CASE REPORT

The transclival artery: a variant persistent carotid–basilar arterial anastomosis not previously reported

Jared D Kirkland,¹ Brian C Dahlin,² William T O'Brien^{1,2}

¹Department of Radiology, David Grant Medical Center, Travis AFB, California, USA
²Department of Radiology, UC Davis, Sacramento, California, USA

Correspondence to

Dr Jared D Kirkland, Department of Radiology, David Grant Medical Center, 101 Bodin Circle, Travis AFB, CA 94535, USA; jared.kirkland@gmail.com

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SUMMARY

During embryological development, primitive anastomoses exist between the carotid and vertebrobasilar arteries. These anastomoses typically regress or are incorporated into the developing vasculature. Persistence beyond fetal development, however, results in vascular anomalies that alter haemodynamic flow with a predisposition for aneurysm formation. The carotid–vertebrobasilar anastomoses mirror the primitive communications and include (from most to least common) the trigeminal, hypoglossal, proatlantal and otic arteries. The hypoglossal and proatlantal variants extend through the hypoglossal canal or foramen magnum, respectively. We present a previously undescribed variant of these persistent fetal anastomoses, the 'transclival artery', which courses through its own transclival skull base canal/foramen.

BACKGROUND

Primitive embryological anastomoses exist between the carotid arteries and developing vertebrobasilar system during early development. The primitive vasculature from inferior to superior includes the proatlantal and hypoglossal arteries, which involve the cervical carotid arteries, and the otic and trigeminal arteries which involve the intracranial segments of the internal carotid arteries (ICAs) (figure 1). These anastomoses typically regress during normal development. Failure to regress results in persistence of the primitive vascular remnants throughout life. The persistent vasculature is predictable in location and appearance due to the corresponding primitive arterial remnant(s). We report a unique case of a persistent carotid–vertebrobasilar anastomosis that, unlike the known precursors, traverses through its own transclival foramen; this has not been previously described or reported. As with other vascular anomalies, multiple aneurysms were identified due to alteration of normal haemodynamic flow.

CASE PRESENTATION

A 61-year-old woman presented to the emergency department (ED) after experiencing recurrent episodes of dizziness. Clinical history revealed similar symptoms over a period of several years with increasing frequency and duration. She had no loss of consciousness, altered mental status or focal neurological defects. Past medical history was significant for a facial and scalp haemangioma that had been treated with radiation therapy decades earlier.

Physical examination, including neurological assessment, showed no gross abnormality.

INVESTIGATIONS

Non-contrast CT of the head in the ED demonstrated microvascular ischaemic disease and age-related volume loss without acute intracranial haemorrhage or transcortical infarction. Upon admission CT angiography (CTA) of the head and neck was performed, demonstrating multiple vascular abnormalities. The bilateral cervical vertebral arteries were diminutive in calibre and terminated at the skull base. The intracranial posterior circulation was supplied by an anomalous vessel which originated from the cervical left internal carotid artery (ICA) at the C4 level approximately 1.5 cm distal to the carotid bifurcation (figure 2). This anomalous vessel coursed cephalad anterior and medial to the cervical ICA, penetrated the clivus through its own canal/foramen medial to the left hypoglossal canal, and continued intracranially ventral to the brainstem as the sole contributor to the vertebral artery (figure 3). CTA demonstrated and digital subtraction angiography (DSA) confirmed several aneurysms, including aneurysms of the aortic arch, proximal basilar artery and anterior communicating artery (ACOM) (figure 4). Luminal irregularity was also noted at the level of the anomalous transclival canal/foramen.

TREATMENT

The ACOM aneurysm was successfully coiled with no residual flow identified within the aneurysmal sac. The basilar artery aneurysm was left untreated due to the significant risk of catastrophic complication with attempted coiling and difficult surgical access.

OUTCOME AND FOLLOW-UP

At 1-year follow-up the patient remained clinically stable with intermittent episodes of dizziness. No complications associated with the known or treated aneurysms had occurred.

DISCUSSION

Persistent carotid–vertebrobasilar anastomoses refer to remnants of embryological vessels that provide vascular supply to the hindbrain prior to maturation of the vertebrobasilar system. Near 20 days of gestation, several vascular connections form between the ICAs and paired neural arteries, which eventually form the vertebrobasilar system. These vascular connections include the proatlantal,

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hypoglossal, otic and trigeminal arteries.¹ The hypoglossal, otic and trigeminal arteries regress at the time when the intracranial posterior communicating arteries (PCOMs) normally develop. Subsequently, the proximal portions of the proatlantal arteries

Figure 1 Illustration demonstrating the primitive carotid–vertebrobasilar anastomoses which include (from inferior to superior) the proatlantal, hypoglossal, otic and trigeminal arteries. The proatlantal and hypoglossal arteries arise from the cervical carotid arteries. The otic and trigeminal arteries originate from intracranial segments of the internal carotid arteries. The posterior communicating artery labeled superiorly occurs normally postnatally, when present.

regress while the distal portions are incorporated with the developing vertebral arteries.² Failure of these embryological vascular anastomoses to regress leads to a persistent fetal communication between the anterior and posterior circulations.

