Annals of Clinical Case Reports

Case Report
Published: 25 Apr, 2020

Modified Non-Transposed Brachiobasilic Fistula is a Good Choice for Patients with Radial Artery Insufficiency in the Forearm

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Abstract

A Non-Transposed Brachiobasilic Arteriovenous Fistula (NT-BBAVF) involves a side-to-side anastomosis between the brachial artery and basilic vein. An NT-BBAVF must be considered in the elbow region before placing a brachiocephalic arteriovenous fistula in patients with radial artery insufficiency of the forearm that requires hemodialysis. Herein, we introduce another modified Non-Transposed Brachio Cubital AVF (NT-BCAVF). In this case, we lowered the anastomotic position, ligated the perforating vein, and rendered the forearm cephalic vein valves incompetent by inserting a ureteral catheter. In this case, NT-BCAVF was comparable to wrist radiocephalic AVF. The NT-BCAVF is an ideal surgical procedure, especially when the forearm arteries are insufficient and the cephalic vein is good.

Keywords: Non-transposed brachiobasilic arteriovenous fistula; Median cubital vein; Perforating vein; Ureteral catheter; Cephalic vein

Introduction

The National Kidney Foundation-Kidney Disease Outcomes Quality Initiative (NKF-KDOQI)™, European Best Practice Guidelines (EBPG) for hemodialysis, and the Japan Society for Dialysis Therapy (JSDT) all recommend a wrist Radiocephalic Arteriovenous Fistula (RCAVF) as the first choice for native AVF [1-3]. A recent systematic review suggested that the optimal diameter of the Radial Artery (RA) and Cephalic Vein (CV) for construction of an RCAVF should be at least 2 mm to predict successful maturation and primary patency. Attempts to construct RCAVFs with RA or CV diameters ≤ 1.5 mm are not recommended [4]. For such patients with poor vascular conditions, a brachiocephalic elbow fistula may be preferred, which usually involves the formation of an end-to-side anastomosis between the cephalic vein and brachial artery. The brachiocephalic elbow fistula may not be the best option for patients with poor forearm radial artery but good cephalic vein condition. The Non-Transposed Brachio-Basilic Arteriovenous Fistula (NT-BBAVF) was first introduced by Geis et al. in 1977 and [5] recently modified by Lomonte et al. [6] and Hu et al. [7]. It involves a side-to-side anastomosis between the brachial artery and the basilic vein, thus allowing antegrade and retrograde flows along the basilic vein from its arterial anastomosis. For some patients, NT-BBAVF may be the first choice for native AVF. However, NT-BBAVF is not addressed in vascular access guidelines. In this article, we introduce another modified Non-Transposed Brachio Cubital AVF (NT-BCAVF) with good maturation.

Case Presentation

A 38-year-old Chinese woman presented to our hospital with nausea. She had a medical history of chronic kidney disease. Her initial investigations showed bicarbonate of 17.4 (reference range: 21.4 to 27.3) mmol/L, Intact Parathyroid Hormone (iPTH) 582.6 (12 to 88) pg/mL, hemoglobin 69 (115 to 150) g/L, urea 21.6 (2.6 to 7.5) mmol/L, and creatinine 942 (41 to 73) μmol/L. The patient's nausea was relieved after correction of metabolic acidosis. On further evaluation, it was clear that she had end stage renal disease and would need long-term renal replacement therapy. As she had chosen hemodialysis as the long-term renal replacement therapy, a well-functioning vascular access was essential. Physical examination and Doppler ultrasonography were used for pre-operative assessment and access planning. We found that the inner diameter of the radial artery in the forearm of both upper limbs was <1.5 mm, the cephalic vein in the left forearm was occluded,

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Received Date: *01 Apr 2020*
Accepted Date: *20 Apr 2020*
Published Date: *25 Apr 2020*

Citation:
Yi H, Guozheng F, Yonghong Y, HGuocun o. Modified Non-Transposed Brachiobasilic Fistula is a Good Choice for Patients with Radial Artery Insufficiency in the Forearm. Ann Clin Case Rep. 2020; 5: 1828.

