

MR Angiography Imaging of Absence Vertebral Artery Causing of Pulsatile Tinnitus: A Case Report

Imagen Angiográfica através de RM de la Ausencia de Arteria Vertebral
Causante de Tinitus Pulsatil: Reporte de Caso

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SUMMARY: Absence of the vertebral artery is rare, and incidentally encountered in radiological imaging technics. We reported a 74 years old man suffering from pulsatile tinnitus with absence of the left vertebral artery. The purpose of the case report is the description absence of the vertebral artery causing of pulsatile tinnitus, in order to offer useful data to anatomists, otorhinolaryngologist, radiologists, vascular, head and neck surgeons.

KEY WORDS: Arterial agenesis; Vertebral artery; Anatomical variations; MR angiography.

INTRODUCTION

Pulsatile tinnitus (PT) usually originates from vascular structures within the cranial cavity, head, and neck region, and the thoracic cavity either by increased blood flow or lumen stenosis. Pulsatile tinnitus can be classified either as arterial or venous according to the vessel of origin, and differentiation between these two types can be made easily by applying light digital pressure over the ipsilateral internal jugular vein (IJV). This maneuver has no effect on the intensity of the arterial type, whereas it makes the venous type subside immediately. Venous PT can originate not only from primary venous anomalies, but also from conditions causing increased intracranial pressure and transmission of arterial pulsations to the dural venous sinuses (Sismanis, 1987). Classification of PT as objective or subjective is based on whether it is audible by both patient and examiner or only by the patient. Nonvascular PT is very rare and originates from sources other than vascular. But in our case, there was no bruit in neck and post-auricular area in his consultation with a stethoscope. And, lumen of IJV, common carotid artery and its branches were clear open in his cranial MR angiography. The remarkable point in our case was only absence of left vertebral artery.

Absence or hypoplasia of the terminal portion of one vertebral artery (VA) is a commonly observed anatomic variant. In such instance, the VA either shows a very small connection to an otherwise normal basilar artery (BA) continues its course as the posterior inferior cerebellar artery (PICA). In our case report, the BA was normal and receives most or all of its blood supply from the contralateral VA. On the other hand, absence all segments of the left VA was exceptional. Magnetic resonance angiography findings of the case were demonstrated absence the left VA causing of pulsatile tinnitus.

The VA is classically divided into 4 segments (Cavdar *et al.*, 1996; Güvencer *et al.*, 2006; Heary *et al.*, 1996). The first segment starts from its origin on the subclavian artery to the C6 transverse process, the second from C6 to C2 transverse process, third from C2 to the foramen magnum, and the fourth from the foramen magnum dura to vertebrobasilar junction. Close to their origin, each VA ascends between the longus colli and scalenus anterior muscles, posterior to the common carotid artery and vertebral vein. At this level, each artery is situated anterior to the transverse process of C7, the

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cervicothoracic (or inferior) sympathetic ganglion and ventral rami of C7 and C8 (Figs. 1a,1b). It then passes through the foramen transversarium of C6 with a branch from the inferior sympathetic ganglion and vertebral venous plexus and ascends almost vertically through the foramina transversaria of C5 to C2, anterior to the ventral rami of C6 to C2 (Figs. 2a,2b). From the foramen transversarium of C2 (axis) the VA passes laterally to enter the foramen transversarium of C1 (atlas) (Figs. 3a,3b). Each artery lies medial to rectus capitis lateralis and curves postero-medially behind the lateral mass of C1, thereby leaving the first cervical ventral spinal ramus medial to it. Each vertebral artery then lies in the groove on the superior surface of the posterior arch of C1 and enters the vertebral canal below the inferior border of the posterior atlanto-occipital membrane. At this level the artery is covered by semispinalis capitis in the subcostal triangle and the dorsal ramus of C1 lies between the vertebral artery and the posterior arch. The vertebral artery subsequently pierces the dura and arachnoid mater, ascends into the skull through the foramen magnum and passes anterior to the roots of the hypoglossal nerve (XII cranial nerve). Once through the foramen magnum, the left and right vertebral arteries join at the lower pontine border and form the basilar artery (Figs. 4a,4b).

