

## Extradural Posterior Inferior Cerebellar Artery - Lateral Spinal Artery Type - and Foramen Magnum Meningioma: Case Report

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## 1. Abstract

### 1.1. Background

Being parts of the cranio-cervical junction's crucial anatomical structures, the vertebral artery and the posterior inferior cerebellar artery (PICA) relationships, location and trajectories must be meticulously studied when dealing with foramen magnum tumors, including the possible detection of an unusual C1-C2 extradural origin of PICA.

### 1.2. Clinical Case

In this report we present a patient with the diagnosis of a foramen magnum meningioma. Digital subtraction angiogram (DSA) definitely showed the contribution of the left lateral spinal artery to the vascularization of the lesion and confirmed a left extradural emergence of PICA, at the level of the C1-C2 portion of the ipsilateral vertebral artery. The patient underwent surgery without complications.

### 1.3. Conclusion

The coincidence of an extradural origin of PICA between C1 and C2 with a foramen magnum meningioma is extremely rare. Brain DSA constitutes a key radiological test in providing paramount vascular details when dealing with lesions in this particular region. Surgical planning and technique must take into great consideration this anatomical variation in order to avoid neurological deficits caused by ischemic damage of the medulla oblongata and upper spinal cord related to this vessel's injury.

## 2. Introduction

Posterior inferior cerebellar artery (PICA) is the largest branch of

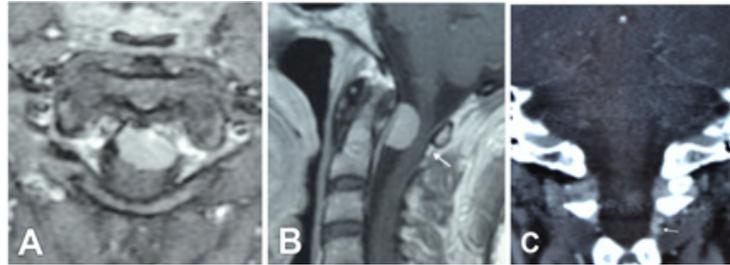
the vertebral artery (VA) and its origin is frequently found above the foramen magnum in more than 80% of the cases. However, from 5 to 20% of the times PICA's origin occurs in the extradural compartment [6], including a rare anatomic variant emerging between the transverse foramen of C1 and C2 [12]. Its coincidence with a foramen magnum meningioma is exceptional and, to our knowledge, has not been previously described. An extradural PICA should be suspected whenever neuroimaging suggests the artery arises below the foramen magnum, especially between C1 and C2. This information must be kept in mind during surgical approaches to this area in order to protect this vessel during extradural dissection and diminish the risk of neurological insult. Therefore, it is essential to optimize preoperative imaging studies so that surgeons may acquire a thorough understanding of the regional neurovascular anatomy. Finally, in this report we review the main developmental anatomy variation of the extradural PICA in relation to the posterior and lateral spinal arterial systems that may be involved in this singular scenario.

## 3. Clinical Case

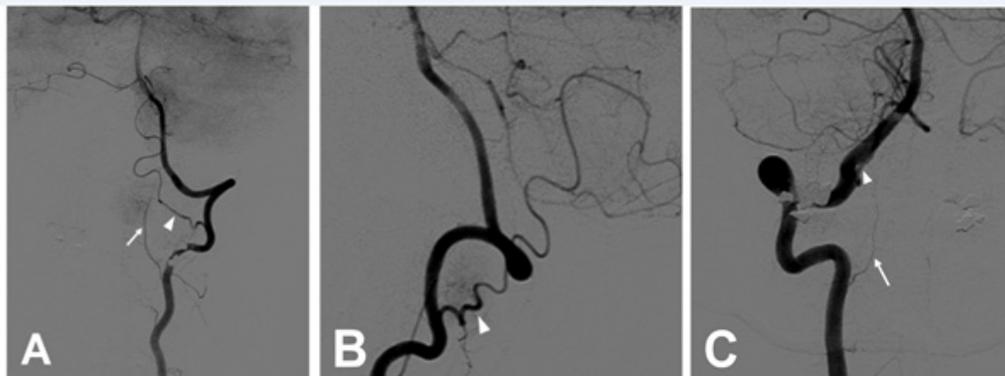
A 46-year-old female, with no remarkable findings in her medical history, presented with progressive neck pain, and only mild generalized hyperreflexia on physical examination. Magnetic resonance imaging (MRI) showed an anterolateral intradural extramedullary lesion in the area of the foramen magnum, suggesting the diagnosis of meningioma (Figure 1A, 1B). An extradural origin of the left PICA was suspected in contrast computed tomography (CT) scan and MRI (Figure 1B, 1C). A brain and spinal digital subtraction angiogram (DSA) was performed, clearly depicting the ori-

