



Treatment of Dialysis Access Steal Syndrome with Concomitant Vascular Access Aneurysms

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Limb ischemia is a known complication of vascular access that may appear early postoperatively or after years. Over the last few decades, various techniques based on different physiological mechanisms have been used for treatment. A standardized treatment does not exist, and must be individualized based on the flow volume, and the type and location of the access. True and false vascular access aneurysms are another common complication of arteriovenous fistulas, which develop because of venous hypertension or repeated needling. Evidence in the literature regarding treatment of patients with steal syndrome and concomitant true arteriovenous aneurysms is scarce. A female with a brachiocephalic fistula complicated by steal syndrome and vascular access aneurysms was treated successfully with tapered graft placement and aneurysm exclusion.

Key Words: Arteriovenous fistula, Aneurysm, Ischemia, Vascular grafting

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INTRODUCTION

Hand ischemia is a known complication of arteriovenous access (AVA) for hemodialysis. Severe ischemia requiring intervention is seen in 1% to 8% of cases, while mild ischemia treated conservatively is seen in 10% to 20% of AVAs [1]. This is due to the diversion of blood from the distal arteries toward the fistula, leading to a steal effect, which may affect nearly 80% of asymptomatic functional AVAs [1]. The shift from steal phenomenon to steal syndrome could result from an interplay between the volume of access flow, collateral circulation, inadequacy of arterial adaptation, and the presence of arterial stenotic lesions [1,2]. Excessive access flow is the most common cause [1]. Arteriovenous fistulas (AVFs) can be complicated by the formation of large vascular access aneurysms (VAAs). False VAAs due to cannulation are present in 60% of AVFs. True VAAs are a con-

sequence of venous hypertension and wall degeneration; however, their incidence is unknown.

We performed an extensive literature review and found many reports on the optimal diagnosis and proper treatment of dialysis access-associated steal syndrome (DASS) or vascular access-induced limb ischemia. Treatment strategies vary depending on the flow volume, the type and location of the access, and the comorbidities and life expectancy of the patient [1]. The coexistence of DASS and large VAAs that compromise the available puncture sites requires special consideration during treatment. However, relevant data is scarce in the literature. Although tapered prosthetic grafts placed primarily are not better than tube grafts in terms of the risk of DASS, they may be valuable as DASS treatment for specific indications [1]. We performed a tapered graft placement and aneurysm exclusion in a female with a brachiocephalic fistula complicated by DASS and

VAs. The tapered portion of the graft was used to restrict inflow and bypass the aneurysms that were later ligated. This procedure led to sufficient flow reduction and the disappearance of her ischemic symptoms, and needling was feasible through the new graft.

This case report was approved by the Institutional Review Board of the University Hospital of Patras (IRB no. 29/11-07-2018). The patient provided the written informed consent for the presentation of this case report.

CASE

A 70-year-old female on hemodialysis presented with

rest pain in her right hand, which was relatively cold and pale, with an absent radial pulse. She had a functional right brachiocephalic fistula created 10 years ago and large VAs had developed along the cephalic vein. CDU revealed a hyperfunctioning fistula with a mean brachial arterial flow of 2,200 mL/min (Fig. 1). The anastomotic length was 9 mm (Fig. 2), and the adjacent cephalic vein was approximately 1 cm in diameter (Fig. 3). CDU excluded arterial pathologies such as stenosis, obstruction, or calcification. Radial waveforms were monophasic and attenuated with a peak systolic velocity of 28 m/s but returned to normal after digital closure of the fistula (Fig. 4). We did not perform venography because dialysis sessions did not reveal increased intradialytic pressure, suggesting cephalic arch or central venous steno-occlusion.

We performed a bypass procedure under local anesthe-

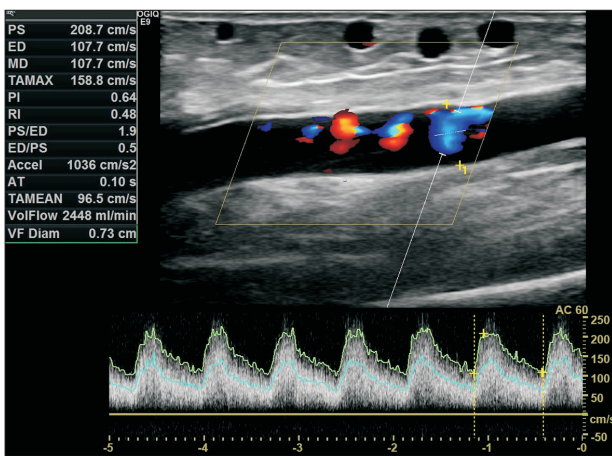


Fig. 1. Duplex ultrasonography measured flow volume at the brachial artery. The mean flow was 2,200 mL/min after three consecutive measurements.

