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Arteries that supply the brain and the formation of circulus arteriosus cerebri in donkeys

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Summary

The study investigated the anatomy of the arteries of the brain in seven donkeys following intravascular injection of colored latex via the a. vertebralis and a. carotis communis. Arterial blood washed the brain via the bilateral a. carotis interna and a. vertebralis and via the unpaired a. basilaris. A. carotis interna entered the cavum cranii at the level of sulcus pontocruralis, and ramified at the level of the corpus mamillare into a. cerebri rostralis and a. communicans caudalis. At the level intracranial entry, a. carotis interna gave rice to a. caroticobasillaris which was bilaterally present in 4 cases and unilaterally in 1 animal, a. caroticobasillaris, whereas the other branch was and a. constant a. intercarotica caudalis which was located at the level of sulcus pontocruralis. In one cadaver, a very slender a. intercarotica rostralis originated from a. carotis interna at the level of the origin of a. cerebri rostralis, and joined its counterpart vessel at the border between tuber cinereum and chiasma opticum. In all cases, a. ethmoidalis interna originated from a. cerebri rostralis. It was observed that a. cerebri rostralis dextra et sinistra fused directly into a. single median vessel named a. communicans rostralis.

Keywords: donkey, brain artery, circle arteriosus

The brain is one of the internal organs of the organism displaying the highest level of continuous active metabolism. Due to its quite limited energy stores and ability to survive under anaerobe conditions for a limited period as well as requiring high levels of energy to maintain its structure, the brain demands blood and therefore oxygen. Disruption of cerebral circulation causes deep nervous and mental disorders (1). Moreover, congenital differences in the size and configuration of cerebral arteries may result in a predisposition for ischemic paralysis. A hypoplastic basilar artery is frequently accompanied with vertebral arterial hyperplasia and this phenomenon may render the organism predisposed to posterior circulation ischemia (5). Blood supply to the brain is provided by four main vessels including two carotid arteries (aa. carotides internae) and two vertebral arteries (aa. vertebrales) in humans and black bears (1-3), a. vertebralis, a. basilaris and a. carotis interna (13) and, in addition to the indicated arteries by a. ophthalmica interna (18) in guinea pigs, a. carotis interna, a. basilaris, a. ethmoidalis interna in horses (4), and in addition to the indicated arteries by a. ophthalmica interna in dogs and bovine foetuses of the zavot breed (11, 12), furthermore a. basilaris, a. carotis interna and a. carotis externa in dogs (8), and in addition to a. basilaris and a. carotis interna, by a. communicans caudalis that has its origin at rete mirabile epidurale rostrale in camels (17). These arteries anastomose with each other in the vicinity of the stalk of the hypothesis at the ventral surface of the brain to form circulus arteriosus cerebri (circle of Willis) (1, 11-13, 18). The circulus arteriosus cerebri distributes the blood supplied by these arteries to various quarters of the brain at equal pressure (3).

The pre-anterior, mid-anterior and posteriolateral areas of the circulus arteriosus cerebri are formed by aa. cerebri rostrales, a. communicans rostralis, and a. communicans caudalis, respectively. Furthermore, a. communicans caudalis connects a. carotis interna with a. basilaris (4, 7, 19). Three arteries originating from circulus arteriosus cerebri, i.e. cerebralis rostralis, a. cerebralis media and a. cerebralis caudalis supply the cerebrum (9, 10). It has been reported that a. intercarotica caudalis may exist in dogs, horses and cats (14, 19).

The present study was undertaken to define the arteries that supply the brain in adult donkeys, and the arteries that form circulus arteriosus cerebri, in order to compensate for the deficiency of information on this particular subject.

