Subclavian steal syndrome from high-output brachiocephalic arteriovenous fistula: A previously undescribed complication of dialysis access

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A 28-year-old dialysis-dependent man presented with episodic vertebrobasilar insufficiency. Noninvasive studies demonstrated an estimated 5.8 L/min flow through the arteriovenous fistula in his left arm and reversal of flow in the left vertebral artery. Surgical reduction of fistula flow resulted in the elimination of symptoms and the return of antegrade flow in the left vertebral artery. Intraoperative invasive monitoring corroborated the pressure gradient responsible for his subclavian steal syndrome. (J Vasc Surg 2001;33:883-5.)

Classic subclavian steal syndrome is caused by retrograde vertebral artery flow “stealing” vertebrobasilar perfusion. This is usually caused by a stenosis in the subclavian artery central to the origin of the vertebral artery, sometimes aggravated by exercise of the ipsilateral upper extremity. As far as we know, this is the first report of subclavian steal syndrome caused by the extremely low resistance associated with a dialysis arteriovenous fistula, without an intrinsic flow-limiting lesion in the subclavian artery.

CASE REPORT

A 28-year-old man with chronic dialysis-dependent renal failure presented with a 3-month history of transient episodes of ataxia, discoordination, vertigo, presyncope, and a tendency to fall toward his left side. The episodes lasted 15 to 20 minutes with spontaneous resolution and occurred two to three times per week, but with increasing frequency. The episodes were precipitated by left arm use, most consistently while he was taking a warm shower. He was active, employed, and otherwise enjoyed good health, except for his dialysis dependency. His renal failure was the result of congenital polycystic kidney disease. He had a 20-year history of arteriovenous dialysis access, and all of his arteriovenous access had been in the left upper extremity, beginning with a left wrist Cimino fistula. He later used a prosthetic graft in the left forearm and, ultimately, an above-elbow left brachiocephalic fistula. All of his access procedures had used the cephalic vein as the venous outflow. He had no symptoms of vascular insufficiency in the left arm or hand.

Physical examination revealed a healthy-appearing adult man with blood pressure in the right upper extremity of 142/88 mm Hg. He had a dramatically enlarged left cephalic vein (Fig 1) with a prominent pulse and thrill. The palpable thrill was appreciated across the shoulder and to the left parasternal area. Left radial and ulnar pulses were not palpable, and the patient had an old surgical scar overlying the left radial artery from a remote Cimino fistula. Both hands were symmetrically warm and well perfused, with normal and symmetric capillary refill. Neurologic examination results were normal, and the remaining results of the physical examination were normal except for surgical scars from his prior failed renal transplant.

Duplex vascular evaluation demonstrated antegrade flow in the right vertebral artery and retrograde flow in the left. Duplex estimation of total fistula flow in the cephalic vein (mean velocity × cross-sectional luminal area) was 5.8 L/min. An arteriogram demonstrated no stenosis in any of the arch vessels (Fig 2) and retrograde flow in the left vertebral artery (Fig 3). Vertebral artery flow reverted to antegrade with manual compression of the left arm fistula during angiography. Results of cranial computed tomographic scan were normal.

The patient underwent surgical reduction of flow in his arteriovenous fistula. Intraoperatively, a 4F catheter was passed retrograde from the fistula, through the brachial artery, to the subclavian/axillary artery region for intraoperative pressure monitoring. This demonstrated a blood pressure of 80/50 mm Hg.
Fig 2. Arch aortogram demonstrates no central abnormality in the arch vessels. White arrow, Antegrade flow in dilated left subclavian artery. Black arrow, Rapid opacification of the left subclavian vein. Asterisk indicates no antegrade flow in left vertebral artery.

Fig 3. Selective right vertebral artery arteriogram demonstrates retrograde flow in left vertebral artery through vertebrabasilar system. Asterisk indicates contrast washout into left subclavian artery.

Fig 4. Intraoperative direct pressure tracings from left subclavian artery during flow reduction in left arm arteriovenous fistula. Before revision there is a peak of 76 mm Hg and mean gradient of 57 mm Hg (A). After creation of iatrogenic 75% stenosis in fistula inflow, peak gradient has been reduced to 34 mm Hg, and mean gradient has been reduced to 25 mm Hg (B). This resulted in an estimated total flow reduction from 5.8 to 1.9 L/min, and fistula remains patent and adequate for dialysis on 1-year follow-up.
(mean, 68) with the fistula open and a blood pressure of 163/103 mm Hg (mean, 126) during temporary occlusion of the arm fistula by cross-clamping the enlarged cephalic vein just beyond the arteriovenous anastomosis (Fig 4). At the time of this pressure tracing, the blood pressure in the right arm by standard sphygmomanometry was 142/88 mm Hg. An iatrogenic stenosis was then created just to the venous side of the anastomosis by making a wedge-shaped plication with horizontal mattress sutures during ongoing pressure monitoring. An approximately 70% stenosis was created to reduce the pressure gradient in the subclavian artery. Before stenosis there was a 76 mm Hg systolic and 57 mm Hg mean pressure gradient. After stenosis, the systolic and mean pressure difference was reduced to 34 and 25 mm Hg, respectively. Postoperatively, the cephalic vein fistula flow is estimated with duplex scan at 1.9 L/min. Antegrade left vertebral artery flow is corroborated with duplex scan evaluation. The pulse is subjectively softer, the fistula continues to function adequately for dialysis efficiency, and the patient’s episodes of vertebrobasilar insufficiency have resolved, on 1-year follow-up.

DISCUSSION

Contorni1 is credited with reporting the first angiographic demonstration of flow reversal in the vertebral artery in 1960. The term subclavian steal syndrome was coined by C. M. Fisher in the editorial discussion of the classic report by Reivich et al2 who described two patients with vertebrobasilar insufficiency and vertebral artery flow reversal in 1961. North et al in 19623 reported the association of exercise of the ipsilateral upper extremity with precipitation of symptoms, although further clinical experience over the years has demonstrated that this classic physiologic manifestation is rarely seen. The precise relationship between the reversal of vertebral artery flow and the creation of significant neurologic symptoms is unpredictable. Most demonstrated cases of retrograde vertebral artery flow are asymptomatic,4 and most symptomatic patients also have some degree of atherosclerotic changes in the other extracranial cerebrovascular supply.5 However, all prior reports of clinically significant subclavian steal syndrome have involved a hemodynamically significant stenosis in the central portion of the ipsilateral subclavian artery (or more rarely, in the innominate artery). A significantly high resistance in the central part of the cerebrovascular circulation was presumed to be required to create a sufficient pressure gradient to produce retrograde flow from the basilar artery to the ipsilateral vertebral artery. Other hemodynamic complications of dialysis angioaccess are known: hand ischemia occurs in as many as 4% of new patients with angioaccess, and high-output cardiac failure rarely occurs.6 However, symptomatic vertebrobasilar insufficiency caused by ipsilateral pressure drop from the vertebral artery and its effects on cerebral circulation. N Engl J Med 1961;265:878-85.

CONCLUSION

Symptomatic subclavian steal syndrome can be caused by a high-output dialysis arteriovenous fistula, a phenomenon not described until now. The pressure gradient resulting in vertebral artery flow reversal is caused by the extremely low peripheral resistance of the enlarged arteriovenous fistula. Reduction in fistula flow can result in both elimination of cerebrovascular symptoms and maintenance of adequate dialysis access. Intraoperative invasive pressure monitoring was found to be useful both for demonstrating the relevant physiology and for calibrating an effective degree of reduction in fistula flow.

REFERENCES


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