Chapter 2
Proximal Forearm Arteriovenous Fistula Creation

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Introduction

Worldwide greater than two million patients need renal replacement therapy. The aging population coupled with increasing need of dialysis access leaves surgeons gaining innovative ways to solve this crisis. Guidelines developed by the DOQI and Society of Vascular Surgery advised the creation of autologous fistula due to better long-term patency, fewer re-interventions, lower health-care cost, and low incidence of complications before use of grafts [1, 2]. Fistula first initiative uses distal radiocephalic and snuff box as the first choice, but this is impeded by lack of appropriately sized vessels for fistula creation and relatively high rates of non-maturations (8–40%).

Proximal forearm fistula has become grossly overlooked, likely due to the paucity of published literature, but is still a viable option. This preserves arm vessels for future use and has the theoretical advantage of reduced risk of steal syndrome, ischemic monomelic neuropathy, and high-output cardiac failure.

Proximal Radiocephalic Arteriovenous Fistula

Proximal radiocephalic arteriovenous fistula (pRCF) is an infrequently used option between the proximal radial artery and cephalic vein, first described in 1997 by Gracz et al. [3].

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Fig. 2.1 Proximal radiocephalic fistula (the anastomosis can be to the radial artery at the elbow)

Fig. 2.2 Proximal radiocephalic fistula after failed distal radiocephalic fistula

This is an end-to-side construct through a 4–6 cm longitudinal incision commencing 1–2 cm below the antecubital crease and along the separation between the brachioradialis and flexor carpi radialis muscle. This allows mobilization of the cephalic vein and radial artery for an end-to-side anastomosis. This has a few options for venous outflow from the cephalic veins to the medial antecubital or a perforating vein. If the inflow through the radial artery is unfit, then the medial portion of the proximal incision can be extended to utilize the brachial artery for inflow.

The anastomosis is usually very deep and covered by muscles, which is thought to be protective. A large series of 105 patients reported a 91% primary patency after 11 months of follow-up [4]. A retrospective single-institution review of proximal vs. distal radiocephalic fistula revealed that patients are more likely to have had previous access (47% vs. 18%) and despite this have a low primary failure rate (32% vs. 59%). Cumulative pRCF vs. distal radiocephalic fistula patency was 92% vs. 86% at 1 year [5]. Proximal radiocephalic fistula is an attractive option for non-maturation distal radiocephalic fistula as the cephalic vein is likely more sizable distally and using the radial artery as inflow will limit the risk of steal and preserving the brachial inflow, thus, limiting steal and ischemic monomelic neuropathy (Figs. 2.1 and 2.2).

Basilic Vein Arteriovenous Fistulas in the Forearm

Forearm basilic vein fistula remains an underutilized option for fistula creation, even though advocated for by some authors on the basis of preservation of arm veins with patency rates greater than forearm grafts. The availability of literature with forearm basilic vein is rather scant, and the guidelines continue to exclude this as an option. Basilic veins can be anatomically deep in location making accessibility difficult but more likely preserved due to hidden nature and less susceptibility from multiple needle sticks or even previous access attempts. There are two constructs that can be utilized using either the radial or ulnar artery as the inflow. Both types are suggested to need transposition to allow for dialysis needle access. It is anxiety provoking to create an ulnar-basilic AVF (UBAVF) after a failed distal radiocephalic fistula due to the increased risk of distal ischemia reported to be 28% in one series. UBAVF has much higher failure rates and longer maturity times compared to distal radiocephalic fistula with 1-year patency rates that range from 42% to 70% and a secondary patency rate of 53% [6]. Complication of hand ischemia is 0.4% in one pooled analysis.

Transposed radio-basilic fistula (tRBF) is gaining favor and is particularly attractive after failure of distal radiocephalic fistula with a reported 1-year patency rate as high as 93% in a small series of 30 patients (mostly after a thrombosed cephalic vein) [7–9]. Patency rates are non-inferior to arteriovenous grafts but more importantly without the infectious risk. Additionally, if not matured enough to be used for dialysis, it will contribute to the increased size of arm veins and hence extrapolates to improved outcomes of a more proximal fistula patency at a later date. One study comparing tRBF vs. arteriovenous graft proves fistula first is better with reported patency periods of 16.9 vs. 12.6 months with primary-assisted patency at 1 year 79% and 75%, respectively [9, 10]. Compared to distal radiocephalic fistula, primary patency rates are lower at 1 year (40–54%) and with maturation failure as high as 14% [7, 10]. Shintaro and Natario et al. suggested that low initial patency could be improved with intense observation and surveillance with early introduction of balloon angioplasty to increase as much as 77% [7, 11].

Procedurally, tRBF is more difficult with longer operative time but still feasible under local anesthesia. Preoperative duplex ultrasound is important in patient selection and planning of these fistulas. Technique is key: skin sparing with three to four separate incisions for harvest or long elbow-to-wrist incision with a counter-incision over the approximate radial artery after tunneling of available vein. The basilic vein usually runs a little far from the arteries; hence, usually the best positioning during harvesting is flexion at the elbow with forearm supination. General principles of harvesting apply with special care not to injure the vein. The basilic vein after ligation of the side branches forms a high-resistance conduit which is prone to thrombosis [8]. Once the vein is harvested, great care is taken to gently angio-dilate. Some authors prefer to use a 3/4 Fogarty catheter. Meticulous tunneling then allows for subcutaneous access and anastomosis to the radial artery. This moves the vessel away from its native course which can be deep and restrictive with scar tissue formation and healing. Anastomosis is created in an end-to-side construct with

Glowinski et al. suggesting 6 mm as being better than a larger diameter [8]. This can be performed in the forearm from the brachial to the distal radial depending on the suitability with maximizing the entire vein by looping as is needed. Outcomes are dependent on vein size with 3.5 mm vein yielding patency of 93/78/55% at 1, 2, and 3 years, respectively. Use of 2.5 mm veins yields a 1-year patency of 54% [7]. Duplex ultrasound should also demonstrate good inflow with radial artery diameter of >2.5 mm. Silva classified anatomic variants of the basilic vein into three types [9]. Type A (15%) vein is close to the radial artery, and a single incision is needed for harvest and creating anastomosis. Type B (33%) vein is located dorsally, and type C (52%) vein is more volar. Both B and C require separate incisions for harvest and anastomosis, but all will need superficialization for the normal deep position.

Conclusion

Proximal forearm fistula remains an untapped resource for fistula creation, which has escaped the guidelines but is with acceptable patency rates and preservation of arm veins for future use. Additionally, this offers a theoretical reduced risk of steal syndrome, ischemic monomelic, and high-output cardiac failure. This requires a skilled and highly experienced team of surgeons, nephrologists, and dialysis nurses to ensure the success of these accesses. More studies are encouraged to continue for the improvement of these unique proximal forearm fistulas.

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