Vertebral segmental agenesis is seldom reported (Lasjaunias *et al.*, 2001). A rete vertebralis is rare in animals (Du Boulay & Verity, 1973). Hyogo *et al.* (1996) and Karasawa *et al.* (1997) reported cases in Asian individuals. Although, Hachem *et al.* (2008) and Woodcock *et al.* (2001) reported a case of bilateral vertebral arteries agenesis. Kao *et al.* (2003) reported a case of unilateral vertebral artery agenesis.

We hypothesize on the possible factors causing of pulsatile tinnitus can be only explained with absence the left vertebral artery caused of inadequate vertebrobasilar circulation. And, the introduction of MR-angiography has enabled better and more precise detection of vascular variants without invasive angiography.

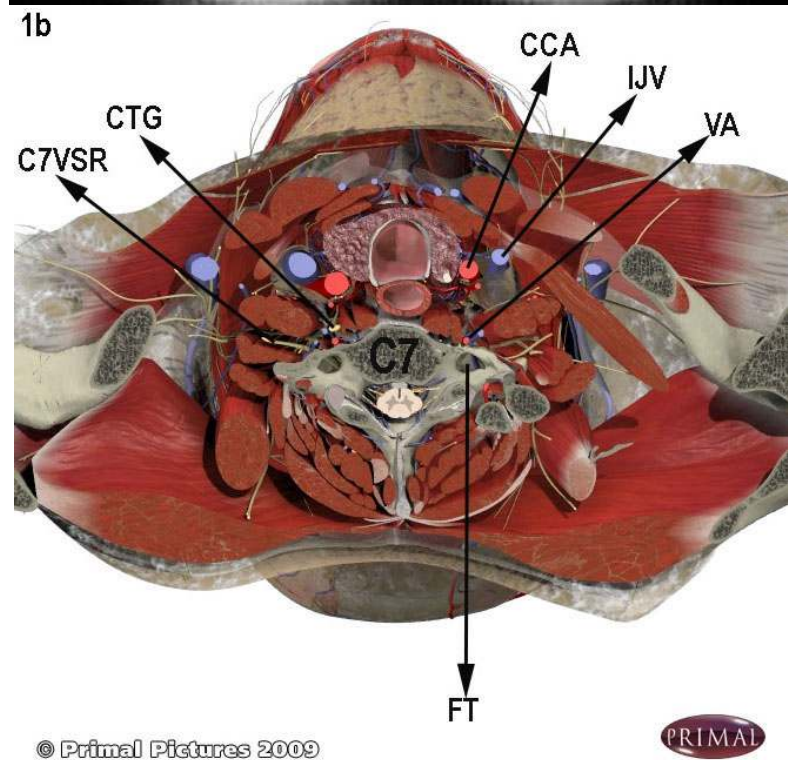
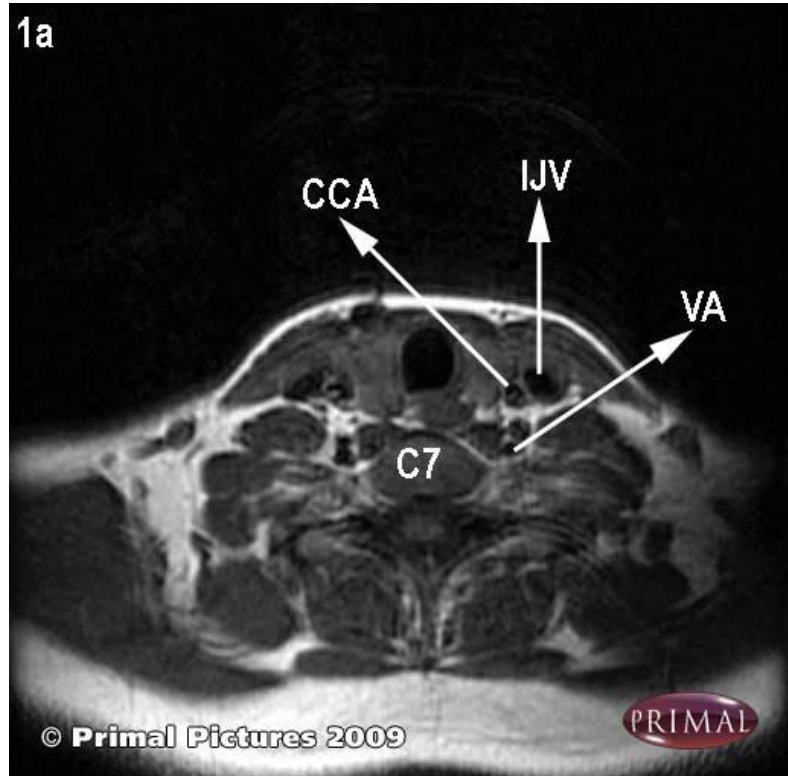


