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ELECTRONIC JOURNAL OF POLISH AGRICULTURAL UNIVERSITIES

2015
Volume 18
Issue 1

Topic:
Veterinary Medicine

Skoczylas B. , Brudnicki W. , Kirkiłło-Stacewicz K. , Nowicki W. , Wach J. 2015. TELENCEPHALON VASCULARITY IN RACCOON DOG (NYCTEREUTES PROTEYONOIDES GREY 1834), EJPAU 18(1), #04.
Available Online: http://www.ejpau.media.pl/volume18/issue1/art-04.html

TELENCEPHALON VASCULARITY IN RACCOON DOG (NYCTEREUTES PROTEYONOIDES GREY 1834)

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ABSTRACT

The studies of the vascularization of the cerebrum in raccoon dog were performed on 60 cerebral hemispheres. The middle cerebral artery is the strongest vessel supplying blood to the cerebrum. The artery gets divided into ten permanent branches. Two olfactory arteries supply the region of the cerebrum located on the border between the old and the new cortex. The other eight supply the region of the new cortex: three branches aiming at the frontal lobe, two branches at the parietal lobe and three temporal branches aiming at temporal area. The frontal, parietal and temporal branches descended independently from the main trunk of the middle cerebral artery or formed a common trunk. Common trunks for respective groups of branches have been described as the anterior, superior and posterior middle cerebral artery. In 5% of cases there were two independent branches of the middle cerebral artery extending from the rostral cerebral artery.

Key words: telencephalon, vascularity, raccoon dog.

INTRODUCTION

Raccoon dog is a species that lives in eastern Asia. It has recently been acclimated in the eastern areas of Russia and its culture has been developed. Individuals that have managed to escape from the farm, spread throughout Europe.

Polish population of raccoon dog is so large that you can gain its carcass from hunters in order to perform morphological studies. In the family Canidae it is the only species that goes into hibernation.

A review of the literature shows that the first information on the construction of the middle cerebral artery in various mammalian species can be found in the publication of Hofmann [9]. More detailed information on the construction of the middle cerebral artery and its branches in the dog were reported by Habermehl [8]. Similar studies were performed in mink [14], in polecat [17], in common fox [10, 13]. These authors mention that the middle cerebral artery is one of the vessels extending from the arterial circle of the brain.

There are publications that discuss the blood supply to the brain in raccoon dog [6]. One may find publications describing in detail the cortical branches of the middle cerebral artery. These issues were described in cat by Chadzypanagiotis [7], the author gives nomenclature for the various branches of this artery. Structured descriptions of the construction and the course of the cortical branches of the middle cerebral artery in some predatory species were presented by Wiland [16].

In recent years there have been numerous studies that discuss the construction of the middle cerebral artery in various animal species. This applies to vessels that expand as a single branch, e.g. in porcupine [3], red squirrel [1], ground squirrel [2], common fox [10] and multiple arteries occurring in the domestic pig [11]. It has been stated that the branches of the middle cerebral artery cortical come to the same areas of the telencephalon. The differences occur in the pattern of descent and division of respective cortical branches of the middle cerebral artery. In mammals on the surface of the cortex there is a different pattern of sulci, which can affect the structure of the cortical branches of the middle cerebral artery [4].

The extensive literature does not provide a publication on the cortical branches of the middle cerebral artery in the raccoon dog, which is the main blood vessel supplying the telencephalon.

Submitted work next to the description of the course and the variability of the arteries contains information on the vascularity of the brain by various cortical branches of the middle cerebral artery in raccoon dog. The results are significant in terms of the diagnosis and treatment of diseases of the vascular system.

