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Case Report

Venous aneurysm development in left upper limb brachiocephalic arteriovenous fistula with manifestations of steal syndrome: a case report

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ABSTRACT

Steal syndrome is a rare but significant complication of arteriovenous fistulas (AVF), characterized by distal limb ischemia due to blood diversion from the arterial circulation into the low-resistance venous side of the AVF. This phenomenon can lead to symptoms such as pain, pallor, and compromised tissue perfusion, requiring careful diagnosis and management. To describe the diagnosis, surgical management, and clinical outcome of a patient with a dysfunctional AVF due to steal syndrome in the context of hemodialysis (HD), emphasizing the importance of early diagnosis and surgical planning to prevent complications such as distal ischemia and access dysfunction. A 42-year-old female with a longstanding history of end-stage renal disease (ESRD) and HD presented with a progressively enlarging, painful left brachiocephalic AVF. She exhibited symptoms of steal syndrome, including palpitations and tachycardia during dialysis. Diagnostic imaging revealed a dysfunctional AVF with a venous aneurysm, necessitating surgical intervention for correction.

Keywords: Steal syndrome, Arteriovenous fistula, Hemodialysis, Vascular access, Ischemia

INTRODUCTION

Chronic kidney disease (CKD) and its advanced stage, end-stage renal disease (ESRD), require dialysis as a life-sustaining therapy. The cornerstone of efficient dialysis lies not only in the successful creation of vascular access but also in the complex management of its associated complications, such as steal syndrome in arteriovenous fistulas (AVF).[1]

Steal syndrome is a well-recognized but infrequent complication in the creation of vascular accesses, occurring in 1-8% of all patients undergoing vascular access for hemodialysis (HD), particularly in AVFs.[2] This syndrome occurs when the formation of an AVF causes a diversion of blood flow from the distal arterial circulation to the low-resistance venous side, resulting in ischemia and compromised tissue perfusion in the affected limb.[3] Its clinical manifestations can range from coldness, pallor, mild paresthesia, and pain during dialysis to more severe symptoms such as resting pain, paralysis, ulcers, tissue necrosis, and loss of one or more fingers or even the entire hand.[4] Early diagnosis using imaging techniques and a high index of suspicion are essential for timely intervention, which may include surgical revision or the creation of an alternative access to preserve limb function and ensure adequate dialysis.[5]

CASE REPORT

We present the case of a 42-year-old female patient undergoing renal replacement therapy with HD.

Her medical history includes:

Toxic habits

Active smoking for 7 years, ceased 20 years ago.

Chronic conditions

CKD stage V, diagnosed in 1999, initially treated with peritoneal dialysis until 2002, discontinued due to peritonitis and removal of Tenckhoff catheter. Currently on HD via right jugular Mahurkar catheter (3 sessions per week).

Transient ischemic attack in May 2021.

Meniere's disease, diagnosed 17 years ago, treated with cinnarizine and diphenidol.

Surgical history

Placement and removal of Tenckhoff catheter in 1999 and 2000; living-donor kidney transplant (from mother) in 2002 with chronic graft dysfunction after 13 years; brachiocephalic AVF creation in the left arm in 2015, now nonfunctional due to steal syndrome.

Her current condition began in September 2018 after a puncture error in the AVF, with subsequent progressive swelling and pain during HD sessions. In July 2021, she developed palpitations, dyspnea, diaphoresis, finger pallor, and tachycardia during HD, which improved after ultrafiltration pause. Cardiology consultation (ECG, Holter, echocardiogram) ruled out arrhythmias, ischemia, and heart failure. A Doppler ultrasound of the left upper limb (LUL) was requested, confirming steal syndrome as the cause of symptoms during HD.

Laboratory results (14 June 2024)

Glu-85, urea-71, Fe-62, Cr-7.7, Na-137, K-5.2, Ca-7.7, P-2.8, Col-145, Tg-141, Alb-4.4, Hb-9.5, PLT-240, WBC-3.96, PTH-460 and vit D-10.7.

Imaging studies

Doppler US of LUL (14 June 2023): A brachiocephalic AVF is identified at the antecubital fossa, with the distal humeral artery and basilic vein, featuring a latero-terminal anastomosis. The arterial end is tortuous with a biphasic flow (VPS 127 cm/s), a 6.6 mm anastomosis, and a flow volume of 755 cm/s. The venous component shows a saccular dilation of 3.4 cm, with multiple distal basilic vein saccular dilations, no thrombosis.

Clinical and imaging diagnosis: Dysfunctional AVF due to steal syndrome in LUL.

A surgical plan was made for the closure of the LUL AVF and creation of a new AVF in the right upper limb (RUL). A Doppler US of the RUL was requested for surgical planning, as well as pre-anesthetic and preoperative evaluations. A Mahurkar catheter was placed in August 2024 for pre- and post-operative HD access.

Doppler US of RUL (13 June 2024): No abnormalities in the venous and arterial systems, with adequate diameters of the brachial artery (4.6 mm) and cephalic vein (3.5 mm).

Flebography RUL: Adequate contrast flow to central veins (subclavian and axillary).