Fig. 1a, 1b. MR angiography and schematic section of head in axial model at the level of C7 vertebrae (permission by Primal Pictures 3D Anatomy). (C7: seventh cervical vertebrae, VA: vertebral artery, IJV: internal jugular vein, FT: foramen transversarium, CCA: common carotid artery, CTG: cervicothoracic ganglion, C7VSR: seventh cervical ventral spinal ramus).

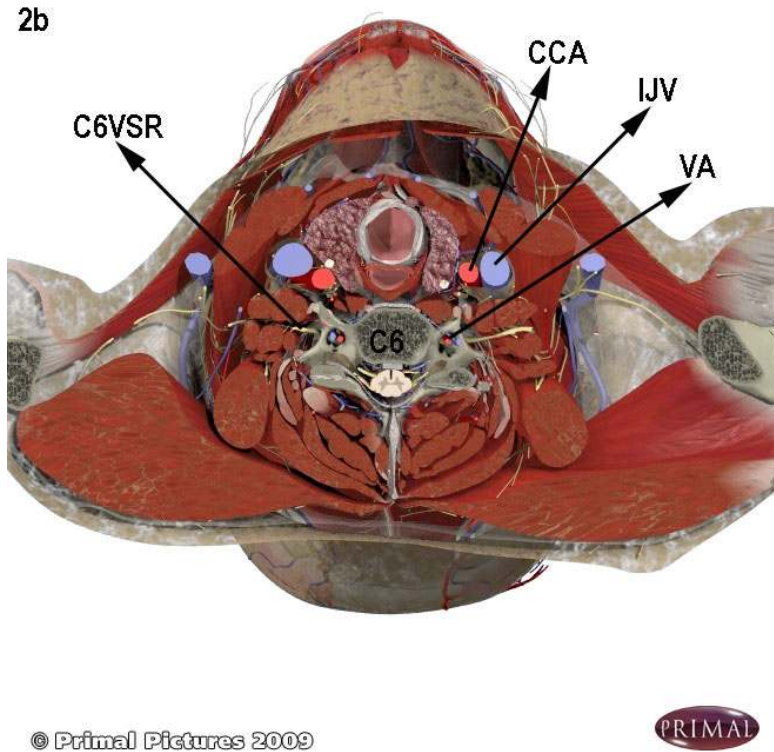
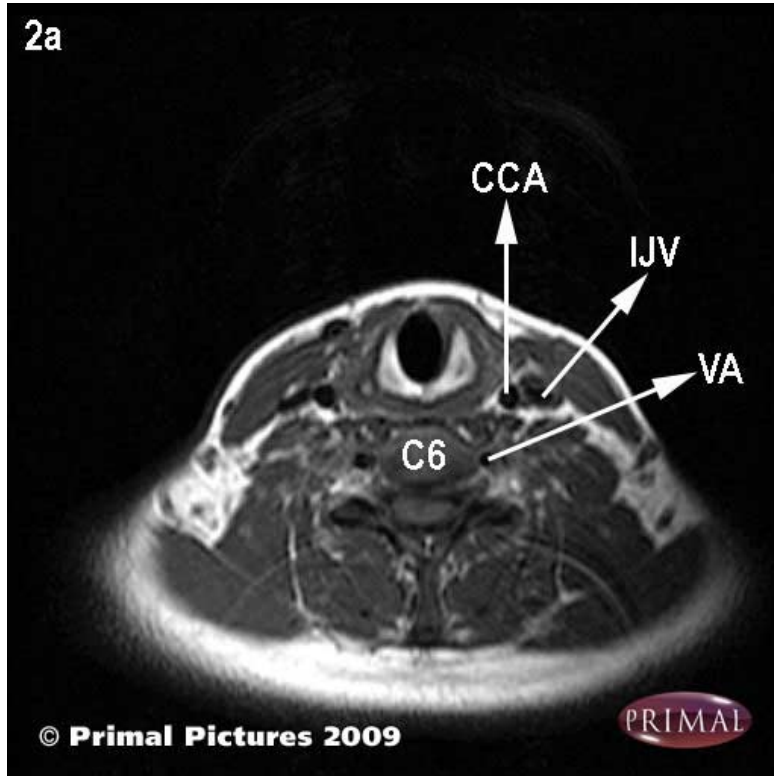