MATERIALS AND METHODS

The research was performed on 30 brains in raccoon dog, namely a total of 60 cerebral hemispheres. Ethics approval was not required – animals died because of natural reasons. The animal heads were cut off at the height of the 3rd–4th cervical vertebrae. The arteries were filled with latex introduced with medical syringe into the common carotid artery. Filling of vessels was terminated after the appearance of latex in the overleaf common carotid artery and vertebral arteries. Vessels were closed and the vascular tree was carefully filled up with injection mass. The heads were fixed in a 5% formalin solution and then decalcified in hydrochloric acid, the skull cavity was opened and brains were taken out. Dissection of the brain was made using preparative scissors, scalpel and tweezers. After dissection of the brain and the spinal cord, the brain was placed in a 2% solution of hydrogen peroxide for whitening and removal of the venous thrombus formation for a period of three days. The cerebral hemispheres were photographed and the following were being described: the anatomy, the division pattern and the course of cortical branches of the middle cerebral artery.

RESULTS

In raccoon dog the blood is supplied to the brain with internal carotid arteries (Fig. 1-a) and vertebral arteries.

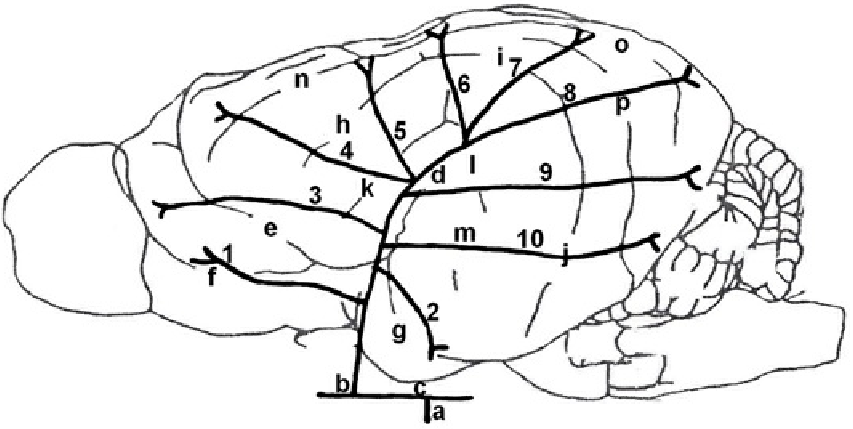

Fig. 1. Diagram of the division of the middle cerebral artery on the surface of the cortex in raccoon dog

1 – Anterior olfactory artery, 2 – Posterior olfactory artery, 3 – Orbital branch, 4 – Inferior frontal branch, 5 – Superior frontal branch, 6 – Anterior parietal branch, 7 – posterior parietal branch, 8 – superior temporal branch, 9 – middle temporal branch, 10 – inferior temporal branch, a – internal carotid artery, b – rostral cerebral artery, c – caudal communicating artery, d – Sylvian fissure, e – Presylvian sulcus, f – rostral lateral olfactory sulcus, g – caudal lateral olfactory sulcus, h – rostral Suprasylvian sulcus, i – middle Suprasylvian sulcus, j – caudal Suprasylvian sulcus, k – rostral external Sylvian sulcus, l – middle external Sylvian sulcus, m – caudal external Sylvian sulcus, n – coronary sulcus, o – marginal sulcus, p – external marginal sulcus.

The internal carotid artery, having entered the skull cavity and penetrated the dura mater, bifurcates into the rostral cerebral artery (Fig. 1-b) and caudal communicating artery (Fig. 1-c) which, together with their symmetrical vessels form an arterial circle of the brain.

From the initial section of the rostral cerebral artery towards the cortex there separates the middle cerebral artery, which is the strongest vessel supplying blood to the cerebrum. The initial section of the main trunk of the middle cerebral artery goes along the dorsal surface of the optic tract. Then the section gets bended around the piriform lobe and goes through its rostral margin. Further on it runs to the lateral olfactory sulcus and, having passed it, it gets divided. From the initial section of the main trunk of the middle cerebral artery there descend minor central branches supplying blood to olfactory tracts and the piriform lobe. The main trunk of the middle cerebral artery gets divided into a number of cortical branches which run to the specific region of the cerebral hemisphere, supplying blood to specific regions of the brain.

The first permanent branches of the middle cerebral artery which supply both the old and the new cortex are olfactory arteries.

