



Aberrant course of the petrous internal carotid artery associated with ipsilateral type 1 proatlantal artery

Kaho Watanabe¹ · Akira Uchino^{1,2}  · Hiroshi Kimura³ · Yasutaka Baba¹

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Abstract

Purpose To describe an extremely rare case of an aberrant course of the petrous internal carotid artery (ICA) associated with an ipsilateral type 1 proatlantal artery (PA) that was diagnosed by cerebral magnetic resonance (MR) angiography.

Case report The patient was a 64-year-old man with double vision. Cerebral MR imaging and MR angiography were subsequently performed using a 1.5-T scanner. MR angiography showed an aberrant course of the petrous right ICA that was associated with right type 1 PA. The left vertebral artery (VA) and proximal right VA were absent.

Discussion An aberrant course of the petrous ICA is rare but clinically significant, because it is dangerous during middle ear surgery. Type 1 PA is an extremely rare type of persistent fetal anastomosis between the carotid and vertebrobasilar systems. Type 1 PA is also clinically significant, because it is dangerous during craniovertebral junction surgery. We found no similar cases in the relevant English-language literature.

Conclusion Although both variations were seen ipsilaterally and were located relatively close to each other, the embryological development of these variations is quite different. In addition, no similar case has been reported previously. Thus, these may have formed incidentally.

Keywords Anatomic variation · Cerebral arteries · Internal carotid artery · Magnetic resonance angiography · Proatlantal artery

Introduction

An aberrant course of the petrous internal carotid artery (ICA) is a rare but well-known arterial variation [1, 5, 9]. It is diagnosed radiologically by a lateralized course of reduced-caliber ICA and passage through the middle ear cavity. Thus, the vertical segment of the petrous ICA is absent. Type 1 proatlantal artery (PA) is an extremely rare type of carotid-vertebrobasilar anastomosis [3, 4, 10]. It arises from the cervical segment of the ICA and travels upward parallel to the ICA. It penetrates the dura mater at

the level of the superior margin of the atlas and enters the skull through the foramen magnum to anastomose with the proximal V4 segment of the vertebral artery (VA).

We present a case of an aberrant course of the petrous ICA that was associated with ipsilateral type 1 PA, which was diagnosed by magnetic resonance (MR) angiography. To our knowledge, no similar cases have been reported in the relevant English-language literature.

Case report

A 64-year-old man with double vision visited a general hospital. A neurological examination revealed no significant abnormality; however, cerebral MR imaging and MR angiography were subsequently performed using a 1.5-T scanner (MAGNETOM Aera, Siemens Healthineers, Erlangen, Germany). MR angiography was performed with a standard 3-dimensional time-of-flight technique.

MR imaging showed non-specific small white matter lesions (not shown). MR angiography showed an aberrant

✉ Akira Uchino
auchino0528@gmail.com

¹ Department of Diagnostic Radiology, Saitama Medical University International Medical Center, 1397-1 Yamane, Hidaka, Saitama 350-1298, Japan

² Department of Radiology, Saitama Sekishinkai Hospital, 2-37-20 Irumagawa, Sayama, Saitama 350-1305, Japan

³ Department of Radiology, Kan-Etsu Hospital, 145-1 Suneori, Tsurugashima, Saitama 350-2213, Japan

course of the petrous right ICA that was associated with right type 1 PA (Fig. 1). The left VA and proximal right VA were absent.

Because there were no symptoms related to the variations, and no significant abnormality was found, he was treated conservatively. The clinical course was uneventful.

Discussion

Aberrant course of the petrous ICA

An aberrant course of the petrous ICA is a rare but clinically significant arterial variation that may cause pulsatile tinnitus, hearing loss, otalgia, and aural fullness [2]. The incidental diagnosis of the arterial variation by high-resolution CT, CT angiography, or MR angiography is not rare. This arterial

variation is dangerous during middle ear surgery, because it runs in the middle ear cavity [5]. Takano et al. [6] reported that an aberrant course of the petrous ICA may be associated with life-threatening otorrhagia if it is inadvertently injured during middle ear surgery, including myringotomy.