Fig. 2a, 2b. MR angiography and schematic section of head in axial model at the level of C6 vertebrae (permission by Primal Pictures 3D Anatomy). (C6: sixth cervical vertebrae, VA: vertebral artery, IJV: internal jugular vein, CCA: common carotid artery, C6VSR: sixth cervical ventral spinal ramus).

CASE REPORT

A 74-year-old man presented at our hospital with a pulsatile tinnitus on the left side. He suffered from acute pulsatile tinnitus in his left ear for ten years. At first, routine medical tests were performed respectively. Temporal bone CT, tympanogram and audiological findings were within normal clinical boundaries. Radiography revealed no bony lesion of the cervical vertebrae. And, we had listened to patient's head (especially the post-auricular area), and neck with a stethoscope. There was no bruit in neck and post-auricular area in his consultation. In his cervico-cranial MR angiography, IJV, common carotid artery and its branches were clear and open. There was no dural arteriovenous fistulae. In addition, the patient had no cardiac, neurologic and vascular illness. On the other hand, MR angiography represented absence of the left vertebral artery (Fig. 5a). Once through the foramen magnum, the left vertebral artery at the lower pontine margin continues as the basilar artery. (Fig. 5b) There was no clinical findings that caused pulsatile tinnitus medically, except for absence of the left vertebral artery. Upon observing the single arterial supply to the basilar system of the brain. We realized that inadequate vertebrobasilar circulation could cause pulsatile tinnitus. Therefore, the patient was discharged from the hospital after administration of betahistin di hydrochloride and trimetazidine for a long time. After one month, when we checked up on the patient again, we confirmed that pulsatile tinnitus had reduced the intensity. But, it had not disappeared entirely.

DISCUSSION

There are lots of arterial etiological factors causing pulsatile tinnitus. Atherosclerotic carotid artery disease (ACAD) is a common cause of PT in patients older than 50 years of age, especially when associated with certain risk factors, such as atherosclerosis, hypertension, angina, hyperlipidemia, diabetes mellitus, or smo-

