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Arterial supply of the olfactory trigone and the anterior perforated substance in macrosmatic and microsmatic animals

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An investigation was conducted into the differences between macrosmatic and microsmatic animals of arterial supply in the area of the olfactory trigone and the anterior perforated substance. A brain of domestic cat was taken as an example of a macrosmatic animal and a brain of baboon as an example of a microsmatic animal. The cerebral blood vessels of the cadavers of 30 cats and 11 baboons were filled with latex and, after fixation in acid alcohol by means of microscopic operation, the cortical and deep branches of the anterior and middle cerebral arteries were dissected.

We discovered that there were differences between these two groups of animals in the places of arising of deep branches and in their course. In the cat the deep branches running through the area of the olfactory trigone arose from the beginning part of the middle cerebral artery in numbers 5–10 and entered the brain in the olfactory tubercle. In the baboon the deep branches arose from two sources: the middle cerebral artery and the anterior cerebral artery. The branches of the middle cerebral artery went through the anterior perforated substance, forming two groups of branches: lateral and medial.

key words: olfactory trigone, anterior perforated substance, arterial supply, cat, baboon

INTRODUCTION

The aim of the study was to investigate the differences between macrosmatic and microsmatic animals in arterial supply of the area of the olfactory trigone and the anterior perforated substance. The brain of domestic cat was taken as an example of a macrosmatic animal and the brain of baboon as an example of a microsmatic animal.

In articles which have been published up until now concerning arterial supply of the brain of the cat and some other macrosmatic animals, i.e., dog, sheep, rabbit or fox [1–8, 11, 16–18], the topography of the vessels of the arterial circle and the range of supplying of the main arterial stems running on the surface of the cerebral hemispheres have been described. However, in the available literature there have been differences between the results of the research works into arterial supplying of the olfactory trigone and anterior perforated substance either in a cat or a baboon [2–5, 9, 12–15].

MATERIAL AND METHODS

Cerebral blood vessels of 30 cats and 11 baboons were filled with latex. After fixation in acid alcohol the arterial circle was morphologically estimated. By means of microscopic operation the cortical and deep branches of the anterior and middle cerebral arteries were dissected.

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RESULTS

We discovered that there were differences between these two groups of animals in places where the deep branches arose and in their course. In the cat the deep branches running through this area arose from the beginning part of the middle cerebral artery in numbers 5–10 and entered the brain in the olfactory tubercle (Fig. 1). These branches were from 70 to 140 μm in diameter (Fig. 2). The bigger arteries of this group gave superficially running branches to the cerebral cortex as well. In 6% of specimens of the investigated cat brains the deep branches arising from the middle cerebral artery gave broad but not numerous anastomoses of 70 μm in diameter in their extracerebral segments.

In the baboon the deep branches arose from two sources: the middle cerebral artery and the anterior cerebral artery. The deep branches of the middle cerebral artery went through the anterior perforated substance, forming two groups of branches: lateral and medial (Fig. 3).

Usually one or two bigger stems arose from the anterior cerebral artery at a distance of 0.2–1.0 mm of its beginning. This stem, of diameter 110–170 μm, went back and, after about 5.0 mm, it divided into several branches (mostly 6–8). They were running in the direction of the medial part of the anterior perforated substance and olfactory trigone (Fig. 4).

A branch of diameter 180–240 μm arose from the beginning part of the medial cerebral artery — usually about 1.0 cm of its length (0.7–1.3 cm). This branch typically had a diameter slightly bigger than the branch arising from the anterior cerebral artery (110–170 μm). This ramification of the medial cerebral artery ran medially and after about 5 mm it divided into several branches (8–14), which further penetrated into the

