A Rare Carotid-Basilar Anastomosis Traversing the Jugular Foramen: Origin and Clinical Implications

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Summary

This report describes imaging in a patient with a unique unnamed carotid-basilar anastomosis, where the entry into the skull was via the jugular foramen. There were associated findings of absent right and hypoplastic left vertebral arteries and an aberrant right subclavian artery. We speculate that the persistent anastomosis is developmentally related to the jugular branch of the ascending pharyngeal artery. Clinical implications of the course via the jugular foramen are also discussed.

Introduction

We describe a patient with a unique unnamed carotid-basilar anastomosis - a primitive artery arising from the right internal carotid artery, passing through the jugular foramen to enter the skull and continue as the vertebral artery. There were associated aortic arch vessel abnormalities.

Case Report

A 37-year-old male presented with a history of sudden onset left-sided weakness. He had a spastic left hemiplegia with a left seventh nerve palsy and left homonymous hemianopia. He also had left hemisensory loss to light touch, pain and proprioception. His blood pressure on admission was 215/120. Laboratory investigations revealed no biochemical or haematologi-

cal abnormality. Non contrast computed tomography (CT) demonstrated a right sided basal ganglia haemorrhage with intraventricular extension. Digital subtraction angiography (DSA) demonstrated a primitive carotid-basilar anastomosis, with a primitive artery arising from the right ICA at the level of the anterior arch of C1. This artery then continued as the right vertebral artery, joined the hypoplastic left vertebral to form the basilar artery and provide a normal posterior circulation (Figures 1 and 2). The extracranial right vertebral artery was absent. Further findings included absence of both posterior communicating arteries (PCoA) and an absent A1 segment of right anterior cerebral artery. CT angiogram of the brain confirmed the above intracranial findings and also demonstrated that the primitive artery entered the skull through the jugular foramen (Figures 3A,B,4-6). In addition, the right posterior inferior cerebellar artery (PICA) originated from the anomalous vessel within the jugular foramen (Figure 4). The hypoglossal canals were present with no abnormal vessel passing through (Figure 5). There were no aneurysms, or other vascular abnormalities to account for the bleed. CT angiogram of the chest showed an aberrant right subclavian artery (Figure 7).

Discussion

The cerebral vasculature at the 4 mm embryo stage consists of a primitive carotid system supplying the forebrain, and a primitive vertebro-basilar system supplying the hindbrain ^{1,2}. The

Figure 1 Lateral common carotid DSA: primitive artery (arrowhead) arising from the right ICA (long arrow). This artery then continues as the vertebrobasilar artery. Note the ECA (short arrow).

Figure 3 A,B) Sagittal MIP CT angiograms: primitive artery (white arrowhead) arising from the ICA (white arrow) and coursing to the jugular fossa. Note the CCA (black arrowhead) and ECA (black arrow).

Figure 4 Axial MIP CT angiogram: primitive artery (white arrowhead) entering the cranial fossa through the jugular foramen, anterior to the jugular bulb (arrow). Note the right PICA (white arrow).

Figure 2 Frontal common carotid DSA: the common carotid run shows the ECA (long arrow), ICA (arrowheads) and primitive artery (short arrows).

Figure 5 Coronal MIP CT angiogram: primitive artery (arrowhead) entering the cranial fossa through the jugular foramen which is superior to the hypoglossal canal (arrow).

↑ Figure 7 Axial MIP CT angiogram: aberrant right subclavian artery (black arrow).

← Figure 6 3D CT angiogram: primitive vessel (arrow-head) entering the skull through the jugular fossa (long arrow) and continuing intracranially as the vertebrobasilar artery (short arrow).

carotid system comprises two internal carotid arteries (ICA), which extend from paired dorsal aortic arches¹. The primitive vertebrobasilar system comprises two parallel longitudinal neural arteries^{1,2}. This longitudinal neural artery plexus is supplied by the carotid system via four major anastomoses². These primitive carotid-vertebrobasilar anastomotic arteries are named according to their neighbouring structures and include the trigeminal, otic, hypoglossal and proatlantal intersegmental arteries¹.

