

Variation in the Pattern of Arteries of the Encephalon Base in Roe Deer

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Accepted November 4, 2005

JABŁOŃSKI R. 2005. Variation in the pattern of arteries of the encephalon base in roe deer. *Folia biol. (Kraków)* 53 (Suppl.): 31-34.

The paper covers the structure of the arteries of the encephalon base in roe deer and a range of vascular variation in the area. The final shape of the vascular tree is affected by many factors classified as intracorporal and extracorporal. Variation in the region of arteries of the encephalon base could be presented by considering variation in intervascular connections, variation in the descent of respective vessels and the asymmetry of the same arteries. In all animals examined, the greatest range of variation was observed in the pattern of anastomosis of rostral cerebral arteries and in the descent of rostral cerebellar arteries.

Key words: Roe deer, arteries, variation, brain, blood supply.

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The final shape of the vascular tree of the encephalon base in mammals is affected by different factors classified as intracorporal and extracorporal (GODYNICKI 1972; WILAND 1974; GILLILAN 1972). However, irrespective of their kind, variation does not go beyond a border defined by the phylogenetic development of a given systematic group. Variation in the arteries of the encephalon base may be presented considering variation in intervascular connections, variation in the branching out of respective vessels and asymmetry of the same arteries.

This paper concerns the pattern in arteries of the encephalon base in roe deer and a range of vascular variation of this area.

Material and Methods

The observations included 39 adult individuals of both sexes. The arteries were filled with synthetic latex. The specimens were fixed in a 5% formalin solution. After removal of muscles, skull bones and vertebrae were decalcified in a 5% solution of hydrochloric acid and then prepared, followed by record-taking. The paper uses anatomical terms according to PILARSKI (1978).

Results and Discussion

The Cervidae brain is supplied with blood mainly via the dextral and sinistral internal carotid artery (*a. carotis interna dextra et sinistra*), and also, although only slightly, via vertebral arteries (*aa. vertebrales*). Internal carotid arteries in this species branch out from *rete mirabile epidurale rostrale*. Having gone through dura mater at the frontal border of the pituitary gland, each of them gives a thin internal ophthalmic artery (*a. ophthalmica interna*) and then divides into a rostral cerebral artery (*a. cerebri rostralis*) forming together with the same vessel of the other side the anterior-lateral part of the cerebral arterial circle and caudal communicating artery (*a. communicans caudalis*), forming together with its symmetrical artery – the posterior-lateral part of the cerebral arterial circle.

The arterial pattern in this vascular region shows considerable variation both in the arterial communication pattern as well as in the departure of respective vessels. Considerable variation was recorded in the shape itself of the cerebral arterial circle: in 25 (65%) specimens it was regular showing a clear symmetry. In 14 (35%) specimens the posterior part of the cerebral arterial circle formed by caudal communicating arteries showed a considerable asymmetry.

An interesting variation was observed in the pattern of descent of rostral cerebral arteries. In 5 (13%) brains the asymmetrical rostral cerebral ar-

tery branched out from the internal carotid artery with two independent vessels which then anastomosed into a single trunk, which made a button-hole formation between these vessels. In 4 (10.4%) brains both vessels were similarly developed, in one case (2.6%) the internal branch was much less developed.

The first branch of the rostral cerebral artery is constituted by the rostral choroidal artery. In five cases (13%) where double rostral cerebral arteries occurred, the choroidal artery always separated from the external branch. In 2 (5.2%) brains, the asymmetrical rostral choroidal artery was a double vessel. In one case the rostral choroidal artery branched out from the internal carotid artery where it bifurcated. The descent pattern of the middle cerebral artery was, in general, constant, only in 2 (5.2%) specimens did the asymmetrical middle cerebral artery bifurcate into two independent branches of similar thickness. In 5 (13%) brains a double middle cerebral artery was observed, however one of the branches was clearly less developed.

The greatest range of variation was noted in the pattern of communication of vessels forming the anterior section of the arterial circle and in the descent of the median callosal artery.