The anterior olfactory artery (Fig. 1-1), having separated from the main trunk of the middle cerebral artery, runs to the rostral part of the lateral olfactory sulcus it can ascend into in various places. Its terminal branches can also appear again from under the lateral olfactory sulcus and then ascend under the cortex surface.

The posterior olfactory artery (Fig. 1-2) ascends into the caudal part of the lateral olfactory sulcus and its terminal branches supply the area of the cortex found under the sulcus.

The other branches of the middle cerebral artery supply the areas of the cortex over the lateral olfactory sulcus. On the cortex towards the frontal lobe spread three thick branches. As the first one there separates the orbital branch (Fig. 1-3) which is located lowest and it goes towards the region of the Presylvian sulcus where its terminal branches reach the coronary sulcus.

The inferior frontal branch (Fig. 1-4) vascularizes the middle part of the frontal lobe. The vessel goes through the rostral external Sylvian sulcus and the rostral Suprasylvian sulcus towards the coronary sulcus it passes towards the fornix.

The superior frontal branch (Fig. 1-5), having separated from the middle cerebral artery at the height of the rostral external Sylvian sulcus, goes up to the region of the cruciate sulcus. The vessel supplies blood to the upper part of the medial surface of the frontal lobe.

The next vessel which runs towards the parietal lobe bifurcates into two branches.

The anterior parietal branch (Fig. 1-6) runs towards the middle external Sylvian sulcus to the marginal sulcus. The terminal twigs of that vessel supply blood to the area of the cortex found under the ansiform sulcus.

The posterior parietal branch (Fig. 1-7) also runs to the region of the marginal sulcus and further on it branches out into smaller vessels. Some of them ascend into the medial Suprasylvian sulcus.

The lateral-posterior surface of the cerebral hemisphere is supplied by the branches of the middle cerebral artery which descend from at various heights and they are referred to as temporal branches.

The superior temporal branch (Fig. 1-8) is usually the strongest cortical branch of the middle cerebral artery. Having left the Sylvian fissure, it runs towards the middle Suprasylvian sulcus and further to the upper margin of the cerebral hemisphere. The branch supplies blood to the upper part of the cortex.

The middle temporal branch (Fig. 1-9) descends a small distance away from the previous branch. The branches of that vessel spread towards the external marginal sulcus. Its terminal branches go onto the surface of the occipital lobe.

The inferior temporal branch (Fig. 1-10) runs to the end of the caudal external Sylvian sulcus. Having passed the posterior part of the sulcus, its branches spread towards the caudal Suprasylvian sulcus. Its terminal branches take part in the supply of a part of the occipital lobe.

Considering the general pattern of the spread the cortical branches of the middle cerebral artery in raccoon dog, one shall note that respective sections of those branches can run inside respective sulci, always running towards the cortex areas described.

The way of departure of cortical branches of the middle cerebral artery from the rostral cerebral artery is presented in Table 1.

Table 1. The way of departure of cortical branches of the middle cerebral artery from the rostral cerebral artery

from the main trunk descended rostrally the independent anterior olfactory artery, then a common descend for orbital branch and the inferior and superior frontal branches	9 (15%)
from the main trunk departed rostrally the common departure for the anterior olfactory artery and for the orbital branch, then a common departure for the inferior and superior frontal branches	9 (15%)
from the main trunk departed rostrally the common departure for the anterior olfactory artery and for the orbital branch, then a common departure for the inferior and superior frontal branches	9 (15%)
from the main trunk of the middle cerebral artery rostrally there separated the common trunk for the anterior olfactory artery and the orbital branch, then the common departure for the inferior and superior frontal branch	9 (15%)
from the main trunk the following separated rostrally with a common trunk: the anterior olfactory artery and the common descent for the orbital branch and the inferior and superior frontal branch	6 (10%)
from the main trunk departed rostrally the orbital branch, the superior and inferior frontal branch and anterior olfactory artery	6 (10%)
from the main trunk of the middle cerebral artery rostrally there separated, independently, the anterior olfactory artery, the orbital branch and the common departure for the inferior and superior frontal branch	3 (5%)
from the main trunk of the middle cerebral artery rostrally there separated the anterior olfactory artery and the common departure for the orbital branch and inferior frontal branch	3 (5%)
from the main trunk with a common trunk separated the orbital branch, the posterior	

frontal branch as well as anterior olfactory artery	3 (5%)
from the rostral cerebral artery in raccoon dog there bifurcated two independent branches of the middle cerebral artery	3 (5%)

Analysing the pattern of descent of the cortical branches of the middle cerebral artery in the raccoon dog individuals investigated, it was found that from the rostral cerebral artery on 57 (95%) cerebral hemispheres there descended a single independent vessel; the middle cerebral artery.

