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Research article

Infundibular dilatation of the posterior communicating artery in a defined population

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ABSTRACT

Unusual widening of the posterior communicating artery (PCoA) at its beginning from the cerebral portion of the internal carotid artery (ICA) was described as its infundibular dilatation (ID). A possibility of ID rupture or progression to aneurysm was the reason for an investigation of its frequency and morphologic features in specimens of the Serbian population. Cerebral arteries on the brain base of 267 adult cadavers of both genders and varying age and causes of death were dissected. The images of the PCoA in 190 fetuses were also reviewed. ID of the PCoA was defined as a funnel shaped beginning of different width from ICA, wherein PCoA continues from ID apex to the posterior cerebral artery. There were no cases of ID in fetuses. ID and aneurysms of the PCoA were found in 6/267 or 2.2% and 3/267 or 1.12% of adults, respectively. Unilaterally, they existed on the left side and, frequently, in male cases aging 70 years and older, that had died without cerebral cause. Bilaterally, ID was found in 2/6 cases. There was only one case of ID and aneurysm of the PCoA, but from the ID. We are of the opinion that ID of the PCoA only develops postnatally and probably is due to the influence of hemodynamic factors or hypertension.

1. Introduction

The posterior communicating artery (PCoA) originates from the cerebral part of the internal carotid artery (ICA) on both sides, mainly from its posterolateral or posterior aspect, and after a course of about 12 mm it unites with the posterior cerebral artery (PCA) in the interpeduncular cistern (Baskaya et al., 2004; Uz and Mine, 2004). The outer diameter of the PCoA of human fetuses in gestational weeks 13 to 24 ranged from 0.1 to 1.0 mm (Vasović et al., 2008a), whereas in adults ranged from 1.0 to 2.9 mm (Uz and Mine, 2004). However, it was proved that the size of the PCoA does not reflect its functional significance; it gives off 2–10 branches that supply the inferior optic chiasm, optic tract, tuber cinereum, mammillary bodies, anterior thalamus, subthalamus and posterior hypothalamus (Baskaya et al., 2004).

Morphological and clinical importance of abnormalities of the PCoA were underlined in descriptions of its aplasia (Huber, 1982), or hypoplasia (Huber, 1982; Vasović et al., 2011, 2013), or hyperplasia (Vasović et al., 2008a, 2011, 2013), or fenestration (Vasović et al., 2002), and partial or total duplication (Huber, 1982), or infundibular dilatation of the origin (Miyasaka et al., 1982; Ebina et al., 1986; Moreĩhon et al., 1989; Dimmick and Faulder, 2009) and single and/or associated aneurysm (Miyasaka et al., 1982; Jang et al., 2006; Dimmick and Faulder, 2009). According to the findings based on 400 autopsies, it was noted that PCoA showed normal diameter in 46%, wide lumen in 29%, narrow lumen in 23.9%, duplication in 0.75%, unilateral aplasia in 2.25% and bilateral aplasia in 0.25% of cases (Huber, 1982).

An infundibular dilatation (ID) of the PCoA was described as a funnel shaped beginning from ICA, wherein PCoA continues from ID dome (Dimmick and Faulder, 2009). Although there were clinical cases of the PCoA aneurysm developed from ID (Yoshimoto and Suzuki, 1974; Miyasaka et al., 1982; Huber, 1982; Patrick and Appleby, 1983a; Martins et al., 2002; Jang et al., 2006; Fisher et al., 2011), this still remains controversial (Baskaya et al., 2004). As quoted by Jang et al. (2006) the incidence of the "true" PCoA aneurysm varies from 0 to 3.3%. Single aneurysms of PCoAs were more common in women and associated with a fetal type of the PCoA in specimens of Brazil population (Silva Neto et al., 2012). In order to determine whether this is also the case in the Serbian population, we have investigated the ID and/or aneurysm of the PCoA in cadavers.

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2. Materials and methods

The examination was carried out on the brains of 267 human adult cadavers of both sexes (146 males and 121 females) and different ages (from year 20 to 95), autopsied because of different causes of death. This research was performed by the second coauthor (MT) during her academic and postdoctoral studies at the Institute for Forensic Medicine in Niš in the period between 2006 and 2013; approval was granted by the Research Ethics Committee (No. 01-9068-1) of the Faculty of Medicine in Niš, Serbia.

Control group represented images of 380 PCoAs of 190 fetuses, as well as their quantitative and qualitative parameters in tables noted by the coauthor in her doctoral thesis (Vasović, 1990).

The research of fetal vessels was carried out at the Department of Anatomy of the Faculty of Medicine in Niš. All fetuses were obtained from the Clinic of Gynecology and Obstetrics in Niš. The age of the individual fetuses was determined according to the scale in the embryological book (Patten, 1948). The arteries of most fetuses were injected with Micropaque (Merck, Darmstadt, Germany) or latex through the left ventricle of the heart or through the common carotid artery. All fetuses were fixed in 10% neutral-buffered formalin for 2 weeks. The brains were removed from the fetal skulls after this period and kept in individual calvarias. All measurements were performed by means of an ocular micrometer mounted on a surgical microscope (Olympus MTX; Olympus Optical Co, Ltd, Japan) with magnification; a calibration of the ocular micrometer was performed with an objective micrometer.