king. Objective PT can be the first manifestation of ACAD in these patients (Sismanis *et al.*, 1994). PT in such cases is secondary to bruits produced by turbulent blood flow at stenotic segments of the carotid artery. In our case, there was no bruit in common carotid arteries and its branches in his medical consultations. And, MR angiography confirmed that these vessels had clear open lumen and no atherosclerosis. It was an unexpected situation in clinical boundaries. In intracranial vascular abnormalities, the most common abnormality has been dural arteriovenous fistulae (AVFs). Aneurysms, with the exception of dissecting aneurysms of the internal carotid and vertebral arteries, do not present with PT. On the other hand, we didn't observe AVFs in our case. The transverse and sigmoid dural sinuses are the most common sites involved, followed by the cavernous sinus (Carmody, 2000). In contrast to AVMs, AVFs are usually acquired and thought to result from dural venous sinus thrombosis. Thrombosis may be spontaneous or secondary to trauma, obstructing neoplasm, surgery, and infection. As the thrombosed segment recanalizes, ingrowth of dural arteries takes place and artery-to-sinus anastomoses are formed (Carmody). PT in these patients is of the arterial type and is associated with a bruit over the involved dural sinus and objective PT. But, all dural sinuses were normal anatomical coursing, and also had no dural venous sinus thrombosis. Though, there were reported lots of arterial etiological factors causing pulsatile tinnitus. We have not observed absence of the vertebral artery as an arterial etiological factors in pulsatile tinnitus.

Segmental agenesis does not usually compromise the supply to the brain, and is exceptionally described in children despite the embryonic nature of the disorder. It may sometimes be associated with severe disorders such as PHACES, which can include complete or segmental agenesis of the carotid or vertebral artery, with persistent trigeminal, hypoglossal or proatlantal arteries (Bhattacharya *et al.*, 2004). The incidence of congenital atresia or hypoplasia of the left vertebral artery is 3.1%, and of the right ver-

