Radiology Case Reports 19 (2024) 1294–1297

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/radcr

Case Report

Symptomatic hemodialysis arteriovenous fistula with associated subclavian stenosis and a normal fistulogram ☆

Yudhvir Bhatti, BSc[a], *Kiat Tsong Tan, MBChB, MD, MRCP, FRCR, FRCPC*[a,b,*]

[a] *Michael G. DeGroote School of Medicine, McMaster University, Hamilton, Ontario, Canada*
[b] *Department of Interventional Radiology, Niagara Health, St. Catharines, Ontario, Canada; Department of Radiology, McMaster University, Hamilton, Ontario, Canada*

ARTICLE INFO

Article history:
Received 27 September 2023
Revised 14 December 2023
Accepted 18 December 2023

Keywords:
Interventional radiology
Vascular access
Hemodialysis

ABSTRACT

While arteriovenous fistulas (AVFs) are the optimal route of access for hemodialysis in terms of duration of patency and infection rates, they can still fail due a variety of reasons. Most commonly, AVF failure is due to venous stenotic lesions, resulting in reduced blood flow rate across the fistula. Fistulograms are often used to investigate cases of symptomatic or poor fistula function. This case discusses a 71-year-old man with a mature brachiocephalic AVF who presented with severe right upper extremity edema, and had a negative fistulogram, despite a severe stenosis in his AVF.

Introduction

Hemodialysis (HD) is the primary form of renal replacement therapy for 70% to 90% of individuals suffering from end-stage renal disease worldwide [1]. Arteriovenous fistulas (AVFs) are often created as a first line means of long-term vascular access for HD. This surgical procedure allows for a direct connection to be formed between an artery and a vein, most commonly in the arm, resulting in a fistula with an optimal flow rate for HD [2]. The 3 most common types of AVFs are radiocephalic, brachiocephalic, and brachial artery-to-transposed basilic vein fistulas [3]. A maturation period of 4-6 weeks is then required for the AVF to undergo vascular remodeling before it can be used for HD access [4]. AVFs are associated with the most favorable outcomes in terms of infection rates and number of procedures required to maintain patency [1].

Despite this, fistula failures can occur for a variety of reasons and result in a loss of vascular access for HD. The most common reason for fistula failures is venous stenotic lesions, in which the venous component of the AVF becomes narrowed, leading to impaired blood flow [2].

AVF failure is detected both by clinical examination and imaging. Clinical symptoms such as painful swelling, ulceration, and fistula pulsatility are often indicative of venous stenosis. This can be further examined via Doppler ultra-

☆ Competing Interests: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

* Corresponding author.
E-mail address: KiatTsong.Tan@niagarahealth.on.ca (K.T. Tan).

https://doi.org/10.1016/j.radcr.2023.12.027

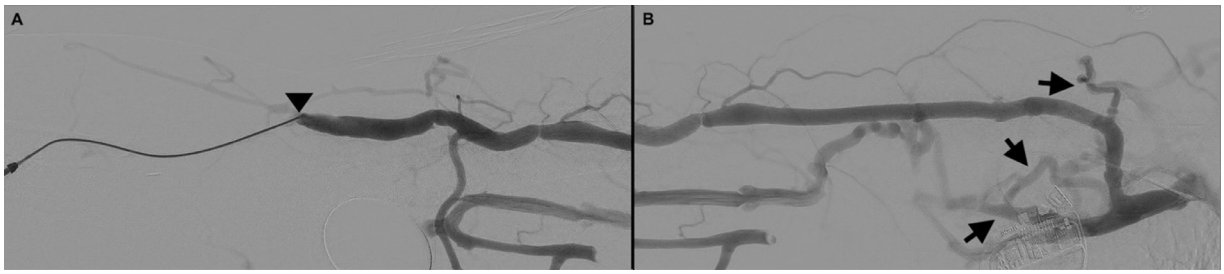

Fig. 1 – Central venogram with contrast prior to balloon angioplasty during initial patient visit. (A) Image shows absent contrast flow at the anastomotic site of the right brachiocephalic fistula (black arrowhead) prior to balloon angioplasty and (B) Contrast flow into collateral vessels (black arrow) can be seen in the venous outflow tract, with no stenosis or filling defect. A pacemaker can be seen.

sonography to determine blood flow within the AVF [5]. In the case of clinical symptoms or detection of fistula dysfunction, patients should be referred for fistulography, which can detect anatomic lesions in almost all cases [6]. Here we present a case in which fistulography was not able to detect any stenotic lesions, despite a patient presenting as symptomatic and benefiting from a percutaneous angioplasty procedure.

Case report

A 71-year-old man, with a history of end-stage renal disease being treated with HD for the past 5 years, presented to the dialysis clinic with severe edema in the entire right upper extremity. The patient underwent a procedure to create a right brachiocephalic AVF in November 2022 which was given 6 weeks to mature before being used for HD. The patient's past medical history was also significant for atrial fibrillation with bradycardia, for which a pacemaker was inserted into the right subclavian vein in October 2022.

