The morphology of circulus arteriosus cerebri in the porcupine (*Hystrix cristata*)

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ABSTRACT: The circulus arteriosus cerebri of the porcupine was investigated in this study. Five porcupines were used. Coloured latex was given from the left ventricles of three and from the communis carotid artery of two porcupines. The circulus arteriosus cerebri was examined after dissection was done. The basilar artery was formed by a merge of the right and left vertebral artery. The caudal communicans artery which was the caudal part of circulus arteriosus cerebri was formed by the basilar artery on crus cerebri. From caudal to cranial, the branches originating from the basilar artery and circulus arteriosus cerebri to cerebrum and cerebellum were as follows: caudal cerebelli artery, media cerebelli artery, rostral cerebelli artery, caudal choroidea artery, artery which extended to the mesencephalon, caudal cerebral artery, internal ophthalmic artery, rostral choroidea artery, media cerebral artery, rami striati and rostral cerebral artery. The rostral cerebral artery dexter and sinister joined to each other by the rostral communicans artery, forming the circulus arteriosus cerebri. It was determined that the internal carotid artery did not participate in the formation of circulus arteriosus cerebri and the arterial blood to the circulus arteriosus cerebri of porcupine is provided via the basilar artery only.

Keywords: circulus arteriosus cerebri; brain; porcupine; *Hystrix cristata*

The porcupine is a member of the family Hystricidae, a small group of Rodentia (Weichert, 1970; Kuru, 1987; Demirsoy, 1992). The circulus arteriosus cerebri has been studied in a variety of mammals including dog (Miller et al., 1964), cat (McClure et al., 1973), rat (Brown, 1966; Green, 1968), rat and mouse (Firbas et al., 1973), mouse (Cook, 1965; Wiland, 1974), guinea pig (Ocal and Ozer, 1992), guinea pig and rabbit (Popesko et al., 1990), rabbit (Brehmer and Beleites, 1988). Although there are several studies investigating the spinal nerves composing (Aydin, 2003) and the peripheral nerves (Aydin, 2004) originating from the brachial plexus and immunohistochemical localization of calbindin-D28k in the kidney and cerebellum (Timurkaan et al., 2003), to our knowledge no study exists that investigates the circulus arteriosus cerebri in porcupines (*Hystrix cristata*), so this is the first study on the circulus arteriosus cerebri of porcupines (*Hystrix cristata).* The purpose of this study was to document arteries that constitute the circulus arteriosus cerebri of porcupines (*Hystrix cristata*) and its morphological structure.

MATERIAL AND METHODS

Five adult porcupines were used. They were hunted by villagers in Eastern Anatolia. After the animals were anaesthetized with pentathol (6 ml/kg), the blood contents of the carotid communis artery were drained. Coloured latex was injected by hand, from the left ventricles of three porcupines to the carotid communis artery dexter and sinister of two porcupines.

After a few days of fixation in 10% formaline, the skulls of porcupines were placed in 10% hydrochloric acid for 24 h for decalcification and the skull was then easily removed. The arterial patterns at the base of the brain were examined and pictured. For the terminology, the Anonymous (1994) was used.

RESULTS

The basilar artery was formed by the right and left vertebral artery of the porcupines joined to each other at the base of the medulla oblongata. The basilar artery was separated into two branches on the crus cerebri forming the caudal communicans artery. In the front the circulus arteriosus cerebri was formed by the rostral cerebral artery sinister and dexter joined by the rostral communicans artery. Arteries which vascularise cerebrum and cerebellum originated from the caudal communicans artery, basilar artery and rostral cerebral artery.

Arteries originating from the basilar artery

The caudal cerebellar artery which arose asymmetrically from the basilar artery dispersed to the caudal part of cerebellum and ventriculus quartus. The small branches which originated from between these asymmetric branches dispersed through the medulla oblongata.

The middle cerebellar artery originated from the basilar artery symmetrically and dispersed to the lateral part of cerebellum after passing between the pons and the corpus trapezoideum.

Rami ad pontem separating symmetrically from the basilar artery went to the pons.

Arteries originating from the caudal communicans artery

The rostral cerebelli artery which arose symmetrically dispersed to the caudal part of the tectum mesencephali and cranial part of the cerebellum.