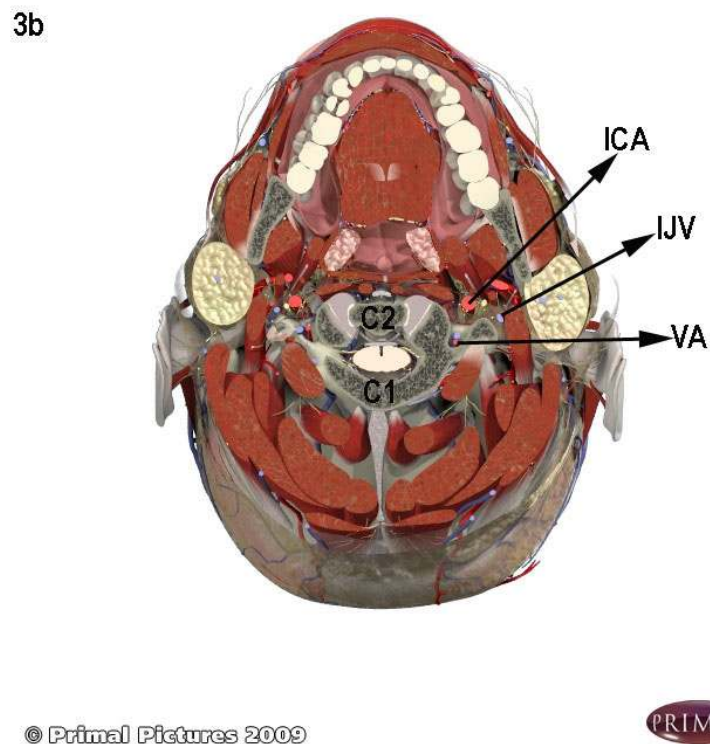
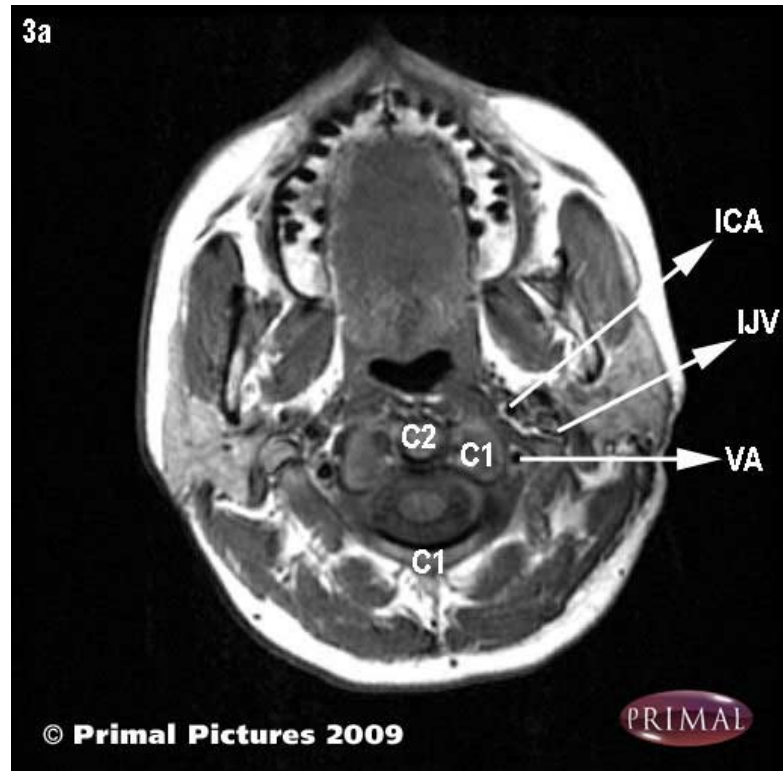
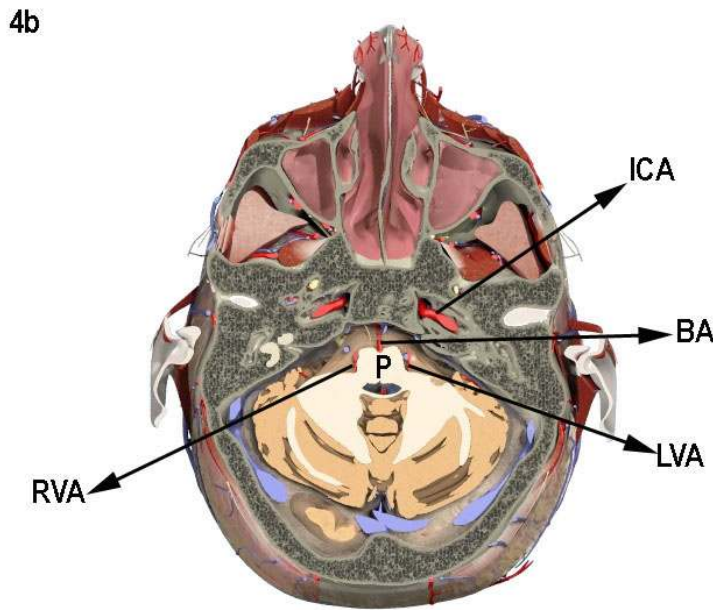
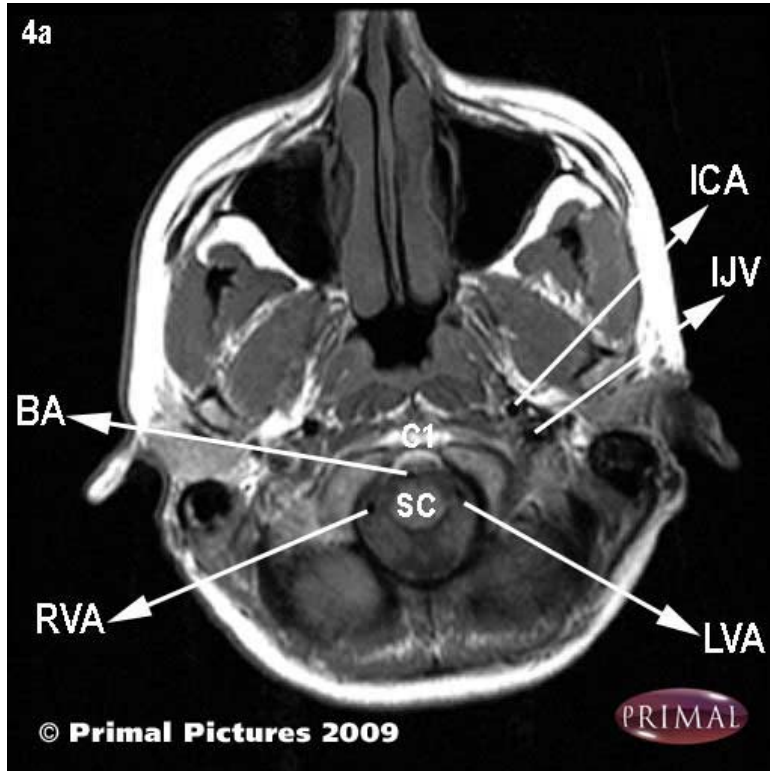