During the 5-6 mm embryo stage, the PComA develops as a distal communication between the carotid system and the longitudinal neural arteries^{2,3}. Subsequent to the development of the PComA, the primitive anastomotic arteries involute starting with the primitive otic artery followed by the hypoglossal and trigeminal arteries^{2,3}. The proatlantal intersegmental artery fuses with adjacent cervical intersegmental arteries to form the vertebral artery². In addition, fusion of the longitudinal neural artery plexus results in formation of the basilar artery³. When these anastomotic arteries fail to regress, persistent primitive carotid-vertebrobasilar arteries are found in the adult cerebral vasculature. These primitive arteries are exceedingly rare^{1,3}. The primitive trigeminal artery is the most common with a reported prevalence of 0.1%-0.6%¹. The next most common is the hypoglossal artery with a prevalence of 0.02%-0.1%^{1,2}. The proatlantal and otic anastomoses are rarer.

Our patient demonstrated an additional, undescribed anastomotic vessel. This had features

in common with a persistent hypoglossal artery based on its origin and distal vertebro-basilar anastomosis, but its entry into the skull via the jugular foramen is inconsistent with any named carotid-basilar anastomoses. Passage through the hypoglossal canal is a key diagnostic criterion for the persistent hypoglossal artery⁴. In an attempt to explain development of this vessel it should be remembered that the ascending pharyngeal artery (APhA) is the remnant of the embryonic hypoglossal artery⁵.

Embryologically the third aortic arch becomes the cervical portion of the ICA and the embryonic hypoglossal artery arises from the origin of the cervical ICA. This relationship between the hypoglossal artery and the third aortic arch can result in various connections between their adult counterparts i.e. the APhA and the cervical ICA⁵. Therefore the origin of the APhA or its branches can be from the ICA but it most commonly arises from the external carotid artery, followed by the occipital artery and rarely the ascending cervical artery⁶.

It is evident that the anomalous vessel in our patient is developmentally related to the hypoglossal artery. However because it passes through the jugular foramen and not the hypoglossal canal, it cannot be considered a variant of the hypoglossal artery but rather represents a unique carotid basilar anastomosis. The APhA has two trunks, the pharyngeal and neuromeningeal trunk⁶. The neuromeningeal trunk further divides into a hypoglossal and jugular branch. The jugular branch enters the cranial

cavity through the jugular foramen, where it supplies the ninth, tenth and eleventh cranial nerves⁵. Therefore we speculate that the vessel in our patient is derived from the jugular branch of the neuromeningeal trunk of the APhA, in much the same way as the hypoglossal artery is related to the APhA.

This unique variant could have potential clinical implications. Previously described hypoglossal arteries and variants have reported the association with hypoglossal nerve palsy and glossopharyngeal neuralgia^{1,7,8}. These are postulated to occur on the basis of compression of the hypoglossal nerve within the hypoglossal canal and irritation of the glossopharyngeal nerve respectively^{7,8}. The presence of a large artery within the jugular foramen has the possibility of causing glossopharyngeal, vagus and accessory nerve palsies. Furthermore, additional clinical implications resulting from potential compression of the jugular bulb and inferior petrosal venous sinus need to be considered. None were present in our patient but both the clinicians and the patient have been advised regarding these possible complications and the expected symptoms.

Additional vascular pathologies associated with primitive carotid-basilar anastomoses include absent/hypoplastic vertebral and post communicating arteries and aneurysms⁷. The

associated absent right vertebral and posterior communicating arteries and hypoplastic left vertebral artery in our patient, result in the posterior circulation being predominantly derived from the anomalous vessel. Therefore, knowledge of the vascular anatomy is imperative in endovascular and surgical procedures particularly those involving cross clamping of the carotid vessels.

Conclusion

To our knowledge, this is the first reported case of a persistent carotid-basilar anastomosis passing through the jugular foramen. We speculate that its genesis is related to the jugular branch of the APhA. There are potential clinical implications related to its unique course. The finding of both a persistent carotid-basilar anastomosis and an aberrant right subclavian artery is in addition an unusual association.

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