Right and left branches of the caudal choroidea artery arose symmetrically and divided into two branches at the point where the lateral parts of the tectum mesencephali and crus cerebri join. The first branch dispersed to ventriculus quartus and tectum mesencephali and the second one dispersed to the cranial part of the cerebellum and tectum mesencephali.

The artery which extended to the mesencephalon originated from the caudal communicans artery on the left side, and originated from the caudal cerebral artery on the right and dispersed to the tectum mesencephali.

After the caudal cerebral artery originated from the caudal communicans artery, it passed through the caudo-ventral part of the hemispherium to the dorsal part of the brain, and extended to dorsale of the caudal partial of the corpus callosum in the fissura longitudinalis cerebri. Terminal branches of caudal cerebral artery merged with branches originating from the rostral cerebral artery dexter and the rostral communicans artery, at the caudal part of the facies media cerebri.

The internal ophthalmic artery which originated from medial of the middle part of the circulus arteriosus cerebri extends to the orbita by passing through the sulcus chiasmaticus after giving one branch to the hypophysis.

Arteries originating from the rostral cerebral artery

The rostral choroidea artery which arose from the rostral cerebral artery was divided into two branches as extending under the lobus piriformis. The first branch extended to the ventriculus lateralis. The second extended to the ventriculus tertius by giving its branches to the hypocampus and cranial of the tectum mesencephalon.

The middle cerebral artery was the thickest branch which separated from the middle part of the rostral cerebral artery symmetrically. After it gave the branches to basal and lateral of the forepart, middle and caudal partial of the hemispherium, it was separated to cortical and central branches and terminated on the facies convexa cerebri.

Rami striati distributing on the gyrus olfactorius lateralis were edged with the cranial branch of the middle cerebral artery.

Left and right rostral cerebral arteries were joined to each other by the rostral communicans artery after giving rami striati. One branch originating from the rostral communicans artery gave the branches extending to medial of the dorsal part of the cerebri and facies medial cerebri at the cranial part of the corpus callosum in the fissura longitudinalis cerebri, branches and continuing join. One branch originating from the rostral cerebral artery dexter was edged with the last branches of the caudal cerebral artery. In addition, the rostral communicans artery together with the branches of rostral cerebral artery gave the branches to the cranial and medial part of the hemispherium. Left and right rostral cerebral arteries were extended as the internal ethmoidal artery after giving these branches (Figure 1).

