

Anastomosis between an extracranial C1/2-origin left posterior inferior cerebellar artery and the V4 segment of the vertebral artery diagnosed by magnetic resonance angiography

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Research Article

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Abstract

Purpose

To describe a case of a congenital anastomosis between the posterior inferior cerebellar artery (PICA) arising from the vertebral artery (VA) at the extracranial C1/2 level and the V4 segment of the VA, forming a large arterial ring involving the V3–V4 segments.

Methods

Magnetic resonance imaging (MRI), including magnetic resonance angiography (MRA), was performed in a 64-year-old man presenting with right lower-extremity weakness for evaluation of suspected cerebrovascular disease. MRI was performed using a 3-T scanner, and MRA was performed using the standard three-dimensional time-of-flight technique.

Results

MRI revealed no evidence of acute cerebral infarction. MRA demonstrated that the left PICA originated from the extracranial VA at the C1/2 level. A short but large anastomotic artery was identified between the left PICA and the V4 segment of the left VA, forming a large arterial ring involving the V3–V4 segments. The right VA and right PICA were normal in appearance. Other findings included a small aneurysm of the right internal carotid artery (ICA) and stenosis of the left ICA at its origin.

Conclusion

To our knowledge, this is the first reported case of an anastomosis between an extracranial C1/2-origin PICA and the V4 segment of the VA diagnosed by MRA. Although a tiny anastomosis between these arteries may be detected by catheter angiography or cadaveric dissection, it may not be visualized on MRA because of its limited spatial resolution. In the event of occlusion of one channel of the arterial ring, the other channel and the anastomotic artery may serve as important collateral pathways.

Introduction

The posterior inferior cerebellar artery (PICA) usually arises from the V4 segment of the vertebral artery (VA), but its origin and course show several anatomical variations. Among these variations, PICAs originating from the VA at the extracranial C1/2 level are relatively rare, with a reported prevalence of approximately 1% [3, 10, 11]. Using catheter angiography, Dahl et al. [1] reported a case of a tiny, long anastomotic vessel between a C1/2-origin PICA and the V4 segment of the VA.

We herein report an extremely rare arterial variation consisting of a C1/2-origin PICA and a short but large anastomotic vessel connecting it to the V4 segment of the VA, forming a large arterial ring involving the V3–V4 segments. To the best of our knowledge, such a variation has not been previously reported on magnetic resonance angiography (MRA) in the English-language literature.

Case report

A 64-year-old man presented to a local hospital with weakness of the right lower extremity. Magnetic resonance imaging (MRI) revealed no evidence of acute cerebral infarction. However, MRA demonstrated a small aneurysm of the right internal carotid artery (ICA) and stenosis of the left ICA at its origin. He was managed conservatively with antihypertensive therapy. However, he subsequently developed numbness in both lower extremities and was transferred to our university hospital. Emergency cerebral angiography revealed severe stenosis of the left ICA at its origin, and carotid artery stenting was subsequently performed. Left vertebral angiography was not performed.

MRI and MRA were performed to evaluate the postoperative status of the brain and cerebral arteries. The MRI examinations were performed using an Achieva TX 3.0T scanner (Philips Medical Systems, Best, The Netherlands). MRA was performed using the standard three-dimensional time-of-flight technique. The following imaging parameters were used: flip angle, 17.0°; repetition time, 22.0 ms; echo time, 3.45 ms; slice thickness, 1.3 mm; number of slices, 384; slab thickness, 499.2 mm; field of view, 23.0 × 25.2 cm; and imaging matrix, 512 × 512. Maximum-intensity-projection (MIP) images were reconstructed from the source images and evaluated.

MRI revealed no evidence of acute cerebral infarction. MRA demonstrated a small aneurysm of the right ICA and a patent stent at the origin of the left ICA. The left PICA originated from the extracranial VA at the C1/2 level and gave rise to a short but large anastomotic branch connecting it to the V4 segment, forming a large arterial ring involving the V3–V4 segments (Fig. 1). Partial volume-rendering (VR) images of the vertebrobasilar system were reconstructed, which clearly demonstrated this anatomical variation. The right VA and PICA showed normal configurations (Fig. 2).

The patient had an uneventful clinical course without treatment of the small right ICA aneurysm. Follow-up MRA was performed, and the aneurysm showed no change. Computed tomography angiography (CTA) was not performed. Follow-up left carotid angiography was performed, but left vertebral angiography was not performed.

