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BASILAR ARTERIES OF THE BRAIN IN DOMESTIC GOAT (*Capra hircus L*)

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ABSTRACT

The course and variability of cerebral base arteries in *Capra hircus L* was researched in 27 cerebra. It was observed that the vascular pattern of the species researched remains similar to the pattern observed in the members of *Cervidae*. The features characteristic for this species include the variability of descend of the rostral choroid artery as well as of the posterior cerebral artery.
Key words: goat, brain, basilar arteries

INTRODUCTION

Arteries supplying the cerebrum with blood have attracted attention for a long time, both in human and animals. Although many years have passed since the first description of this vascular area, the research is still open both for scientific and practical investigation. An extensive coverage includes the papers whose authors investigate the arteries of cerebral base in ruminants.

The first literary coverage of arterial circle of the brain in that group of animals includes the papers of Hoffmann (Hoffman;1900) and of de Vriese (1905). Besides traditional researching our knowledge depends on, the arteries of cerebral base in cattle were described by other authors (Chomiak, Welento 1967), in sheep (Jabłoński, Wiland 1973) in representatives of *Cervidae*, (Godynicki, Wiland 1970,1971, Godynicki 1972). The course and variability of the cerebral base arteries in cattle fetuses were described by some authors (Brudnicki, Gielecki 1996).

The present paper investigates the arterial circle of the brain and its branches in *Capra hircus L* as well as a comparative study of the pattern and variability observed between this species and other representatives of Artiodactyla.

MATERIALS AND METHODS

The research investigated 27 *Capra hircus L* individuals of both sexes and of different age. The arteries of the head in the animals researched were filled with latex via both left and right common carotid arteries and then the preparations were being preserved with a 5% formalin solution for two weeks. Then muscles were being removed and bones decalcified with a 5% hydrochloric acid. Having prepared the cerebrum, the course and variability of cerebral base arteries were investigated and a digital-camera photographic documentation made.

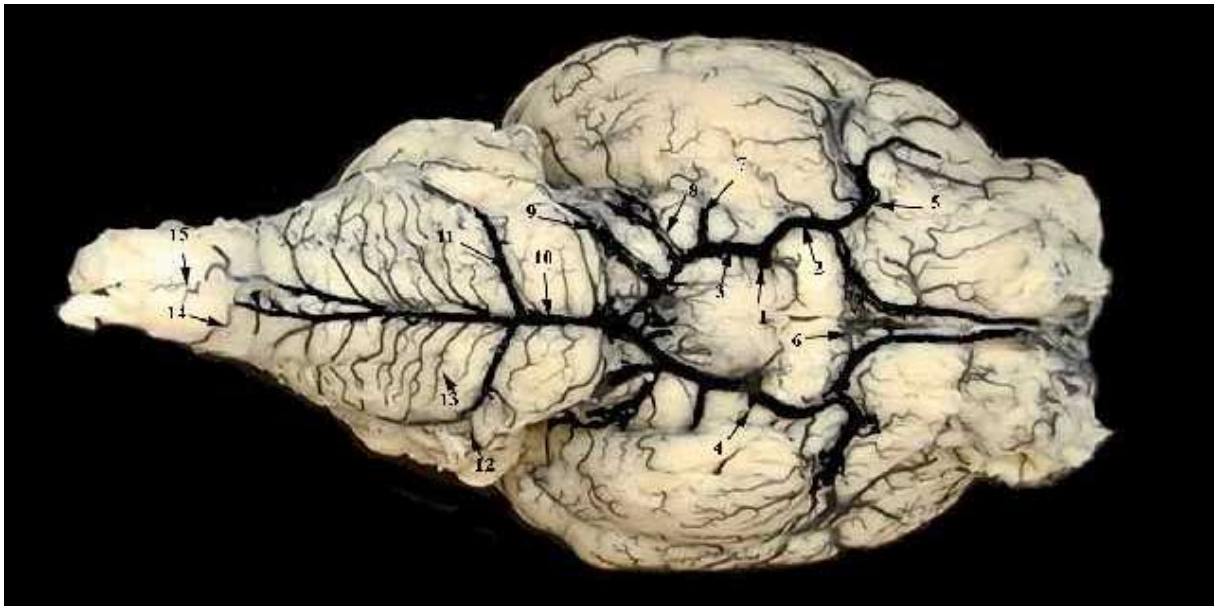
RESULTS

The cerebrum in *Capra hircus L ,* similarly to other representatives of Artiodactyla., is supplied with blood via internal carotid arteries (*aa.. carotis internae -fig. 1-1)* and, to a much lesser degree, via vertebral arteries (*aa. vertebrales*). The vessels with their branchings and connections create in the cerebral base – two main arterial circles of the brain *(circulus arteriosus cerebri)* and the basilar artery (*a. basilaris*).

