Arteria trigemina primitiva — radiological report of three cases and review of literature

Authors: Adam Tomalczyk, Zbigniew Kaurzel, Wojciech Szubert, Piotr Oszukowski

DOI: 10.5603/FM.a2017.0054

Article type: CASE REPORTS

Submitted: 2017-03-26

Accepted: 2017-05-19

Published online: 2017-06-14

This article has been peer reviewed and published immediately upon acceptance. It is an open access article, which means that it can be downloaded, printed, and distributed freely, provided the work is properly cited. Articles in "Folia Morphologica" are listed in PubMed.
Arteria trigemina primitiva — radiological report of three cases and review of literature

Arteria trigemina primitive — report of three cases

Adam Tomalczyk¹, Zbigniew Kaurzel¹, Wojciech Szubert¹, Piotr Oszukowski²

¹Department of Radiology, Copernicus Memorial Hospital, Łódz, Poland
²Department of Clinical Morphology in the Chair of Anatomy, Medical University of Łódz, Poland

Address for correspondence: Adam Tomalczyk, Department of Radiology, Copernicus Memorial Hospital, ul. Pabianicka 62, 93-513 Łódz, Poland, tel: (+48) 42 689 57 53, fax: (+48) 42 689 50 41, e-mail: adam.tomalczyk@gmail.com

Abstract
The main aim of this paper is to present three cases of persistent (patent) primitive trigeminal artery, presence was incidentally revealed during various radiological examinations. The presence and function of these vessels in extrauterine life is sometimes associated with other vascular abnormalities e.g. aneurysms, hemangiomas, moyamoya disease but frequently found incidentally without any negative signs or symptoms. The presented cases of patients with primitive trigeminal artery clearly show that the reported ailments, which had made the diagnostic imagining necessary, were not associated with the patency of this artery.

Key words: primitive carotid-basilar anastomosis, primitive trigeminal artery, anatomic variations, incidence

Introduction
The blood supply of the human brain stems from four main arteries: left and right internal carotid arteries, which originate from the bifurcation of the common carotid arteries and two vertebral arteries - left and right, as well - branches of the subclavian arteries. After entering the skull they form a more or less regular vascular
circle around the diencephalon, also referred to as the circle of Willis (Fig 1). After passing through the carotid canal and cavernous sinus, each of the internal carotid arteries (ICA) ends with a bifurcation into the middle cerebral artery (MCA) (larger in diameter) and the anterior cerebral artery (ACA) (smaller in diameter). Before entering longitudinal cerebral fissure both anterior cerebral arteries are connected with each other by a single vascular anastomosis known as anterior communicating artery (ACoA). This junction divides anterior cerebral artery into two parts: pre- (A1) and postanastomosing (A2). The vertebral arteries (VA) after passing through the foramen magnum ascend in the posterior skull fossa and feed into a single artery called the basilar artery (BA). After giving off branches that mainly supply the brain stem basilar artery ends with a bifurcation into the symmetric posterior cerebral arteries (PCA). The junction between each of the latter with ipsilateral internal carotid artery is called the posterior communicating artery (ACoP) and similar to ACoA it divides posterior cerebral artery into two parts: pre- (P1) and postanastomosing (P2) [6, 11, 14, 16, 19, 27].

The above described scheme applies to extrauterine life and adolescence only. During the embryonic life the system of brain arteries is more complex. It is suspected that posterior cerebral arteries are developmentally associated with internal carotid artery. At the beginning, the posterior fossa is fed by the “carotid-basilar anastomosis” and by the caudal division of the ICA which is the ACoP and the future P1 that connects with the ipsilateral longitudinal neural artery. A caudal branch of ICA gives rise to the posterior choroidal, diencephalic and mesencephalic arteries. As this branch reaches caudally, communication is made with the developing longitudinal neural arteries, which initially are fed primarily by the trigeminal artery connections to the ICA’s but also by the primitive otic, hypoglossal and pro-atlantal intersegmental arteries. The fusion of the two longitudinal neural arteries is depending on the trigeminal regression: if the trigeminal arteries regress, the basilar trunk is made and connects the vertebral arteries followed by an arterial flow reversal in the basilar trunk. If the fusion doesn’t occur, the ICA system remains dominant; the basilar trunk doesn’t totally develop with possibilities of persistence of the two longitudinal neural arteries, hypoplasia of the inferior part of the basilar artery, aplasia of the vertebral arteries [10, 18, 20, 26].