gin of left PICA at the lower part of the vertical segment of the non-dominant left vertebral artery, between the C1-C2 transverse foramen. The tumor's main vascular supply was dependent on the left lateral spinal artery (LSA), that displayed a distal thin anastomosis with the ipsilateral PICA. The right vertebral artery was dominant, branching off a typical intradural PICA; it also gave rise to a right LSA, which didn't participate in the vascularization of the lesion. (Figure 2A, 2B, 2C). The patient underwent surgery and a modified left far lateral approach was selected, with careful dissection throughout craniocervical exposure and dural opening

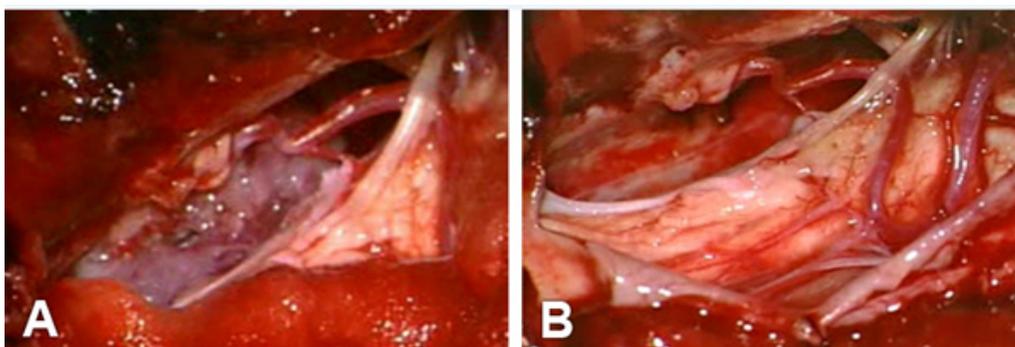
without inadvertent injury to the left vertebral artery and extradural PICA. An anterolateral extramedullary tumor in the foramen magnum was observed and a connection between the left PICA and LSA was revealed. Using standard microsurgical techniques, complete tumor resection was achieved without damage to the surrounding neurovascular structures (Figure 3A, 3B). The postoperative course was uneventful, free from new neurological deficits. The early postoperative MRI demonstrated gross total resection (Figure 4). Histological examination confirmed the diagnosis of a psammomatous meningioma (WHO Grade I).



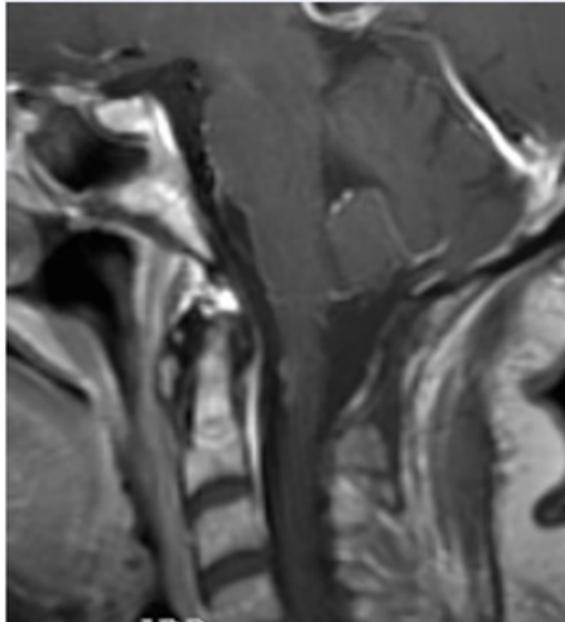
**Figure 1:** Preoperative axial A) and sagittal B) contrast enhanced T1-weighted MRI (T1W1) and CT with coronal reconstruction C) showing a foramen magnum meningioma, with the suspicious of the presence of an extradural PICA (arrow).



