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Recurrent Dialysis Access Steal Syndrome in a Non-Mature AVF: A Case of Radial Artery Ligation Following Initial Venoplasty

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Abstract: Dialysis access steal syndrome (DASS) is a rare but serious complication of arteriovenous fistula (AVF) used for hemodialysis (HD). While initial interventions such as venoplasty and banding are effective in many cases, recurrent steal syndrome can occur, which may necessitate a surgical intervention such as ligation. We reported a 63-year-old male presented with continuous pain in the left forearm at the AV shunt site for two days. The patient was referred to Kandou Hospital for further management due to suspected stenosis and risk of total occlusion. Vascular ultrasound and venography confirmed the diagnosis, followed by venoplasty, banding repair and central dialysis line insertion. Post-procedure angiography demonstrated restored, though weak, distal blood flow, but after three weeks, the patient returned with an edematous left distal limb and oxygen level of 93-96%. The gold standard for DASS, ligation, was then performed. Although this patient experienced edema after the first procedure, the outcome after the second intervention was very good, and the patient did not report any recurrence. In conclusion, recurrent DASS, especially in a non-mature AVF, presents unique challenges in management. This case highlights the importance of continuous post-intervention monitoring, patient education on proper AVF care, and the need for escalation to more definitive treatments like radial artery ligation when initial interventions, such as venoplasty failed. After the second intervention, the outcome was very good, and the patient did not report any recurrence. Early recognition of complications, including patient-induced factors like AVF manipulation, is crucial to prevent further morbidity and ensure the preservation of vascular access.
Keywords: steal syndrome; chronic kidney disease; hemodialysis; arteriovenous fistula; venoplasty; radial artery ligation

INTRODUCTION

Ischemia induced by arteriovenous fistula (AVF) is a rare case that can cause necrosis on the access's limb.[1] The incidence of dialysis access steal syndrome (DASS) has been reported to be around 2% in AVF and 4% in bridge graft shaft blood. A study conducted by Leake et al[2] showed that most patients' hemodialysis (HD) access was found to be 80% in AVF, 19% in the upper extremity prosthetic grafts, and 1% in thigh grafts. Major risk factors include use of the brachial artery for access creation, female sex, diabetes, coronary heart disease, cerebrovascular disease, tobacco use, hypertension, and age over 60 years old. Possible causes of DASS include extremity inflow or outflow arterial occlusive disease, high AV access flow rate, and reversal of distal extremity arterial blood flow. Thid DASS might also exist without any of those features.[3-4]

Patients with critical hand ischemia experience pain even during resting, ischemic non-healing ulcers, digital gangrene, or finger contractures require prompt surgical intervention.[5] Adequate access flow should be more than 600 mL/min to support both HD and maintain access patency according to KDOQI. A flow rate of below 300 mL/min indicates imminent thrombosis.[6] Moreover, DASS treatment should be individualized according on access location, underlying vascular disease, flow dynamics, and provider expertise.

CASE PRESENTATION

A 63-year-old male presented with continuous pain at rest in his left forearm at the HD access site. The patient has a comorbid of hypertension and diabetes. The access was made a year ago and has been used for eight months. The last HD session was the day before admission. During physical examination, the patient showed signs of anemia without signs of jaundice, cyanosis or delirium, and capillary refill time was less than 2 seconds. Local examination revealed no hematoma with palpable thrill and pulsation (Figure 1). Laboratory report showed anemia with hemoglobin of 8.8 and hematocrit of 24.9%, which indicated chronic disease, prothrombin of 15.5 seconds, APTT of 34.1 seconds, and OT/PT of 15/13, which could suggest a mild coagulation disorder, urea of 36mg/dL and creatinine of 3.8mg/dL, suggesting impaired kidney function. The patient underwent vascular ultrasound followed by venography and venoplasty. During ultrasound, a reduction in blood flow was found which is consistent with stenosis in the draining vein (Figure 2).