The arterial circle of the brain in *Capra hircus L* usually takes the form of the digit "8".

The interior carotid artery, whose intracranial section is recreated from the rostral supraduralis rete mirabile (*rete mirabile epidurale rostrale)*, having passed the dura mater, it bifurcates into the rostral cerebral artery (*a.cerebri rostralis - fig. 1-2*) and the caudal communicating artery (*a. communicans caudalis)*.

fig. 1. Arteries of cerebral base in *Capra hircus L.* 1 - Internal carotid artery, 2 - Rostral cerebral artery, 3 - Caudal communicating artery, 4 - Rostral choroid artery, 5 - Medial cerebral artery, 6 – Rostral communicating cerebral artery, 7 - Caudal cerebral artery, 8 - Caudal choroid ramus, 9 - Rostral cerebellar artery, 10 - Basilar artery, 11 - Caudal cerebellar artery, 12 - Labyrinthian artery, 13 - Pontine and medulla oblongata branches, 14 - Vertebral artery, 15 - Ventral spinal artery



The rostral cerebral artery creates an anterior-lateral part of arterial circle of the brain; initially it describes a wide curve towards the pear-shaped lobe and descends into the rostral choroid artery (*a. chorioidea rostralis – fig. 1-4)*. At the level of the rostral terminal crossing of the optic nerves, the rostral cerebral artery gives rise to the medial cerebral artery *(a. cerebri media – fig. 1.-5*); the most powerful branch of the arterial circle of the brain. The vessel describes a considerable curve and goes towards the lateral fissure where it divides up into cortical branches. The anterior section of the rostral cerebral artery goes towards the longitudinal cerebral fissure. Right before reaching it, however, it goes along the medial olfactoral track towards olfactoral bulbs**;** here it gives rise to a thin rostral communicating artery *(a.communicans rostralis – fig. 1-6)* which joins a similar counterpart vessel; thus closing up the arterial circle of the brain rostrally. Similarly the rostral cerebral arteries

gave rise to well-developed corpus callosum arteries *(aa. corporis callosi)* developed due to a strong join of rostral cerebral arteries; while in the medial fissure, the vessels form a common trunk to divide up again into arteries supplying blood to the area of corpus callosum in both hemispheres. Having branched out into the arteries of corpus callosum, rostral cerebral arteries run further towards the olfactoral bulbs and at the level of their caudal margin, they ascend into the longitudinal cerebral fissure where they divide up on the medial surface of the hemispheres into two cortical branches also descending onto the dorsal surface of the hemispheres; the section of the rostral cerebral artery is referred to by some authors as the marginal artery *(a. marginalis)*. Besides the rostral cerebral artery bifurcates into the internal ophthalmic artery *(a.ophtalmica interna)*, in the vicinity of the descend of the medial cerebral artery, the rostral meningeal artery *(a.meningea rostralis)* in the vicinity of optic nerves cross as well as the ethmoidal internal artery *(a. ethmoidalis interna).*

The posterior section of the arterial circle of the brain in *Capra hircus L* is made up of caudal communicating arteries *(.aa.communicans caudales* – *fig. 1-3*) which describe a curve around corpus mamillare and then run medially from the oculomotor nerve to join at the level of prepontian sulcus, and to transform into the asymmetric basilar artery.

In its course, the caudal communicating artery gradually gives rise to the caudal cerebral artery *(a.cerebri caudalis* – *fig. 1-7*), caudal choroid ramus *(ramus choroidea caudalis* – *fig. 1-8*) as well as the rostral cerebellar artery (*a. cerebelli rostralis* – *fig. 1-9)*. Medially the caudal communicating artery bifurcates into short arterioles descending deep into the midbrain.