Among them on 9 (15%) hemispheres from the main trunk there descended rostrally the independent anterior olfactory artery, then a common descend for orbital branch and the inferior and superior frontal branches. The main trunk, having ascended into the Sylvian fissure, on the surface of the cortex it showed a common trunk for anterior and posterior parietal branches as well as for the superior temporal branches. Caudally from the main trunk of the middle cerebral artery, with a common trunk there separated the superior, middle and inferior temporal branches, whereas the posterior olfactory artery got separated independently from the main trunk of the middle cerebral artery.

In another 3 (5%) cerebral hemispheres from the main trunk with a common trunk there separated the orbital branch, the posterior frontal branch as well as anterior olfactory artery. The main trunk of the middle cerebral artery got onto the surface of the cortex with a common descent for the superior frontal branch, anterior and posterior parietal branches. Caudally from the main trunk of the middle cerebral artery, with a common trunk there separated the superior, middle and inferior temporal branches and independent posterior olfactory artery.

On 6 (10%) hemispheres from the main trunk the following separated rostrally with a common trunk: the anterior olfactory artery and the common descent for the orbital branch and the inferior and superior frontal branch. Caudally from the main trunk of the middle cerebral artery, with a common trunk there separated the middle and inferior temporal branch as well as posterior olfactory artery. The main trunk, having ascended into the Sylvian fissure, on the surface of the cortex it showed a common trunk for anterior and posterior parietal branches as well as for the superior temporal branch.

On another 9 (15%) cerebral hemispheres from the main trunk departed rostrally the common departure for the anterior olfactory artery and for the orbital branch, then a common departure for the inferior and superior frontal branches. Caudally from the main trunk there descended the common trunk for the inferior temporal branch and the posterior olfactory artery. The main trunk, having descended into the Sylvian fissure, got onto the surface of the cortex with a common descent for the superior frontal branch, anterior and posterior parietal branches as well as the middle and superior temporal branch.

On the other 6 (10%) cases it was found that from the main trunk departed rostrally the orbital branch, the superior and inferior frontal branch and anterior olfactory artery. Caudally from the main trunk of the middle cerebral artery, with a common trunk there separated the anterior and posterior parietal branches as well as superior, middle and inferior temporal branches. The posterior olfactory artery departed independently from the main trunk.

On another 9 (15%) cerebral hemispheres from the main trunk departed rostrally the common departure for the anterior olfactory artery and for the orbital branch, then a common departure for the inferior and superior frontal branches. Caudally from the main trunk of the middle cerebral artery, with a common trunk there separated the posterior olfactory artery as well as the inferior temporal branch. Having descended into the Sylvian fissure, got onto the surface of the cortex with a common descent for the anterior and posterior parietal branches as well as the middle and superior temporal branch.

On yet another 3 (5%) cerebral hemispheres from the main trunk of the middle cerebral artery rostrally there separated, independently, the anterior olfactory artery, the orbital branch and the common departure for the inferior and superior frontal branch. Caudally from the main trunk the following separated with a common descent: the posterior olfactory artery and the inferior and the middle temporal branch. The main trunk of the middle cerebral artery, having got into the surface of the cortex, separated a common descent for anterior and posterior parietal branches and the superior temporal branch.