Fig. 3a, 3b. MR angiography and schematic section of head in axial model at the level of C1 and C2 vertebrae (permission by Primal Pictures 3D Anatomy). (C1: first cervical vertebrae, C2: second cervical vertebra, VA: vertebral artery, IJV: internal jugular vein, ICA: internal carotid artery).



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Fig. 4a, 4b. MR angiography and schematic section of head in axial model at the level of cervical spinal cord and pons respectively (permission by Primal Pictures 3D Anatomy). (SC: spinal cord, C1: first cervical vertebrae, RVA: right vertebral artery, LVA: left vertebral artery, IJV: internal jugular vein, ICA: internal carotid artery, BA: basilar artery, P: pons).

tebral artery it is 1.8% (Blickenstaff *et al.*, 1989).

Woodcock *et al.* reported a case report of bilateral proatlantal arteries, both vertebral arteries were absent. Similarly, Hachem *et al.*, presented a case report of the absence of cervical segments of both vertebral arteries. MR-angiography performed on a 3T machine confirmed the bilateral absence of cervical segments and the presence of normal intracranial segments arising from the occipital arteries, branches of the external carotid arteries. On the other hand, Kao *et al.* described the case of a 40-year-old woman who presented with a large aneurysm of the left VA in the angiographic absence of a right vertebral artery. In our case, MR-angiography confirmed absence of the left vertebral artery. It continued as the basilar artery at the lower pontine margin. The mean branches of cerebral arterial circle consisted of only the right VA and both internal carotid arteries.

Agenesis of the VA without a rete is even more rare than absence of the cavernous internal carotid artery; it seems to occur at the junction of extradural and intradural portions. However the anomaly of the VA at C1/2 with collateral circulation has been described (Du Boulay & Verity). Hyogo *et al.*, first reported a bilateral vertebral “rete mirabile” with a network supplying the distal VA bilaterally, becoming the “vertebral rete mirabile”.

To our knowledge, there has been no previous report of absence of VA causing of acute pulsatile tinnitus. In addition to the various arterial PT etiologies that were reported so far. Absence of VA which may cause pulsatile tinnitus should be taken into consideration.

