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A rare anomaly of persistent primitive trigeminal artery, directly connected with posterior cerebral artery

Akira Tempaku

CASE REPORT

A 63-year-old woman underwent a medical checkup of the brain. She had a history of a benign thyroid tumor but had not undergone medical treatment. She had no headaches or abnormal symptoms affecting the central nervous system (CNS). A head magnetic resonance imaging (MRI) revealed the presence of a branch vessel originating from the C4 portion of the left internal carotid artery (ICA) and extending posteriorly to the posterior cerebral artery (PCA) (Figure 1). The P1 portion of the PCA runs anterolaterally and anastomoses with the PCA (Figure 1). Perfusion was observed in the posterior circulation in the basilar artery (BA) and bilateral superior cerebellar arteries (SCA), independently. MRI study was performed with 3.0 Tesla MRI (Signa, GE Health Care; Chicago, IL, USA).

DISCUSSION

The PCA is formed through the consolidation of primitive vascular anastomoses during embryogenesis [1, 2]. It typically anastomoses with the posterior circulation at the posterior communicating artery (Pcom A), which branches off from the C2 portion of ICA. In the present case, however, the vessels that anastomoses between the ICA and BA branched from the C4 part, rather than the C2 part, as would normally be expected. In addition, a vessel forming the PCA branched from its proximal part.

The potential embryological origins of the anomaly of the PCA can be categorized as follows: firstly, the

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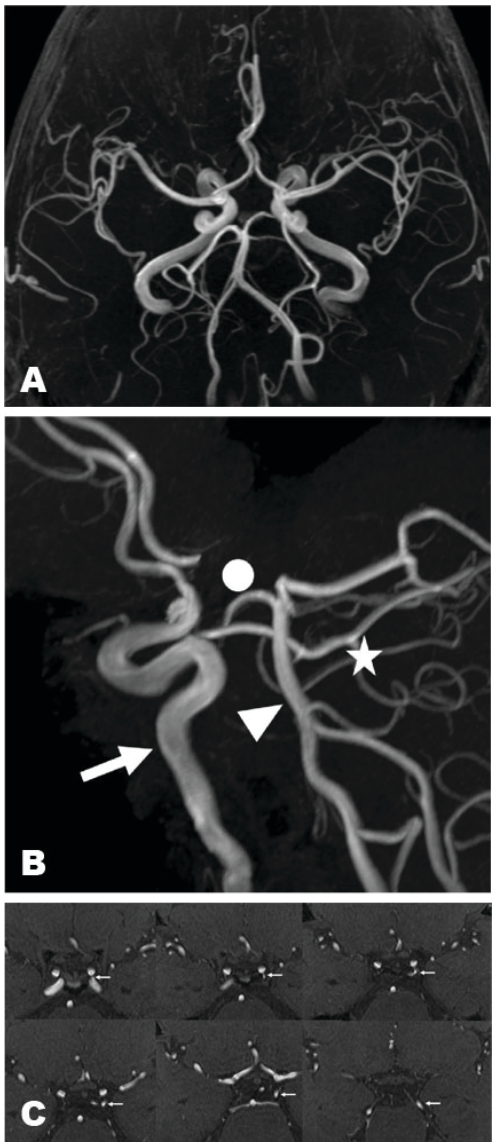

Figure 1: (A) Magnetic resonance angiography of whole brain is shown. (B) Maximum intensity projection of left internal carotid artery and basilar artery including the posterior cerebral artery. Left inferior oblique view is shown with focusing at the left C4 portion with persistent primitive trigeminal artery (PPTA). Arrow points the ICA, and arrow head shows the BA. Circle means the P1 portion of left PCA, while star means the P2 portion of left PCA. (C) Sequential axial views of the time-of flight image. PPTA trajectory is traced by thin arrow.

persistent primitive trigeminal artery (PPTA) may be considered a variant that directly anastomoses with the PCA; alternatively, the tentorial branch of the meningohypophyseal trunk (MHT) may be an anomaly that anastomoses with the PCA.

The PPTA is one of the four persistent carotid-vertebrobasilar anastomoses. With a reported prevalence of 0.061–0.6%, it accounts for 80–85% of persistent arteries and is usually unilateral [3–6].

Prior to the development of the posterior communicating and vertebral arteries, the basilar artery is supplied by the trigeminal artery. The PPTA originates at the point where the petrous and cavernous segments of the internal carotid artery meet. It runs posterolaterally alongside the trigeminal nerve (the lateral type), or crosses over or through the dorsum sellae (the medial type). The lateral type is observed to be 11 times more predominant than the medial type [5, 7]. The PPTA is often accompanied by hypoplastic vertebral, posterior communicating, and caudal basilar arteries.