In 39 brains, 5 patterns of rostral closing-up of the cerebral arterial circle were recorded (Fig. 2). In 18 (46.8%) specimens a communication was observed which was described above as a model. In 10 (26%) brains the cerebral arterial circle from the anterior side closes up with a thin rostral communicating artery. The median callosal artery descended from one of the rostral cerebral arteries. In 6 (15.4%) brains the rostral communicating artery anastomosed rostral cerebral arteries below the descend of the middle cerebral arteries. The median callosal artery constituted a branch of the rostral communicating artery (Fig. 2c). In 4 (10.2%) specimens the cerebral arterial circle was closed by a thin rostral communicating artery. Rostral cerebral arteries were connected additionally with a vascular branch which gave rise to a median callosal artery (Fig. 2d).

In one case (2.6%), at the level of the cerebral median fissure on the left rostral cerebral artery bifurcated into two terminal branches running on both sides of the fissure towards the olfactory bulbs, and between them the median callosal artery descended. On the right the section of rostral cerebral artery over the descend of middle cerebral artery was very poorly developed (Fig. 2e).

The posterior section of the cerebral arterial circle also showed a considerable degree of variation both in its shape and in the descend pattern of respective vessels.

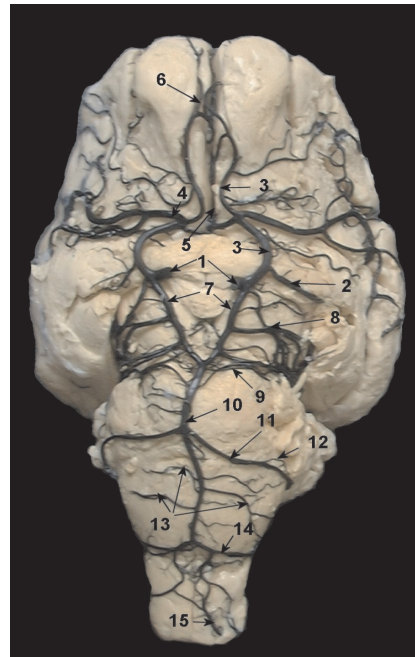


Fig. 1. Arteries of the brain in roe deer. 1 – Internal carotid artery, 2 – Choroidal rostral artery, 3 – Rostral cerebral artery, 4 – middle cerebral artery, 5 – median callosal artery, 6 – lateral olfactory bulb artery, 7 – caudal communicating artery, 8 – caudal cerebral artery, 9 – rostral cerebellar artery, 10 – basilar artery, 11 – caudal cerebellar artery, 12 – labyrinthine artery, 13 – branches onto medulla oblongata, 14 – vertebral arteries, 15 – ventral spinal artery.

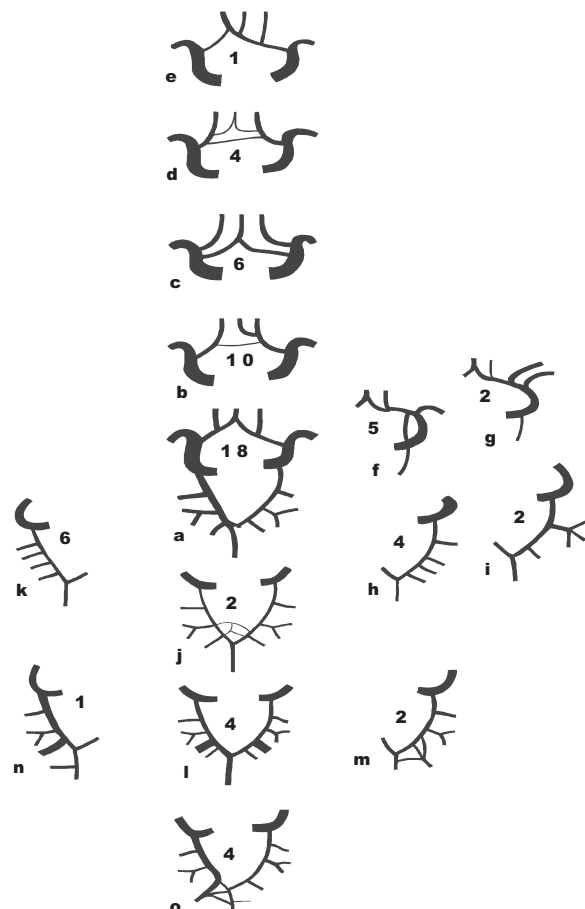


Fig. 2. The structure and variation in the arteries of the encephalon in roe deer.