Surgical procedure (05 August 2024)

The patient underwent "AVF deconstruction + aneurysmectomy + construction of RUL AVF" without incidents or complications. Findings:

Left AVF: Steal syndrome with a 3 cm aneurysm in the cephalic vein, turbulent flow, and vascular wall thinning.

Right upper limb: Adequate diameter of cephalic vein and brachial artery, functional AVF with adequate thrill.

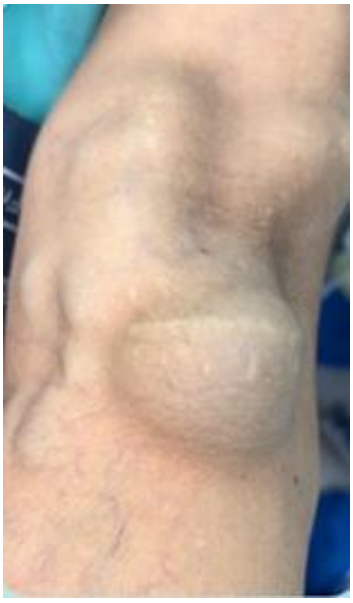

Figure 1: Aneurysm in the left upper limb.

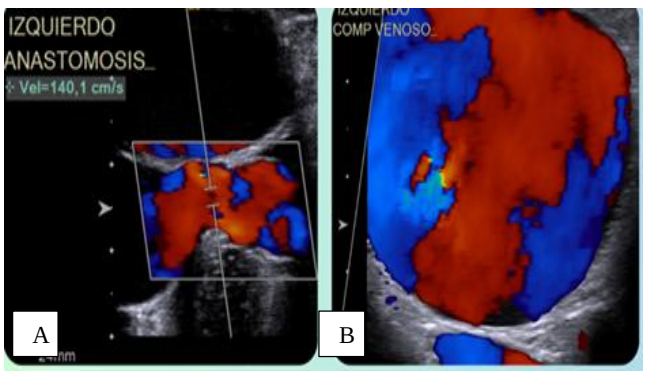

Figure 2 (A and B): Doppler ultrasound showing AVF between the humeral artery and basilic vein.

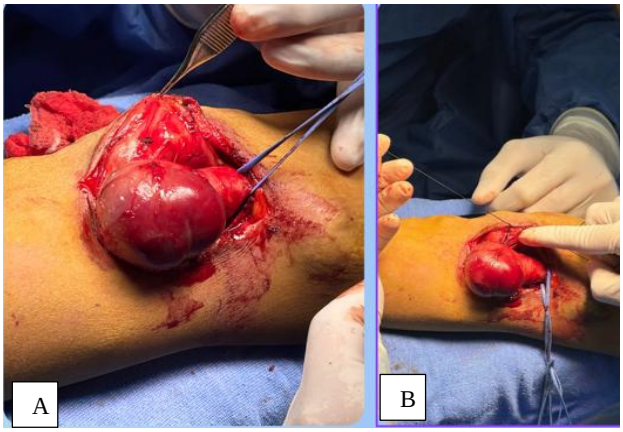

Figure 3 (A and B): Intraoperative image of AVF dismantling + aneurysmectomy + creation of AVF in right upper limb.

DISCUSSION

Steal syndrome is a condition that requires prompt surgical resolution, not only because the pain reduces the patient's functional capacity, but also due to the ischemia that can cause severe compromise of distal tissues, potentially leading to the loss of fingers or even the entire hand.[4,5] The AVF remains the treatment of choice for patients on HD requiring long-term management, as it provides reliable vascular access. Fistulas are monitored by Doppler ultrasound to assess vessel status and predict complications such as the steal syndrome presented in this case.[6] Differential diagnosis should include carpal tunnel syndrome, ischemic monomelic neuropathy, iatrogenic nerve injury, and other neuropathies.[7]

Patients with accesses created in the brachial artery are at a higher risk of developing steal syndrome compared to those with accesses in the radial or axillary arteries, and this is considered a risk factor.[8] In this case, the decision was made to dismantle the previous AVF and create a new one due to the unavailability of endovascular surgery services at the unit. This decision was driven by the urgent need to ensure proper access for HD, allowing continuous and tolerable sessions for the patient. Furthermore, the patient was experiencing intolerable pain related to the steal syndrome, requiring immediate surgical intervention to relieve symptoms and restore adequate blood flow. The creation of a new AVF was essential to improve the patient's quality of life and ensure the viability of dialysis treatment. Additionally, only a few studies have conducted extensive comparisons between various treatments for the management of steal syndrome.[9]

Various techniques have been proposed for the treatment of steal syndrome in AVFs (DASS), including banding, short graft interposition, distal inflow revision (RUDI), distal revascularization with interval ligation (DRIL), proximalization of arterial inflow (PAI), extension of existing grafts, distal radial artery ligation, anastomosis reduction, and ligation. However, there is no clear, definitive evidence on which technique is best for managing these patients.[10]

CONCLUSION

In conclusion, steal syndrome in AVFs represents a serious complication in HD patients that can compromise the function of the affected limb. Early diagnosis and surgical intervention, as in this case, are crucial to restore adequate perfusion and improve the patient's quality of life. The creation of a new AVF was essential to ensure effective HD access, emphasizing the importance of surgery in situations where endovascular options are not available.

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