The PPTA branches from the C4 segment of the ICA and classically anastomoses with the SCA and anterior inferior cerebellar artery (AICA) of the BA (24%) [8, 9]. However, variants such as anastomosis to the SCA have also been reported. Saltzman classifies PPTA into three types [10]. Saltzman type I supplies the distal vertebrobasilar arteries. The posterior communicating artery is absent, as is the caudal basilar, which is absent or hypoplastic, as are the distal vertebral arteries. Saltzman type II supplies the superior cerebellar arteries, while the posterior cerebral arteries are supplied by the posterior communicating artery. Saltzman type III does not join the basilar artery, instead, it terminates directly in the superior cerebellar artery (type IIIa), the anterior inferior cerebellar artery (type IIIb) or the posterior inferior cerebellar artery (type IIIc). However, there were no reports of anastomosis to PCA within the scope of data base research. This is the first report to visualize the direct anastomosis of the PPTA to the PCA.

The MHT branches posteriorly via the tentorial artery (the artery of Bernasconi and Cassinari). It may have anastomosed with the PCA. It is possible for perfusion to develop retro-directionally from the MHT to the PCA through the dura via the dural branch of P2 of the PCA (the artery of Davidoff-Schechter). A connection between the C4 artery, the artery of Bernasconi and Cassinari, and the artery of Davidoff-Schechter was considered. However, there is a lack of evidence and case reports to support this, so it remains speculative.

From an embryological perspective, the internal carotid artery branches off the primitive maxillary artery to form the intracranial carotid artery. The anterior cerebral and choroidal arteries belong to the cranial division and form a choroidal arcade at the Foramen of Monro. The caudal division comprises the posterior communicating artery, the P1 portion of the posterior cerebral artery and the basilar artery distal to the trigeminal artery branch. This branch anastomoses with the newly formed vertebrobasilar artery system. Initially, the anterior choroid plexus artery supplies a wide area of the cerebral cortex, although most of it migrates (distal annexation) as the posterior P2 portion of the posterior cerebral artery. This forms the telencephalic, diencephalic, and choroidal branches. The extent of perfusion varies. The branches of the anterior choroidal artery form embryonic anastomoses with the corresponding branches of the caudal division of the internal carotid artery (the telencephalic, diencephalic, and choroidal branches). Some of these branches are left behind and transform into the adult-type vascular architecture.

Following these embryological findings, the posterior communicating artery belongs to the caudal division of the internal carotid artery. As development occurs, the carotid-basilar anastomoses disappear. The posterior cerebral arteries that mainly perfuse from the basilar artery are labelled “adult type,” while those that mainly perfuse from the posterior communicating artery are called “fetal type.” The fetal type differs from the posterior cerebral artery after P2, which originates from the cranial division.

Conversely, the BA receives blood flow through a pair of ventral longitudinal arteries that anastomose with the anterior circulation, which developed earlier, via carotid-basilar anastomoses. As the BA develops, the vessels of these primitive anastomoses subsequently disappear. As these primitive anastomoses regress, the two ventral longitudinal arteries undergo medial fusion to form the single BA.

Based on the vascular anatomy of the developmental process, it appeared to be a schema-like formation process (Figure 2). Blood flow in the VA-BA system and the right PCA was well maintained, with perfusion from the posterior circulation.

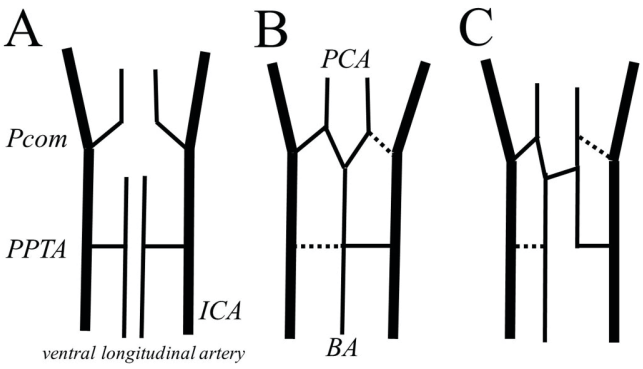

Figure 2: The following schema illustrates the speculated embryological vascular architecture. (A) The primary intracranial vascular structure is demonstrated. The bold bars indicates the ICA, whereas the small bars signifies posterior circulation vessels, including the primary BA (ventral longitudinal arteries) and PCA. (B) The usual development with PPTA remnant is characterized. Ventral longitudinal arteries are fused to form a BA. The posterior communicating artery and/or contralateral PPTA, shown by dot lines, disappear. (C) The present case vascular structure is illustrated schematically. The left PPTA is anastomosed to the left PCA directly, with the BA connected via the P1 of the left PCA.

CONCLUSION

Various reports have been published on vascular anastomosis with PPTA. In the present case, however, the author observed a PPTA anastomosis that was directly connected to the PCA. This type of PPTA did not correspond to any of the existing classifications and appears to be a breakthrough that has not yet been reported.

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Akira Tempaku – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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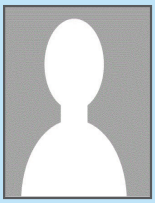

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