ISSN: 2474-1655

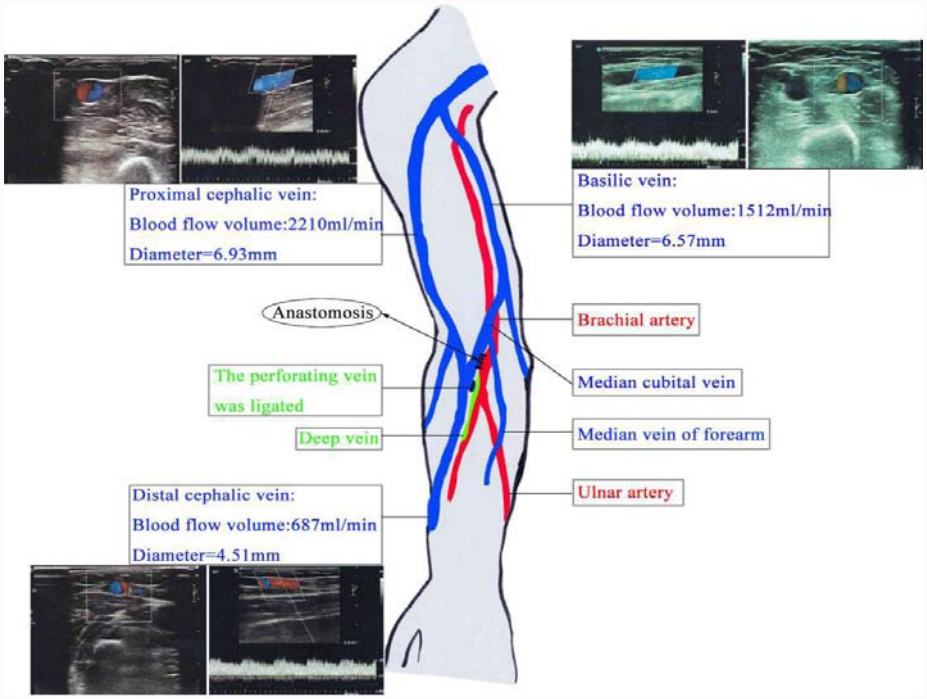

Figure 1: Illustrations for surgical anatomy and ultrasonographic examination of the cephalic vein (including forearm and upper arm) and the basilic vein.

and the inner diameter of the forearm cephalic vein in the right upper limb was >2.5 mm. The conditions of the brachial artery (diameter: 0.35 mm, Peak Systolic Velocity (PSV): 77.9 cm/s); median cubital vein (diameter: 0.25 mm); cephalic vein (diameter: 0.28 mm); and basilic vein (diameter: 0.40 mm) of the right upper limb were good.

The patient opted for modified NT-BCAVF. The surgery was performed under local anesthesia. Briefly, an oblique incision measuring ~3 cm to 4 cm in length was made on the ulnar side of the elbow. The cephalic vein and median cubital vein were dissected to locate the perforating branch of the antecubital venous system. The perforating vein was ligated, and the brachial artery was then carefully isolated.

Clamps were applied to control the circulation of the median cubital vein. A venotomy measuring 4 mm to 5 mm was performed. A 5-French ureteral catheter was introduced into the median cubital vein and passed as far as possible distally to render the distal cephalic vein valves incompetent. This maneuver eliminates the cul-de-sac which may cause turbulence and allows retrograde flow down the cephalic vein of the forearm. After that, an arterotomy (4 mm to 5 mm in length) was performed, and a side-to-side anastomosis was created between the median cubital vein and brachial artery (Figure 1). After flow was established and thrills were palpated in the cephalic vein (including the forearm and upper arm) and basilic vein. Thrills were not palpated in other superficial veins of the forearm.

Figure 1 presents the detailed assessment of postoperative AVF vein diameters and blood flow rates at 4 weeks. The average velocity was calculated using the following formula: Average velocity (cm/s) = (PSV-EDV)/3+EDV, where PSV and EDV denote the peak systolic velocity and end diastolic velocity, respectively. Blood flow volume was then calculated using the formula: Flow volume (mL/min) = average velocity (cm/s) × area ($\pi\gamma 2$) × 60s. The Spiral Laminar Flow (SLF) of the out-flow vein was visible as a red-blue shift on the color mode images.

Discussion

A modification of the BBAVF surgical technique was first described by Geis et al. in 1977: It involved the formation of an end-to-side anastomosis between the brachial artery and perforating vein with the creation of a reverse flow into the antecubital venous system [5]. This modification did not render the cephalic vein valves incompetent in the forearm. Moreover, retrograde flow in the cephalic vein of the forearm was established in only about 25% of all patients.

Similar to the NT-BBAVF, the Modified Non-Transposed Brachiobasilic Arteriovenous Fistula (mNT-BBAVF) in Hu's study created a side-to-side anastomosis between the brachial artery and basilic vein [7]. To maximize the blood flow into the distal vein, they ligated the basilic vein immediately proximal to the anastomosis and the perforating veins. However, a portion of blood flow was diverted to the distal basilic vein and median vein of the forearm (Figure 1). In addition, ligation of the proximal basilic vein reduces the available vascular resources for AVF in the future.

In the elbow, the topographical characteristics of this region allow easy access to both the brachial artery and the median cubital vein, which are usually of good quality, not very far from each other, and relatively superficial. In our case, we lowered the anastomotic position and ligated the perforating vein and rendered the distal cephalic vein valves incompetent by inserting a ureteral catheter. After flow was established and thrills were palpated in the cephalic vein (including forearm and upper arm) and basilic vein. Ultrasound monitoring of AVF at 4 weeks postoperatively showed outward remodeling and wall thickening in both the cephalic vein and basilic vein; no changes were noted in the other superficial veins of the forearm. In this case, elbow fistula was comparable to wrist AVFs.

Conclusion

Besides a detailed pre-operative history and physical examination, non-invasive ultrasound imaging plays an important role in AVF

selection. An individualized surgical plan was developed based on the vascular conditions of the patient. A modified non-transposed brachiocubital AVF is an ideal surgical procedure, especially when the forearm arteries are insufficient and the cephalic vein is good.

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