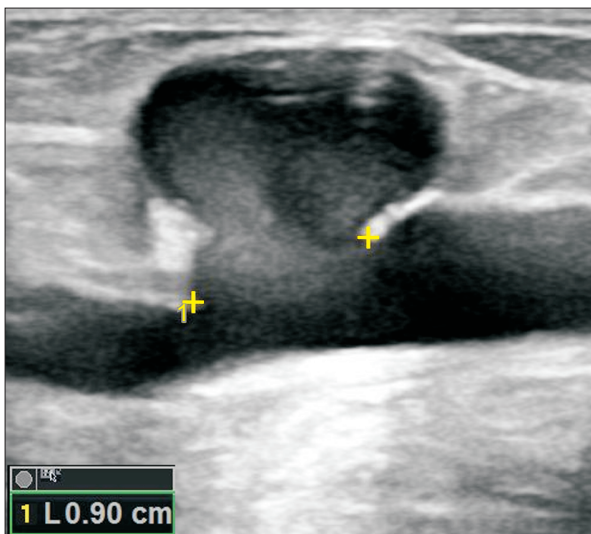


Fig. 2. The longitudinal view of the brachial anastomosis showed an anastomotic length of 9 mm.

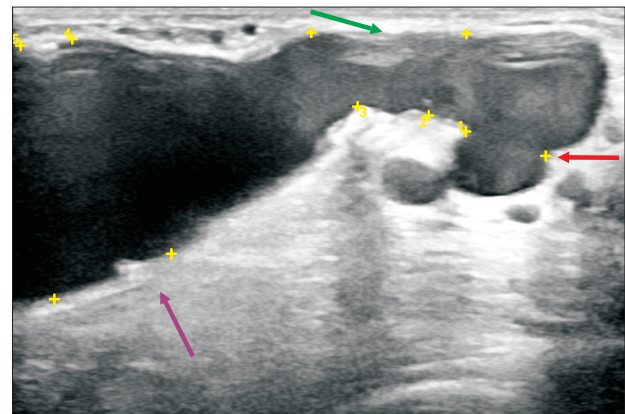


Fig. 3. The longitudinal view of the brachiocephalic arteriovenous fistula showed the anastomosis (red arrow), juxta-anastomotic outflow vein of 1-cm diameter (green arrow), and aneurysms (purple arrow).

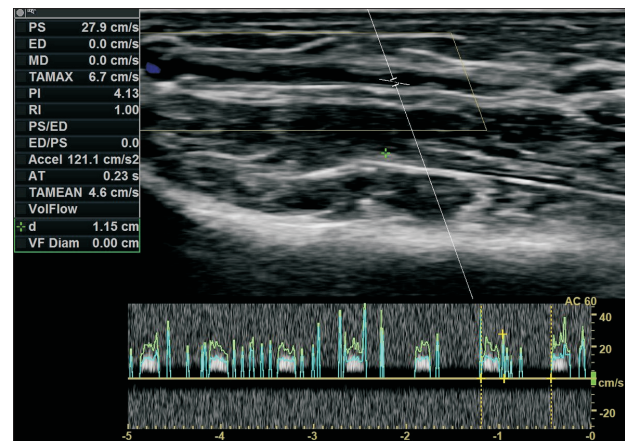


Fig. 4. Radial waveforms showed a slow peak systolic velocity of 28 cm/s.

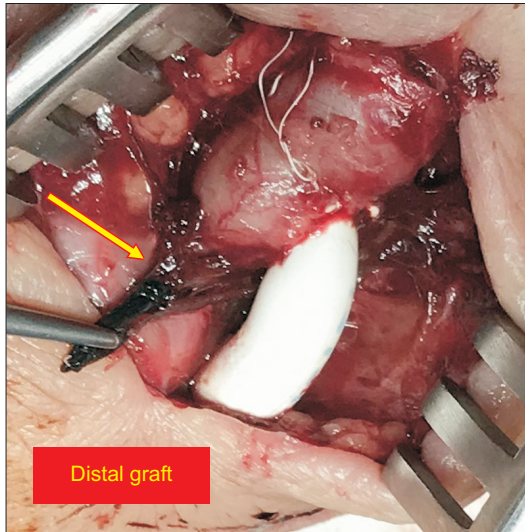


Fig. 5. The distal anastomosis with tapered portion of the graft (4 mm) was performed in the end-to-side with the outflow vein beyond the original anastomosis. The venous ligature was clearly seen (arrow).

