Case Report
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An unusual arrangement between the highest denticulate ligament and posterior inferior cerebellar artery

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Abstract: The posterior inferior cerebellar artery (PICA) is often involved in pathologies of the posterior cranial fossa. Therefore, a good understanding of the vessel's normal and variant courses is important to the neurosurgeon or neurointerventionalist. During the routine microdissection of the craniocervical junction, an unusual arrangement between the highest denticulate ligament and PICA was observed. On the right side, the PICA was given rise to by the V4 segment of the vertebral artery 9 mm after the artery entered the dura mater of the posterior cranial fossa. The artery made an acute turn around the lateral edge of the highest denticulate ligament to then recur 180 degrees and travel medially toward the brainstem. Invasive procedures that target the PICA should be aware of the variant as described herein.

Key words: Artery, Posterior cranial fossa, Ligament, Vertebral artery, Aneurysms

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Introduction

The denticulate ligaments are extensions of the pia mater that extend to the internal aspect of the dura mater and segregate the ventral from the dorsal rootlets of the spinal cord. They also play a role in spinal cord movements [1]. These ligaments attach the lateral aspect of the spinal cord to the internal aspect of primarily, the spinal dura mater. The highest denticulate ligament (intracranial or first denticulate ligament) attaches into the floor of the posterior cranial fossa (Fig. 1) [2]. Here, we describe a case in which a highest denticulate ligament entrapped and compressed the posterior inferior cerebellar artery (PICA).

Case Report

During the routine microdissection (Zeiss) of the craniocervical junction, an unusual arrangement between the highest denticulate ligament and PICA was observed. The specimen was a 94-year-old at death male cadaver that was latex injected and who had died of natural causes. On the right side, the PICA was given rise to by the V4 segment of the vertebral artery (VA) 9 mm after the artery entered the dura mater of the posterior cranial fossa. The vessel measured 0.85 mm in diameter per digital calipers (Mitutoyo).

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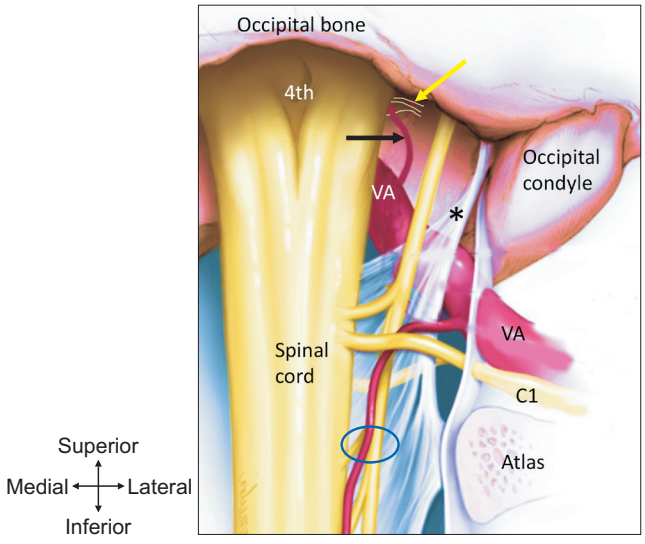

Fig. 1. Schematic drawing of the craniocervical junction (posterior view with the posterior elements of the atlas removed) noting the right-sided highest denticulate ligament (*) and its typical relationships with, for example, the vertebral artery (VA), posterior spinal artery and spinal accessory nerve (circle), and C1 spinal nerve. Note the usual course of the posterior inferior cerebellar artery (arrow) medially toward the brainstem (indicated here by the 4th ventricle) and cerebellum (not shown). The hypoglossal nerve rootlets are seen at the yellow arrow.

As soon as the PICA arose from the vertebral artery, it was noted to take an extreme lateral course toward the entrance site of the VA into the posterior cranial fossa (Fig. 2). With this course laterally, the artery made an acute turn around the lateral edge of the highest denticulate ligament to then recur 180 degrees and travel medially toward the brainstem (Fig. 2). With this course, the artery was tethered by the highest denticulate ligament. At the ligament, the artery was mildly compressed against the floor of the posterior cranial fossa just inferior to the entrance of the V4 segment of the VA (Fig. 2). The distal course of the vessel was normal, and no similar finding was seen on the contralateral side. Additionally, distal to this turn of the PICA around the highest denticulate ligament, the ligament was duplicated into two longitudinally traveling slips with a more or less horizontally traveling part connecting the two slips at the level of the first cervical nerve. Distally to the C1 spinal nerve, the two slips terminated in the dura mater.

The authors state that every effort was made to follow all local and international ethical guidelines and laws that pertain to the use of human cadaveric donors in anatomical research [3].