The most common persistent carotid–vertebrobasilar fetal anastomosis is the persistent trigeminal artery (PTA), which comprises 80% of all fetal anastomoses and has a prevalence of approximately 0.2% in the general population.¹ The PTA connects the cavernous segment of the intracranial ICA with the distal segment of the basilar artery.³ It courses superior to cranial nerves (CNs) III, IV and VI and courses medial to the first division of CN V. Due to its course, the PTA is a rare cause of trigeminal neuralgia or CN palsies, typically CNs III or VI. The basilar artery proximal to the anastomosis is typically diminutive in calibre.

There are several primary subtypes of PTA based upon the site of communication with the basilar artery.^{2,4} With the type 1 variant, the anastomosis is located between the anterior inferior cerebellar artery and the superior cerebellar artery (SCA). The PCOMs frequently are absent. The type 2 variant has an anastomosis superior to the SCA, typically forms the majority of the SCA vascular supply, and is associated with fetal or fetal-type origin of the posterior cerebral artery (PCA) from the PCOM. The type 3 variant may have an anastomosis above or below the SCA and supplies the SCA and contralateral PCA, with the PCOM supplying the ipsilateral PCA.¹

The second most common persistent carotid–vertebrobasilar anastomosis is the hypoglossal artery, which has a prevalence of 0.02–0.1% in the general population.¹ It originates from the cervical ICA at the C1–C3 level, extends through the hypoglossal canal and unites with the basilar artery near the pontomedullary junction.^{2,4} Its persistence beyond fetal development may be associated with absence of one or both vertebral arteries.¹

The third most common persistent carotid–vertebrobasilar anastomosis, the proatlantal artery, also arises from the cervical carotid vasculature and is categorised into one of two variants. Type 1 arises from the cervical ICA at the C2–C4 level, courses through the foramen magnum and unites with the intradural V4 segment of the vertebral artery. Type 2 arises from the cervical external carotid artery, courses through the foramen magnum and unites with the V3 segment of the vertebral artery. The

Figure 2 CT angiography (CTA) of the head and neck demonstrating the origin and course of the anomalous/persistent vasculature. (A) Sagittal maximum intensity projection CTA image showing the anomalous/persistent vessel originating anteriorly from the proximal cervical internal carotid artery shortly after its bifurcation. (B) Frontal projection CTA volume rendered image showing the anomalous/persistent fetal artery originating from the cervical ICA and continuing intracranially as the vertebral artery. Multiple aneurysms are noted and illustrated in figure 4.

Figure 3 CT angiography (CTA) images demonstrating the transclival canal. (A) Axial and (B) reformatted sagittal CTA maximum intensity projection images showing the anomalous/persistent vessel coursing through the transclival canal/foramen (white arrows) to the left of midline and medial to the hypoglossal canal (black arrow).

Figure 4 Labeled CT angiography (CTA) and digital subtraction angiography (DSA) images illustrating the vascular anatomy and highlighting multiple aneurysms. (A) Frontal projection CTA volume rendered image demonstrating aneurysms of the proximal vertebral and anterior communicating (ACOM) arteries (arrows). (B) Frontal and (C) lateral projection DSA images illustrating the carotid and anomalous/persistent arterial anatomy and confirming the proximal basilar and ACOM artery saccular aneurysms.

vertebral arteries proximal to the anastomosis are often diminutive or hypoplastic.^{1 3}

The final and least common persistent carotid–vertebrobasilar anastomosis is the primitive otic artery. The rarity of this finding is limited to mention in only a small number of case reports. It most often arises from the petrous portion of the intracranial ICA and traverses the internal auditory canal to join the proximal basilar artery.¹

Patients with vascular anomalies, including persistent carotid–vertebrobasilar anastomoses, are prone to aneurysm formation due to alternations in the normal haemodynamic flow. Aneurysms typically occur at or near the anomalous vessels and/or at vascular branch points or arterial origins. As was the case with our patient, patients with vascular anomalies may be prone to formation of multiple aneurysms.

The illustrative case presented in this report has some similar characteristics to the hypoglossal and proatlantal arteries but is unique in that it enters the cranial vault through its own transclival canal/foramen rather than through the hypoglossal canal or foramen magnum. To our knowledge, the presence of a transclival foramen in the setting of a persistent fetal carotid–vertebrobasilar anastomosis has not previously been described or reported, hence the designation ‘transclival artery’. Based upon the known

embryological precursors and imaging characteristics of the case presented, the transclival artery likely represents a previously unknown variant of the persistent hypoglossal or proatlantal artery.

Learning points

- ▶ Although relatively rare, the most common persistent fetal vascular anastomoses in the head and neck include the trigeminal, hypoglossal, proatlantal and otic arteries.
- ▶ The ‘transclival artery’ is a unique vascular anomaly that courses through its own skull base canal/foramen and likely represents a previously unknown variant of the hypoglossal or proatlantal arteries.
- ▶ Persistent vertebrobasilar anastomoses place patients at increased risk of aneurysm formation.

Correction notice This article has been updated since it first published Online First. Figure 2 has been corrected.

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