Case Report

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Persistent carotid-vertebrobasilar anastomoses: cases of proatlantal artery Type I and Type II

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Abstract

Persistence of fetal communications between the carotid and vertebrobasilar systems is uncommon. Persistent proatlantal artery is an anastomosis between the carotid and vertebrobasilar systems, typically classified as Type I and II. In this case report, 600 angiographies are examined retrospectively and two persistent proatlantal arteries were observed - one with Type I (0.16%) and the other with Type II (0.16%) proatlantal artery. Existence of these arteries are associated with intracranial vascular anomalies, especially aneurysms. In both of our cases, an aneurysm was detected in the middle cerebral artery. Precise knowledge of these anastomoses is essential for intracranial operations and catheterizations performed in this region.

Keywords: angiography; carotid-vertebrobasilar anastomosis; persistent proatlantal artery

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Introduction

Persistent carotid-vertebrobasilar anastomoses occur as a result of discontinuation in the development of the vertebrobasilar system.[1] These are embryonic presegmental arteries supplying the primitive vertebrobasilar system from the primitive internal carotid artery (ICA).[1-4] The primitive vertebrobasilar system comprises two parallel longitudinal neural arteries supplied by the carotid system with four major anastomoses.[5] In the early stage of embryonic life, these longitudinal neural arteries supply the hindbrain. Blood flows here by the embryonic cerebral arteries that directly connect the carotid and basilar arteries. These arteries form anastomoses named presegmental arteries and are named by the adjacent cranial nerves:[1] trigeminal, otic, hypoglossal, and proatlantal. Presegmental arteries provide connection between the longitudinal neural arteries and the internal carotid artery, and disappear after the development of the posterior communicating and vertebral arteries. The one that persists most frequently is the primitive trigeminal artery with an incidence of 0.2% in cerebral angiograms. The incidence of other presegmental arteries were found as 0.1% after birth.[6] Persistant proatlantal artery (PPA) is classified Type I and Type II. Both types are rare developmental anomalies; both originate from the carotid artery and enter the cranium through the foramen magnum.

Type I originates from the ICA, takes a dorsal course cephalad to the transverse process of C1, and then travels rostral to enter the foramen magnum. Type II proatlantal artery arises from the external carotid artery (ECA) laterally, remains more lateral in position than the Type I artery, and joins the course of the horizontal portion of the vertebral artery (VA) before entering the foramen magnum[1,7] (**Figure 1**). Type I does not pass through the transverse foraminae of the cervical vertebrae; in contrast, Type II passes through the transverse foramen of C1 vertebra and then joins with the V3 of the VA.[1] We studied cerebral angiographies performed between 2011-2015 at The Department of Radiology, School of Medicine, Akadeniz University, Antalya, Turkey to reveal subarachnoidal haemorrhagies retrospectively and investigate carotid-vertebrobasilar anastomoses. Out of 600 angiographies examined retrospectively, only two cases with persistent proatlantal artery were observed.

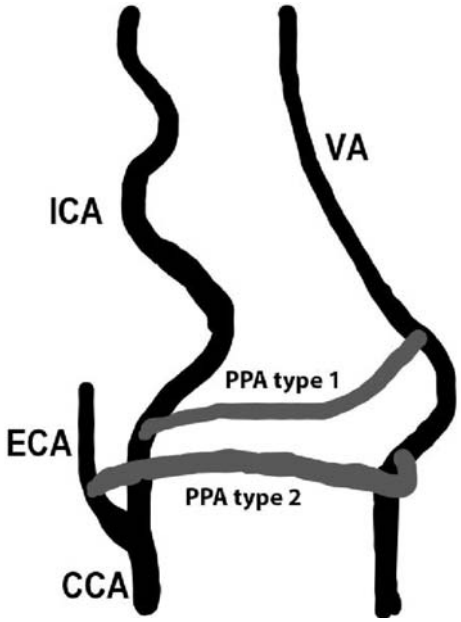

Figure 1. Illustration of proatlantal arteries; Type I and Type II. **CCA:** common carotid artery; **ECA:** external carotid artery; **ICA:** internal carotid artery; **PPA:** persistant proatlantal artery; **VA:** vertebral artery.

