

ARCUATE FORAMEN OF ATLAS: DO I NEED TO DIAGNOSE?

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Summary

It was found that the joint presence of bone and vascular changes in the craniovertebral region, or even one of them, can lead to a clinically significant decrease in cerebral blood flow. One of the fairly common anomalies is the arcuate foramen, which does not have a characteristic clinic and is disguised as other pathologies.

Purpose.To analyze the computed tomographic characteristics of the bone jumper of the first cervical vertebra.

Materials and methods. A retrospective analysis of computed tomographic examinations of the upper cervical spine in 479 patients using 3-dimensional (3D) reconstruction was carried out. The patients' age ranged from 12 to 85 years. In 61

patients, Kimmerle anomaly was diagnosed. The average age of men was 39.7 ± 6.3 years, women - 44.8 ± 6.7 years.

Results. When conducting a computed tomography of the brain of patients with Kimmerle's anomaly, in 25 cases out of 42 - signs of vascular encephalopathy, in 11 cases signs of cerebellar atrophy and in 5 cases - single cysts. In 84% of patients with Kimmerle's anomaly, who underwent 3D CT of the cervical spine, osteochondrosis was noted and in 21% - spondylosis, in 74% of cases combined with degenerative changes in the intervertebral disc. In 70% of patients with Kimmerle's anomaly, there is a bilateral arrangement of the atlas bone jumper. With a one-sided arrangement, the atlas bone jumper is often located on the left. The vaulted hole was located on both sides equally often. The anteroposterior dimension of the arcuate foramen on the right is 5.4 ± 2.32 mm, on the left - 5.9 ± 2.43 mm. Vertical dimension - 3.35 ± 1.83 mm on the right, 3.49 ± 1.87 mm on the left. The incidence of the anomaly was 12.7%.

Conclusions. A spondylogenic factor, in the form of Kimmerle's anomaly, can cause impaired craniovertebral circulation, given the combination with ischemic changes in the computed tomographic picture of the posterior parts of the brain. Additional research is needed to assess the state of the vascular bed and blood flow in the vessels, which will provide the prevention and treatment of cerebrovascular disorders in patients with Kimmerle's anomaly.

Key words: computed tomography, arcuate foramen, vertebrobasilar system, Kimmerle's anomaly, atlas.

Introduction

The problem of cerebral and spinal circulation disorders is of increasing interest in clinical and radiological research. Recently, there has been a tendency for the growth of vascular lesions of the central nervous system in the general structure of morbidity and mortality in the world population. Changes in blood flow in the vertebrobasilar system play an important role in impaired cerebral and spinal circulation. Circulatory disorders in the vessels of the vertebrobasilar basin account

for more than 30% of all vascular pathologies of the brain. Circulatory disorders in the vertebrobasilar system account for about 70% of temporary disorders of cerebral circulation [1].

The complications of circulatory disorders in the vertebrobasilar basin include infarctions of the brain and spinal cord, while cerebral ischemic stroke accounts for 7 to 11% of the total number of ischemic strokes. Spinal cord infarction accounts for only 1-2% of all strokes. According to the observations of researchers, bone abnormalities, as well as arterial abnormalities or a combination of both, are asymptomatic [2], although they can cause a decrease in cerebral blood flow [3, 4].

A considerable proportion of the consequences of circulatory disorders entails a change in blood circulation in the vertebral arteries of the vertebrobasilar zone. It is well known that the vertebral artery, supplying the neurological structures of the posterior cranial fossa and the posterior parts of the cerebral hemispheres, passes into the skull in the transverse processes from the sixth to the first cervical vertebrae. Therefore, various degenerative-dystrophic lesions of the cervical spine are quite often a pathogenetic factor in circulatory disorders in the vertebrobasilar system in different age periods - from newborn to old and senile age [5].

There is evidence that one of the leading factors leading to structural changes in the cerebral arteries is a change in the course of the vertebral arteries in the canal of the transverse processes of the cervical vertebrae of the atlas [5]. Kimmerle's anomalies (anomalous rings on the posterior arch of the Atlantean) need a separate discussion. This anatomical variant is also known as the sagittal foramen, posterior atlas foramen, superior retroarticular foramen, canalisvertebralis, arcuate foramen, retroarticular canal, vertebral artery retroarticular annulus and vertebral artery retroarticular annulus [5, 8, 10].