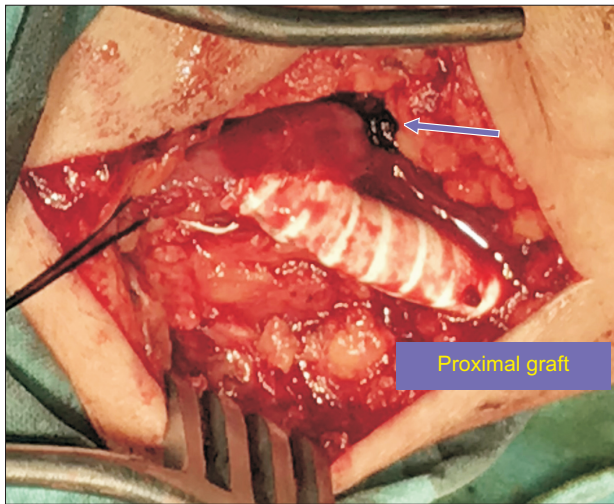


Fig. 6. The proximal anastomosis was made with the grafts wide end (7 mm) and the cephalic vein near the shoulder in the end-to-side. The venous ligature was also seen (arrow).

sia, using a tapered 25-cm-long ringed ePTFE graft (Gore Interlog; W.L. Gore & Associates, Flagstaff, AZ, USA) 4 to 7 mm from the distal to the proximal cephalic vein, using a 7-0 PTFE Gore suture (W.L. Gore & Associates). The intervening venous aneurysm was ligated and excluded (Fig. 5-7). The patient recovered uneventfully, with the resolution of her ischemic symptoms. After the procedure, her radial pulse was palpable and radial waveforms returned to normal with a peak systolic velocity of 40 m/s. The patient was discharged on the same day, and the graft was suc-



Fig. 7. Intraoperative photo after graft insertion showed the distal anastomosis at the elbow (green arrow), proximal anastomosis near the shoulder (blue arrow), and the subcutaneous tunnel laterally (arrowheads).

cessfully cannulated for hemodialysis 1 month later. The brachial flow volume at 3 months was 950 mL/min.

DISCUSSION

DASS may manifest with clinical symptoms of various severities ranging from arm numbness or pain to digital gangrene. Differential diagnosis should include carpal tunnel syndrome, ischemic monomelic neuropathy, iatrogenic nerve injury, and other neuropathies. Mild symptoms are treated conservatively. DASS is associated with a reduced life expectancy, with a mortality rate of nearly 80% at 5 years [1,3].

Many different techniques have been described in the literature to prevent and treat steal syndrome in high-risk patient groups, including those with diabetes, smoking, advanced age (>60 years), peripheral arterial disease, history of steal syndrome, and previous ipsilateral access, and females [2,4]. A non-palpable radial artery and a digital-brachial index <0.6 (especially <0.45) puts patients at increased risk [1]. Patients with brachial-based accesses are at an increased risk for steal syndrome than patients with radial or axillary-based accesses [2,4]. Patients with arteriovenous grafts (AVGs) are at increased risk than patients with native AVFs [3]. In native AVFs, the risk for steal syndrome increases with time due to possible progressive dilatation of the venous outflow tract, and the inverse is true for AVGs. A brachial artery with a diameter <4 mm, lupus erythematosus, and small vessel disease are additional risk factors [3]. Patients in the high-risk group require special modifications to the AVA techniques to prevent DASS [3].

Treatment may differ according to the access flow volume [1]. Many consider 800 mL/min for AVFs, 1,000 to 1,200 mL/min for AVGs, and 600 mL/min/m² in pediatric patients as a cut-off point for high flow [1,5]. Hyperfunctioning fistulas predisposes patients to cardiac failure, ventricular remodeling, and VAA formation [1,2]. Consequently,

overflow (>1,500-2,000 mL/min) is an indication for flow-restricting procedures, regardless of the presence of DASS [6-8]. Although some consider a low flow of 300 to 400 mL/sec as adequate, normal flow AVAs require different treatment strategies, as moderate flow reduction may cause access thrombosis [1].

Several procedures have been suggested to treat DASS such as banding, short graft interposition, revision using distal inflow (RUDI), distal revascularization with interval ligation (DRIL), proximalization of arterial inflow (PAI), prolongation of existing grafts, distal radial artery ligation, anastomosis reduction, and ligation. Banding, short graft interposition and RUDI are suggested for high-flow AVAs, while DRIL, modified DRIL, and PAI are suggested for normal-flow AVAs [1].