**Figure 2:** Preoperative angiograms of the left and right vertebral arteries. A and B). PA and lateral view, respectively, with visualization of extradural PICA (white arrowhead) from non-dominant left vertebral artery (V2 segment) and a LSA (white arrow) which was involved in the vascularization of the tumor. C) PA view showing a right dominant vertebral artery and LSA (white arrow).



**Figure 3:** Intraoperative pictures. A) Intradural tumor exposure with PICA and LSA connection. B) Preservation of transient vessels, including the PICA-LSA connection, after complete resection of the mass.



**Figure 4:** Sagittal contrast enhanced T1-weighted MRI (T1W1) after surgery demonstrating complete tumor removal.

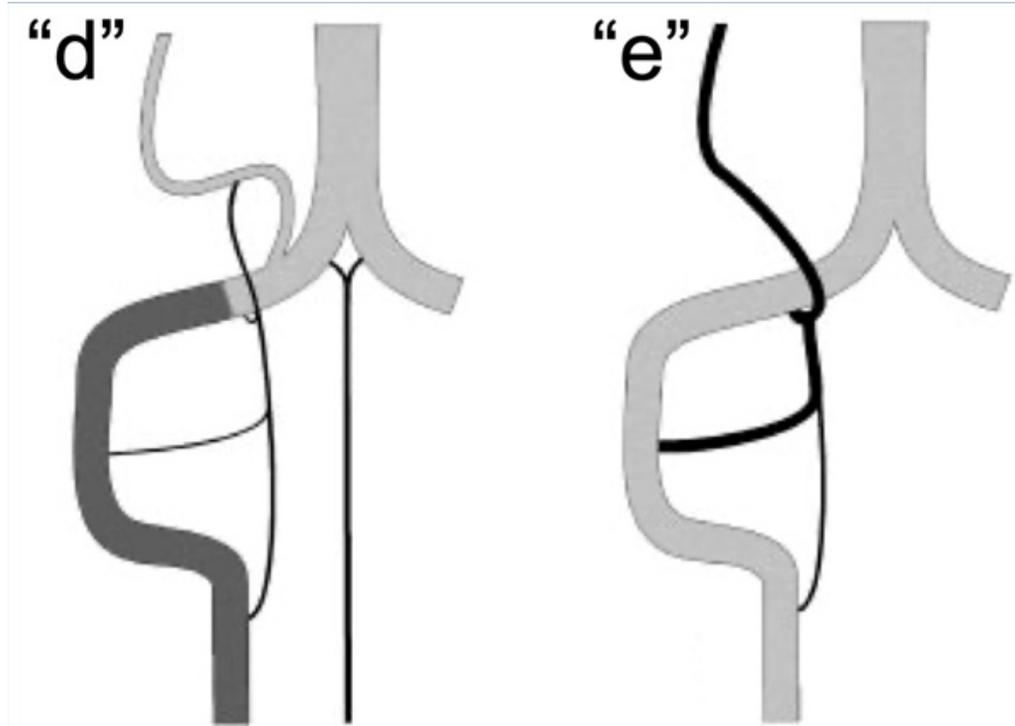
#### 4. Discussion

PICA is the most complex branch of the vertebral artery and usually originates from the intradural segment of the vertebral artery (V4). Nonetheless, in up to 15-20% of the times, it may occur at the extradural compartment. Rhoton described the origin of PICA from the V3 segment, which is the extradural portion from the transverse foramen of the atlas to the point where it crosses the dura in the foramen magnum [9]. Fine et al described four types of PICA depending on their origin; extradural just before the entry of the dura, somewhat more laterally over the transverse foramen of the atlas, in the vertical segment between C1 and C2 and the typical intradural origin [1]. Even though their distinct frequency is not well known [11], PICA's emergence between the transverse foramen of C1 and C2, such as in the presented case, is quite unusual, with an approximate prevalence of only 1.1%. In a literature review, Wang et al collected 54 cases in which the origin of PICA was at the extradural level between C1 and C2 [12]. Isaji et al reported the origin of PICA from segment V3 was significantly more frequent in the non-dominant vertebral artery than in the dominant one [2], and in any situation did they observe the exit of the PICA below the atlas (segment V2) as illustrated in our patient, where, in addition, PICA arose from the non-dominant vertebral artery. On the other hand, Lasjaunias suggested that LSA congenital variations would be the cause of anatomic variants such as the C1 and C2 origins of the PICA [4], proposed that these kind of variants result from modifications in the development of the posterior spinal artery (PSA) rather than the LSA<sup>[10]</sup>, describing two types of extradural PICA, the PSA type and the LSA type. Foramen magnum meningiomas are infrequent [7], and, for surgical planning purposes, PICA and its branches are perhaps the most crucial vascular structures to take into account [6]. In this regard, Contrast-CT scan