They can restrict the mobility of the vertebral artery loop at the site of the formation of an abnormal ring on the posterior arch of the atlas and cause vertebrobasilar insufficiency. Stretching during movement, rotation, and bending of the cervical spine in the foramen can cause excessive external pressure on the V3

segment of the vertebral artery, with dynamic stenosis and changes in normal blood flow. This observation has been associated with posterior circulation stroke in patients with Kimmerle's anomaly [11]. The presence of this pathology can also play a causal role in the genesis of vertebral artery dissection (dissection) [5] and this has been described as a predisposing factor in sudden infant death syndrome [4, 6, 12].

During clinical observations with angiography and intraoperative verification, it was shown that Kimmerle's anomaly is rarely accompanied by vertebrobasilar insufficiency (in 5.5%), only when a cicatricial strangle is attached in the area of the bone ring around the vertebral artery, and therefore the term “variant” may be limited a form of normal anatomy that does not cause adverse effects on physiological functions. [4]. In most cases, Kimmerle's anomaly does not lead to vertebrobasilar ischemic insufficiency and may be asymptomatic [2]. The main factors in the development of clinical symptoms in patients with Kimmerle's anomaly are: extravasal compression of the vertebral artery, long-term trauma to the vascular adventitia, and irritation of the paravasal sympathetic nerves and branches of the occipital nerve. [3, 4, 7, 10].

The vaulted foramen is an important anatomical variant of the atlas that surrounds the vertebral artery and periarterial structures, and it can be considered another example of how minor abnormalities of the atlanto-occipital region can lead to pathophysiological conditions of clinical significance [9, 11, 13].

Purpose. To analyze the computed tomographic characteristics of the bone jumper of the first cervical vertebra.

Materials and methods. A retrospective analysis of a computed tomographic study of patients who applied for headaches and discomfort in the cervical region was carried out. In 61 out of 479 examined, arcuate foramen of the first cervical vertebra was revealed, of which 42 patients underwent X-ray computed tomography of the brain with the capture of the upper cervical spine and, also, in 19 patients - only the cervical spine. The examination was carried out on a GE-Optima 520 (manufactured in the USA).

Research results. Computed tomograms of patients, carried out on the brain with the capture of the craniocervical region and examinations of the cervical region, were studied, among which 61 patients were diagnosed with a bone jumper of the first cervical vertebra.

The clinical symptoms in the examined patients varied: headache, dizziness, tinnitus, transient hearing and visual impairment, fatigue, sleep disturbances, unsteady gait, falls, panic attacks, anxiety or asthma, hand numbness and convulsions.

The age of the examined patients ranged from 12 to 85 years. The average age in the male part of the patients was 39.7 ± 6.3 years, in the female part - 44.8 ± 6.7 years. In accordance with the WHO age classification, all patients with the Atlanta vaulted hole were divided into groups, which is shown in Table 1.

Table 1.

Distribution of the examined patients with the Atlanta arcuate foramen by age and gender

Group	Age	Gender		Total
		men	women	
teenage years	10-18	2	-	2
young age	18-44	16	17	33
average age	45-59	8	9	17
elderly age	60-74	1	5	6
old age	75-89	1	2	3
Total		28	33	61

As you can see, from the presented table, there was no gender predisposition for the occurrence of Kimmerle's anomaly.

When evaluating computed tomograms of the brain of patients with diagnosed Kimmerle's anomaly, in 25 cases out of 42, signs of vascular encephalopathy were observed, in 11 cases signs of cerebellar atrophy, and in 5 cases single cysts. In 16 patients out of 19 who purposefully underwent computed tomography of the cervical spine, osteochondrosis of varying severity was noted, in 74% of cases combined with the presence of protrusion or herniation of the intervertebral disc and in 21% of cases there was a picture of spondylosis.