Case Report

Case 1

In the first case, angiography of the right common carotid artery (CCA) indicated that the CCA continued with the middle cerebral artery (MCA). At the bifurcation level of the MCA a saccular aneurysm was detected (**Figure 2a**). Angiography of the left CCA showed that Type I proatlantal artery originated from the cervical part of the ICA. The left VA arose through the Type I proatlantal artery and ICA continued with the left anterior cerebral artery (ACA) and MCA, and the right ACA was visualized via the anterior communicating artery (**Figure 2b**). The left VA was filled by the proatlantal artery and continued with the basilar artery. Two posterior cerebral arteries were also visualized (**Figures 2c** and **d**). In the angiography of the left subclavian artery, proximal part of VA was not visualized (**Figure 2e**).

Case 2

In this case, angiography of the right CCA showed that the right MCA and ACA were arising from ICA and left

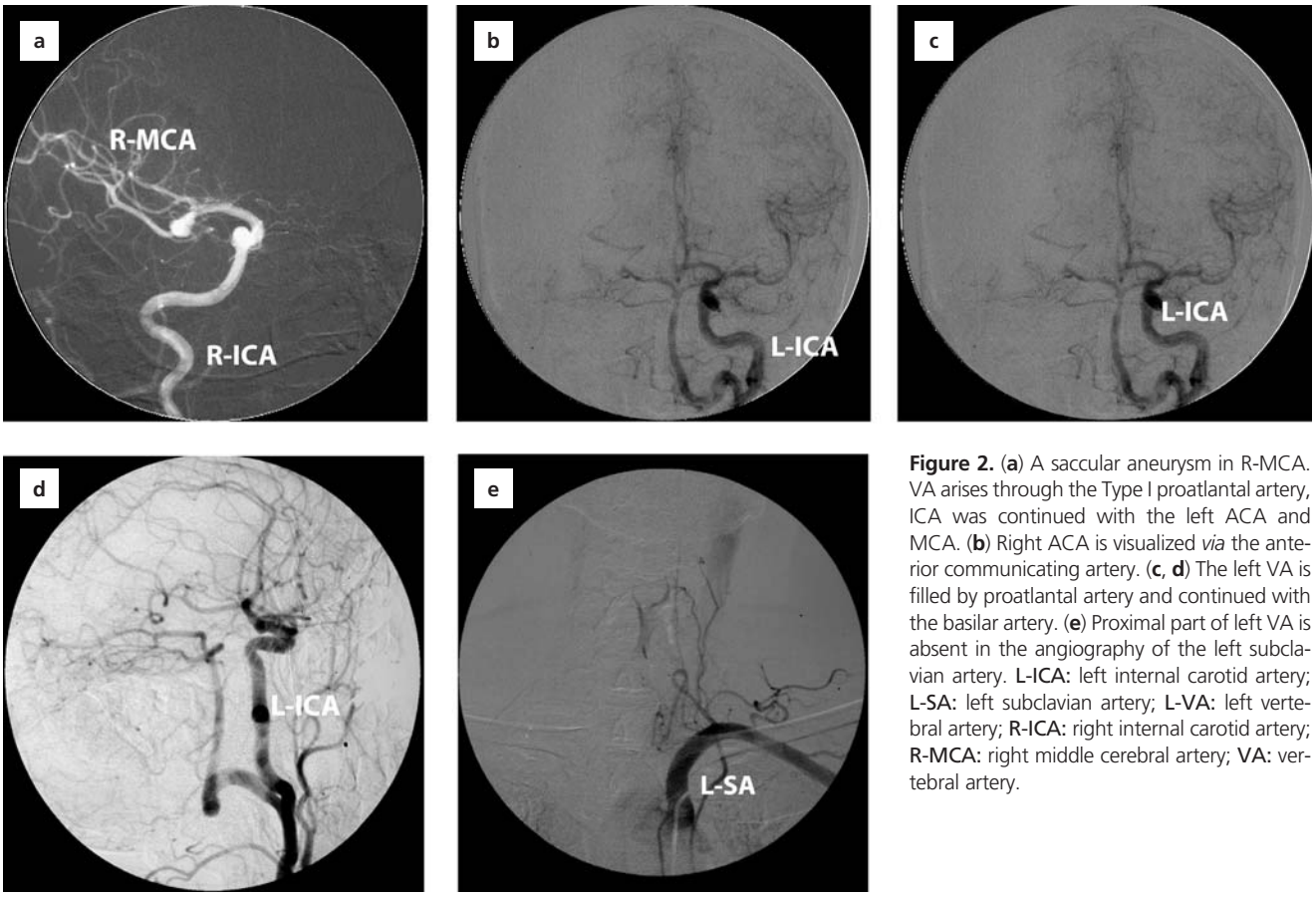

Figure 2. (**a**) A saccular aneurysm in R-MCA. VA arises through the Type I proatlantal artery, ICA was continued with the left ACA and MCA. (**b**) Right ACA is visualized *via* the anterior communicating artery. (**c**, **d**) The left VA is filled by proatlantal artery and continued with the basilar artery. (**e**) Proximal part of left VA is absent in the angiography of the left subclavian artery. **L-ICA:** left internal carotid artery; **L-SA:** left subclavian artery; **L-VA:** left vertebral artery; **R-ICA:** right internal carotid artery; **R-MCA:** right middle cerebral artery; **VA:** vertebral artery.

ACA was visualized via the anterior communicating artery (**Figures 3a** and **b**). Angiography of the left CCA showed that the ICA is continued isolated MCA. From the ECA, a thick Type II persistent proatlantal artery arose and VA was filled through this artery (**Figure 3c** and **d**). Right VA originated from the right subclavian artery as usual, but on the left side, proximal part of VA wasn't visualized (**Figure 3e**).

