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Anatomy

Microanatomy of the subependymal arteries of the lateral ventricle

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Abstract

Background: Scarce information about the anatomy of the subependymal arteries (SEAs) is present in the scientific literature.
Methods: Twenty cerebral hemispheres with injected arteries were microdissected, and the magnetic resonance imaging scans of 100 patients with lacunar infarcts were examined.
Results: The SEAs were found to range in diameter from 40 to 490 μm (mean, 149 μm) and in number between 3 and 12 (average, 5.2). Of these, numbers from 1 to 3 originated from the anterior choroidal artery (AChA), between 1 and 10 from the lateral posterior choroidal artery (LPChA), 1 from the medial posterior choroidal artery (MPChA), and 1 from the internal carotid artery. The SEAs most often arose from the choroidal branches (90%) and less frequently from the thalamic (30%), caudate (35%), or thalamocaudate twigs (20%). The SEAs of the AChA supplied the walls of the temporal horn (100%), the occipital horn (85%), and the atrium (35%). Those of the LPChA perfused the walls of the occipital horn (15%), the atrium (65%), the body of the ventricle (100%), and partially the frontal horn. The SEAs of the MPChA partially nourished the body and the frontal horn (10%). The SEAs may also occasionally supply the caudate nucleus (20%) and the stria terminalis. The anastomoses involving the SEAs were absent. In spite of this, ischemia in the territory of a single SEA was noticed in only 1% of our patients.
Conclusions: The SEAs are tiny vessels that supply the walls of the lateral ventricle, as well as the caudate nucleus and the stria terminalis occasionally. The obtained anatomic data can have important neurosurgical implications in intraventricular operations.

Keywords: Subependymal artery; Cerebral artery; Anterior choroidal artery; Lateral posterior choroidal artery; Caudate artery; Thalamic artery; Lateral ventricle; Choroid plexus; Periventricular region

1. Introduction

Many neurosurgeons and anatomists, including the present authors, examined in detail the choroidal arteries of the lateral ventricle, that is, the anterior choroidal artery (AChA), the lateral posterior choroidal artery (LPChA), and the medial posterior choroidal artery (MPChA) [11,14,16,20,34,37,41,43]. In spite of this, however, there is only one article in the available literature that is partially devoted to the subependymal branches of the choroidal arteries [39]. These "ventriculofugal" arteries have only been mentioned in some other radiological and neurosurgical references [29,37], but without any anatomic description. Because the subependymal arteries (SEAs) may have certain significance in ventricular surgery, we decided to examine in detail their origin, diameter, course, branching pattern, and region of supply.

2. Materials and methods

Thirteen brains were taken during routine autopsy from persons aged between 39 and 68 years immediately after

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death. No neuropathologic process was evident in those patients. The arterial system of each brain was perfused with isotonic saline solution and then injected either with a radiopaque substance (Micropaque) or with a 10% mixture of India ink and gelatin. After fixing the brains in 10% formaldehyde solution for 3 weeks, the right and left cerebral hemispheres were separated from each other by a midsagittal section of the corpus callosum and the basal structures.

The 20 best injected hemispheres were used in this study. The peripheral portions of each hemisphere, including the corpus callosum, uncus, hippocampal formation, and parahippocampal gyrus, were cut off to expose the lateral ventricles and the thalamus. After dissecting the main choroidal arteries, the free portion of the choroid plexus was excised or displaced medially to expose the corresponding walls of the body, the atrium, and the temporal horn of the lateral ventricle. The initial parts of the SEAs were identified in the choroidal fissure. The arteries were then microdissected under the stereoscopic microscope using magnifications from ×4 to ×40.

In spite of the fact that we used the finest microinstruments available, the microdissection often was very difficult for 2 reasons: Firstly, because of the very small size of some arteries, particularly of their side branches. Secondly, because of the high elasticity and resistance of the ependymal layer. In several cases, some amount of the India ink escaped from certain arteries, especially from the larger vessels (Fig. 4), but this event did not alter the validity of our results. After completing the microdissection, a precise drawing was made of each specimen. The diameter of the vessels was measured using an ocular micrometer scale. Each mark on the scale had a value of 25 μm at a magnification of ×40. The photographs of the specimens were taken after immersing them in water. For that reason, a small number of the air bubbles appeared occasionally (Figs. 2 and 4).

The statistical analysis comprised the counting of the frequencies, as well as the mean values of the number, diameter, and origin of the vessels.

To find the ischemic zones in the subependymal or the periventricular region, we examined the magnetic resonance imaging (MRI) scans of 100 patients with lacunar infarcts of the cerebral hemispheres. All the MRI scans had been performed in a T2-weighted technique. Three scans showed the ischemic areas in the mentioned regions. Unfortunately, the medical records of these patients were not available.

3. Results

The SEAs ranged in number from 3 to 12 and in diameter from 40 to 490 μm (Table 1). When these vessels were smaller in number, they all arose from the choroidal arteries and extended through the subependymal layer of a larger part of the ventricular wall (Fig. 1). In the cases with a larger number of vessels, some of them were smaller and they usually arose from the thalamic, caudate, or thalamocaudate branches of the main choroidal arteries (Fig. 1, Table 1).

3.1. The AChA branches

One, two, or three subependymal vessels always originate from the AChA, that is, from its plexal segment (Fig. 2, Table 1). In 15% of the hemispheres, the most proximal vessel arose at a distance of less than 1 mm to one or more perforating branches of the AChA (Fig. 2). The subependymal vessels most often (90%) arose from the choroidal branches of the AChA at the level of the choroidal fissure (Fig. 1) and rarely from the AChA itself (10%). They continued transversely or obliquely across the superior and lateral wall of the temporal horn of the lateral ventricle, sometimes in close relationship with the inferior ventricular vein. They gave rise along their course to the side and terminal branches (Figs. 1 and 2). These branches not only supplied the subependymal area, but also the tail of the caudate nucleus and the stria terminalis (20%). In addition to the temporal horn, the most distal SEA predominantly supplied the wall of the occipital horn (85%) and also the wall of the atrium in 35% of the hemispheres (Fig. 1).

3.2. The internal carotid artery branches

In one hemisphere (Fig. 3), the largest part of the wall of the temporal horn was perfused by a subependymal branch of the internal carotid artery (ICA). This branch arose from the choroidal segment of the supraclinoid (C4) part of the ICA. It resembled a typical ICA perforating artery. The vessel entered the caudal part of the anterior perforated substance, made an intraparenchymal loop (Fig. 3), and extended across the wall of the temporal horn.

3.2.1. The LPChA branches

From 1 to 10, subependymal vessels were seen to arise from the LPChA in all the hemispheres (Figs. 1 and 4).

Table 1
Characteristics of the SEAs

Origin (%)							No., range (mean)	Diameter (μm), range (mean)
AChA	LPChA	MPChA	ICA	Thalamic arteries	Caudate arteries	Thalamic and caudate arteries		
100	100	10	5	30	35	20	3-12 (5.2)	40-490 (149)