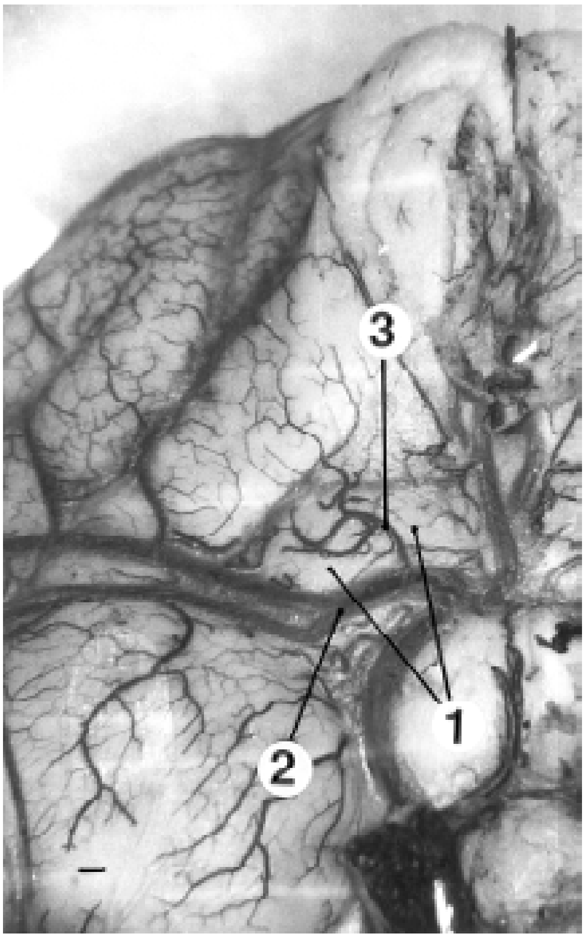

Figure 1. The brain of a cat. Topography of the deep branches of the middle cerebral artery in the area of the olfactory tubercle of the right cerebral hemisphere. Arteries filled with latex. Scale bar 1 mm; 1 — olfactory tubercle, 2 — middle cerebral artery, 3 — arteries arising from the middle cerebral artery.

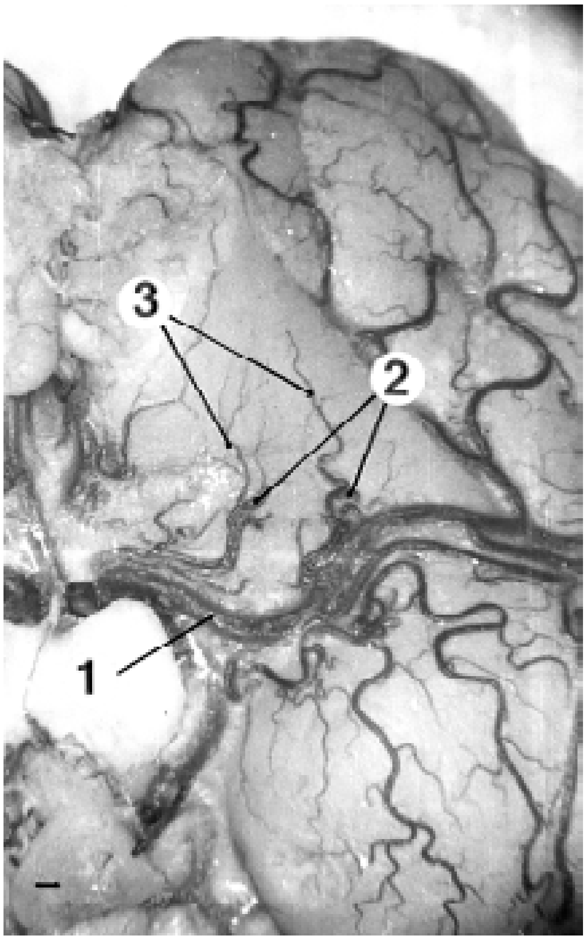

Figure 2. The brain of a cat. The left hemisphere. Topography of the deep branches of the middle cerebral artery entering the brain and superficial branches going to the cortex. Arteries filled with latex. Scale bar 1 mm; 1 — middle cerebral artery, 2 — deep branches of the middle cerebral artery, 3 — superficial branches running to the cortex.