Figure 1. Clinical picture before intervention

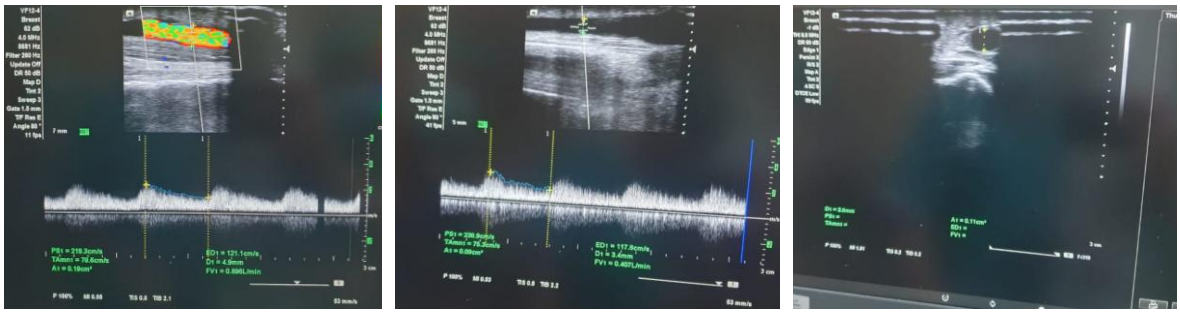

Figure 2. Vascular ultrasound of the cephalic vein

The procedure went as follows: The patient was positioned supine on the operating table and field of antisepsis was applied. A puncture was made in the left brachial artery and a sheath was inserted. Initial angiography showed arterial flow into the ouflow draining vein with no distal flow in the radial artery, consistent with steal syndrome (Figure 3).

The vein was release from surrounding tissues and banding repair was performed in the juxta region. In the end, a central dialysis line (CDL) was inserted into the jugular vein. Post-procedure evaluation revealed palpable thrill and final angiography showed weak distal radial artery flow and positive flow in the draining vein (Figure 4).

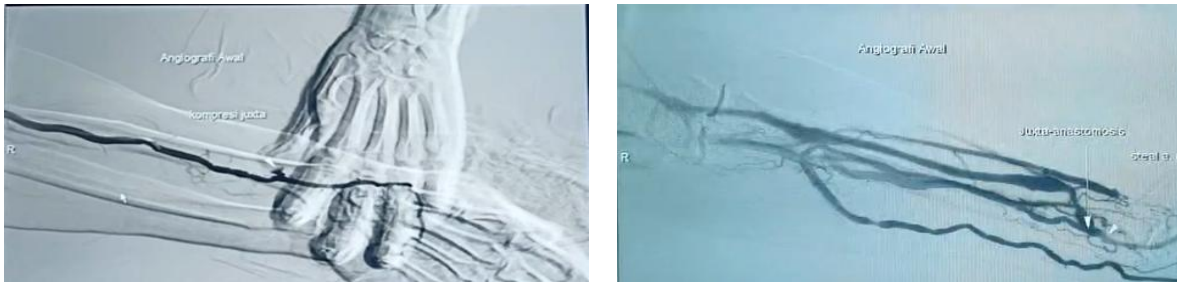

Figure 3. Angiography pre-intervention

Figure 4. Angiography post-intervention

The patient returned after three weeks with an edematous left distal limb. His saturation fell to 93-96%, showing venous hypertension and arterial insufficiency. He explained that he tends to feel slight discomfort on the access site so he or a massager tends to massage his forearm to relieve the discomfort. Due to these complications, he was admitted to the hospital and proceeded with ligation of the radial artery (Figure 5, 6).

Figure 5. Clinical picture 3 weeks after intervention

Figure 6. Ligation of the radial artery

After the procedure, the patient was evaluated during hospitalization. The edema gradually decreased, and the discomfort in the patient's hand began to subside. The patient was then discharged and scheduled for a follow-up visit in one week. During the follow-up, no recurrence was observed; the only complaint was related to the surgical wound.

DISCUSSION

Several case reports on DASS were found in patients around the age of 60 with comorbid hypertension and diabetes. Patients with CKD often have underlying vascular abnormalities, including vascular calcifications and reduced arterial compliance, which can exacerbate the risk

of steal syndrome.[3,4] Although no overt signs of peripheral arterial disease were noted, subclinical vascular changes could have contributed to reduced distal perfusion. The patient's DASS severity score was stage 3 which suggested a moderate steal syndrome (Table 1).[7] The patient presented with signs of steal syndrome secondary to venous outflow stenosis, which exacerbated the diversion of blood flow. Duplex ultrasound can quantify flow and identify arterial stenosis and/or flow reversal. For proximal steal syndrome, angiography (digital subtraction angiography/DSA) provides insight into AVF anatomy and identifies stenosis or decreased anterograde flow.[7]

The ultrasound findings indicated significant venous outflow stenosis. Juxta-anastomotic stenosis (JAS) is more align according to the ultrasound results. Stenosis was found 2 to 5 cm within the arterioventricular anastomosis and the physical findings shown weak thrill and reduced distal flow which matches the description in this case (Table 2). If there was a pulsatile, tense fistula with prolonged bleeding after dialysis would more likely be cephalic arch stenosis (CAS).[8]