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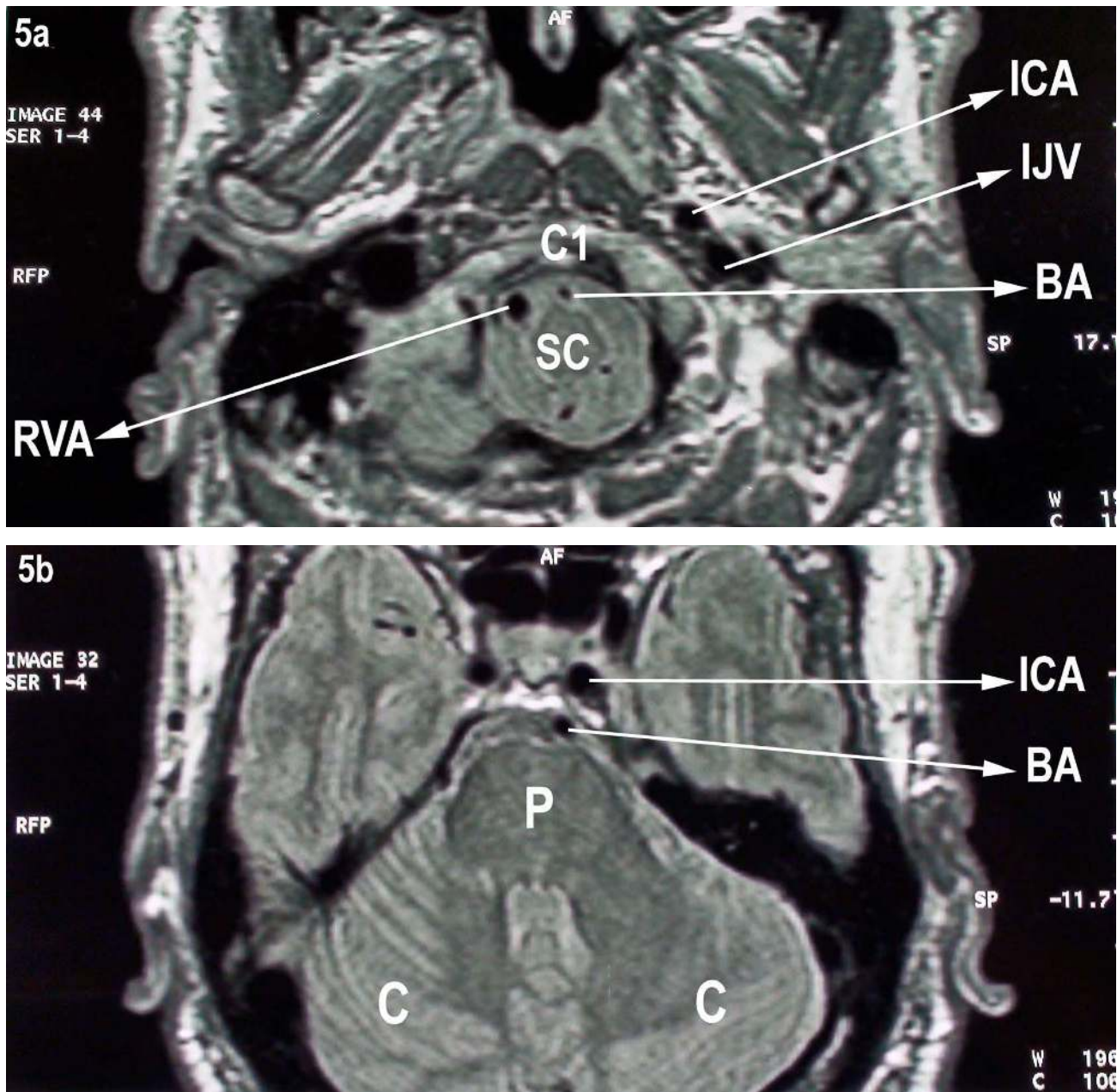


Fig. 5a. Absence of the left vertebral artery in MR angiography of head in axial model at the level of cervical spinal cord and C1 vertebrae. (SC: spinal cord, C1: first cervical vertebrae, RVA: right vertebral artery, BA: basilar artery, IJV: internal jugular vein, ICA: internal carotid artery). Fig. 5b. MR angiography demonstrated that the right vertebral artery continued as the basilar artery at the level of pons. In addition, the basilar artery was seen on the left sided, not in the basilar sulcus (P: pons, C: cerebellum, BA: basilar artery, ICA: internal carotid artery).

TUNCER, M. C.; AKGÜL, Y. H. & KARABULUT, Ö. Imagen por MR angiografía de la ausencia de arteria vertebral causante de un tinnitus pulsátil: reporte de un caso. *Int. J. Morphol.*, 28(2):357-363, 2010.

RESUMEN: La ausencia de la arteria vertebral es rara, y accidentalmente encontrada en técnicas de imagen radiológica. Reportamos un hombre de 74 años que sufre de tinnitus pulsátil con la ausencia de la arteria vertebral izquierda. El propósito del reporte del caso es la descripción de la ausencia de arteria vertebral que causante del tinnitus pulsátil, con el fin de ofrecer datos útiles para anatomistas, otorrinolaringólogos, radiólogos, cirujanos vasculares y de cabeza y cuello.

PALABRAS CLAVE: Agénesis arterial; Arteria vertebral; Varaciones anatómicas variations; MR angiografía.

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