A referral was made to interventional radiology for fistulography due to suspicion of a stenotic lesion in the AVF. Physical examination indicated a tense pulsatile fistula with full right upper edema. Imaging revealed no stenosis in the venous outflow tract; however, significant stenosis was found at the anastomotic site of the brachial artery and cephalic vein (Fig. 1). A percutaneous balloon angioplasty was performed to correct this stenosis, and postprocedural angiographic imaging revealed patent vasculature at the previously stenotic site. Given the positive angiographic result, and the absence of any direct evidence of further stenotic lesions, the patient was discharged home with instructions to monitor the site for edema.

The patient returned after 1 month for a second fistulogram, due to a lack of improvement in his symptoms. Physical examination once again revealed a tense pulsatile fistula on palpation and significant hand edema. Imaging showed no stenosis in the venous outflow tract; however, once again many venous collateral branches were visualized (Fig. 2). An attempt to advance a Bentson wire (Cook Medical, Bloomington, IN, USA) across the right subclavian vein at the site of pacemaker wire entry was made. There was difficulty passing the wire through, which increased the level of suspicion for a stenotic lesion at this location. Eventually a hydrophilic

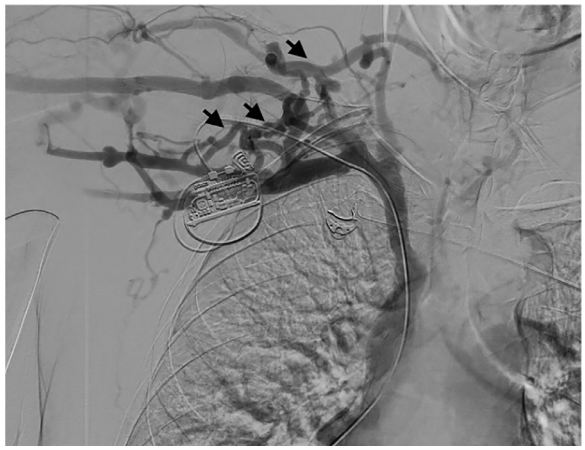

Fig. 2 – Central venogram with contrast prior to balloon angioplasty during subsequent patient visit. Image shows contrast flow into collateral vessels (black arrows) in the venous outflow tract, with no stenosis or filling defect. A pacemaker can be seen.

coated guidewire (Terumo Interventional Systems, Somerset, NJ, USA) was advanced through the suspected stenotic site. In retrospect, there was also reflux into the distal subclavian vein but not into the cephalic arch, which would suggest the presence of a stenotic lesion. In the patient's initial presentation, a guidewire was not advanced through the venous outflow tract, as fistulography showed normal vasculature in the region.

A second percutaneous balloon angioplasty was performed at the junction between the cephalic arch and subclavian vein. Waisting of the balloon was observed in the brachiocephalic vein and at the site of pacemaker entry into the subclavian vein, indicating a stenotic process (Fig. 3). Postprocedural fistulographic imaging of the AVF showed decreased collateral contrast backflow (Fig. 4), and physical examination of the fistula revealed a palpable thrill with reduced pulsatility.

Discussion

AVFs provide an optimal route of vascular access for hemodialysis due to their prolonged patency, durability, and

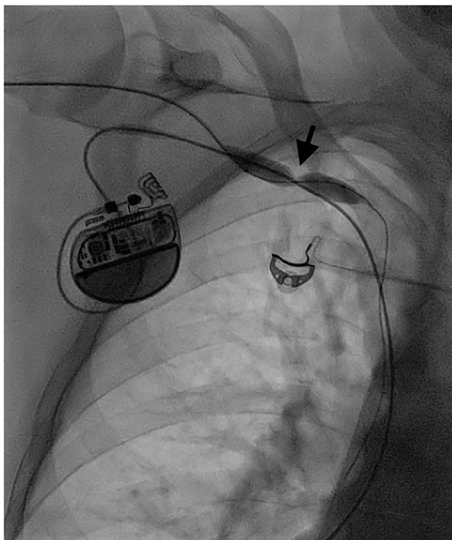

Fig. 3 – Fluoroscopic image of subclavian vein balloon angioplasty. Image shows balloon waisting (black arrow) at the region of the pacemaker line inserting into the subclavian vein.

Fig. 4 – Central venogram with contrast postballoon angioplasty. Image shows markedly decreased contrast flow into collateral vessels, and no stenosis or filling defect.

decreased risk of infection, compared to other modalities such as central venous catheters [1]. The overall risk of infection in fistula patients is 4.1% and AVFs have a reported 1-year primary and secondary patency rate of 64% and 79%, respectively [7]. These rates refer to the proportion of AVFs that do not require any reinterventions for maintenance of patency or are not abandoned from functionality, within 1 year, respectively. Fistula failures can be categorized as primary or secondary failures. Primary failures indicate that the fistula was not able to mature and become viable for use in HD, whereas secondary failures refer to complications that render a fistula dysfunctional after being used for dialysis [2].