The above mentioned arterial anastomoses disappear during the intrauterine life.
After delivery the only vessels connecting two main sources of brain blood supply are the posterior communicating arteries (left and right).

Yet, the fetal arteries, do not always have to vanish [4,7]. The presence and function of these vessels in extraterine life is sometimes associated with other vascular abnormalities [1, 2, 5, 13, 15, 17, 23, 24] but frequently found incidentally without any negative signs or symptoms.

The main aim of this paper is to present the cases of persistent patent primitive trigeminal artery, which was found incidentally during radiological examinations.

Cases reports

Case 1

A 67-year-old woman, with a negative past medical history, was admitted to the hospital due to the sudden acute headache with a probable loss of consciousness. No other complaints were reported. The patient's neurological examination revealed mild neck stiffness. Computed tomography showed subarachnoidal hemorrhage, whereas CT-angiography revealed the presence of the anterior communicating artery aneurysm. Additionally, the wide vessel (diameter approximately 3 mm) connecting the cavernous segment of the right internal carotid artery and the basilar artery was observed (Fig 2 and 3). The classical angiography and embolization were planned. Due to wide neck of aneurysm sack and high tension in catheter-guidewire system it was impossible to perform the embolization and patient underwent neurosurgical treatment.

Case 2

A 82-year-old woman with a history of microangiopathic leukoencephalopathy, polyneuropathy and ischemic heart disease underwent diagnostic procedures for chronic non-systemic balance disorders lasting for a couple of years. The neurological examination revealed hypertonia of the lower limbs, discreet weakness of the left lower and upper limbs, dysmetria of both upper and lower limbs. The patient fell backward on Romberg's test.

The patient was referred for CT-angiography of cervical and cerebral vessels. The examination revealed critical stenosis of basilar artery localized distally to posterior inferior cerebellar artery (PICA) branches, the occlusion of the vessel could not have
been ruled out. Above the stenosis a wide vessel that runs to the cavernous segment of ICA dx was found - i.e. primitive trigeminal artery. Aplasia of P1 segment of right PCA and hypoplasia of A1 segment of left ACA were also observed (Fig 4 and 5).

Case 3

A 45-year-old woman was admitted to the Department of Neurology for further diagnostic of the lesion localized in the left cerebral hemisphere. The patient presented signs and symptoms of escalated right-sided hemiparesis and speech disorders which, during the neurological examination, occurred to be aggravated probably by the conversion disorder.

Contrast-enhanced MRI showed few lesions localized peripherally in the left parietal and occipital lobes, hyperintense in T2 weighted images, some of them with heterogeneous contrast enhancement. Due to various size and different localization in comparison with previous MRI scans differential diagnosis between vascular dependent lesions and vasculitis was suggested. The patient underwent a panangiography which did not confirm vasculitis. Instead it showed wide vessel connecting the cavernous segment of right internal carotid artery with the middle section of basilar artery (Fig 6 and 7).

Discussion

The reports concerning the presence and function of patent fetal arteries are not very rare, with PTA being the most frequent carotid-basilar anastomosis discovered incidentally in adults [8]. It has been reported to become visible in 0.1% to 0.6% of all cerebral angiograms [3]. The persistence of this vessel usually leads to hypoplasia or agenesis of the ipsilateral posterior communicating artery, and leaves the internal carotid artery as the main source of blood supply to the upper brainstem region [3]. It may also be associated with the presence of hypoplastic vertebral and basilar arteries [8].