(specifically CT angiography) and MRI show the relationship of the neurovascular structures of the cranio-cervical junction with the tumor, and aids in the identification of the vertebral artery and PICA [2]. But ultimately, it's brain DSA the one that offers unique and more accurate information about PICA's blood supply to the brainstem, cerebellum, and the tumor itself; and opens up the possibility to perform preoperative embolization. Furthermore, it clearly demonstrates anatomic variations of the vertebral arteries (including dominance pattern), and distinct aspects of their branches such as the presence of an LSA and/or PICA's collateral circulation. In our case, preoperative contrast CT and MR angiography made us suspect of the presence of an extradural PICA, confirmed after the performance of a brain DSA which allowed not only the visualization of PICA's origin and trajectory, but also the presence of both LSAs (coming from each vertebral artery respectively), and, finally, the vascularization of the tumor. In this regard, in the anteroposterior view of the DSA, the arterial branch from the left vertebral artery supplying the meningioma and penetrating the dura at C2-C3 seemed to correspond to the LSA, which, in turn, anastomosed with the extradural PICA; therefore resembling the type "e" of PSA and LSA systems described by Lasjaunias [4] and Siclari [10]. This was additionally supported by the absence of PSA type features such as the presence of a separate LSA, a hairpin turn of its proximal segment and a posterior location of PICA at the level of foramen magnum [3], that were not distinguished on the lateral view of DSA. In a different manner, the right vertebral artery displayed the LSA and an intradural PICA similar to a type "d" configuration (Figure 5) [10]. Lasjaunias [5]. Stated that extracranial emergence of PICA does not send perforating arteries to the lateral surface of the brain stem (they would emerge from the vertebral artery itself), a situation that could prevent the occurrence of a lateral medullary syndrome after the occlusion of

an extradural PICA [6]. Nonetheless, its injury can cause important ischemic sequelae such as swallowing disorders, dysarthria, disorders of the autonomic system and altered sensitivity, since, according to Fine, despite not sending perforating branches to the anterior surface of medulla oblongata, an extradural PICA can still contribute to the lateral and posterior supply of medulla oblongata [8]. As depicted in brain DSA, a close contact of the extradural

PICA with the tumor was demonstrated during surgery, as well as PICA's anastomosis with the left LSA, whose participation in the tumor and spinal cord supply respectively was born in mind throughout microsurgical dissection, leading to the preservation of both PICA and LSA as originally intended, consequently avoiding postoperative iatrogenic ischemic lesions at the medulla and upper spinal cord.



**Figure 5:** Schematic representation of the normal anatomy of the LSA type “d” and the variation observed in this case, “e”. Adapted and edited from Siclari F, Burger IM, Fasel JHD, Gailloud P. Developmental Anatomy of the Distal Vertebral Artery in Relationship to Variants of the Posterior and Lateral Spinal Arterial Systems. *Am J Neuroradiol.* 2007;28(6):1185-90.

## 5. Conclusion

All things considered and to the author's knowledge, the coexistence of a meningioma of the foramen magnum with a PICA-LSA type hasn't been reported before. We have highlighted some anatomic remarks regarding the presence of an extradural PICA-LSA type and its impact in surgical planning. It becomes relevant for the clinicians to be aware of the possibility of this anatomical variation when evaluating neuroimaging data of a patient harboring a tumor in this site. We believe, in this subset of patients, it is mandatory to perform a brain DSA that can provide key information to take notice of during surgical exposure at the craniocervical junction, so that the risk of vessel injury is decreased, avoiding neurological deficits.

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