On another 3 (5%) cerebral hemispheres from the main trunk of the middle cerebral artery rostrally there separated the anterior olfactory artery and the common departure for the orbital branch and inferior frontal branch. The superior frontal branch departed independently. Caudally from the main trunk separated the posterior olfactory artery. Having passed the lateral olfactory sulcus it separated the common trunk for the inferior and middle temporal branch. The main trunk, having ascended into the Sylvian fissure it showed the common trunk for the parietal branches and for the superior temporal branch.

On another 9 (15%) cases from the main trunk of the middle cerebral artery rostrally there separated the common trunk for the anterior olfactory artery and the orbital branch, then the common departure for the inferior and superior frontal branch. The main trunk gave caudally on the surface of the cortex a common departure for the anterior and posterior parietal branches as well as superior, middle and inferior temporal branch. The posterior olfactory artery separated caudally from the main trunk of the middle cerebral artery as an independent vessel.

On the other 3 (5%) hemispheres it was found that from the rostral cerebral artery in raccoon dog there bifurcated two independent branches of the middle cerebral artery. Among them the first independent branch from the rostral cerebral artery was the anterior olfactory artery, while the second branch from the rostral cerebral artery – the main trunk of the middle cerebral artery from which there descended rostrally independently: the orbital branch, the common trunk for the inferior and superior frontal branch as well as posterior parietal branches. Caudally from the main trunk there separated an independent posterior olfactory artery and the inferior temporal branch. The main trunk, having descended into the Sylvian fissure, got onto the surface of the cortex with the posterior parietal branch and a common descent for the middle and superior temporal branch (Fig. 2).

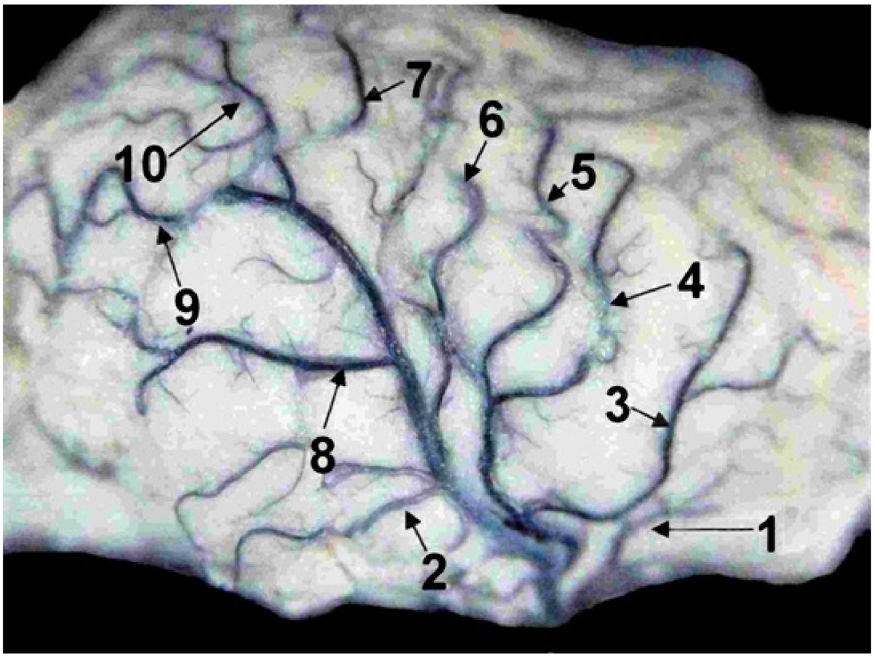

Fig. 2. Departure of the anterior olfactory artery and the main trunk of the middle cerebral artery from the rostral cerebral artery

1 – Anterior olfactory artery, 2 – Posterior olfactory artery, 3 – orbital branch, 4 – inferior frontal branch, 5 – superior frontal branch, 6 – anterior parietal branch, 7 – posterior parietal branch, 8 – superior temporal branch, 9 – middle temporal branch, 10 – inferior temporal branch

DISCUSSION

The middle cerebral artery supplies blood to the greatest region of the cerebrum and is the most shaped branch extending from the rostral cerebral artery. In raccoon dog the middle cerebral artery supplies the same areas of the brain as in the mammalian species studied so far. The discrepancies concern mostly its division into respective branches. Chadzypanagiotis [7], describing the cortical branches in cat, differentiated between the branches supplying the old cortex, the branches on the border of the old and the new cortex as well as the branches for the new cortex.

