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Arteries to the proximal part of the olfactory tract

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Destruction of the vascularisation of the olfactory structures during fronto-orbital surgical approaches to the sellar region may result in anosmia as a complication. The goal of this study was to describe the sources of blood supply to the proximal olfactory tract and the macroscopic distribution of these vessels.
20 human brains fixed in formalin with arteries injected with ink-coloured gelatine were studied using a surgical microscope and the micro-dissection technique. The vessels running along the olfactory tract posteriorly and anteriorly on its inferior and superior surface were observed. These arteries and arterioles were most often branches of the constant artery supplying the posterior part of the straight gyrus and orbital gyri (38/40). Similarly, as branches of the medial orbitofrontal artery (7/40), they were found on the superior aspect of the tract. Branches of the distal medial striate artery directed to the olfactory structures were observed on the basal surface of the tract (20/40).

Key words: anterior cerebral artery, Heubner's recurrent artery, distal medial striate artery, medial orbitofrontal artery, anosmia

INTRODUCTION

The olfactory tract is an elongated structure connecting the olfactory bulb with the olfactory trigone on the basal surface of the frontal lobe. When viewed from below, it partially covers the olfactory sulcus and is located in a narrow subarachnoid cistern [5, 11].

Dissection of the olfactory tracts from the frontal lobes is necessary in some neurosurgical approaches to the anterior cranial fossa and parasellar region [19]. In these cases much effort should be put into preservation of the integrity of the tracts as well as their blood supply. Nevertheless, despite efforts during surgery, postoperative anosmia is a common complication. Loss of olfaction may significantly influence a patient's quality of life and should be prevented if possible. The reason why anosmia occurs may not only be direct damage to the olfactory neural pathway, but also destruction of the vessels supplying the olfactory structures. Here preliminary observations of the arterial blood supply to the olfactory tract are presented.

MATERIAL AND METHODS

The study was performed on the material of 20 human brains. These were obtained during routine autopsies of subjects without any neurological pathology. Macroscopic examination did not reveal any abnormalities or evidence of neurosurgical interventions. The proximal part (at least 1.5 cm in length) of the olfactory tract was preserved in all the brains. The arteries of the specimens were perfused with normal saline and next injected with ink-coloured gelatine. The specimens were then fixed in formaldehyde solution. The micro-dissection technique with the use of

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neurosurgical instruments under a surgical microscope was performed in order to visualise the arterial branches supplying the proximal part of the olfactory tract.

RESULTS

Arterial branches directed to the proximal part of the olfactory tract were observed on 40 cerebral hemispheres. Three sources of blood supply were found to the structure under examination: the artery to the posterior orbitofrontal surface, the medial orbitofrontal artery and the distal medial striate artery. The results of the observations are summarised in the Table 1.

Branches of the artery to the posterior orbitofrontal surface

The posterior part of the straight gyrus, the orbital gyri and the olfactory sulcus are supplied from a constant artery (POfA, posterior orbitofrontal artery), which in most cases is a direct branch of the A2 segment of the anterior cerebral artery and commences between the anterior communicating artery (ACoA) and the medial orbitofrontal artery (MOfA). In 28 of 40 hemispheres this artery gave off branches to the olfactory tract (Fig. 1). It was usually the source of at least one artery running along the tract in the olfactory sulcus or on the side of the tract. These arteries gave off perpendicular arterioles to the olfactory tract, branching most often on the superior surface of the tract or on its margins.

Branches of the medial orbitofrontal artery

In 10 of 40 cases the olfactory tract was vascularised by branches of the posterior orbitofrontal artery, which started as a branch of the medial orbitofrontal artery (Fig. 2a). Only in 7 hemispheres did the medial orbitofrontal artery directly supply the superior surface of the tract (Fig. 2b, 2c).

Table 1. The number of hemispheres in which branches supplying the olfactory tract came from the POfA, MOfA or DMSA respectively

	POfA from A2	POfA from MOfA	MOfA	DMSA
Right hemispheres	13/20	7/20	4/20	10/20
Left hemispheres	15/20	3/20	3/20	10/20
Total	28/40	10/40	7/40	20/40
	37/40		—	—
	—	15/40		—

