

Clinical Significance of the Unpaired Anterior Cerebral Artery

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Abstract

The Willis circle is an arterial anastomotic ring that connects the left internal carotid artery (ICA), the right ICA, and the vertebro-basilar system arteries via connecting arteries.

Any changes in the structure of the Willis circle can lead to severe neurological abnormalities. Currently, cerebrovascular diseases are a serious threat to modern society, which is characterized by an increasing number of patients with brain strokes.

One of the types of anatomical variation of the Willis circle is the absence of one of the anterior cerebral artery. This variation is sometimes described as an unpaired anterior cerebral artery (UACA).

A rare case of an unpaired anterior cerebral artery was described in this article.

Keywords: *Unpaired Anterior Cerebral Artery (UACA); Willis Circle; Left Internal Carotid Artery (ICA)*

Introduction

The arterial ring of the brain, also known as the Willis circle, was originally described in 1664 [1]. The Willis circle is an arterial anastomotic ring that connects the left internal carotid artery (ICA), the right ICA and the vertebrobasilar system arteries via connecting arteries. Thus, the initial section of the anterior cerebral artery, the anterior communicating artery that connects the two anterior cerebral arteries near the frontal pole of the cerebral hemispheres, the sphenoidal segment of the internal carotid artery, the posterior communicating artery, and the initial section of the posterior cerebral artery are involved in the formation of the Willis circle. The resulting closed circle participates in brain collateral blood supply and allows to continuously feed the brain, even if one of its arteries is occluded [2,3].

Any changes in the structure of the Willis circle can lead to severe neurological abnormalities. Currently, cerebrovascular diseases are a serious threat to modern society, which is characterized by an increasing number of patients with brain strokes. According to WHO, strokes are registered in 5 - 6 million people every year, with a mortality rate of up to 4.6 million people [4,5]. The variety of clinical manifestations of strokes is probably associated with variability of the structure of the cerebral arteries involved in the pathological process [6].

One of the types of anatomical variation of the Willis circle is the absence of one of the anterior cerebral artery. This variation is sometimes described as an unpaired anterior cerebral artery (UACA). The clinical significance of UACA is changing the arterial hemodynamics of the frontal lobe and increasing the frequency of malformations such as agenesis of the corpus callosum, hydrocephalus, aneurysms and arteriovenous malformations [7]. According to some data, the aneurysms can occur in 13 up to 71% of cases [7]. This rather rare anatomical variation is very important in the treatment of neurological and neurosurgical patients.

The introduction of new minimally invasive and endoscopic surgical technologies makes increased demands on doctors for detailed knowledge of abnormalities in the development of brain vessels, which, in turn, poses new challenges for anatomists.

Case Report

A 61-year-old man was taken to the Grodno Emergency Hospital with a clear violation of cerebral circulation. He was conscious, but there was aphasia and paralysis. Physical examination revealed no reaction to painful stimuli. The pupils were medium-sized and did not respond to light.

An urgent MRI of the head showed no obvious acute or chronic intracranial pathology. However, a rare variation of the Willis circle was found - an open circle with a single, left anterior cerebral artery (Figure 1).



Figure 1: Left unpaired anterior cerebral artery (indicated by an arrow).

The unpaired left anterior cerebral artery gave off branches to both the left and right hemispheres. It was noted the increased diameter of the UACA, but it was unclear at the time of the study whether this was a pathological aneurysm or a compensatory increase in the artery supplying blood to the both hemispheres instead of one.

The next day after being admitted to the neurology department, the patient's limbs began to move, and the speech resumed. The lumbar puncture analyses were in norm.

Discussion

Anterior cerebral artery is one of the main blood vessel of the brain, which supplies blood to the frontal lobe of the cerebral hemispheres, anterior perforated substance, a large part of the corpus callosum, the anterior 2/3 of the cingulate gyrus, paracentral lobule

and parietal lobes, anterior parts of the lentiform and caudate nuclei, the anterolateral part of the internal capsule, optic chiasm, fornix, hypothalamus, pituitary gland and the anterior part of the dura mater.

According to D. N. Padget [8,9], all branches of the terminal portion of the internal carotid artery are detected on the 35th day of intra-uterine development, although they still look like a plexus.

In the process of development, three anterior cerebral arteries appear from this vascular plexus - the right, left and median. The last artery then disappears.

The anterior cerebral artery is usually divided into segments (according to Fischer, 1938): the first segment is from its beginning from the internal carotid artery up to the anterior communicating artery; the second one - from the anterior communicating artery, which is located at the level of rostrum of corpus callosum) up to the genu of the corpus callosum; the third segment of the artery passes around the genu up to the beginning of the trunk of corpus callosum; and finally the fourth segment passes around the corpus callosum [10,11].

Rhoton AL [12] has modified this classification of the artery. According to him the anterior cerebral artery is divided into the proximal segment (precommunicative) which is from beginning up to the anterior communicating artery and the distal (postcommunicative) segment, which in turn is divided into four portions: subcallosal, precallosal, supracallosal and postcallosal segments.

Most of the anterior cerebral artery anomalies are recorded in the first segment: hypoplasia of the anterior cerebral artery (in 10 - 35% of cases), triple anterior cerebral artery (in 0.2 - 13%), single trunk of the anterior cerebral artery (in 3 - 5%) [13,14].

The unpaired anterior cerebral artery, also known as *arteria cerebri anterior azygos*, occurs in only 0.3 - 1% of cases [15,16], usually supplies blood to both hemispheres, i.e. the area of blood supply to both anterior cerebral arteries in norm. The development of this vascular anomaly is associated with a violation of the segments of the anterior cerebral artery [16]. In the literature, it is possible to find information when some authors use the term UACA in the case of presence of a single median anterior cerebral artery running between the hemispheres and supplying blood to the territory of the anterior cerebral arteries in both hemispheres [17,18]. However, this description of UACA is not correct, because this anomaly means that the common trunk of the anterior cerebral artery is formed after the merger of two arteries just after their beginning, i.e. initially two anterior cerebral arteries are observed, which then adjoin into one.

Conclusion

The anterior portion of the Willis circle arises from an undifferentiated vascular network. The development of the most vascular abnormalities of the brain occurs in the stage of formation of constant arteries of the brain from this network. Despite the relatively rare occurrence of an unpaired anterior cerebral artery, it is necessary to keep it in mind, that will allow to clinicians to understand the causes of changes in the arterial hemodynamics of the frontal lobe and the development of malformations such as agenesis of the corpus callosum, hydrocephalus, vascular aneurysms, etc. Understanding the genesis of this anomaly and the possible complications caused by it will allow to make more informed decisions about the management of patients with UACA.

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