In the prevailing percentage of the patients examined by us with a vaulted hole, the posterior arch of the atlas was visualized on the screen as a high-density band on computed tomography, over which an annular hypodense zone was defined, bordered by a partially or completely closed hyperdense ring - a bone "bridge" (ponticulusposticus).

An analysis of the location and characteristics of the vaulted foramen of the first cervical vertebra is shown in Table 2.

Table 2.

Location and characteristics of the arcuate foramen of the first cervical vertebra

Arcuate foramen	1-sided		2-sided		% of occurrence
	Closed	Open	Closed	Open	
Right side	7	0	29	15	49
Left side	8	3	34	8	51
Total:	18 examined patients		43 examined patients		

Measurements of the parameters of the vaulted hole by tomography showed that the anteroposterior size of the hole located on the right during measurements was 5.4 ± 2.32 mm, the vertical size of the hole was 3.35 ± 1.83 mm. The anteroposterior dimension of the left vaulted foramen was 5.9 ± 2.43 mm, the vertical dimension of the foramen was 3.49 ± 1.87 mm. The thickness of the bony septum forming the roof of the foramen varied from 1 to 5.14 mm.

According to our data, the frequency of occurrence of this anomaly was 12.7%.

Discussion. As you can see, the study of the pathogenesis of vertebrobasilar insufficiency, clarification of the effect of degenerative changes in the cervical spine on the development of hemodynamic disorders in the vertebrobasilar vascular basin, the search and testing of new approaches to diagnosis, optimization of therapeutic effects in this pathology seem relevant, which create the preconditions for conducting research.

In our study, the frequency of the arcuate foramen is close to the average occurrence of this feature on the average for the population - 16.7% [9, 12, 14]. On the other hand, in some studies, similar changes were diagnosed in 37.5% of patients [5]. Studies of individual authors say that incomplete forms with many different variations are often encountered, as a result of which there is no consistent classification in the literature [15] and they may not be taken into account.

The capabilities of modern methods of radiological diagnostics provide a unique opportunity to obtain detailed anatomical information in such a complex area of the skeleton as the craniovertebral spine [4].

On average, the occurrence of a vaulted hole is 16-20%, which is every 5-6 people! This change can be combined with variants of pathological changes in the vessels of the arterial circle of the large brain, the main arteries of the head and the intracerebral venous system. A review of literary sources confirms the importance of vascular changes in the pathogenesis of headache, which determines the tactics of treatment and prevention. Unfortunately, today doctors do not think, and some do not even know about the existence of this pathology for months, and sometimes for years,

they carry out symptomatic therapy, not suspecting that the Kimmerle anomaly can be confirmed or excluded by routine methods. The data from these examinations could provide prevention and treatment of cerebrovascular disorders in these patients.

In order to predict the effect of the presence of a vaulted hole, several questions must be resolved:

- to establish the ratio of the diameters of the vessels between themselves and with the diameter of the bone jumper of the first cervical vertebra,
- determine full or incomplete jumper,
- unilateral or bilateral nature of the change,
- options for the structure of the great vessels in each individual case.

The combination of these data can predict possible causal factors that can cause a decrease in cerebral blood flow, which in turn leads to early disability and loss of working capacity.

Thus, the importance of the role of the spondylogenic factor, which can cause or contribute to the development of circulatory disorders in the vertebrobasilar system, is emphasized. Early detection of signs of arterial and venous dyscirculation will provide prevention and treatment of cerebrovascular disorders in patients with Kimmerle's anomaly.

Conclusions. Studies of the variant of the development of the first cervical vertebra with the presence of a bony bridge have shown that Kimmerle's anomaly can occur at any age. A arcuate foramen can occur in every 5-6 person, with a prevalence in young and middle age. It can be detected in children and adolescents, when the diameter of the vessels is still small and there is no clinic, but there may be rudiments of fibrous changes noted on radiographs. In most cases, there is a complete bilateral Kimmerle anomaly and in the bulk of this anomaly is combined with signs of vascular encephalopathy.

All this indicates the need for an integrated approach to the diagnosis of this problem.

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