Discussion

Variations in the origin and course of the PICA are well recognized and include an extradural (V3) VA origin, a basilar artery origin, absence, duplication, duplicate origin, a VA terminating in the PICA, and an intradural origin with an abnormal course below the foramen magnum [8]. Recently, Triantafyllou et al. [8] classified V3-origin PICAs into three types: (1) inferior to the foramen magnum, (2) VA groove (C1 segmental type), and (3) C2 segmental type. The C2 segmental type PICA arises from the extracranial VA at the C1/2 level (Fig. 3a). Using MRA, the second author previously reported a prevalence of 1.1% for this variation [10]. Using CTA, Kim [3] and Wakao et al. [11] reported prevalences of 0.96% and 1.3%, respectively. According to a meta-analysis by Triantafyllou et al. [9], the pooled prevalence of V3-origin PICAs, including the three types described above, was 2.69%.

Arterial variations are formed by abnormal regression, fusion, or persistence of the primitive arterial network during early embryonic development. Lasjaunias et al. [5] initially reported that a C1/2-origin PICA may be formed by variations in the size and connections of the lateral spinal artery (LSA) system. Later, Siclari et al. [7] reported two types of C1/2-origin PICA: the LSA type and the posterior spinal artery (PSA) type. A VA that enters the spinal canal through the C1/2 intervertebral space rather than through the foramen magnum is regarded as a C2 segmental-type VA [4]. This VA variation was previously considered to represent a persistent first intersegmental artery [10, 11]. However, it is now thought to result from the same embryological developmental failure as a C1/2-origin PICA. If a VA with this anomalous course is accompanied by a VA with a normal course and the two vessels fuse at the V4 segment, a large arterial ring involving the V3–V4 segments is formed (Fig. 3b). Using MRA, the prevalence of this variation was reported to be 0.9% [10]. Using CTA, Kim [3] and Wakao et al. [11] reported prevalences of 0.64% and 1.3%, respectively. Using CTA, Kim [4] subsequently reported a prevalence of 1.4% for a large arterial ring involving the V3–V4 segments and a prevalence of 2.2% for the C2 segmental-type VA without a normally coursing VA (Fig. 3c).

According to a review article by Polguj et al. [6], fenestration is defined as a short segment of a vessel in which the lumen is divided into two separate channels that subsequently fuse during their course, thereby restoring a single vessel. Each trunk has its own tunica muscularis and is lined by a separate layer of endothelium. The adventitia may be shared between the channels. In contrast, duplication of the VA is usually characterized by a large duplicated vessel with two origins that fuse at different levels. There are three types: (1) duplicate origin, (2) segmental duplication, and (3) distal-end duplication. The arterial ring involving the V3–V4 segments can be regarded as a form of segmental duplication. However, segmental duplication has frequently been reported as fenestration [10, 11].

Using CTA, Kim [4] reported a case of a PICA arising from a large C2 segmental-type VA that fused with a small VA with a normal course. In contrast, our patient had a C1/2-origin PICA and a large VA with a normal course, with a short but large connecting vessel between these two arteries that was identified by MRA (Fig. 3d). In both cases, a large arterial ring involving the V3–V4 segments was present, and the PICA arose from the arterial ring. However, the dominant artery differed between the two cases. Using catheter angiography, Dahl et al. [1] reported a case of a tiny, long anastomotic vessel between a C1/2-origin PICA and the V4 segment of the VA. Tiny arteries may be detected by catheter angiography or cadaveric dissection. In contrast, because of their limited spatial resolution, CTA and MRA may not identify such tiny arteries.

Recognition of this variation may have clinical significance. Extracranial C1/2-origin PICAs have been reported in association with Bow Hunter syndrome caused by rotational compression of the anomalous artery [2]. Aneurysms arising from C1/2-origin PICAs have rarely been reported [1]. Because anomalous vessels around the craniovertebral junction may influence surgical or endovascular management, careful evaluation of the vascular anatomy is important before treatment. In our patient, an anastomotic channel was present between the C1/2-origin PICA and the V4 segment of the VA, forming a large arterial ring. In

the event of occlusion of one channel of the arterial ring, the other channel and the anastomotic artery may serve as important collateral pathways.