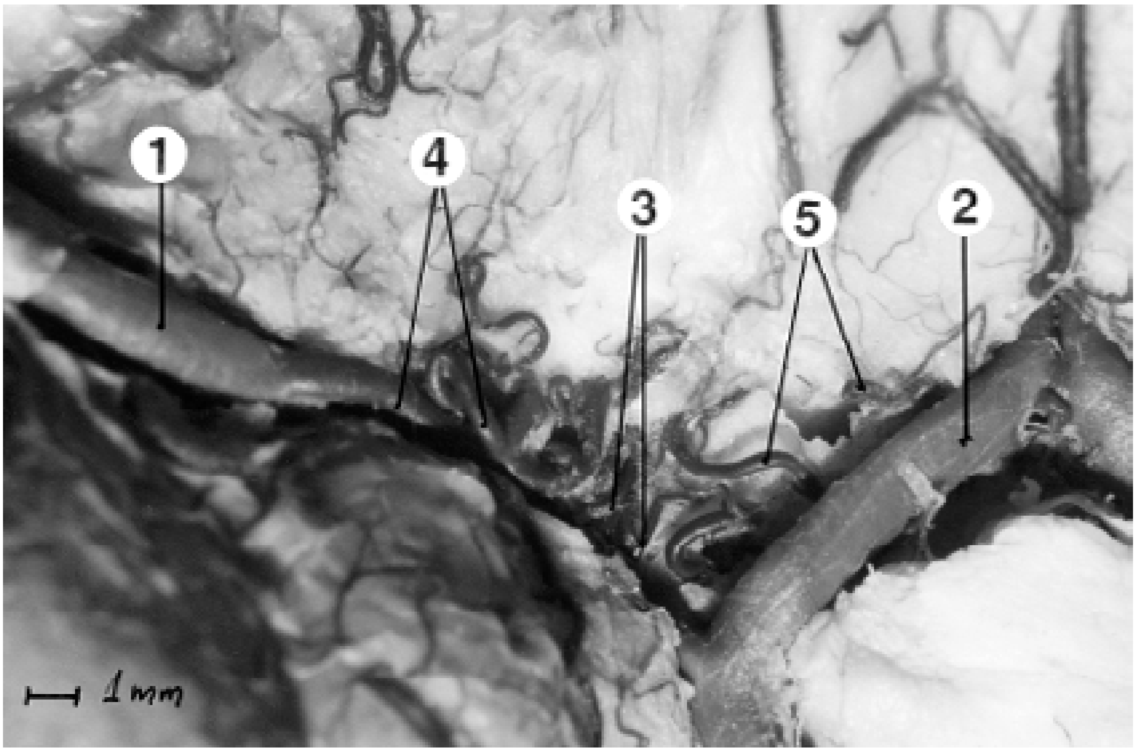

Figure 3. The brain of a baboon. Topography of the deep branches of the middle lobar artery and anterior cerebral artery in the area of the olfactory trigone and the anterior perforated substance of the right cerebral hemisphere. Arteries filled with latex. Scale bar 1 mm; 1 — middle cerebral artery, 2 — anterior cerebral artery, 3 — deep branches forming medial group of arteries, 4 — deep branches forming lateral group of arteries, 5 — deep branches of the anterior cerebral artery.

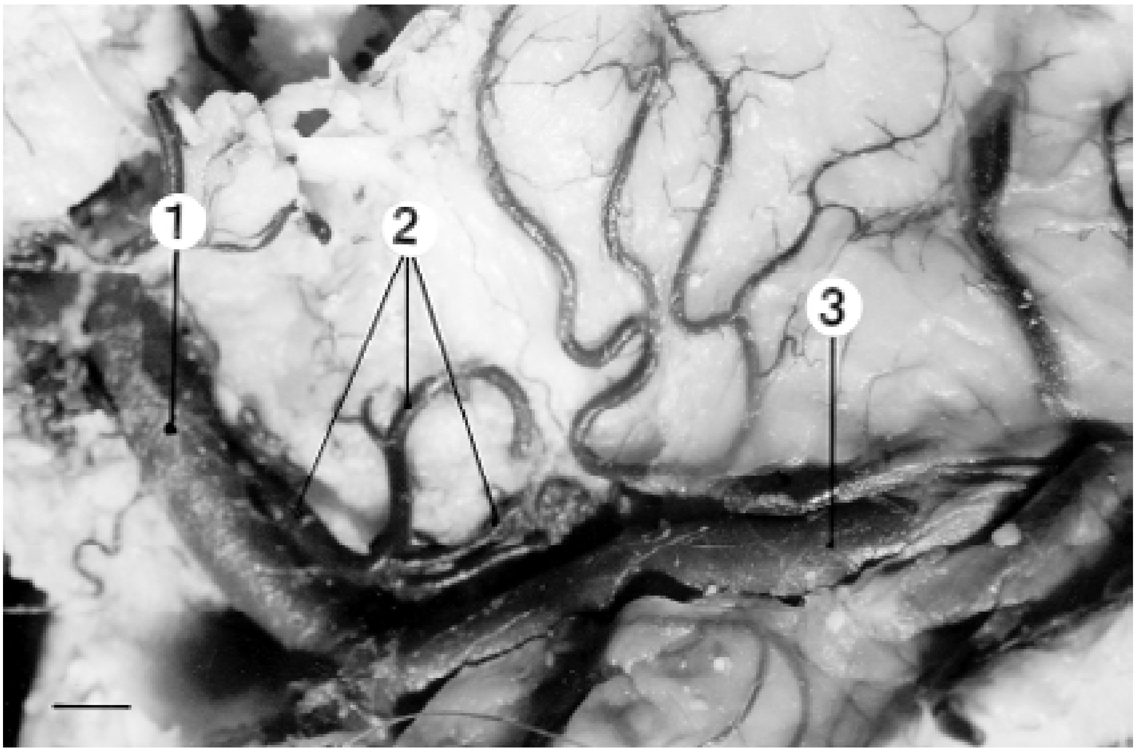

Figure 4. The brain of a baboon. Topography of the deep branches of the anterior cerebral artery in the area of the anterior perforated substance of the left cerebral hemisphere. Arteries filled with latex. Scale bar 1 mm; 1 — anterior cerebral artery, 2 — deep branches of the anterior cerebral artery and their ramifications, 3 — middle cerebral artery.

anterior perforated substance (Fig. 4). Two or three of its bigger branches went superficially to a lateral part of the olfactory trigone penetrating into the cerebral cortex. In contrast to the extracerebral segments of the deep branches of the middle cerebral artery in cat brains, we did not find arterial anastomoses in these segments in the baboons.