In 32 (80.6%) brains the caudal communicating arteries showed a clearly regular symmetrical course and only in 8 (20.5%) brains some deviations from symmetry were observed. In these cases there was also noted a clear difference in the thickness of the symmetrical vessels.

The connection of caudal communicating arteries into the asymmetrical basilar artery in 37 (94.8%) specimens was recorded on the inferior surface of the cerebral peduncles, in 2 (5.2%) specimens caudal communicating arteries came closer to each other and then ran along the sagittal plane of the brain and communicated as late as on the pons. Also in 2 (5.2%) brains the arteries formed buttonhole formations before communication. The caudal cerebral artery in roe deer showed a constant descent and course. Only in two brains (5.2%) did the sinistral caudal cerebral artery descend from the caudal communicating artery with a common trunk with the choroidal arteries of the third ventricle.

The choroidal arteries of the third ventricle were placed in six cases on the right and in four cases on the left – and descended as independent vessels.

Substantial variation was also observed in the descent pattern and development of rostral cerebellar arteries. A model departure of these vessels was recorded in 28 specimens (71.8%). In 4 brains (10.4%) double rostral cerebellar arteries were noted, however one of the branches was clearly thicker.

In two cases (5.1%) on the left, the caudal communicating artery bifurcated into two similarly developed vessels, the third one, however, descended from the basilar artery, and then all three branches communicated into a common trunk.

In one brain (2.6%), the dextral caudal communicating artery, having given rise to choroidal arteries of the third ventricle, decreased in diameter and running in an arc dorsally towards the cerebral peduncles transformed into the rostral cerebellar artery, after giving a thin anastomosis to its symmetrical caudal communicating artery.

In four specimens (10.2%) the sinistral rostral cerebellar artery descended from the basilar artery. On the right, two branches descended; one from the caudal communicating artery and the other one from the basilar artery. The branches then communicated to form a common trunk.

The basilar artery in 32 (83.2%) brains showed a regular course, positioning itself on the median sagittal plane on the pons and medulla oblongata.

In 2 (5.2%) brains it was a vessel of a wavy course.

The largest branch of the basilar artery are the caudal cerebellar arteries. They descend at the level of the caudal margin of the pons. In 25 (65%) cases the descent was symmetrical and in 10 (26%) slight deviations from symmetry were recorded and in the other 4 (10.4%) the caudal cerebellar arteries separated from basilar artery at different levels.

Labyrinthine arteries in 32 (83.2%) specimens separated from the caudal cerebellar arteries. In 7 (18.25%) brains they descended directly from the basilar artery.

Throughout its course, the basilar artery gave numerous minor branches to the pons and medulla oblongata. They were especially numerous below the descent of the caudal cerebellar arteries.

Vertebral arteries were poorly developed and the place of their descent varied; only in one brain was the dextral vertebral artery quite considerable in diameter.

The final shape of the vascular tree in mammals is affected by various factors classified as intracorporal and extracorporal. However, irrespective of their kind, variation does not go beyond the border defined by the phylogenetic development of a given systematic group. Variation in the region of arteries of the encephalon base may be presented considering variation in intervascular connections, variation in the descent of respective vessels and the asymmetry of the same arteries (JABŁOŃSKI 2001).

In roe deer, similarly as in other ruminants, the rete mirabile epidurale occurs which gives rise to intracranial sections of the internal carotid arteries. The rete in some Cervidae was described by GODYNICKI (1972).