The following methods may be used primarily to prevent steal syndrome in high-risk patients. First, a snuff-box fistula should be offered, if possible [3]. Second, the length of the arteriotomy in brachiocephalic AVFs should be minimized. Primary arteriotomy of only 3 mm in length has been reported to lead to 5% of steal cases not requiring repair [2]. Others advocate for the length of the anastomosis to be 75% of the diameter of the brachial artery, not more than 4 mm [3] or between 4 and 6 mm [1,9]. The creation of the anastomosis to proximal radial or ulnar artery using the median cubital, antecubital, or the deep communicating vein has been reported as "primary extension" [3,4,10]. Charlwood and Al-Khaffaf used primary extension in 64 patients with diabetes, with 5% of cases with primary failure and no cases of steal [10]. Primary PAI has also been described especially in cases of AVGs [3]. Additionally, PAI can be used with a transposed basilic vein after valvulotomy with retrograde flow and outflow to the cephalic or brachial veins through collaterals [3]. Surprisingly, DRIL has also been used as a prophylactic procedure in high-risk patients. In a recent report, PAI was the most common procedure, followed by the primary extension technique and DRIL method [4]. The results were satisfactory and equal for all three procedures [4].

The coexistence of DASS and large VAAs requires special consideration during treatment. In our case, steal syndrome was associated with generalized aneurysmal dilatation of the entire outflow venous tract, making needling problematic due to the elimination of puncture sites. Therefore, we decided to treat the steal syndrome along with exclusion of VAAs. Ligation is an easy and attractive option, but it sacrifices access, and a new one is needed. Plication of the aneurysms along with banding was not performed due to the extensive skin incision and surgical trauma needed, causing postoperative soft tissue complications. In our case, based on the RUDI concept, we could ligate the outflow vein and

create a new graft anastomosis in the proximal radial artery with a diameter of 4 mm. This technique would create increased flow reduction, but would require an additional skin incision and operative trauma in the antecubital fossa, increasing the likelihood of postoperative complications.

An alternative technique is access ligation and an axillo-axillary loop graft. We did not prefer this because it would be an aggressive option requiring an additional axillary incision. Instead, we decided to ligate the aneurysms and bypass them using a synthetic graft. Since the graft was tapered on the arterial side, with a diameter of only 4 mm, it would restrict flow in the access and improve hand perfusion. This would be further enhanced by the increased resistance in the elongated graft, in contrast to the previous wider and shorter venous outflow. Since the intended diameter after banding is 4 mm in many reports, we decided to use the entire tapered segment and not trim it [1]. Therefore, beyond the 9-mm anastomosis and an outflow vein 1 cm in diameter, we created a stenotic tapered segment of at least 4 mm, leading to a diameter reduction of approximately 60%. We considered further stenosis after pseudo-intima creation and additional graft resistance would aid in volume flow reduction. Therefore, we anticipated a diameter reduction between 50% to 75% [1,6-8,11]. The results were satisfactory, and the patient remained asymptomatic for 6 months.

We would like to emphasize some key points and technical details of this type of treatment. First, aneurysmal dilatation of the proximal cephalic vein is an issue because anastomosis is constructed in a dilated vein. However, in our previous experience of bypass in VAAs, these grafts worked well, and clinically relevant proximal venous dilations were not observed in the long term. Second, we proceeded with longitudinal incisions for anastomoses because we think they provide more room for easier anastomosis. Regardless, a transverse skin incision to maximize the needling site and minimize the risk of graft infection is a reasonable alternative. Third, the ligated VAAs were occluded with a thrombus. At the end of the operation, we emptied the VAAs before proximal ligation of the cephalic vein and applied an elastic bandage to decrease the amount of thrombus. Ligated VAAs are sometimes complicated by superficial thrombophlebitis with pain, tenderness, and skin erythema. Lastly, we prefer to use interring grafts to prevent compression without needling problem.

Our technique employs three different concepts to deal with steal syndrome: a) use of a small segment of tapered graft to reduce fistula flow; b) bypass the venous aneurysms to restore the needling options; and c) use the placement of a long-length graft as an additional means to increase the outflow resistance. Each of these concepts

have been reported in the literature. Our opinion is that the simultaneous employment of these techniques is a novel concept. Furthermore, we were not able to find a similar technique for the concurrent treatment of steal and VAAs in the literature.

In conclusion, we suggest the use of tapered grafts as an effective method for treating DASS when combined with large VAAs. It is a simple technique that can be added to the existing methods used for the management of overflow AVAs.

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CONFLICTS OF INTEREST

The authors have nothing to disclose.

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AUTHOR CONTRIBUTIONS

Concept and design: SIP, SKK. Analysis and interpretation: PK, EP. Data collection: TT, AT. Writing the article: SIP, NK. Critical revision of the article: KGM, EP. Final approval of the article: all authors. Statistical analysis: none. Obtained funding: none. Overall responsibility: SIP.

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