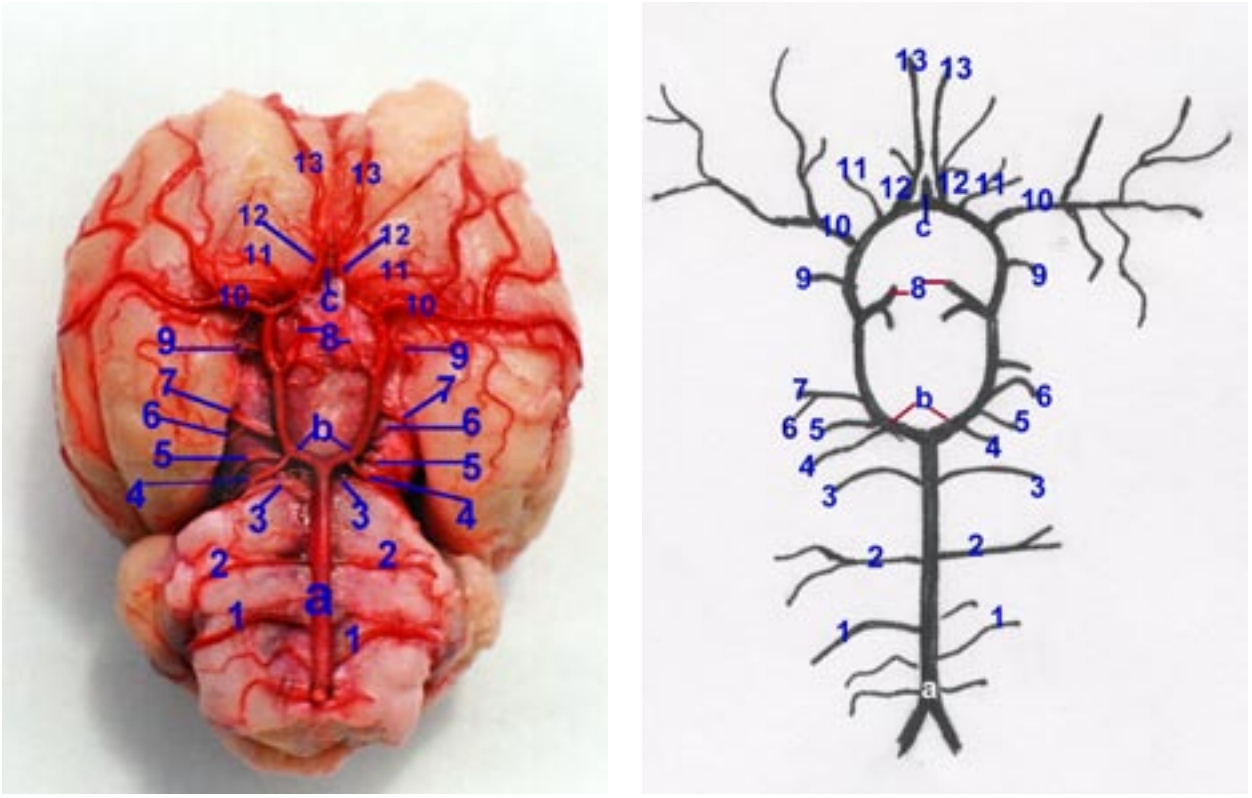

Figure 1. View of the cerebrum basis (left) and of the circulus arteriosus cerebri (right)

a – basilar artery, b – caudal communicans artery, c – rostral communicans artery; 1 – caudal cerebelli artery, 2 – medial cerebelli artery, 3 – rami ad pontem, 4 – rostral cerebelli artery, 5 – caudal choroidea artery, 6 – artery which extends to mesencephalon, 7 – caudal cerebral artery, 8 – internal ophthalmic artery, 9 – rostral choroidea artery, 10 – medial cerebral artery, 11 – rami striati, 12 – rostral cerebral artery, 13 – internal ethmoidal artery

DISCUSSION

It was reported that the circulus arteriosus cerebri is formed by the basilar artery and the internal carotid artery in rat (Brown, 1966; Green, 1968), mouse (Cook, 1965; Wiland, 1974), rabbit (Barone et al., 1973; Brehmer and Beleites, 1988), cat (McClure et al., 1973; Getty, 1975), and dog (Miller et al., 1964; Getty, 1975), whereas according to Ocal and Ozer (1992), it is formed by the internal ophthalmic artery, the basilar artery and the internal carotid artery in guinea pig. We reported here that the circulus arteriosus cerebri of porcupine (*Hystrix cristata*) is formed by the basilar artery only.

It was reported that the caudal cerebelli artery originated from the basilar artery symmetrically in mouse (Wiland, 1974), dog and cat (Getty, 1975) and rabbit (Barone et al., 1973), and asymmetrically in guinea pig (Ocal and Ozer, 1992), dog (Miller et al., 1964) and cat (McClure et al., 1973). The caudal cerebelli artery of porcupine (*Hystrix cristata*) originated from the basilar artery asymmetrically, and its origin resembles that of guinea pig (Ocal and Ozer, 1992), dog (Miller et al., 1964) and cat (McClure et al., 1973).

According to Wiland (1974), the medial cerebelli artery, mostly single, but sometimes as two or three branches, originated from the basilar artery asymmetrically in mouse, and its terminal branches were edged with the last branches of the caudal cerebelli artery. Getty (1975) reported that it originated as a symmetrical branch from the basilar artery in dog, and from the caudal cerebelli artery in cat. Findings of this study are in accordance with those in dog (Getty, 1975) and differ from those in mouse (Wiland, 1974) and cat (Getty, 1975).

It was reported that the rostral cerebelli artery generally separated from the basilar artery, some-

times one branch from the caudal communicans artery, the other branch asymmetrically from the basilar artery in rat (Brown, 1966), originated from the basilar artery (Popesko et al., 1990) or the caudal communicans artery in guinea pig (Ocal and Ozer, 1992). It is known that it originates from the caudal communicans artery in mouse (Wiland, 1974), rabbit (Barone et al., 1973), dog (Miller et al., 1964) and cat (McClure et al., 1973). According to Getty (1975), the rostral cerebelli artery is a branch of the mesencephalic artery which separated from the caudal communicans artery in dog and cat. The results of the present study were not consistent with those reported for guinea pig (Popesko et al., 1990), dog and cat (Getty, 1975) and rat (Brown, 1966), but they were consistent with other literature sources.