Conclusions

We herein described a case of an extracranial C1/2-origin PICA with a connecting branch to the V4 segment of the VA, forming a large arterial ring involving the V3–V4 segments, as demonstrated by MRA. This unusual configuration has rarely been reported previously. Although a tiny anastomosis between these arteries may be detected by catheter angiography or cadaveric dissection, it may not be visualized on MRA because of its limited spatial resolution. In the event of occlusion of one channel of the arterial ring, the other channel and the anastomotic artery may serve as important collateral pathways.

Declarations

Conflict of interest

The authors declare no competing interests.

Ethical approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Consent for publication

The patient gave his written informed consent for the publication of his data and figures.

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Author Contribution

AT and AU designed the study and drafted the manuscript. AT, AU, YU and SK critically reviewed the manuscript and read and approved the final manuscript.

Data availability

Not applicable.

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Figures

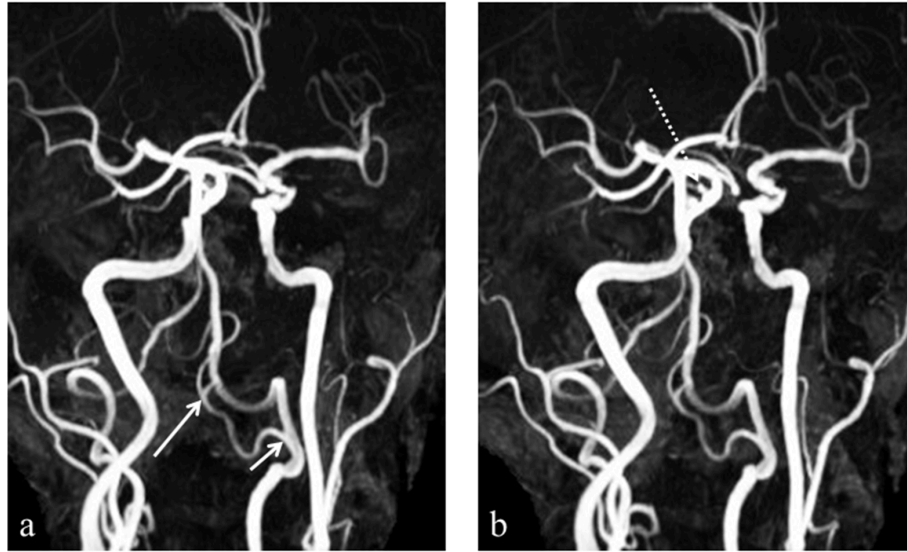


Fig.1

Figure 1

(a, b) Slightly right anterior oblique stereoscopic projections of maximum-intensity-projection images of magnetic resonance angiography.

The left posterior inferior cerebellar artery (PICA) originates from the V3 segment of the left vertebral artery (VA) at the C1/2 level (*short arrow*) and gives off a short anastomotic branch to the V4 segment (*long arrow*), forming a large arterial ring between the V3 and V4 segments. The *dotted arrow* indicates a small aneurysm of the right internal carotid artery. Left carotid artery stenting was performed at a more proximal segment than that covered by the imaging slab.

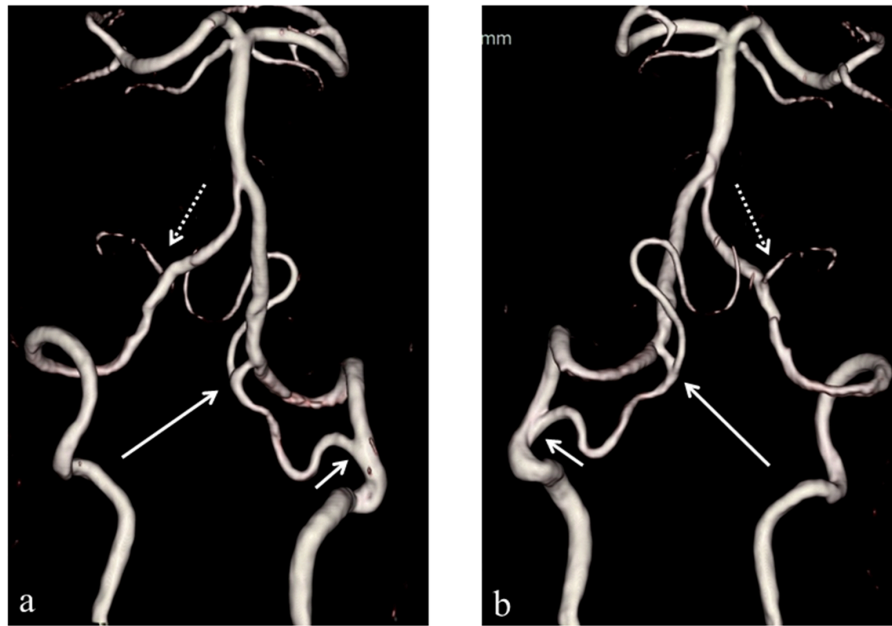


Fig.2

Figure 2

Anteroposterior (**a**) and posteroanterior (**b**) projections of partial volume-rendering images of the vertebrobasilar system.

