DEFORMITY OF SUBCLAVIAN ARTERY AS A CAUSE OF FORMATION OF VERTEBRAL SUBCLAVIAN STEAL SYNDROME

KIRSANOV R.I., KHOREV N.G., KULIKOV V.P.

Altai State Medical University of the RF Public Health Ministry, Barnaul, Russia

Presented herein are 3 clinical case reports concerning formation of vertebral subclavian steal syndrome in deformities of subclavian arteries. By means of duplex scanning, angiography and multispiral computed tomography it was shown that deformities of subclavian arteries in the first segment (proximal to the origin of the vertebral artery) with septal stenosing are accompanied by a typical dopplerographic picture pattern of steal syndrome.

Key words: *vertebral subclavian steal syndrome, deformity, subclavian artery, vertebral artery, duplex scanning.*

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 brachiocephalic arteries with the following diagnosis: connective tissue dysplasia, S-shaped tortuosity of internal carotid arteries on the both sides, transient impairments of cerebral circulation, migraineous paroxysms, presenting no complaints concerning the upper limbs. The examination on the right revealed right-sided dextral deformity of the SCA in the 1st segment and an aneurysmatic dilatation of the SCA up to 10 mm in the second segment. Doppler mode showed revealed in the 1st segment of the SCA turbulent blood flow with acceleration up to 280 cm/s. The peak systolic blood velocity in the right VA was decreased as compared with the contralateral VA, blood flow had antegrade direction, however the Doppler curve was altered by the type of the bunny-spectrum (Fig. 1), with deep mid-systolic notch (type II spectrum according to the classification of M.A. Kliewer, et al [10]). The patient was subjected to the test of reactive hyperaemia of the right upper limb, revealing deepening of the notch on

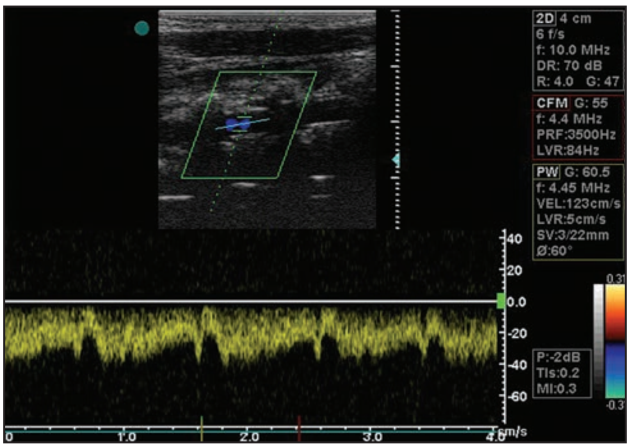

Fig. 1. Patient Sh., 12 years old. Doppler spectrum in the V2 segment of the right VA.

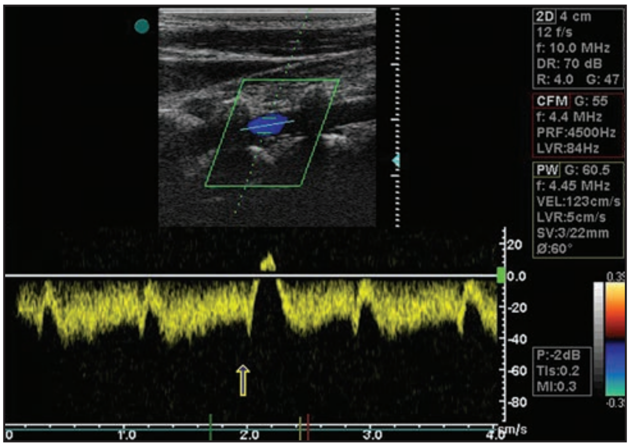

Fig. 2. Patient Sh., 12 years old. Doppler spectrum in the right VA after the test of reactive hyperaemia (moment of decompression of the brachial artery is indicated with an arrow head).