Discussion

Persistence of fetal communications between the carotid and vertebrobasilar systems is uncommon. We found the PPA artery incidence as 0.33% in our study. Bilateral or unilateral presence of PPA Type I was described in some earlier studies.[7–11] We found the incidence of Type I PPA as 0.16% in this study. Bilateral or unilateral presence of PPA Type II was also described previously.[4,12,13] We found Type II PPA in 0.16% of the angiographies. Woodcock et al.[10] found proatlantal artery Type I in 57%, Type II in 38%, and arising from the common carotid artery in 5% . As in our case, most of the proatlantal arteries were found incidentally. Purkayastha et al.[9] suggested that the actual incidence of PPA is probably higher than reported, because in most cases, the discovery is purely coincidental. Existence of these arteries are associated with intracranial vascular anomalies, especially aneurysms.[10,14,15] Yılmaz et al.[11] reported clinical and pathological findings in combination with these primitive persistent anastomoses in seven cases. Tubbs et al.[14] mentioned that, for the co-existence of PPA and aneurysms is reported in the literature, no consensus has been reached as to whether this is an association or simply incidental. In both of our cases, an aneurysm was detected in the MCA. This finding promotes the idea that PPA might be associated with vascular anomalies; however, more extensive studies are needed to clarify this.

Persistence of the proatlantal artery into adult life can be explained on an embryological basis as of a primary error in the development of the VA.[12] Therefore, PPA can be accompanied by ipsilateral, contralateral or bilateral aberrant VAs.[7] Coincidence of PPA and hypoplasia of the ipsilateral, contralateral or both VA was reported as 46%.[16] In both of our cases, proximal parts of the ipsilateral VA was absent. Bahşi et al.[17] conferred that when the VA is absent, posterior cerebral circulation is supplied by persistent arteries, and occlusion of these arter-