When an AVF is created, there is increased turbulent blood flow in the vessels, resulting in vascular remodeling that increases luminal diameter and wall thickness [6]. The most common cause of primary fistula failure is juxtoanastamotic sclerotic lesions, indicated in up to 64% of nonmaturing fistulas [8]. In the present case, a stenotic lesion was first observed at the anastomotic site of the AVF; however, this was not linked with the onset of the edema observed on physical exam. Only stenosis of the venous outflow tract creates a significant backflow pressure that results in third spacing of fluid in the structures adjacent to the AVF [9].

Secondary fistula failure can be due to both venous stenosis or thrombosis, that results in narrowing of the vessel lumen, and thus a decreased flow rate, rendering it unable to be used for dialysis [2]. While the areas that are most susceptible to stenosis depend on the type of fistula, it is believed that levels of shear stress can affect levels of remodeling in the AVF. Low stress areas may not undergo appropriate luminal hypertrophy and wall thickening, resulting in a narrowing in those regions of the vessel [8].

It is possible for venous stenosis to occur due to pathways unrelated to the changes induced by the creation of an AVF [5–6,10] For example, in this case the patient had a permanent pacemaker placed in their right subclavian vein. It is believed that pacemaker insertions can result in endothelial cell disruption caused by repeated trauma from the leads with subsequent vessel wall inflammation, fibrosis and possible thrombus formation [10]. Given the location of the balloon narrowing seen in Figure 3, it is likely that the long-term vascular changes from pacemaker insertion resulted in narrowing of the venous vasculature proximal to the fistula, causing an obstruction in blood flow that led to upper extremity edema. Furthermore, it is possible that the stenosis was masked by the in-situ pacemaker lead.

In conclusion, although fistulography is the gold standard modality to detecting venous outflow stenosis in AVF patients, it is possible for a clinically significant stenosis to be present in a normal appearing fistulogram. Thus, it is important to correlate the fistulographic findings to the patient's physical symptoms. If an AVF stenotic lesion is clinically suspected in a patient, due to the presence of edema in the associated extremity or pulsatility at the site of the AVF, the target vessel should be investigated by passing a wire across it. If there is significant difficulty in wire passage across the vessel, it may be indicative of a masked stenotic lesion. This can be confirmed and potentially corrected via angioplasty.

Patient consent

Written and verbal consent was obtained from the patient prior to submission for publication. The patient was informed of the benefits and risks of the case report and provided their consent voluntarily. Confidentiality was strictly maintained, and all identifying information has been carefully removed or anonymized.

REFERENCES

[1] Agarwal AK, Haddad NJ, Vachharajani TJ, Asif A. Innovations in vascular access for hemodialysis. Kidney Int 2019;95:1053–63.

[2] Manov JJ, Mohan PP, Vazquez-Padron R. Arteriovenous fistulas for hemodialysis: brief review and current problems. J Vasc Access 2022;23:839–46.

[3] Jayroe H, Foley K. Arteriovenous fistula. StatPearls [Internet]., Treasure Island (FL): StatPearls Publishing; 2023. [cited 2023 Nov 2]Available from: http://www.ncbi.nlm.nih.gov/books/NBK559213 .

[4] Li H, Jen S, Ramayya T, Bowers HG, Rotem E. Unanticipated late maturation of an arteriovenous fistula after creation of separate graft access. Quant Imaging Med Surg [Internet] 2018;8(4):444–6. [cited 2023 Nov 2]Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5989091/ .

[5] Hammes M. Hemodynamic and biologic determinates of arteriovenous fistula outcomes in renal failure patients. Biomed Res Int 2015;2015:171674.

[6] Beathard GA, Arnold P, Jackson J, Litchfield T. Aggressive treatment of early fistula failure. Kidney Int 2003;64:1487–94.

[7] Bylsma LC, Gage SM, Reichert H, Dahl SLM, Lawson JH. Arteriovenous fistulae for haemodialysis: a systematic review and meta-analysis of efficacy and safety outcomes. Eur J Vasc Endovasc Surg 2017;54:513–22.

[8] Quencer KB, Arici M. Arteriovenous fistulas and their characteristic sites of stenosis. AJR Am J Roentgenol 2015;205:726–34.

[9] Sands JJ, Jabyac PA, Miranda CL, Kapsick BJ. Intervention based on monthly monitoring decreases hemodialysis access thrombosis. ASAIO J 1999;45:147–50.

[10] Senthilvel E, Papadakis A, Jain V, Bruner J. Pacemaker induced superior vena cava syndrome: a case report. Cases J 2009;2:6463.