The choroidea artery originated from the internal carotid artery in the rat (Green, 1968), as a single branch from the cranial part of the circulus arteriosus cerebri in mouse (Wiland, 1974), from the medial cerebral artery in dog (Miller et al., 1964). Some authors reported the cranial choroidea artery in dog (Miller et al., 1964; Getty, 1975) and the caudal choroidea artery in cats (McClure et al., 1973; Getty, 1975). We found out that both the cranial and caudal choroidea arteries originated from the circulus arteriosus cerebri in porcupine (*Hystrix cristata*).

The caudal cerebral artery originates from the caudal communicans artery in rat (Green, 1968), mouse (Wiland, 1974), guinea pig (Popesko et al., 1990) and rabbit (Barone et al., 1973; Popesko et al., 1990). This artery originated from the joint point of the caudal communicans artery with the basilar artery in rat (Brown, 1966) and guinea pig (Ocal and Ozer, 1992). The origin of the caudal cerebral artery of porcupines (*Hystrix cristata*) resembles that of rat (Green, 1968), mouse (Wiland, 1974), guinea pig (Popesko et al., 1990) and rabbit (Barone et al., 1973; Popesko et al., 1990).

It was reported that the internal ophthalmic artery is separated from the rostral cerebral artery in dog (Miller et al., 1964; Getty, 1975), originating from the internal carotid artery in rat (Green, 1968). Ocal and Ozer (1992) reported that blood is supplied to the brain by the internal ophthalmic artery. The internal ophthalmic artery of porcupine (*Hystrix cristata*) originated from the middle of the medial part of circulus arteriosus cerebri, and differed from that of dog (Miller et al., 1964; Getty, 1975), guinea pig (Ocal and Ozer, 1992) and rat (Green, 1968)

The middle cerebral artery originated from the internal carotid artery in dog (Miller et al., 1964; Getty, 1975), as a single branch from the circulus arteriosus cerebri in mouse (Cook, 1965; Wiland, 1974), guinea pig (Ocal and Ozer, 1992) and cat (McClure et al., 1973; Getty, 1975), as two separate branches from the circulus arteriosus cerebri in rat (Brown, 1966; Green, 1968; Firbas et al., 1973), rabbit (Popesko et al., 1990) and mouse (Firbas et al., 1973). The middle cerebral artery of porcupine (*Hystrix cristata*) was separated as a single branch from the rostral cerebral artery.

It was reported that the two rostral cerebral arteries joined each other with single branch (rostral communicans artery) (Miller et al., 1964; Brown, 1966; Green, 1968; McClure et al., 1973; Wiland, 1974; Getty, 1975; Popesko et al., 1990; Ocal and Ozer, 1992), with two branches (Brown, 1966; McClure et al., 1973) or did not join at all (Brown, 1966). In our study, the rostral cerebral artery was joined to each other with the single rostral communicans artery.

The rostral cerebral artery was reported to give two branches which dispersed between the two hemispheres in dog (Miller et al., 1964), cat and dog (Getty, 1975) and rat (Brown, 1966). In addition to its branch, the last part of this branch was reported to anostomose with the last part of the caudal cerebral artery between the two hemispheres in rat (Green,1968) and mouse (Wiland, 1974). In this study, the branch which originated from both right and left rostral cerebral artery and the rostral communicans artery was dispersed through the two hemispheres, and at the same time, each branch which originated from the rostral cerebral dexter and the rostral communicans artery was anostomosed with the last branch of the caudal cerebral artery in the facies media cerebri.

In addition to the internal ethmoidal artery, it is known that the internal ophthalmic artery originated from the rostral cerebral artery as the last branch in dog and cat (Getty, 1975) and in dog (Miller et al., 1964). It is determined that the last branch of the rostral cerebral artery was the internal ethmoidal artery as reported in rat by Brown (1966) and in mouse by Wiland (1974). The result of our study resembles that of rat (Brown, 1966) and mouse (Wiland, 1974).

The arterial blood to the porcupine (*Hystrix cristata*) brain simply came from the basilar artery. The internal carotid artery was absent. The internal ophthalmic artery originated from the medial of the

middle part of circulus arteriosus cerebri before the middle cerebral artery was separated. It is concluded that the structure of the circulus arteriosus cerebri is constant, and is not variable.

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