Vertebral subclavian steal syndrome (VSSS) is one of the causes of chronic vertebrobasilar insufficiency and ischaemia of the upper extremity. VSSS develops in stenosing lesions of the first segment of the subclavian artery (proximal to the origin of the vertebral artery), which leads to formation of retrograde blood flow through the vertebral artery (VA) on the side of the lesion of the subclavian artery (SCA). L. Contori [1] was the first who in 1960 with the use of angiography first described retrograde blood flow through the VA in a patient with SCA occlusion. A year later, M. Reivich [2] connected this phenomenon with a transitory ischaemic attack and consequently was the first to compare such haemodynamical paradox with neurological symptoms. The term “subclavian steal” was introduced by C.M. Fisher [3] in 1961 in his comment to the article of M. Reivich’s article. The last large-scale study of prevalence of VSSS carried out by Labropoulos, et al. [4] made it possible to detect VSSS in 5.4% of cases while carrying out duplex scanning of extracranial arteries in a total of 7,881 patients. An atherosclerotic lesion of the SCA is one of the most common causes of VSSS [5]. Other rare causes of VSSS include aortic dissection [5], Takayasu arteritis [6], external compression of the subclavian artery or abnormality of the innominate artery [7], abnormalities of the aortic arch [8, 9]. Deformities of the proximal portion of the SCA with formation of septal stenosis as causes of VSSS are not considered in the literature. We present herein 3 clinical case reports wherein SCA deformities were found to be associated with dopplerographic signs of ipsilateral vertebral artery steal.

**Case report 1**

Patient Sh., 12 years old was referred by his neurologist to undergo duplex scanning of brachioce-
the Dopplerogram from the right VA and a short-time episode of retrograde blood flow at the moment of decompression of the brachial artery (Fig. 2), making it possible to draw a conclusion on the presence of latent steal syndrome on the right. In order to specify the nature character of the SCA lesion the patient was subjected to underwent endured spiral computed tomography of the aortic arch and brachiocephalic arteries, confirming which confirmed the presence of a C-shaped deformity of the 1st segment and aneurysmatic dilatation of the 2nd segment of the SCA (Fig. 3). The right VA originated from the SCA in the area of the aneurismal neck.

**Case report 2**

Patient D., 25 years old, presented with complaints of weakness, fast fatigue of the right upper limb. Duplex scanning of the major arteries of the neck revealed right-sided high bifurcation of the brachiocephalic trunk with the origin of the right SCA at an acute angle and its kinking in the area of the outlet. On planimetric measuring stenosing in the area of the origin in relation to the distal segment of the SCA across the diameter amounted to approximately 55% (Fig. 4). Determined were dopplerographic signs of stenosing in the form
of disorganization and acceleration of the blood flow up to 270 cm/s, registered 1 cm distal to the SCA origin (Fig. 5). The Doppler spectrum of blood flow in the VA on the right at the extra- and intracranial levels had a bidirectional character (Fig. 6). The presence of transient steal syndrome was confirmed by the test with reactive hyperaemia of the right limb in the form of increased velocity of the retrograde phase of blood flow in decompression of the brachial artery.

**Case report 3**

Female patient Ch., 55 years old, was subjected to duplex scanning of the brachiocephalic arteries for complaints of dizziness, frequent headache, and numbness in the left upper limb. In the vertebral artery on the left at the extra- and intracranial levels we revealed bidirectional Doppler spectrum of blood flow, characteristic of transient steal syndrome (Fig. 7). The distal segment of the left SCA demonstrated altered main blood flow.

The test of reactive hyperaemia of the left upper limb was also positive, thus confirming the presence of steal syndrome. The study using convex transducer from the suprasternal approach in the mode of colour Doppler mapping made it possible to localize the proximal segment of the left SCA, which had a C-shaped deformity. Accelerated turbulent blood flow was registered in the zone of angulation. In order to specify the character and localization of the lesion we performed angiography of the aortic arch branches, showing no atherosclerotic stenosis in the origin of the left SCA and confirming the presence of a C-shaped deformity of the 1st segment of the SCA with formation of septal stenosis (Fig. 8).

The patient was subjected to operative treatment in the scope of resection of the SCA with reimplantation into the common carotid artery on the left. The control duplex scanning of brachiocephalic arteries revealed a fully passable carotid-subclavian anastomosis on the left, main-type blood flow in the distal portions of the SCA and antegrade blood flow in all segments of the VA on the left, with no signs of steal (Fig. 9).

**DISCUSSION**

Revealing signs of VSSS makes it possible to explain neurological syndromes. Angiography was the original method used to detect VSSS in patients with symptoms [11]. Nevertheless, the advent of non-invasive methods such as ultrasound duplex scanning and magnetic resonance angiography made it possible to reveal a great number of asymptomatic patients [12, 13]. VSSS is clinically provoked by physical activity and is manifested as pain in the ipsilateral hand, ataxia, vestibulopathy, transitory ischaemic attacks in the vertebrobasilar basin and/or angina pectoris in patients who endured mammarocoronary bypass grafting where the internal thoracic artery was used as a transplant for revascularization of the left coronary artery [14].
The presented clinical case reports suggest that VSSS may develop not only in atherosclerotic lesion of the 1st segment of the SCA but in deformities of the SCA in this segment leading to formation of septal stenosis. Deformities of the SCA are probably sequent to congenital developmental abnormalities of brachiocephalic arteries, which is confirmed by young age of the patients in case reports 1 and 2, as well as combination of SCA deformities with other stigmata of connective tissue dysplasia in patient 1. It is not also excluded that formation the development of SCA deformities may be induced by degenerative alterations in the vascular wall (case report 3). The presence of SCA deformity may be suspected in young patients and people with no evidence of atherosclerotic lesions of brachiocephalic arteries with revealed dopplerographic signs of VSSS. Differential diagnosis of the variant of arterial obstruction in such cases is utterly important since the character of the pathological process determines treatment policy. Therapeutic decision-making for atherosclerotic stenoses of the SCA manifesting by clinical picture of cerebrovascular insufficiency include endovascular interventions — balloon angioplasty with or without stenting [15, 16]. In occlusion of the SCA, open reconstruction, i.e., subclavian-carotid transposition is indicated [15, 17]. In SCA deformities, a method of choice should be considered open surgical intervention, since normal expansion and fixation of the stent in the deformed vessel are impossible. Besides, the presence of SCA deformity should be taken into consideration while deciding upon treatment policy in patients intended to undergo revascularization of the coronary bed, since the presence of SCA deformity may limit the use of the internal thoracic artery as transplant for mammaro coronary bypass grafting.

ЛИТЕРАТУРА/REFERENCES

Адрес для корреспонденции:
Кирсанов Р.И.
Тел./факс: (3852) 62-60-68
E-mail: kirsanov@agmu.ru

Correspondence to:
Кирсанов Р.И.
Тел./факс: (3852) 62-60-68
E-mail: kirsanov@agmu.ru