Venous outflow banding for maturation of a percutaneous arteriovenous fistula

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ABSTRACT

In the present report, we have described venous outflow banding as a technique to assist with maturation of a percutaneous arteriovenous fistula (pAVF) without sacrificing potential target veins for future access. A 47-year-old obese man had undergone pAVF creation between the right ulnar vessels with coil embolization of the brachial vein. Follow-up imaging demonstrated the median cubital vein briskly filling the cephalic and basilic veins. The basilic vein was banded with the patient under local anesthesia successfully. Banding of the superficial veins provides an alternative after creation of a pAVF to preserve veins that could be used as conduits for future access. (J Vasc Surg Cases Innov Tech 2022;8:42-4.)

Keywords: Arteriovenous fistula; Maturation failure; Preservation of conduits; Venous outflow banding

The creation of a percutaneous arteriovenous fistula (pAVF)—created via endovascular techniques—has recently emerged as a minimally invasive technique that is potentially a more reliable alternative to traditional surgically-created fistulas for patients with suitable anatomy.[1] Because the endovascular technologies that enable pAVFs are relatively new, a paucity of studies have reported documenting pAVF maturation failure and secondary interventions. In the present case report, we have described failure of maturation of a pAVF caused by splitting of the flow in the superficial veins and subsequent basilic vein outflow banding as a technique to assist with pAVF maturation without sacrificing potential target veins for future access. The patient provided written informed consent for the report of his case details and imaging studies.

CASE REPORT

A 47-year-old obese (body mass index, 38.09 kg/m^2) man with diabetes mellitus complicated by diabetic nephropathy required hemodialysis via a right internal jugular vein tunneled dialysis catheter. He presented for possible open left brachiocephalic arteriovenous fistula (AVF) creation. Additional pertinent history included coronary artery disease, hypertension, hyperlipidemia, obesity hypoventilation syndrome, and obstructive sleep apnea with continuous positive airway pressure noncompliance. Before the scheduled AVF creation, he was admitted to the medical intensive care unit because of hypercarbic respiratory failure in the setting of continuous positive airway pressure nonadherence and fluid overload requiring intubation and a 4-day hospital stay. Once he had recovered from his respiratory failure, the decision was made to pursue pAVF creation as an alternative less-invasive and potentially less risky modality for access creation in this high-risk patient.

The patient underwent pAVF creation in June 2019 between the right ulnar artery and vein using the WavelinQ EndoAVF system (Bard, Tempe, Ariz) with coil embolization of the brachial vein with the patient under local anesthesia. An ultrasound evaluation at 4 weeks postoperatively showed a flow volume of 505 mL/min in the median cubital vein and dual outflow via the cephalic and basilic veins. At 6 weeks after pAVF creation, the access was cannulated with one needle only, because that flow with two needles could not be obtained. The cephalic vein flow volume was only 168 mL/min and had increased to 917 mL/min with compression of the basilic vein. An external clamp was used in the dialysis unit over the basilic vein to redirect flow to the cephalic vein during dialysis sessions. However, this could not be sustained secondary to patient discomfort and his relatively obese arm. After 4 months, with the patient under local anesthesia and awake, angiography of the right arm was performed via right femoral access to assess the inflow and the pAVF. No inflow disease was found, and the anastomosis was 6 mm and intact (Fig 1). The median cubital vein briskly filled the cephalic and basilic veins (Fig 2, *A*). With the patient under local anesthesia, a small incision was made over the basilic vein in the antecubital fossa. Banding of the basilic vein was performed using a 2-0 silk tie around the basilic vein and a right-angle instrument to create an "air knot" to decrease the lumen of the vein and redirect most of the flow volume to the cephalic vein without causing thrombosis of the basilic vein. Completion

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Fig 1. Anastomosis 6 mm in diameter, with no stenosis.

angiography was performed after placement of the tie and demonstrated decreased flow in the basilic vein (Fig 2, *B*).

After the banding procedure, the patient was able to undergo dialysis through the pAVF with no interruptions and no interventions for 2 years after the procedure because of appropriate fistula maturation. Follow-up ultrasound demonstrated the following: the cephalic vein flow had increased to 650 mL/min and was 6 mm in diameter, and the basilic vein remained patent with a flow decrease to 127 mL/min and a diameter of 4 mm proximal to the banding site (mid-arm). The follow-up ultrasound also demonstrated that with compression of the brachial vein, the velocity in the basilic vein was only 136 cm/s and that the cephalic vein had increased to 1122 cm/s.

DISCUSSION

In the present case report, we have described the application of an established technique—banding, which is typically used to treat steal syndrome—to address failure of fistula maturation. Typically, during open surgery, the short venous connection between the cephalic vein and basilic vein will be divided and ligated in the antecubital fossa close to the cephalic vein. Thus, no concern exists for the basilic vein becoming thrombosed because the perforator and distal venous tributaries will continue to provide flow to the basilic vein. In the present case, we were concerned that the basilic vein might have become partially thrombosed with complete ligation higher up in the arm; thus, banding of the basilic vein was performed. More specifically, the location of the banding in our patient was more central and higher on the arm to avoid constricting the flow to the cephalic vein or causing thrombus propagation into the cephalic vein if the basilic vein became thrombosed. However, the basilic vein maintained the flow, and the banding worked without causing thrombosis. Thus, we were able to preserve the longest length of the basilic vein possible for future access.