The basilar artery (*a. basilaris* – *fig. 1-10)* starts at the posterior part of the interpedunculate fissure**,** and then runs caudally over the pont, and then in the medial fissure of the medulla oblongata. The diameter of the basilar artery gradually decreases caudally. In its final section it gives rise to thin vertebral arteries (*aa.vertebrales* – *fig. 1-14*) as well as the ventral spinal artery (*a.spinalis ventralis* – *fig. 1-15).*

In its anterior section, the basilar artery ramifies into numerous branches- *rami ad pontem* (*rami ad pontem* – *fig. 1-13)*; usually minor vessels, changeable in number. Below the abducent nerve from the basilar artery there ascend caudal cerebellar arteries (*a. a. cerebelli caudalis* – *fig. 1-11*). Initially they run at the level of the posterior pont margin and then they go laterally and upwards to, having reached the cerebellum, spread over its caudal and dorsal surface. Caudal cerebellar arteries give rise to labyrinthian arteries *(a.labyrinthi* – *fig. 1-12*) and numerous branches *ad medulla oblongata* (*rami ad medullam oblongatam* – *fig. 1-13*).

In *Capra hircus L* the arteries of the cerebral base show a variability both in its course as well as in its pattern of descend of respective vessels.

The arterial circle of the brain in *Capra hircus L* in 23 (85.2%) cases took a form of the digit ‘8’, while in the remaining 4 (14.8%) individuals it took a form of the heart. In these individuals, the distance of symmetric rostral arteries of the cerebrum forming the anterior section of the arterial circle of the brain was much greater than the distance between the symmetric caudal communicating arteries.

A variability was also observed in the pattern of descend of rostral choroid arteries. In 6 cases (22.2%) they descended symmetrically where the internal carotid artery bifurcated into the rostral cerebral artery and the caudal communicating artery**,** constituting the third branch. In 8 (29.6%) cases the vessels descended from caudal communicating arteries. In 10 (37.0%) brains, the rostral choroid arteries constituted a branch of rostral cerebral arteries. In the remaining 3 cases, the descend of rostral choroid arteries was asymmetric. One of the vessels constituted the branching of the rostral cerebral artery, the other one descended from the caudal communicating artery.

In 4 (14.8%) cerebra, both left and right rostral cerebral arteries were joined by the rostral communicating artery. In 2 (4.4%) cases, both left and right vessels differed in their diameter considerably.

In one individual (2.2%) there was observed a double medial cerebral artery (Fig. 2). In one case there was also observed a vascular button-hole formation where the left caudal communicating artery joined the basilar artery (Fig.3).

Fig. 2. Double medial cerebral artery - 5

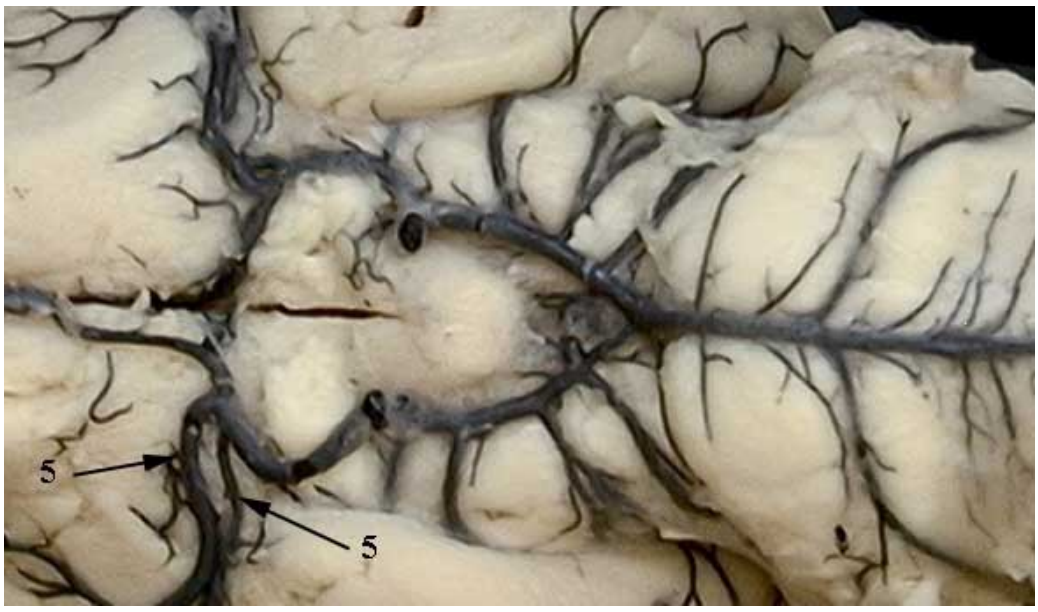
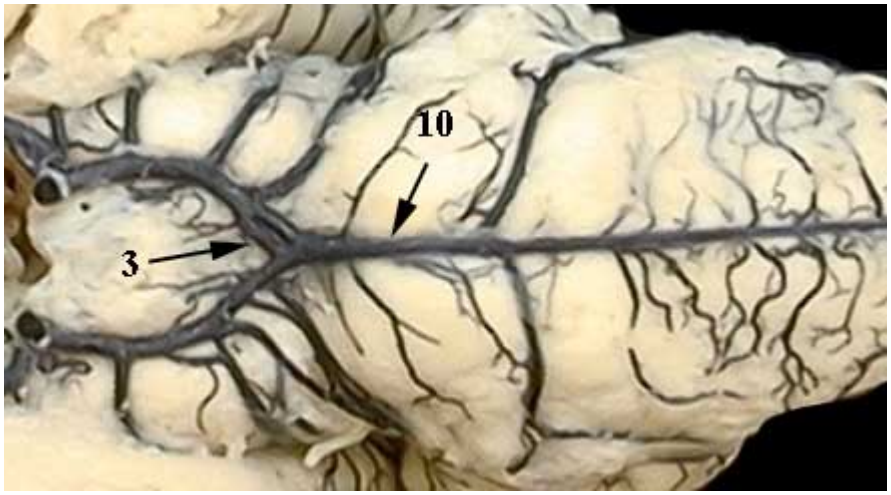