The analysis of angiographic images allowed Saltzman to develop a classification based on the localisation of PCoA and the area supplied by PTA [22]. Type I is described as PTA supplying upper BA with superior cerebellar and posterior cerebral arteries with concomitant hypoplastic proximal BA and absent ipsilateral PCoA. Type II was defined as anterior superior cerebellar arteries being sole branches
of PTA, whereas first part of posterior cerebral arteries is absent and the remaining segments arise from posterior communicating arteries. The recognition of the last type (III) is based on PTA joining the remnant of primitive paired longitudinal neural artery. Such artery does not anastomose with BA and supplies single ipsilateral cerebellar artery, most frequently anterior inferior cerebellar artery [21].

Developmental anomalies of the aortic arch vessels and PTA are repeatedly reported in the literature [1, 17]. Despite the fact that the presence of these vessels usually does not lead to any negative outcomes, there have been reports on various disorders associated with them. Patients may present with symptoms related to hypoperfusion of posterior circulation or microembolization from carotid artery to posterior circulation [8]. Brockhoff and Tiwisina presented a case of PTA aneurysm that had led to subarachnoidal hemorrhage [5]. Svehla and Vitovec suspected that PTA was the cause of epilepsy [25]. Angoli noticed that the patent PTA supplied the hemangioma [2]. Stoeter and Marquardt described a case of 3-year-old child whose PTA accompanied other congenital central nervous system disorders [23]. Battista, Kwartler, Martinez reported that PTA was as a cause of dizziness [3]. Suzuki et al presented identical twin suffering from the moyamoya disease with concomitant persistent PTA variant [24]. Komiyama et al noticed high incidence of persistent primitive arteries in moyamoya and quasi-moyamoya diseases [13].

The incidence of patent primitive hypoglossal artery is very low, as this artery is observed in approximately 1-2 patients out of 2207 to 7382 undergoing diagnostic imaging procedures [9, 12].

The presented cases of patients with primitive trigeminal artery, all Saltzman type I, clearly show that the reported ailments that had made the diagnostic imagining necessary were not associated with the patency of this artery.

Conflict of interest: The authors declare no conflict of interest

References

**Figure 1.** MRI-angiography of the most frequent variation of Circle of Willis: ACoA- anterior communicating artery, RACA- right anterior cerebral artery, RICA- right internal carotid artery, RPCA- right posterior cerebral artery, RVA- right vertebral artery, LVA- left vertebral artery, LMCA- left middle cerebral artery, LACoP- left posterior communicating artery, BA- basilar artery. Gadovist

**Figure 2.** 3D reconstruction of CT-angiography of the brain: PTA – primitive trigeminal artery, RACA- right anterior cerebral artery, LPCA- left posterior cerebral artery, RPCA- right posterior cerebral artery, RMCA- right middle cerebral artery, RICA- right internal carotid artery, LSCA- left superior cerebellar artery, RSCA- right superior cerebellar artery, BA- basilar artery. Ultravist

**Figure 3.** CT-angiography of the brain: PTA- primitive trigeminal artery, RICA – right internal carotid artery, RACA – right anterior cerebral artery, RMCA – right middle cerebral artery, LMCA- left middle cerebral artery, LPCA – left posterior cerebral artery, BA- basilar artery, LVA – left vertebral artery. Ultravist

**Figure 4.** 3D reconstruction of CT-angiography of the brain: PTA – primitive trigeminal artery, RICA- right internal carotid artery, RACA- right anterior cerebral artery, RMCA-right middle cerebral artery, RACoP- right posterior communicating artery, LPCA- left posterior cerebral artery, RPCA- right cerebral posterior artery, RSCA- right superior cerebellar artery, BA- basilar artery. Ultravist

**Figure 5.** CT-angiography of the brain: PTA– primitive trigeminal artery, RICA- right internal carotid artery, BA- basilar artery. Ultravist
**Figure 6.** Towne's view of a right ICA angiogram: PTA– primitive trigeminal artery, RICA – right internal carotid artery, BA- basilar artery. Ultravist

**Figure 7.** Lateral view of a right ICA angiogram: PTA– primitive trigeminal artery, RICA– right internal carotid artery, BA- basilar artery. Ultravist