This stenosis would have increased the pressure within the AV shunt, exacerbating the diversion of blood from the distal arterial circulation. The reduced outflow also contributed to increased resistance, causing further shunting of arterial blood into the venous system.[7-9]

Table 1. Severity of DASS[7]

Stage	Description
Stage 1	Retrograde diastolic flow without symptoms, physiological steal
Stage 2	Pain during exercise or dialysis
Stage 3	Pain at rest
Stage 4	Tissue loss (Ulceration, Necrosis, Gangrene)

Table 2. Physical examination findings and dialysis and surveillance findings for inflow and outflow stenosis[8]

Stenosis type	Typical lesion	Physical examination findings	Findings at dialysis and surveillance
Inflow stenosis	JAS	Fistula is flaccid and shows poor turgor, weak bruit or weak thrill	Difficulty with cannulation, high negative arterial pump pressures, poor access flows
Outflow stenosis	CAS	Fistula is pulsatile and tense and shows aneurismal dilatation	Prolonged bleeding, high venous pressures and poor access flows

Treatments for DASS usually include surgical procedures such as ligation, distal revascularization with interval ligation (DRIL), revision using distal inflow (RUDI), banding, proximalization of arterial inflow, and distal artery ligation.[2] The decision to undergo venoplasty and banding repair in this case instead of a more invasive procedure lies from the outflow obstruction rather than excessive diversion of blood flow. Venoplasty is the first-line treatment for venous stenosis because it is less invasive and effectively restores normal flow by dilating the narrowed section of the vein.[10] Banding repair helps adjust the flow dynamics without fully occluding or drastically altering the AV shunt.[10] Preserving the AVF, which was just been placed recently, made venoplasty more preferable, especially in rural areas where undergoing a more invasive surgery would require creating a new vascular access site. Banding, as described in recent literature, is an effective technique for managing high-flow complications and steal syndrome, offering a balance between preserving the dialysis access and alleviating ischemic symptoms. CDL was inserted to the jugular vein for temporary vascular access after banding intervention since the AV shunt might need time to stabilize and the patient needed continuous dialysis.[12]

The development of distal hand edema and reduced oxygen saturation following the initial intervention suggests persistent or recurrent ischemia, potentially due to insufficient correction of the steal phenomenon or new vascular complications. Massaging the area around AVF can have significant implications for its function and longevity especially when AVF is non-matured. This

practice can inadvertently lead to complications such as compression of the AVF which potentially leads to obstruction or damages the vessel. Such manipulation may increase the risk of thrombosis, stenosis, distal embolization, acute ischemia, or even aneurysm when done repeatedly. These complications lead to decreased blood flow, increased venous pressure and access failure.[13,14]

The persistence of symptoms after these interventions indicated that the underlying hemodynamic issue was not fully resolved. The gold standard to resolve DASS remains the ligation of the AV access. In this case, radial artery ligation was selected as the definitive intervention to eliminate the steal by completely obstructing the diverted blood flow into the AVF, thereby restoring circulation to the distal hand. This approach is typically reserved for cases where other treatments have failed or when complications arise that endanger limb viability. Ligation of the radial artery was chosen as a definitive intervention to eliminate the steal by completely blocking the diverted blood flow into the AVF, thereby, redirecting it to the distal hand. This approach is typically reserved for cases where other interventions have failed or complications arise that threaten limb viability. Radial artery ligation reduces the risk of ischemic damage and resolves symptoms of venous hypertension, such as edema. However, it also necessitates careful consideration of alternative dialysis access strategies, as the AVF may no longer be usable.[2] If left unaddressed, the patient's complications could have progressed to severe ischemia, tissue necrosis, or even limb loss. Hence, timely intervention with radial artery ligation was critical in preserving limb function and preventing further morbidity.

CONCLUSION

Recurrent dialysis access steal syndrome, especially in a non-mature AVF, presents unique challenges in management. This case highlights the importance of continuous post-intervention monitoring, patient education on proper AVF care, and the need for escalation to more definitive treatments like radial artery ligation when initial interventions, such as venoplasty failed. After the second intervention, the outcome was very good, and the patient did not report any recurrence. Early recognition of complications, including patient-induced factors like AVF manipulation, is crucial to prevent further morbidity and ensure the preservation of vascular access.

Conflict of Interest

The authors have no conflicts of interest to declare.

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