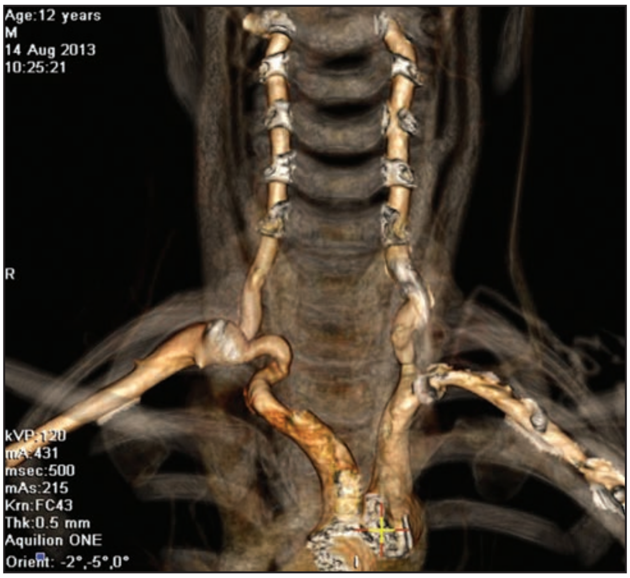

Fig. 3. Patient Sh., 12 years old. MSCT contrast-enhanced angiography of subclavian and vertebral arteries (3D reconstruction). C-shaped deformity of the 1 segment and aneurysmatic dilatation of the 2 segment of the right SCA.

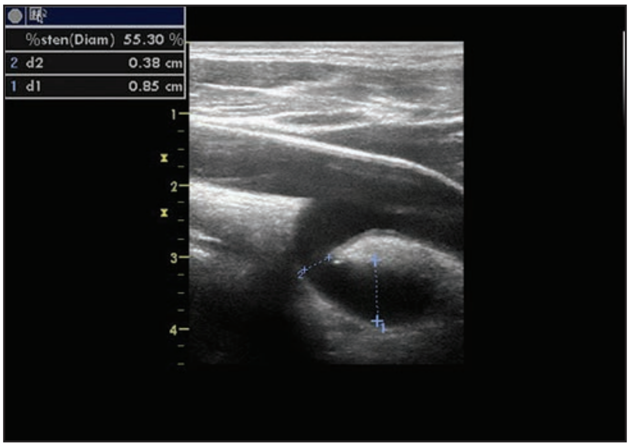

Fig. 4. Patient D., 25 years old. Deformity of the right SCA in the 1st segment with formation of septal stenosis.

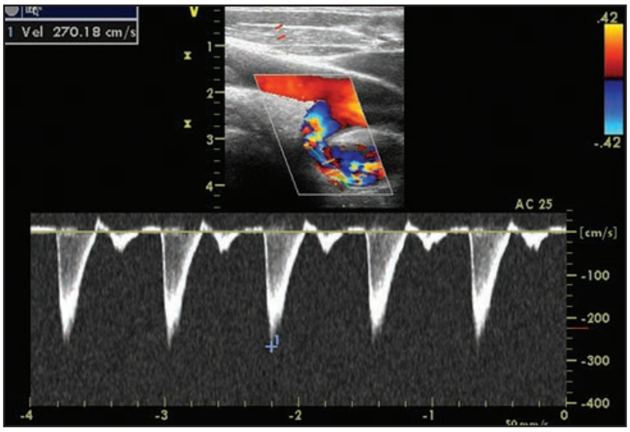

Fig. 5. Patient D., 25 years old. Doppler spectrum in the right SCA registered distal to the stenosing zone.