DISCUSSION

Chadzypanagiotis [3] noted that in the brain of a cat the anterior cerebral artery gave three groups of branches: arteries supplying the archicortex of the olfactory splenium, the artery of the olfactory bulb and the arteries supplying the neocortex. Another paper of this author [4] distinguished three types of division of the middle cerebral artery. He noticed that numerous branches arose directly from this artery as well, and they penetrated the olfactory lobes, which was in accordance with our research, where we observed 5–10 branches of the middle cerebral artery entering the brain in the olfactory tubercle.

Chadzypanagiotis [5] similarly described in the cat brain the distribution of the arteries supplying the archicortex and neocortex, which were branches of the anterior cerebral artery and the posterior cerebral artery. He determined the ranges of supplying these arteries and their individual variability.

Our studies revealed that in only 6% of specimens of the investigated cat brains the deep branches arising from the middle cerebral artery gave a few broad anastomoses in their extracerebral segments, whereas, according to Sztamska and Goetzen [14], these arteries in cat and sheep brains formed numerous anastomoses and, thus, they created anatomical connections for collateral circulation.

The comparative research on deep branches running to the striatum and internal capsule of the cat and the human were described by Nachman and Nachman [13]. They gave evidence of real differences between branches arising from the maternal stems and running to striatum and their course in the subarachnoid cisternes of the cat and of the human, because in cat brains they gave few anastomoses between them, which were absent in human brains.

Our studies showed that a smaller number of deep branches of the middle cerebral artery of the cat brains entered the brain in a spot corresponding with the anterior perforated substance in humans.

In some other macrosmatic animals, for example in a dog, the branches penetrating the anterior perforated substance came from the branches of the anterior communicating artery, similar to the recurrent artery of Heubner in humans, and from the middle cerebral artery [1]. Although some animals had a single source of the perforating arteries, most had two or more. Occlusion of all microscopically visible perforators to the anterior perforated substance reliably resulted in infarction of the internal capsule (100%), caudate nucleus (91–100%), putamen and globus pallidus (82–91%), and (73%) anterior commissure [1].

Librizzi et al. [11] reported that in the guinea pig, the middle cerebral artery and the rostral and caudal posterior cerebral arteries supplied the limbic cortices and some related subcortical regions with a very broad overlap between the distal territories of these vessels. The demonstration of an extensive superimposition between the arterial supply of the entorhinal and perirhinal regions suggests the presence of anastomotic connections that potentially are protective against ischaemic events.

Coyle and Jokelainen [6] showed that distal branches of the anterior cerebral artery were joined by interarterial anastomoses to the rami of the middle cerebral artery in the normal Wistar rat in 36- and 56-day-old animals. There were about 29 junctions per hemisphere.

In our research on baboons the middle part of the olfactory trigone and anterior perforated substance was supplied by branches of the anterior cerebral artery and the lateral part of that territory by branches of the middle cerebral artery. This is compatible with the research of Liu et al. [12], where in baboons the boundary region between the territories of the anterior and middle cerebral arteries lay within 10 mm of the midline.

In our research we did not find anastomoses between deep branches in the extracerebral segments of baboon brains, similarly to Sztamska and Goetzen [14] in human brains.

However, Watanabe et al. [15] claim that in the middle cerebral artery territory in primates the extremely abundant leptomeningeal anastomoses would be among the major factors leading to the variability in the clinicopathological pictures seen in the models of the proximal middle cerebral artery occlusion.

According to Lake et al. [10] the blood supply of the primates (including the baboon Papio ursinus) was found to be similar to that of man in each case. Like man they have a complete circulus arteriosus, but they have a single anterior cerebral artery, whereas man has paired anterior cerebral arteries.

Our studies reveal that there are differences between macrosmatic and microsmatic animals in the arterial supply of the olfactory trigone and the anterior perforated substance. Furthermore, there are differences in the opinions of authors who have studied arterial anastomoses in the limbic territory [1, 6, 11, 14, 15].

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