The left PICA originates from the V3 segment of the left VA at the C1/2 level (*short arrows*). A short anastomotic vessel is present between the PICA and the V4 segment of the left VA (*long arrows*), forming a large arterial ring between the V3 and V4 segments. The right PICA normally originates from the normally coursing V4 segment of the right VA (*dotted arrows*).

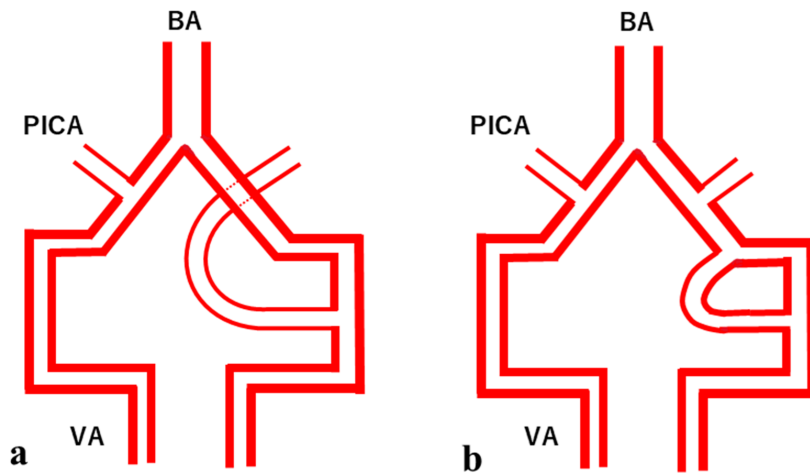


Fig.3a,b

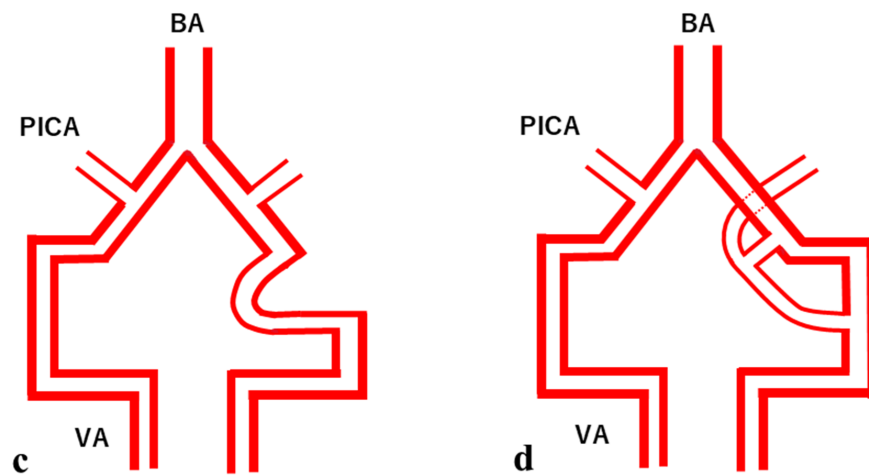


Fig.3c,d

Figure 3

Schematic illustrations of arterial variations of the vertebrobasilar system around the craniovertebral junction in the anteroposterior projection.

(a) C1/2-origin PICA. The left PICA originates from the V3 segment of the left VA and enters the spinal canal through the C1/2 intervertebral space (C2 segmental type [8]). (b) VA segmental duplication of the

V3–V4 segments. The left VA bifurcates at the C1/2 level and fuses at the proximal V4 segment, forming a large arterial ring. **(c)** C2 segmental-type VA. The left VA enters the spinal canal through the C1/2 intervertebral space. There is no normally coursing left VA. **(d)** Left VA variation observed in the present case. The left PICA originates from the V3 segment of the left VA at the C1/2 level (C2 segmental type [8]). A short anastomotic artery is present between the left PICA and the V4 segment of the left VA, forming a large arterial ring between the V3 and V4 segments.

BA, basilar artery; PICA, posterior inferior cerebellar artery; VA, vertebral artery.