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Endoscopic and morphometric assessment of basal cerebral arteries and their bifurcations.

ABSTRACT

In contrast to well described topographic and surgical anatomy of the basal cerebral arteries, their endovascular anatomy remains an undiscovered area of research. Although the first published anatomical description of the internal aspect of basilar artery dates back to the first half of 19th century, only few studies focused on the topic were completed over the last 100 years. It seems, however, that in the age of rapid development of intravascular techniques, knowledge about this topic might become more useful than ever before. The aim of this study was a non-invasive assessment of the endovascular anatomy of the basal cerebral arteries and their bifurcations by means of endoscopy, which was complemented by morphometry and – in selected cases – histological analysis.

Particular attention in this study was paid to the assessment of bifurcations of basal cerebral arteries. The research sample consisted of 30 unfixed brain specimens (154 bifurcations) collected from cadavers who died at the age of between 19 and 77 years (mean: 50, SD = 15,3). Six bifurcations were examined in collected material: 2 unpaired (bifurcation of basilar artery and union of vertebral arteries) and two paired (bifurcations of internal carotid artery and bifurcation of middle cerebral artery). An intravenous cannula was inserted into one of the cerebral arteries and by means of an arthroscopy pump, basal cerebral arteries were filled with 0,9% saline solution. The total bifurcation angle (α) and the diameter of arteries' segments forming the bifurcation (φ) were measured in each case. The measurements were taken while the system was filled with fluid. Next, a rigid endoscope (φ = 1,9 mm, 0°) was inserted into one of the arteries in order to assess the internal anatomy of the cerebral arteries and their bifurcations. If an intravascular structure was encountered, the segment of the artery was collected for the purpose of microscopic examination. Morphometric measurements were made in ImageJ software. Statistical analysis was performed using Microsoft Excel.

Mean total bifurcation angles for each bifurcation were as follows: 79,8° ± 20,3 for bifurcation of basilar artery, 57,2° ± 13,5 for union of vertebral arteries, 116,3° ± 14,7 for bifurcation of internal carotid artery and 62,3° ± 22,4 for the bifurcation of middle cerebral artery. During endoscopy, the appearance of the arterial wall, morphology of the bifurcations, occurrence of intravascular structures

and vascular pathologies (atherosclerosis, intracranial aneurysm, stenoses and a case of vertebrobasilar dolichoectasia) occurring in the material were assessed.

The atherosclerotic plaques were present in 18 out of 30 specimens (60%), most common site being the basilar artery – 17 out of 30 (57%), followed by left internal carotid artery (13 out of 30, 43%) and left middle cerebral artery (11 out of 30, 37%) In two cases (6,67%), pathological stenoses of the arteries were observed, first one involved right vertebral artery, second one – left posterior cerebral artery. Two intracranial aneurysms were present in the material (6,67%) – one in the wall of left middle cerebral artery and the other one in the wall of the anterior communicating artery. In both cases the wall of the aneurysm was noticeably thinner and more translucent than surrounding arterial wall. It was noted that the appearance of the aneurysmal wall was similar to the appearance of arterial bifurcations, what suggested, that increased translucence of the arterial wall might be a sign of its weakness.

Intravascular structures were present in 8 cases (26,7%), all of then within basilar artery - twoin the cranial part, one in the middle part and five in the caudal part. Structures have exhibited three morphological types – six of them had the shape of a string, one formed a septum, and one took the form of a tissue bridge located in the proximity of the orifice of right superior cerebellar artery. In selected cases, microscope slides were prepared and stained using Mallory trichrome stain in order to differentiate between the layers of the arterial wall and assess the presence of their equivalents within the intravascular structures. In all of the cases, they have contained the analogues of the layers of arterial wall, however much more disorganized.

On the basis of the results of the study, it was proposed that the incomplete fusion of the longitudinal neural arteries in the embryonic life might be the cause of the occurrence of intravascular structures in basilar artery. It was also suggested that all of these structures should be perceived as elements of a spectrum of morphological forms, which also include the basilar fenestration and even the complete non-fusion of basilar artery.

Presented results complement current knowledge of the anatomy of cerebral arteries and their bifurcations and establish endoscopy as a reliable and efficient non-invasive method of assessment of endovascular anatomy of this region.