In raccoon dog the arteries supplying the old cortex are minor branches onto the piriform lobe and olfactory tracts. On the border of the old and the new cortex there are found the anterior and posterior olfactory arteries. In raccoon dog the anterior olfactory artery in 5% of the cases was a vessel which descended independently from the rostral cerebral artery. On the other cerebral hemispheres it was a vessel which got separated independently from the main trunk of the middle cerebral artery in 35% of the cases. In 30% of the cases it formed a common departure with the orbital branch. On the 20% of the cerebral hemispheres it was one of the branches descending from the common trunk of the middle cerebral artery which gave rise to the orbital branch and the inferior frontal branch. In the other 10% cases the anterior olfactory artery demonstrated a common descent with the orbital, inferior and superior frontal branches.

The posterior olfactory artery, on the other hand, in 55% of the cases was a vessel which descended independently from the main trunk of the middle cerebral artery. On 30% of cases the posterior olfactory artery separated with a common descent with the inferior temporal branch. In the other 15% hemispheres the posterior olfactory artery was one of the branches of a common trunk for inferior and middle temporal branch.

The other cortical branches of the middle cerebral artery can be divided into a group of frontal, parietal and temporal branches. In dog, similarly as in other Carnivora species there occur eight main vessels which supply blood to the area of the new cortex of the cerebrum.

Besides, respective cortical branches can descend from the main trunk of the middle cerebral artery with a common descent. Such cases of descent were reported by Skoczylas et al. [12] as the anterior, superior and posterior middle cerebral artery. In raccoon dog the anterior middle cerebral artery has been presented as a common trunk for frontal branches and it occurred in 25% of the cases investigated, the superior middle cerebral artery was described as a common trunk for parietal branches, which was observed in 15% of the cases. The posterior middle cerebral artery as a common trunk for temporal branches was found in 20% of the cases.

In raccoon dog the superior middle cerebral artery occurred as the lowest percentage of the cases, however, here the anterior middle cerebral artery dominated. Making a comparison of the present results with those reported by Wiland [16] and by

Skoczylas et al. [12] one can state the superior middle cerebral artery was reported as the lowest percentage of the cases. In raccoon dog, similarly as in the other animal species studied, the parietal branches have developed poorest. On the surface of the cerebrum the best developed are the frontal branches of the middle cerebral artery.

From the description of the structure of the middle cerebral artery in the publications by Ozudogru et al. [10], Skoczylas et al. [12] in the common fox and otter one can see that it is usually a single vessel descending from the rostral cerebral artery. The vessel, having passed the lateral olfactory sulcus, gets divided along its course into respective cortical branches. In the material investigated such a pattern of division of the middle cerebral artery was found in 95% of the cases. In raccoon dog there were identified the cases of descent from the rostral cerebral artery of two independent arterial trunks in 5% of the cases. The second independent branch from the rostral cerebral artery was the anterior olfactory artery. In other mammalian species the presence of two independent descents of the branches of the middle cerebral artery was found in in wild rabbit [5] in 36.5% of the cases.

The present research show that observed in raccoon dog the division of the middle cerebral artery into the same branches or their groups, like in the other mammalian species investigated so far is, according to Wiland [15] a result of genetic limitations.

CONCLUSIONS

1. The middle cerebral artery supplies blood to the greatest region of the cerebrum and is the most shaped branch extending from the rostral cerebral artery.
2. The division of the middle cerebral artery into the same branches, like in the other mammalian species is a result of genetic limitations.
3. In raccoon dog the superior middle cerebral artery occurred as the lowest percentage of the cases.
4. In raccoon dog the arteries supplying the old cortex are minor branches onto the piriform lobe and olfactory tracts.
5. In dog, similarly as in other Carnivora species there occur eight main vessels which supply blood to the area of the new cortex of the cerebrum.

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Accepted for print: 23.02.2015

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