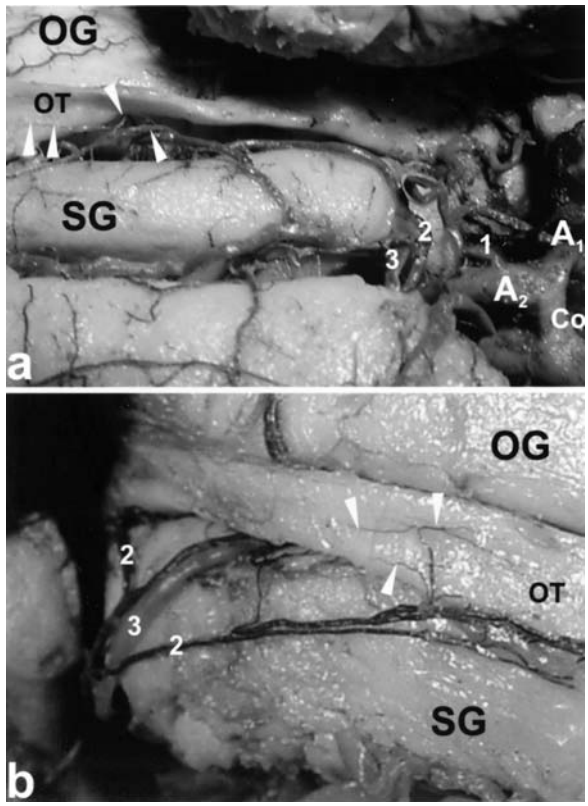

Figure 1. Arteries originating from the post-communicating segment of the anterior cerebral artery (A_2) and branches of the POfA indicated with arrows supplying the superior (**a**) and the inferior (**b**) surfaces of the olfactory tract. A_1 — pre-communicating anterior cerebral artery, Co — anterior communicating artery, OG — orbital gyri, OT — olfactory tract, SG — straight gyrus, 1 — distal medial striate artery, 2 — posterior orbitofrontal artery, 3 — medial orbitofrontal artery.

Branches of the distal medial striate artery

In 20 of 40 hemispheres the branches to the olfactory tract came from the distal medial striate artery (DMSA, also known as the Heubner's recurrent artery). This was observed in cases in which the distal medial striate artery formed an anteriorly directed loop on the surface of the anterior perforated substance, olfactory trigone and olfactory tract. Branches supplying the tract originated from the loop as well as from the proximal part of the artery. In the majority of cases the olfactory branches of the distal medial striate artery ran on the inferior surface of the tract (Fig. 3).

DISCUSSION

The vascular anatomy of the olfactory area of the brain (the anterior cerebral artery and the anterior communicating artery with their branches) has an abundant literature as a result of its clinical significance. Some authors refer to the arterial blood sup-

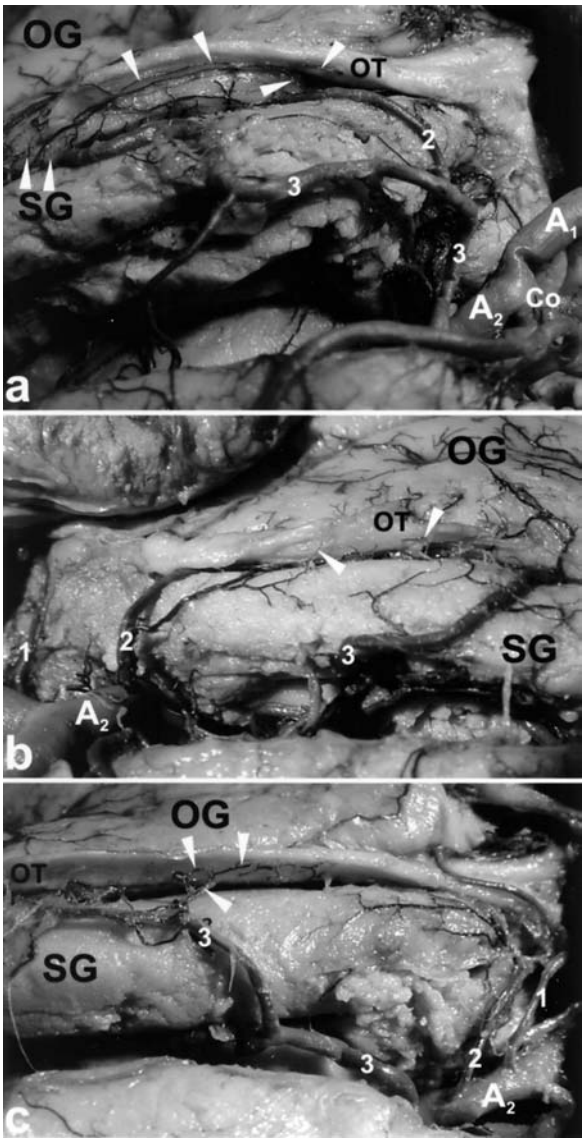

Figure 2. The medial orbitofrontal artery supplying the olfactory tract: through the POfA as a proximal branch of MOfA (**a**) and directly in the middle part of the tract (**b, c**); 1 — DMSA, 2 — POfA, 3 — MOfA.