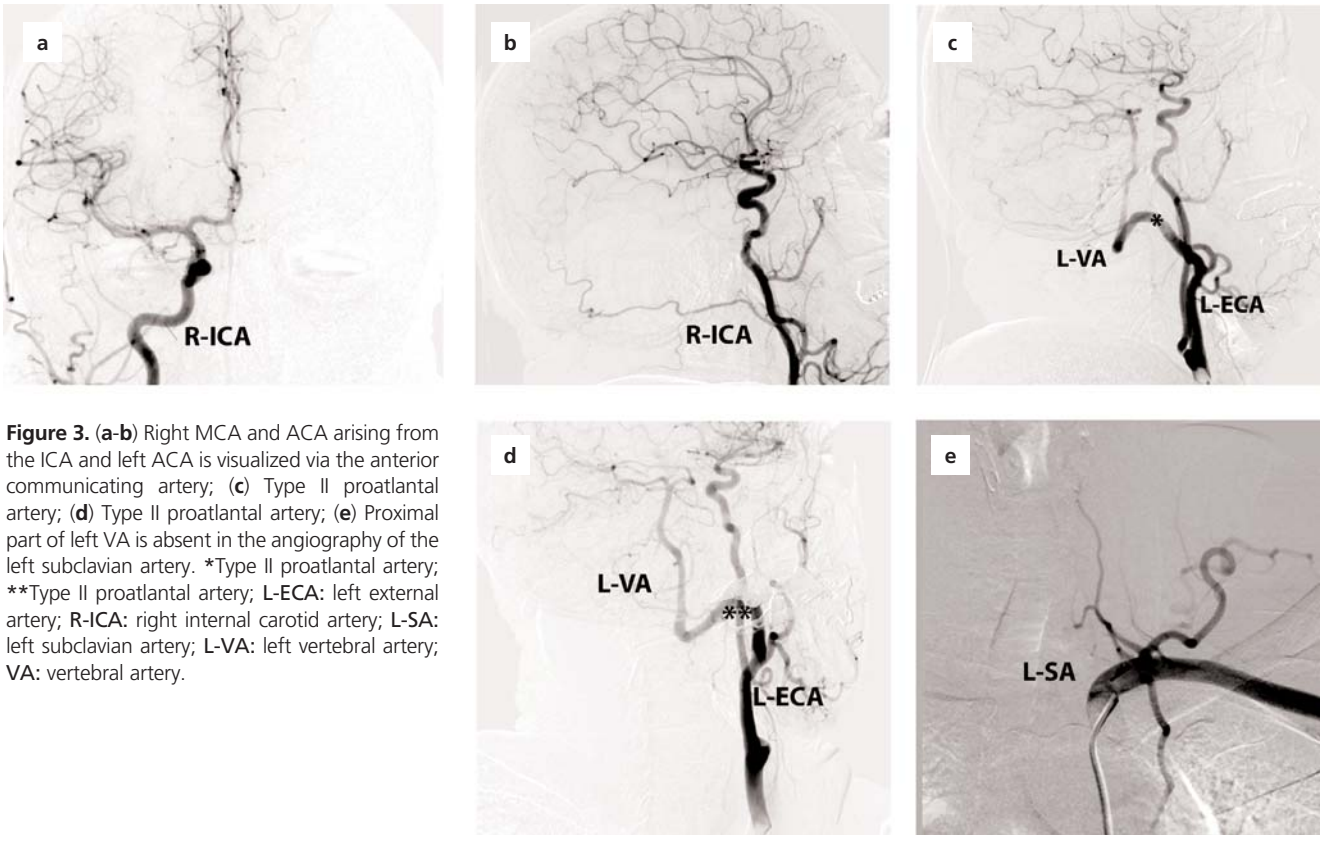

Figure 3. (**a**-**b**) Right MCA and ACA arising from the ICA and left ACA is visualized via the anterior communicating artery; (**c**) Type II proatlantal artery; (**d**) Type II proatlantal artery; (**e**) Proximal part of left VA is absent in the angiography of the left subclavian artery. *Type II proatlantal artery; **Type II proatlantal artery; **L-ECA:** left external artery; **R-ICA:** right internal carotid artery; **L-SA:** left subclavian artery; **L-VA:** left vertebral artery; **VA:** vertebral artery.

ies results in ischemia of the area.[17] Therefore, the knowledge of these persistent arteries before surgery can be crucial while designing the surgical procedure.[9,16,17]

The coincidence of PPA and aneurysms is mentioned in many studies including our study.[7,10,14,15] Besides this, some authors suspected that PPA might be associated with other symptoms or clinical findings such as tinnitus, ischemic cerebrovascular diseases, arteriovenous malformations.[12,13,18] Kolbinger et al.[18] described a case with right cerebellar infarction and ischemic lesions in the left dorsal thalamus and the right upper parietal lobe. In this case, the angiography showed occlusion of the right ICA proximal to an ipsilateral proatlantal artery Type I. They suggested their case demonstrated the clinical significance of a persistent proatlantal artery in the evolution of an atypical ischemic cerebrovascular disease.

Conclusion

The literature on the PPA and other persistent primitive arteries are mostly case reports and/or literature reviews. Thus, incidence of this artery is undecided. Although coincidence of PPA and vascular anomalies is mentioned in numerous articles, there is no consensus about this issue. Also, association with PPA and other diseases or symptoms is still not clear. When the clinical importance of this artery is considered, extended and retrospective studies like this are necessary.

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Conflict of interest statement: No conflicts declared.