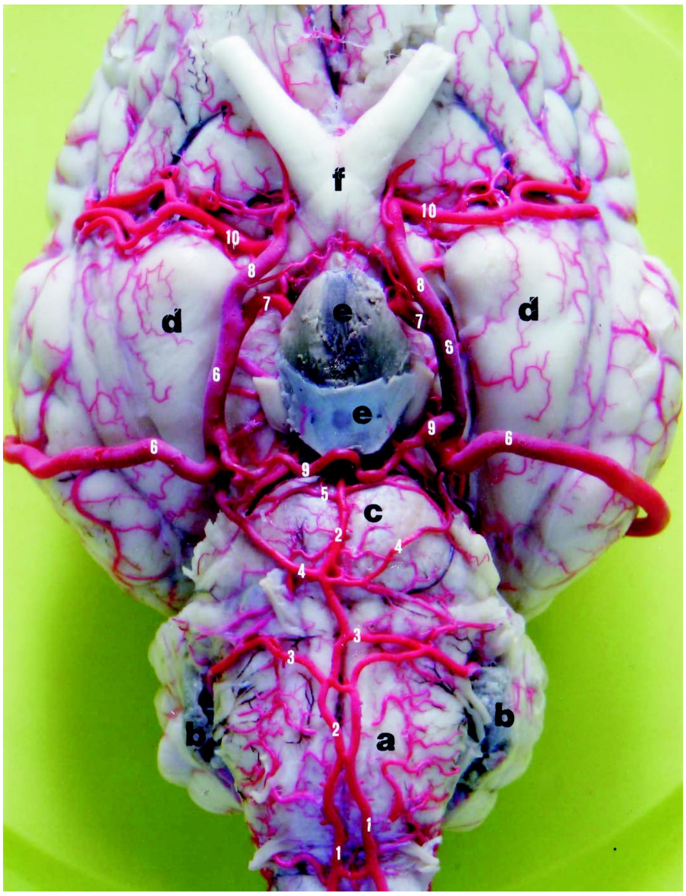

Fig. 1. Ventral view of brain and cerebellum
Explanations: a – medulla oblongata; b – cerebellum; c – pons; d – lobus piriformis; e – hypophysis cerebri; f – chiasma opticum; 1 – a. vertebralis; 2 – a. basilaris; 3 – a. cerebellaris caudalis; 4 – a. caroticobasilaris; 5 – a. cerebellaris rostralis; 6 – a. carotis interna; 7 – a. communicans caudalis; 8 – a. cerebri rostralis; 9 – a. intercarotica caudalis; 10 – a. cerebri media

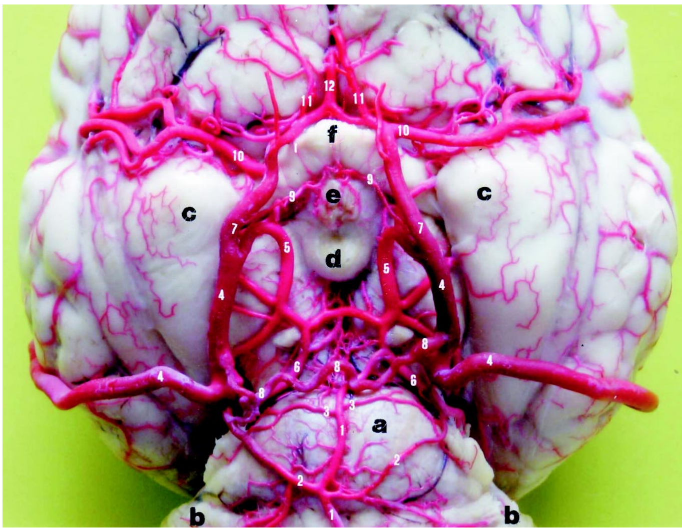

Fig. 2. Ventral view of brain
Explanations: a – pons; b – cerebellum; c – lobus piriformis; d – corpus mamillare; e – tuber cinereum; f – chiasma opticum; 1 – a. basilaris; 2 – a. caroticobasilaris; 3 – a. cerebellaris rostralis; 4 – a. carotis interna; 5 – a. communicans caudalis; 6 – a. cerebri caudalis; 7 – a. cerebri rostralis; 8 – a. intercarotica caudalis; 9 – a. intercarotica rostralis; 10 – a. cerebri media; 11 – a. ethmoidalis interna; 12 – a. communicans rostralis

Material and methods

The study material consisted of the heads of seven adult donkeys (*Equus asinus L.*), used in applied anatomy lessons, which were preserved in formaldehyde and displayed no differences with regard to sex. The arteries of the studied heads were filled with latex colored with red rotring ink (Sanford GmbH, D-22510 Hamburg) via a. carotis communis and a. vertebralis, on both sides, in the vicinity of the heart. Prior to dissection, the materials were kept at +4°C for 24 hours, for the polymerization of latex. The obtained findings were photographed with a (Canon Powershot S70 Digital Camera) model camera. The anatomical nomenclature used is adopted from the established terminology of the Nomina Anatomica Veterinaria (16).

Results and discussion

A. vertebralis was used to enter the canalis vertebralis through the foramen vertebrale laterale. The right and left aa. vertebrales (fig. 1/1) were observed to run cranially for an approximate distance of 15 mm, parallel to the fissura mediana ventralis, and to form a. basilaris by joining either in the vicinity of the roots of n. hypoglossus or at the mid-level of medulla oblongata above the fissura mediana ventralis. Furthermore, both aa. vertebrales were observed to communicate with each other approximately 2.6 mm caudal to the level at which they enter canalis vertebralis. A single thin vessel originating from the indicated site of communication – a spinalis ventralis, was demonstrated to run caudally along fissura mediana ventralis.

Aa. cerebrales caudales were observed to branch out symmetrically from the right and left sides at an approximate distance of 6.7 mm to the level at which a. basilaris (figs. 1/2 and 2/1) forms. Furthermore, a. basilaris was determined to give rise to aa. labyrinthi on both sides at an approximate distance of 3 mm to the origin of a. cerebellaris caudalis (fig. 1/3), above the medulla oblongata, and also to 2-3 thin branches named rami ad pontem a little further at the level of the pons.