Persistent stapedia artery (PSA), which is middle meningeal artery arising from the ICA, is thought to be involved in the development of an aberrant course of the petrous ICA, and the two are often combined [1]. In our case, a PSA was not observed. A case involving an aberrant course of the petrous ICA associated with an ipsilateral occipital artery (OA) arising from the cervical ICA was reported [9].

An aberrant course of the ICA is more frequently observed at the cervical segment, which is referred to as a retropharyngeal course of the ICA. This type is also dangerous during pharyngeal surgery, including needle biopsy. Recently, an aberrant course of the precavernous–cavernous junction ICA was reported. This extremely rare type may be formed by segmental agenesis of the ICA with collateral circulation via the proximal segment of the persistent trigeminal artery [8].

Type 1 proatlantal artery (PA)

There are four types of fetal anastomosis between the carotid and vertebrobasilar systems. These four types of anastomoses: trigeminal, otic, hypoglossal and PA, regress normally during early gestational period. If a PA persists, it becomes a type 1 PA. A type 1 PA arises from the cervical ICA, runs parallel to the ICA, enters the intradural space via the foramen magnum, and finally continues to the proximal V4 segment of the VA. As was observed in our case, bilateral VAs are usually absent or hypoplastic [3]. Type 1 PA is rarely associated with aortic arch variations, such as an aberrant course of the right subclavian artery and a left VA of direct aortic arch origin [4]. Most type 1 PAs are discovered incidentally. However, it remains important to recognize this rare arterial variation, particularly before performing craniovertebral junction surgery or endovascular treatment of vascular lesions of the upper neck. Montechiari et al. [3] reported a similar case to our patient and pointed out that careful follow-up is necessary, because the inability to compensate for the blockage of the posterior circulation can lead to catastrophic stroke.

Type 1 PA should not be confused with type 2 PA, which is regarded as a persistent first cervical intersegmental artery. A type 2 PA arises from the external carotid artery, runs posteriorly (similarly to the OA), anastomoses with the V3 segment of the VA, and enters the intradural space via the foramen magnum [10]. From this rare variation, the distal segment of the OA arises. Because both types enter the intradural space via the foramen magnum, important points

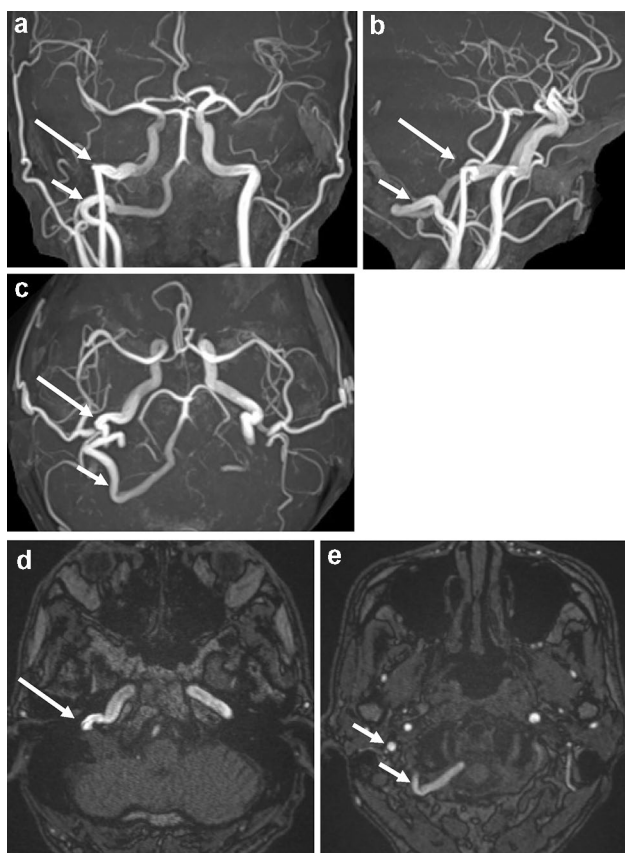


Fig. 1 Antero-posterior (a), slightly oblique right lateral (b), and infero-superior (c) projections of magnetic resonance (MR) angiography show the right aberrant course of the internal carotid artery (ICA) (long arrows) and right type 1 proatlantal artery (PA) (short arrows). The left vertebral artery (VA) and proximal right VA are absent. d, e MR angiographic source images show that the right ICA is located in the middle ear cavity (long arrow) and right anomalous artery is entering via the foramen magnum, indicating type 1 PA (short arrows)

of differentiation between types 1 and 2 are origin and proximal course.

