the authors would have detected this layer relationship if they had added a venous injection. Interposition of the venous plexus between the ASA and dural tube may be the reason why no branches of the ASA leading to the dural tube were found. Even the most prominent and constantly identifiable ASA at C-3, previously named the anterior meningeal artery¹,² or the posterior ascending artery of the axis,³ has no branches supplying the dura mater until it reaches the level of the foramen magnum, despite its long course. Thus the layers of the anterior spinal canal, viewed anterosuperiorly, consist of the deep layer of the PLL, the ASA, the anterior internal vertebral venous plexus, the superficial layer of the PLL, and the dural tube. This anatomical relationship should be borne in mind in any attempt to expose the dural tube anteriorly so that rational hemostasis can be maintained.

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References