Fig. 3. Vascular button-hole formation between the connection of caudal communicating artery- 3 and basilar artery –10



Caudal cerebral arteries remain the most powerful branches of caudal communicating branches; in *Capra hircus L* there was observed a considerable variability of their descend. In 12 (44.4%) individuals there was noted a vessel descend asymmetry; one of the arteries descended where the internal carotid artery branched out, while its counterpart descended from the caudal communicating artery. In 6 (22.2%) individuals, the asymmetric rostral cerebral artery departed from the rostral cerebral artery (Fig. 4).

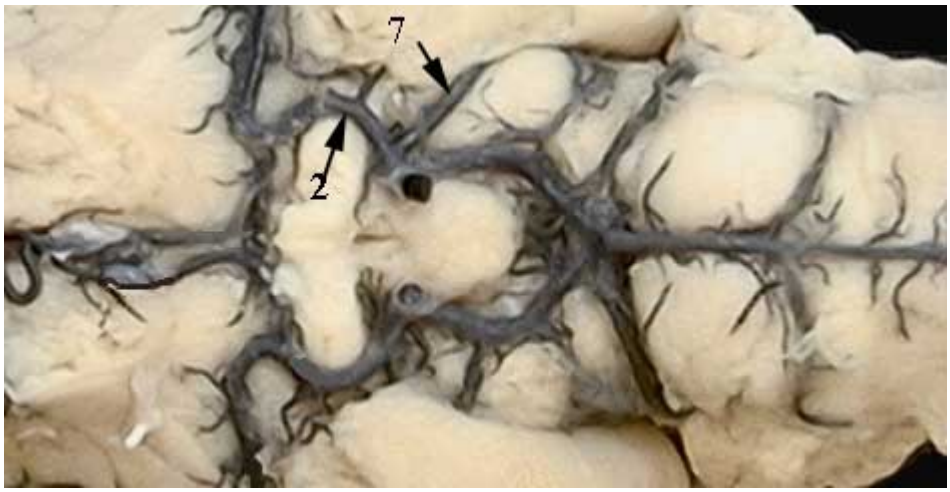
In 3 individuals, there was observed a vascular button-hole formation where the caudal cerebral artery descended.

Caudal choroid arteries, yet another branching of the caudal communicating artery, in 22 (81,5%) individuals separated with a single trunk to divide up after a short course. Finally they created symmetric vessels. In 6 (22,2%) cases, in the left hemisphere two independent arteries were observed to descend. In 3 individuals (11,1%) there were noted three independent asymmetric branches of the caudal choroid artery.

The rostral cerebellar artery, the final branch of the caudal communicating artery, in 3 (11,1%) cases branched out from the initial section of the basilar artery.
The descend pattern of caudal cerebellar arteries in all cases was slightly asymmetric.