A single brain base of adult cadavers with blood vessels was recorded on the film and workbook. The origin of the posterior communicating artery (PCoA) on both sides was inspected macroscopically and by magnifying glass; a vessel's outer diameter was calculated at the digital images, using the ImageJ processing program (http://rsb.info.nih.gov/ij/index.html). Every single image included a visible ruler for the spatial calibration. Spatial calibration was performed by drawing a straight line along known distance of the ruler at every image and then in the Set Scale box of the software its length in pixels was converted in the millimeters. The measured distance was marked by a straight line selection and afterwards by Measure option in ImageJ's Analyze menu, distance in millimeters was shown in Results box.

The interpretation of an infundibular dilatation (ID) at the PCoA origin (Fig. 1) was made according to Zager and Hackney (1996); the mark of ICA–PCoA aneurysm followed a recommendation by Kaufmann et al. (2005).

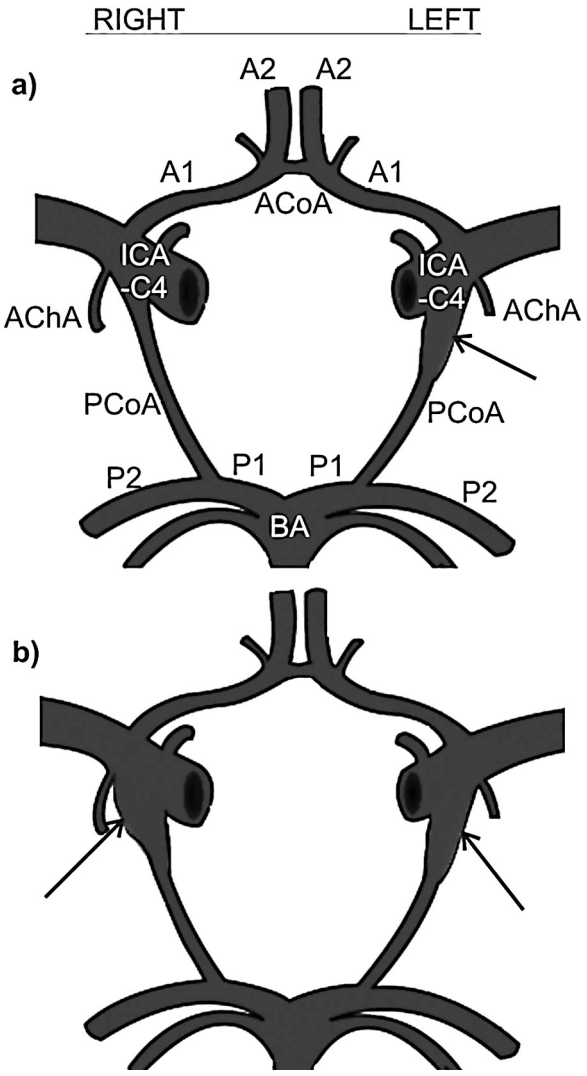

Fig. 1. Schemes of some arteries of the carotid and vertebrobasilar systems on the brain base. Arrows show unilateral (a) and bilateral (b) initial infundibular dilatations (IDs) of the posterior communicating artery (PCoA). It is important for a diagnosis of ID of the PCoA that it should continue from the ID dome.
(ICA—C4) internal carotid artery—cerebral part; (A1) anterior cerebral artery—pre-communicating part; (ACoA) anterior communicating artery; (A2) anterior cerebral artery—post-communicating part; (AChA) anterior choroidal artery; (BA) basilar artery; (P1) posterior cerebral artery—pre-communicating part; (P2) posterior cerebral artery—post-communicating part.

3. Results

We did not find any instance of ID of the PCoA ("affected" PCoA) in 190 fetuses, regardless of vessel caliber or length, and age or gender of fetuses; this is demonstrated in some examples (Fig. 2).

We presented mean values of the P1 and PCoA outer diameters of 267 cases in Fig. 3; their mutual comparison is shown in Table 1.

There were six IDs (6/267) or 2.2% of cases. General and special data about ID and/or aneurysm of the PCoA are presented in Table 2.

An aneurysm of the PCoA was discovered three times or in 1.12% of cases. It was associated with ID, but located caudal to ID in one case, and then it was at the level of PCoA beginning in two cases: in one as the single and, in the second case, in association with the aneurysm of ipsilateral ICA (Fig. 4; cases 6–8).

ID of the PCoA was found in four male and two female cadavers aging 70 and older. Unilateral ID was discovered on the left PCoA in two male and two female cadavers, whereas bilateral IDs were found in two male cadavers (Fig. 4; cases 1–5 and 8). The shape of ID was conical in each of six cases. The width of ID ranged from 2.43 to 5.93 mm (3.78 mm, average) on the left, as well as 3.21 and 4.70 mm on the right side (3.95 mm, average). The outer diameter (OD) of affected PCoA ranged from 0.76 to 2.24 mm (1.43 mm, average) on the left side, and 0.76 mm and 2.03 mm on the right side. PCoA was hypoplastic (OD $\leq$1 mm) in 2/6 cases on the left, and in one of the two cases on the right side. The posterior segment of the cerebral arterial circle (CAC) was of the fetal (bilaterally—one; unilaterally—three), or adult (bilaterally—two; unilaterally—two), or transitory (unilaterally—one) type. Simultaneously, OD of unaffected PCoAs ranged from 0.75 to 2.29 mm. The length of affected PCoA ranged from 5.49 to 15.67 mm on the left side, and 15.23 and 17.52 mm on the right side. The length of unaffected PCoAs ranged from 12.04 to 17.34 mm.

We also presented mean values of the P1 and PCoA of the cases of the same age as the cases with ID (Fig. 5). We did not note any