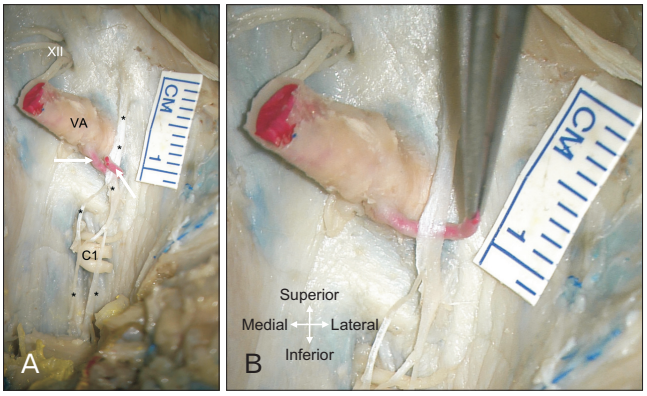

Fig. 2. (A) Right cadaveric findings of the highest denticulate ligament (*) and the variant course of the PICA (arrows). Also note the hypoglossal nerve rootlets (XII) and rootlets of the C1 spinal nerve. (B) Zoomed in view with the PICA retracted laterally with forceps. PICA, posterior inferior cerebellar artery.

Discussion

We describe an unusual case of the PICA traveling around the highest denticulate ligament and found to be mildly compressed by this ligament. Although there were no premortem symptoms that we know of, such an arrangement should be kept in mind my neurointerventionalists who target pathologies of the PICA and neurosurgeons during surgical approaches to the posterior cranial fossa such as tumor resection or aneurysm clipping.

Anatomy

The highest denticulate ligament attaches intracranially and travels between the VA and spinal accessory nerve (Fig. 1) [2]. In some cases, it has been found to attach to the posterior aspect of the VA while it courses toward its lateral attachment into the dura mater of the foramen magnum [2]. The posterior spinal artery classically travels posterior to the highest denticulate ligament, though it has also been noted to travel anterior to it in certain cases. The clinical significance of this ligament lies primarily in its spatial relationship to other essential neurovascular structures.

The PICA arises from the vertebral artery, with varying points of origin. In some cases, it can arise from the basilar artery. The vessel primarily supplies the cerebellum and adjacent brainstem. PICA divides into five segments: the anterior medullary segment, the lateral medullary segment, the tonsillomedullary segment, telovelotonsilar segment, and the cortical segment [4]. PICA's trunk gives rises to choroidal, cortical, and perforating branches [5]. The PICA supplies the

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medulla oblongata, choroid plexus, and the cerebellar hemispheres.

Anatomical variations

The PICA has a high rate of anatomical variability. In some cases, the PICA is smaller than expected and the anterior inferior cerebellar artery will instead supply the area that the PICA customarily would PICA variability is also shown with differentiation in origination site [5]. The PICA originated from the VA in 121 (69.5%) samples and from the basilar artery in 42 (24.1%) samples [6]. In other cases, there was a single PICA in 159 samples (91.4%) and duplicated in 10 (5.7%), while 5 (2.9%) specimens showed hypoplasia [6]. The varying points of origin and anatomical pathways make the PICA vulnerable to injury or damage during surgical interventions. These variabilities also make clinical assessment of injury in patients difficult without knowledge of a patient's particular anatomy.

Clinical/surgical applications

Knowledge of the PICA is clinically relevant in regard to its surgical anatomy *e.g.*, tumors, iatrogenic injury, arteriovenous malformations, and aneurysms and potential for vascular compromise/conflict *e.g.*, stroke, neurovascular compression [5, 7]. PICA is the most common location for a thrombosis related to cerebellar stroke [5]. Lateral medullary syndrome (or Wallenberg's syndrome) results from occlusion of either the PICA or the VA ry which usually gives off the PICA. Symptoms include vertigo, nystagmus, dysphagia, Horner's syndrome, ataxia, pain and numbness, decreased sensation on the face, as well as contralateral loss of pain and temperature sensation. As the highest denticulate ligament is often transected to better visualize more anterior structures of the craniocervical junction, a variant as described in this case report should be taken into consideration so that the PICA blood supply is not compromised.

Neurovascular compression syndrome is a condition in which adjacent blood vessels compress neural structures, either due to pathology such as an aneurysm, or due to the vessel's unique anatomy. PICA has been implicated in various neurovascular compression syndromes, such as glossopharyngeal neuralgia, hemifacial spasm, and medullary compression syndrome [5]. While the PICA has often been the culprit in compressing nearby structures due to its torturous nature and propensity for other pathologies (aneurysm, arteriovenous malformation, etc.), this case is unique. In this case, we describe a PICA that was entrapped and compressed by a bifurcated highest denticulate ligament. To the authors' knowledge, there are no similar cases reported in the literature. Therefore, such a report is of archival value and might be considered when rare PICA compression syndromes are investigated.

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Conceptualization: AP, JB, RST. Data acquisition: AC (Arada Chaiyamoon), JJC. Data analysis or interpretation: AC (Ana Carrera), FR. Drafting of the manuscript: JI, ASD. Critical revision of the manuscript: all authors. Approval of the final version of the manuscript: all authors.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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