Branches named aa. caroticobasilares (figs, 1/4 and 2/2) connecting a. basilaris with a. carotis interna, were determined to branch out during the course of a. basilaris on the ventral surface of the medulla oblongata, at the same level in one cadaver, on only the right side in another cadaver, and on both sides at a distance of 1.5-2.5 mm in between in the remaining 3 cadavers. The indicated artery (a. caroticobasilaris) did not exist in 2 cadavers.

A. basilaris was observed to give rise to aa. cerebellares rostrales (figs. 1/5 and 2/3) asymmetrically on both sides within sulcus basilaris at the level of the pons and to asecend to the cerebellum within sulcus pontocruralis. A. cerebellaris rostralis was observed to join to a. basilaris on the right side in one cadaver, and the left side in another cadaver, and to subsequently join a. communicans caudalis at an approximate distance of 2.8 mm. The artery branching out cranially from a. cerebellaris rostralis was demonstrated to join to a. communicans caudalis at its caudal border, in 5 cadavers.

A. communicans caudalis was observed to give rise to a branch named a. cerebri caudalis (fig. 2/6) that runs bilaterally above crura cerebri to the dorsal surface of lobus piriformis.

A. carotis interna (figs. 1/6 and 2/4) was determined to enter cavum cranii at the level in-between sulcus pontocruralis and crura cerebri. It was observed to reach the level of corpus mamillare in the vicinity of crura cerebri on the medial surface of lobi piriformes and to bifurcate at the indicated site. One of these branches, i.e. a. cerebri rostralis, was determined to be the continuation of the artery and to be of approximately the same diameter, whereas the other branch was determined to be a. communicans caudalis that ran in a caudal direction.

A. carotis interna was determined to enter cavum cranii prior to its bifurcation into these two branches, namely a. cerebri rostralis (figs. 1/8 and 2/7) and a. communicans caudalis (figs. 1/7 and 2/5), and to give rise to two branches on the medial surface at approximately the level of sulcus pontobulbaris. One of the branches was demonstrated to form a. caroticobasilaris by joining to a. basilaris at the level of the pons, whereas the other branch was seen to join to the similar counterpart vessel at the level of sulcus pontocruralis to form a. intercarotica caudalis (figs 1/9 and 2/8).

In one cadaver, the existence of a transverse vessel was noted of a. intercarotica rostralis (fig. 2/9), formed upon the joining of a very thin vessel originating from the site at which a. cerebri rostralis, known to be the continuation of a. carotis interna, departs from the indicated artery at the level of the border of tuber cinereum with chiasma opticum to a similar counterpart vessel.

Along their course, aa. cerebri rostrales gave rise to aa. cerebri media (figs. 1/10 and 2/10) on both sides, which course within fissura lateralis in the vicinity of chiasma opticum. In six cadavers, a. cerebri rostralis was determined to give rise to a branch named a. ethmoidalis interna (fig. 2/11) at the anterior of the chiasma opticum, then it was joined to the counterpart vessel with the same name (a. cerebri rostralis), and it entered fissura longitudinalis cerebri as a main root called a. communicans rostralis (fig. 2/12).

Blood supply to the brain was determined to be provided by a. carotis interna, a. basilaris, a. ethmoidalis interna and a. ophthalmica interna in the donkey, in compliance with previous reports of researchers (11, 12). A. intercarotica caudalis, reported to exist in dogs, horses and cats by (14, 19) was also determined to exist in donkeys. A. intercarotica rostralis reported previously only by (2, 9) was only determined in one cadaver amongst the investigated donkeys.

Despite the origin of a. cerebri media, a. cerebri rostralis and a. communicans caudalis to be previously reported by (2), as a triple root from a. carotis interna, a. carotis interna was determined to ramify into a. cerebri rostralis and a. communicans caudalis, and a. cerebri media was demonstrated to have its origin at a. cerebri rostralis in the donkey.

In compliance with literary reports on horses (4, 6), a. cerebellaris rostralis was determined either to directly open into a. communicans caudalis which forms the caudal end of circulus arteriosus cerebri, or similar to the report of (4) to open into a. communicans caudalis after joining to a. basilaris.

As indicated in literary reports (4, 7) a. communicans caudalis was demonstrated to connect a. carotis interna with a. basilaris in donkeys, and furthermore, in compliance with the report of (7, 15, 19), a. carotis interna was detected to be connected with a. basilaris by means of a vessel named a. caroticobasilaris.

Similar to the reports of (4, 7), the anterior, mid-anterior and posteriolateral of circulus arteriosus cerebri were demonstrated to be formed by aa. cerebri rostrales, a. communicans rostralis and a. communicans caudalis, respectively.

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