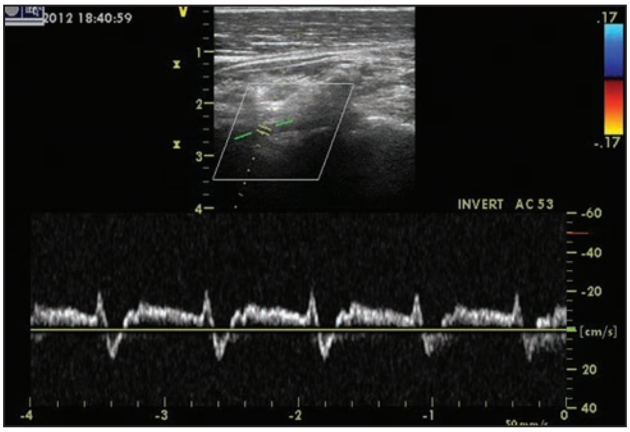

Fig. 6. Patient D., 25 years old. Bidirectional Doppler spectrum in the V2 segment of the right VA.

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).

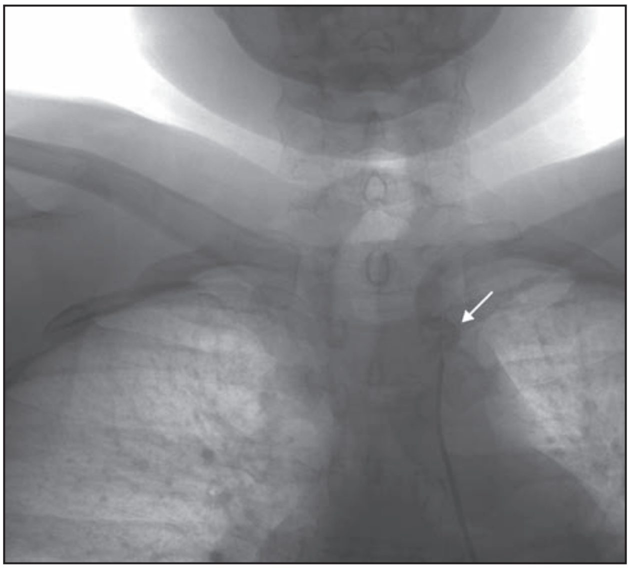

Fig. 8. Patient Ch., 55 years old. Angiogram of the aortic arch branches. The arrow indicates deformity of the left SCA in the proximal segment.

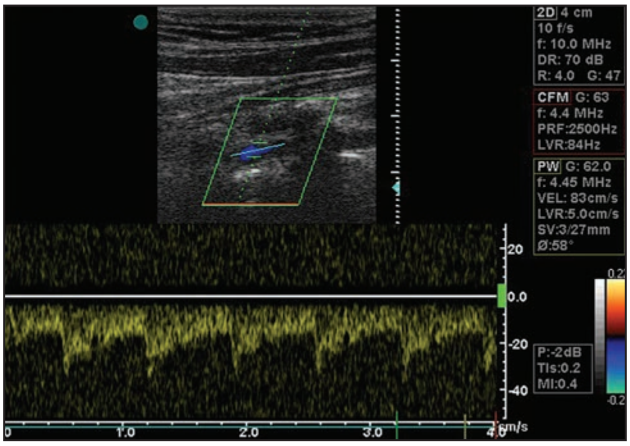

Fig. 9. Patient Ch., 55 years old. Normal spectrum of blood flow in the V2 segment of the left VA after operative treatment.

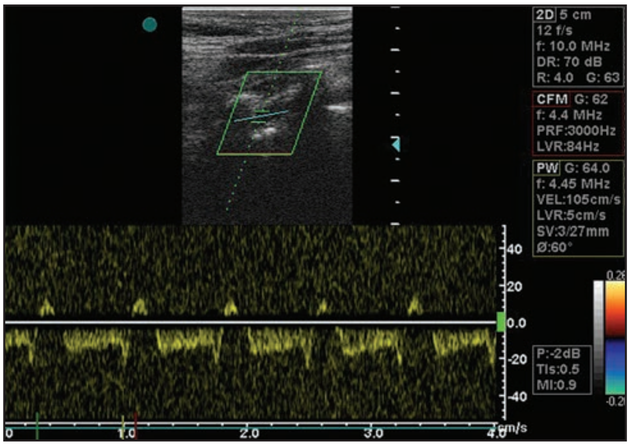

Fig. 7. Patient Ch., 55 years old. Bidirectional Doppler spectrum of the blood flow in the V2 segment of the left VA.