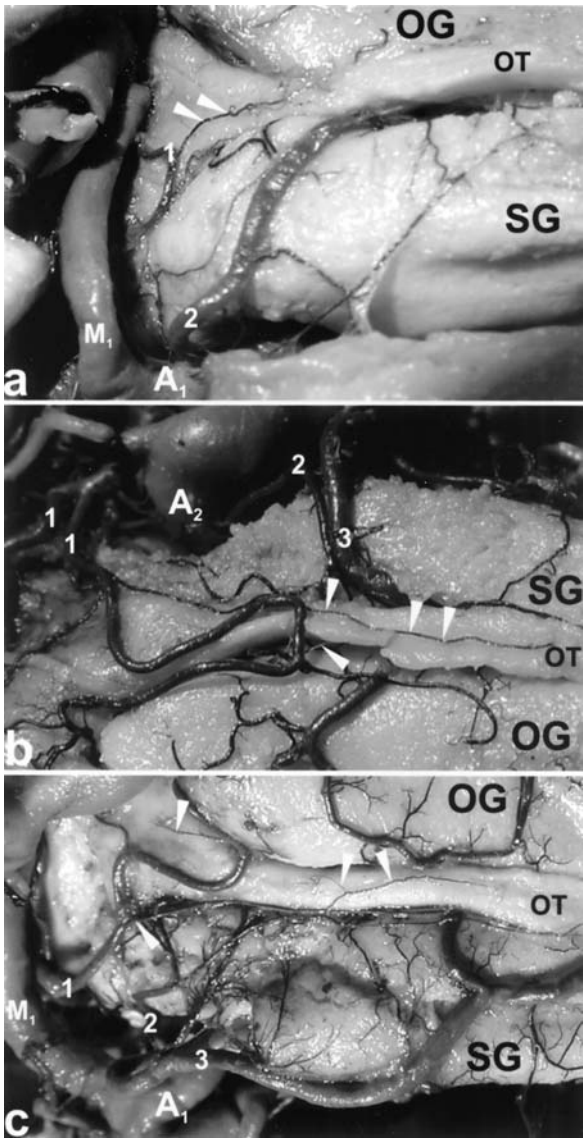

Figure 3. Loops of the distal medial striate artery in the region of the olfactory trigone. Branches of the DMSA directed to the olfactory structures are indicated with arrows; 1 — DMSA, 2 — POfA, 3 — MOfA.

ply to the olfactory structures from Heubner's recurrent artery [1–3, 6–12, 14, 17, 20] and from the medial orbitofrontal artery [2, 4, 5, 11–13, 18, 20], sometimes indicating this only on figures and rarely giving more detailed information.

Few researchers distinguish the artery to the posterior part of the straight and orbital gyri [5, 10, 17] as a separate source of blood supply for the olfactory tract, despite the fact that it seems to be the most important of the vessels directed to the proximal part of the tract. It was seen to supply the olfactory tract in the great majority of the hemispheres examined (Table 1). Sometimes the term "olfactory branch" is used [6], although this suggests a limited area supplied by the vessel and is not precise. Thus this "cortical branch" of the anterior communicating artery complex [10] is here named the posterior orbitofrontal artery. It is regarded as a constant vessel [1, 6] with quite well defined area of supply.

Neither the posterior orbitofrontal artery described above, nor the branches running along the olfactory tract in the olfactory sulcus [5, 14] should be termed "olfactory artery", as this is the name of a primitive vessel of the inferior surface of the frontal lobe normally absent in adults [15, 16]. No possible association between them has been confirmed.

Olfactory structures receive their blood supply from the long cortical and subcortical branches of the anterior communicating artery complex, i.e. the distal medial striate artery, the posterior orbitofrontal artery and the medial orbitofrontal artery, some of which may be multiple but appear in this order in the posterior part of the orbital surface of the frontal lobe. Branches vascularising the olfactory tract are found mostly in its proximal part, where the posterior orbitofrontal artery traverses the straight gyrus and enters the olfactory sulcus and Heubner's artery passes to the anterior perforated substance. Rare distally located branches to the olfactory tract originate either from the medial orbitofrontal artery or from the vessel running along the olfactory tract, which comes from the posterior orbitofrontal artery or from Heubner's artery. That the tract should not be separated from the brain in its proximal (1.5 cm) part [19] concurs with clinically based opinion.

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