Harika et al[2] recently demonstrated that pAVFs had better maturation than open AVFs with a lower risk of infection, aneurysm formation, and hemodialysis access-related distal ischemia. Banding was first described by Ebeid and Saranchak[3] in 1981 demonstrating how banding of a Gore-Tex fistula could reverse steal syndrome without the risk of thrombosis. Decreasing the diameter of the vein surgically, via imbrication, plication, or application of an external band or

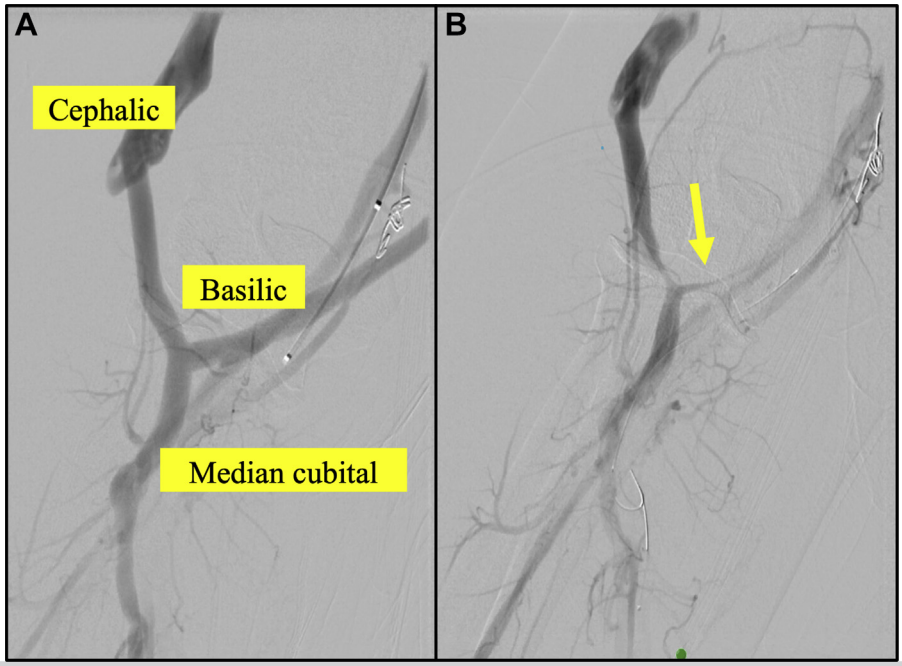

Fig 2. A, Basilic vein before ligation. **B,** Basilic vein after placement of tie (*arrow*).

suture will increase the resistance to flow and decrease the flow volume through the access. This will promote preferential blood flow to the hand to optimize perfusion.

Diversion of flow into branches, which prevents adequate maturation, has been described with traditional AVFs. Failure of these AVFs to mature has classically resulted from vessel stenosis or accessory veins.[4-6] If accessory veins, which are typically smaller superficial branches, underlie failure of maturation, they will typically be obliterated via suture ligation or coiling.[7,8] However, computational modeling has demonstrated that narrowing accessory veins to one third of the diameter of the AVF is sufficient to reduce accessory vein flow volume by 93%.[9] Thus, accessory vein obliteration might not be necessary. In the present patient, the basilic vein was diverting the flow. Because our patient was relatively young, conservation of the basilic vein was important to preserve access options in the future. Although surgical ligation or coil embolization at the antecubital fossa might not have caused the whole vein to thrombose because of the presence of additional draining branches more proximally, we decided to band the vein and limit the flow through it. Therefore, the technique we have described in the present case report allowed us to avoid sacrifice of the basilic vein or a large segment of it and potentially losing it as an option for access in the future.

Redirection of flow without complete ligation promoted fistula maturation by narrowing the basilic vein lumen. This increased vascular resistance, diverted blood flow to the cephalic vein, and provided the necessary flow volume for adequate dialysis.[10,11] The size of the vein at the site of the banding was significantly reduced to 1 to 2 mm approximately from a baseline size of >3 mm by placing a tie over a small right-angle clamp.

Alternative, more controlled, banding techniques using balloon angioplasty catheters have been described and could be used in the future.[12] Although accessory vein embolization and/or ligation are options for AVFs that fail to mature, banding provides an alternative to preserve veins that could be conduits for future access.

Ultrasound of the access site could not visualize the anastomosis very well after pAVF creation. This was concerning for potential stenosis at the site of the anastomosis; thus, a femoral access site was used to avoid any manipulation of the superficial veins or placing a sheath close to the anastomosis. This approach allowed for excellent visualization of the anastomosis (Fig 1) and measurement of the size of the connection, which was 6 mm. An alternative approach with access of the cephalic vein retrograde could have made the procedure more cumbersome and could have led to spasm in the cephalic vein. After dissection and banding, spasm did occur in the cephalic vein (Fig 2, *B*) despite the absence of vessel loops or direct dissection of the cephalic vein. Finally, the basilic vein could have been used for access but would have required superficialization, which would likely have required the use of general anesthesia for our high-risk patient.

CONCLUSIONS

pAVF creation is an alternative to surgical AVF creation, which sometimes requires secondary procedures to achieve functional access. Outflow banding is a useful technique to redirect flow and preserve major superficial veins as targets for future access with avoidance of general anesthesia.

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