In one individual, the basilar artery in its marginal section forked out into two symmetric vessels, parallel-running along the medial fissure of the medulla oblongata, and then they transformed, without a clear-cut border, into vertebral arteries. The main trunk of the basilar cerebral artery was much shorter (Fig.1)

Fig. 4. Descend of caudal cerebral artery – 7 from rostral cerebral artery



DISCUSSION

The main vessels forming the arterial circle of the brain in *Capra hircus L* are internal carotid arteries whose supracranial section, after birth, atrophies, Daniel et al. (1953). The intracranial section is reconstructed mainly from the rete supraduralis. A similar pattern of arteries is found in all the ruminants researched so far, including cattle, as reported by Hofmann (1900), de Vriese (1905), Chomiak, Welento (1967), Brudnicki, Gielecki (1996), roe-deer and in red deer - Godynicki, Wiland (1970, 1971), sheep by Jabłoński, Wiland (1973) and bison Węgrzyn et al. (1983).

The function of the rete mirabile is to regulate the flow of arterial blood towards the cerebrum as well as the thermal regulation of the brain preventing it from overheating; the arterial system of the cerebrum in ruminants, including *Capra hircus L,* is equipped with a safety system.

Comparing the arteries of the base of the cerebrum in *Capra hircus L* with those in other species of ruminants, it was observed that in *Capra hircus L* they were much better developed than those in cattle and similar to those in sheep and in *Cervidae*, mostly in the posterior section of the arterial circle of the brain, namely the vessels descending from the caudal communicating arteries.

In *Capra hircus L* it is characteristic that the arterial circle of the brain is a well-developed anterior section of the circle made up of rostral cerebral arteries. The vessels in 14.81 % individuals took a form of a considerable curve forming a ‘heart’. Such a phenomenon was also observed in members of *Cervidae*.

The medial cerebral artery, like in other mammals, remains the strongest branch of the rostral cerebral artery. A wide curve described by the artery where it descends from the parent vessel is also found in other ruminants as well as in wild boar. According to Bruckner (1909) and Ruedi (1922), the curves of arterial vessels decrease a negative effect of blood beats on the delicate cerebral tissue. Cases of double medial cerebral arteries were reported as a vascular variant in different animal species by Wiland, Brudnicki (1984), in wild boar and domestic pig, its symmetric multiplicity remains typical of the species, Jabłoński et al. (1989), Skoczylas, Wiland (1999).
Analysing *Capra hircus L* arterial circle vessels and the basilar artery there was noted, as compared with other ruminant species, occasional vascular button-hole formation.
Researching the course and variability of cerebral base arteries in *Capra hircus L,* one shall conclude that the variability observed in this species was much limited, as compared with those reported in other ruminant species. The anterior section of the arterial circle of the brain in that species showed a regular structure. The rostral cerebral arteries united in the medial fissure creating a short trunk of arteries of the corpus callosum. Only in 14.8% individuals there were observed rostral communicating arteries, in cattle fetuses the vessels were noted in 86,0% cases. A similar, to the one observed in cattle, the connection of rostral cerebral arteries was observed in bison, Węgrzyn et al. (1983).

The greatest variability was observed in the pattern of descend of rostral choroid arteries. In other ruminant species, the descend of that vessel showed a greater regularity; usually it descends from the rostral cerebral artery.

The descend of the caudal cerebral artery in *Capra hircus L* varied; the descend of that vessel from the rostral cerebral artery can be referred to as a vascular variant, similar observations are reported by Godynicki and Wiland (1970) in red deer.

The basilar artery, similarly to its course in other ruminant species, running caudally showed a diameter decrease. The course of the vessel was regular. Its greatest branch is the caudal cerebellar artery; its descend was slightly asymmetric. On the surface of the pont and medulla oblongata, the basilar artery gave rise to very numerous branches.

Vertebral arteries, similarly to other ruminants, were not well developed, which suggests that their contribution to cerebral blood-supply remains inconsiderable; a similar conclusion was drawn by Fazzari (1929). In one individual the vessels were better developed and ran along the medial fissure of the spinal cord; which was accompanied by a much shorter basilar cerebral artery.

The research conducted showed that the pattern of arteries of the cerebral base in *Capra hircus L* was similar to other earlier investigated ruminants. The variability of the vascular area researched observed in that species, however, is somehow limited, as compared with the variability noted in cattle or representatives of *Cervidae*.

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