Persistent hypoglossal artery (PHA) is the second most common type of anastomosis between the carotid and vertebral systems. The PHA arises from the cervical ICA (a segment that is slightly distal in comparison to type 1 PA), runs upward parallel to the ICA (the same as type 1 PA), enters the intradural space via the hypoglossal canal, and anastomoses with the distal V4 segment of the VA. PHA is sometimes misdiagnosed as type 1 PA [7]. An important point of differentiation between type 1 PA and PHA is the level at which it enters the intradural space.

Combination of two rare variations

Both rare variations can be associated with other relatively common variations. However, our patient had two rare variations on the same side. No similar cases have been reported previously. As mentioned above, a case involving an aberrant course of the petrous ICA associated with ipsilateral OA arising from the cervical ICA was previously reported [9]. Because the OA arising from the cervical ICA is regarded as a partial remnant of the PA, our patient may have similar embryological relationship between an aberrant course of the petrous ICA and type 1 PA.

Although both variations in our patient were seen ipsilaterally and were located relatively close to each other, the embryological development of these variations is quite different. In addition, no similar case has been reported previously. Thus, these may have formed incidentally.

Conclusions

In the present case, an aberrant course of the petrous ICA associated with ipsilateral type 1 PA was incidentally diagnosed. This combination of two rare variations has not previously been reported. Thus, these may have formed incidentally.

Author contributions KW and AU carried out the study design and drafted the manuscript. All authors reviewed the manuscript critically, and have read and approved the final manuscript.

Declarations

Conflict of interest We declare no conflict of interest.

References

- Celebi I, Oz A, Yildirim H, Bankeroglu H, Basak M (2012) A case of an aberrant internal carotid artery with a persistent stapedia artery: association of hypoplasia of the A1 segment of the anterior cerebral artery. *Surg Radiol Anat* 34:665–670
- Endo K, Maruyama Y, Tsukatani T, Furukawa M (2006) Aberrant internal carotid artery as a cause of objective pulsatile tinnitus. *Auris Nasus Larynx* 33:447–450
- Montechiari M, Iadanza A, Falini A, Politi LS (2013) Monolateral type 1 proatlantal artery with bilateral absence of vertebral arteries: description of a case and review of the literature. *Surg Radiol Anat* 35:863–865
- Saito N, Uchino A, Ishihara S (2013) Complex anomalies of type 1 proatlantal intersegmental artery and aortic arch variations. *Surg Radiol Anat* 35:177–180
- Sauvaiget E, Paris J, Kici S, Kania R, Guichard JP, Chapot R, Thomassin JM, Herman P, Tran Ba Huy P (2006) Aberrant internal carotid artery in the temporal bone: imaging findings and management. *Arch Otolaryngol Head Neck Surg* 132:86–91
- Takano K, Wanibuchi M, Ito F, Himi T (2016) Pseudoaneurysm of an aberrant internal carotid artery in the middle ear caused by myringotomy. *Auris Nasus Larynx* 43:698–701
- Uchino A (2016) Persistent hypoglossal artery versus type 1 proatlantal artery. *Surg Radiol Anat* 38:273
- Uchino A, Kimura H (2021) Aberrant course of the precavernous-cavernous junction of the internal carotid artery. *Surg Radiol Anat* 43:1979–1981
- Uchino A, Saito N, Okano N, Kakehi Y (2015) Aberrant internal carotid artery associated with occipital artery arising from the internal carotid artery. *Surg Radiol Anat* 37:1137–1140
- Vasović L, Mojsilović M, Andelković Z, Jovanović I, Arsić S, Vlajković S, Milenković Z (2009) Proatlantal intersegmental artery: a review of normal and pathological features. *Childs Nerv Syst* 25:411–421

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