Internal carotid arteries usually go through the dura mater and, having given rise to a thin internal ophthalmic artery, get divided. This pattern of division of internal carotid arteries was not observed in roe deer. The rostral cerebral artery in Cervidae runs in a wide arc towards the piriform lobe and then bends and runs under the optic chiasma. A similar course of both vessels was observed in all the ruminants described so far. It should be noticed that the rostral part of the cerebral arterial circle is more constant, e.g. in rodents (JABŁOŃSKI 1975), predators (WILAND *et al.* 1976) and pigs (JABŁOŃSKI *et al.* 1989).

According to such authors as BRÜCKNER (1909) and RUEDI (1922), arcs and bends of arterial vessels decrease the negative effect of pulse wave on delicate brain tissue.

The observations made show that the greatest range of variation coincides with the anterior section of the cerebral arterial circle. In roe deer five

variants of the circle closing-up were identified. However, most frequently the rostral cerebral artery, once the middle cerebral artery departed and after a short course on the olfactory triangle, gave rise to a rostral communicating artery and then headed towards the olfactory bulbs. Rostral communicating arteries anastomosed, giving rise to the median callosal artery.

Caudal communicating arteries usually anastomose before reaching the anterior margin of the pons forming the basilar artery, which is confirmed by FAZZARI (1929) who reports on the pattern of arteries of the encephalon base in ruminants being formed from branches of internal carotid arteries with an inconsiderable share of vertebral arteries and ventral spinal artery. Such a pattern of the developing basilar artery is characteristic for ruminants, in the other orders of mammals the basilar artery emerges from anastomosis of vertebral arteries.

Caudal cerebral arteries in roe deer descend from caudal communicating arteries. In red deer in three cases the sinistral vessel emerged from the connection of two branches descending from the rostral cerebral artery and caudal communicating artery. The descent of the caudal cerebral artery in fallow deer is slightly different. In this species, in all the cases examined, the caudal cerebral artery departed from the rostral cerebral artery.

Rostral cerebellar arteries in the species researched usually descended from caudal communicating arteries, however there were also cases of symmetrical descent of these vessels from the basilar artery or asymmetrical descend, namely one of the vessels descending from the caudal communicating artery and the other one from the basilar artery.

Caudal communicating arteries in all the species examined give numerous vascular branches to cerebral peduncles and the hypothalamus, especially numerous in elk and red deer.

The basilar artery in all the species examined emerges from the connection of caudal communicating arteries. It runs on the pons and medulla oblongata, getting smaller in diameter. Usually it runs in the median sagittal plane. Some deviations from the surface were observed only in red deer in 5 (10.25%) cases, in roe deer in 2 (5.20%) cases and in fallow deer in 3 (8.25%) cases. In elk no deviations were recorded in the course of the basilar artery, however numerous vascular buttonhole formations were noted. A similar phenomenon was described by HOFMANN (1900) in cow. An irregular course of basilar artery was always related to the asymmetrical descent of the caudal cerebellar arteries. The phenomenon has been recorded in all the mammal orders described so far.

Caudal cerebral arteries are in the Cervidae best-developed branches of basilar artery. They supply the posterior section of the cerebellum. Usually these arteries give rise to labyrinthine arteries. However an independent descent of labyrinthine arteries from the basilar artery was also observed, which was most frequent in red deer, in 30% of the cases examined, in roe deer in 18.2%, in fallow deer in 15% and in elk – 10%. In its terminal section the basilar artery turns into the ventral spinal artery. It is here that vertebral arteries usually descend.

Conclusions

1. Morphology of the arteries of the encephalon base in the Cervidae examined is similar to that in the other ruminants, both in the wild and in captivity.

2. Variation in the vessels examined concerns variety in their connections with one another, various patterns and kinds of descent and a frequent asymmetry of the same arteries.

3. The greatest range of variation was noted in the pattern of anastomosis of the rostral cerebral arteries and in the descent of rostral cerebellar arteries.

4. Caudal cerebellar arteries are in the Cervidae described best-developed branches of basilar artery.

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