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 mammarocoronary bypass grafting.

ЛИТЕРАТУРА/REFERENCES

1. ***Contorni L.*** Il Circolo collaterals vertebro-vertebral nella obliterazione dell' arteria subclavia alla sua origine. Minerva Chir. 1960; 15: 268–271.
2. ***Reivich M., Holling H.E., Roberts B., et al.*** Reversal of blood flow through the vertebral artery and its effect on cerebral circulation. N. Engl. J. Med. 1961; 265: 878–885.
3. ***Fisher C.M.*** New vascular syndrome, "subclavian steal". N. Engl. J. Med. 1961; 265: 912–913.
4. ***Labropoulos N., Nandivada P., Bekelis K.*** Prevalence and impact of the subclavian steal syndrome. Ann. Surg. 2010; 252: 166–170.
5. ***Fields W.S., Lemak N.A.*** Joint study of extracranial arterial occlusion. VII. Subclavian steals – a review of 168 cases. JAMA. 1972; 222: 1139–1143.
6. ***Peera A.M., LoCurto M., Elfond M.*** A case of Takayasu arteritis causing subclavian steal and presenting as syncope. JEM. 2001; 40(2): 158–161.
7. ***Reeves M., Colen M., Sheridan B.J., Ward C.*** Isolated innominate artery as a cause of subclavian steal and cerebral hemisphere atrophy. Pediatr. Cardiol. 2010; 31: 1083–1085.
8. ***Luetmer P.H., Miller G.M.*** Right aortic arch with isolation of the left subclavian artery: Case report and review of the literature. Mayo Clin. Proc. 1990; 65: 407–413.
9. ***Edwin F., Mamorare H.M.*** Congenital pulmonary steal in subclavian artery isolation. Ann. Thorac. Surg. 2010; 90(5): 1744–1745.
10. ***Kliewer M.A., Hertzberg B.S., Kim D.H., et al.*** Vertebral artery Doppler waveform changes indicating subclavian steal physiology. AJR. 2000; 174: 815–819.
11. ***Heidrich H., Bayer O.*** Symptomatology of the subclavian steal syndrome. Angiology. 1969; 20: 406–413.
12. ***Grossman B.L., Brisman R., Wood E.H.*** Ultrasound and the subclavian steal syndrome. Radiology. 1970; 94: 1–6.
13. ***Drutman J., Gyorke A., Davis W.L., Turski P.A.*** Evaluations of subclavian steal with two-dimensional phase-contrast and two-dimensional time-of-flight MR angiography. Am. J. Neuroradiol. 1994; 15: 1642–1645.
14. ***Takach T., Reul G.J., Cooley D.A., et al.*** Myocardial thievery: The Coronary-subclavian steal syndrome. Ann. Thorac. Surg. 2006; 81: 386–92.
15. ***Pokrovsky A.V., Beloyartsev D.F.*** Chronic cerebrovascular insufficiency (occlusive lesion of aortic arch branches). In: Clinical Angiology: manual for physicians / under the editorship of A.V. Pokrovsky: in 2 volumes. Moscow, Meditsina Publishing House; 2004; 1: 734–804 (in Russian).
16. ***Galkin P.V., Antonov G.I., Mitroshin G.E., et al.*** Surgical correction of cerebral blood flow steal syndromes in stenosing lesions of aortic arch branches. Surgery. Journal named after N.I. Pirogov. 2009; 7: 15–21 (in Russian).
17. ***Linni K., Ugurluoglu A., Mader N., et al.*** Endovascular management versus surgery for proximal subclavian artery lesions. Ann. Vasc. Surg. 2008; 22(6): 769–775.

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

Correspondence to:
Kirsanov R.I.
Tel./fax: (3852) 62-60-68
E-mail: kirsanov@agmu.ru