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Autogenous forearm loop arteriovenous fistula creation

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ABSTRACT

Introduction: Arteriovenous fistula is a lifeline for end-stage kidney disease patients on dialysis. The quality of the vein and artery to be used plays a crucial role in attaining a functioning, reliable and long-lasting arteriovenous fistula. The aim of the study is to present an alternative for haemodialysis access to preserve the upper arm vasculature for future use – the forearm loop arteriovenous fistula.

Methods: From October 2015 to September 2016, 202 patients with chronic kidney disease (CKD), stages 4 and 5, underwent arteriovenous fistula creation at the Universiti Sains Malaysia Hospital, Malaysia. Nine patients, with severe atherosclerosis of the distal artery, but with satisfactory veins, underwent forearm loop arteriovenous fistula creation. Maturation of the fistula was based on the classification by the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF KDOQI).

Results: All nine patients who underwent forearm loop arteriovenous fistula have had diabetes mellitus for more than 10 years. Only one fistula failed to mature within 6 weeks. Two arteriovenous fistulas thrombosed at 3 and 5 months, respectively, after the commencement of haemodialysis. However, the other six matured fistulas are still functioning well after a year of regular usage.

Conclusions: Distal forearm arteries in diabetics may be severely atherosclerotic. Forearm loop arteriovenous fistula can be considered as the primary access for cases decided as inconvenient for fistula creation due to severe occlusive atherosclerotic disease of the forearm arteries; in order to preserve upper arm veins for future access procedures.

Keywords: End-stage kidney disease, Loop arteriovenous fistula, Atherosclerotic artery

Introduction

A good, reliable and long-lasting vascular access plays an important role in attaining adequate haemodialysis. The more distal the arteriovenous fistula (AVF) creation, the more ideal it is for chronic kidney disease (CKD) patients with stages 4 and 5, as proposed by the Kidney Dialysis Outcomes Quality Initiative (K/DOQI) (1). It is one of the most precious life-lines for end-stage kidney disease (ESKD) patients who will require life-long haemodialysis for survival.

The sequence of fistula creation begins from the 'snuff box' at the base of the thumb, wrist, forearm and, finally, the antecubital fossa (1). However, some CKD patients (especially those with long-term diabetes mellitus) will have severe atherosclerosis of the distal artery, which makes it infeasible for use. Thus, antecubital fistula must be created to increase the availability of access for dialysis in future. The aim of the study is to present an alternative for haemodialysis access to preserve the upper arm vasculature for future use – the forearm loop arteriovenous fistula (loop AVF).

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Method

A prospective study was performed from October 2014 to October 2015 in Universiti Sains Malaysia, Malaysia. Two hundred and two patients with CKD, stages 4 and 5, underwent AVF creation during this time frame. Nine patients, who had severe atherosclerosis of the distal artery, but with satisfactory veins, were chosen to undergo forearm loop AVF creation (Fig. 1). The patients are aged 40-60 years, and have had diabetes mellitus and hypertension for more than 10 years. Severe atherosclerotic artery was detected by palpating weak or absent pulse volume at the distal artery and was confirmed by ultrasonography, which shows atherosclerotic plaque narrowing the lumen of the artery. Size of the vein used should be 2.5 mm and above in external diameter. Maturation of the fistula was based on the classification by the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF KDOQI) (1).

Selected patients for loop AVF were given brachial plexus block. Planning of the incision began with the tracing of the

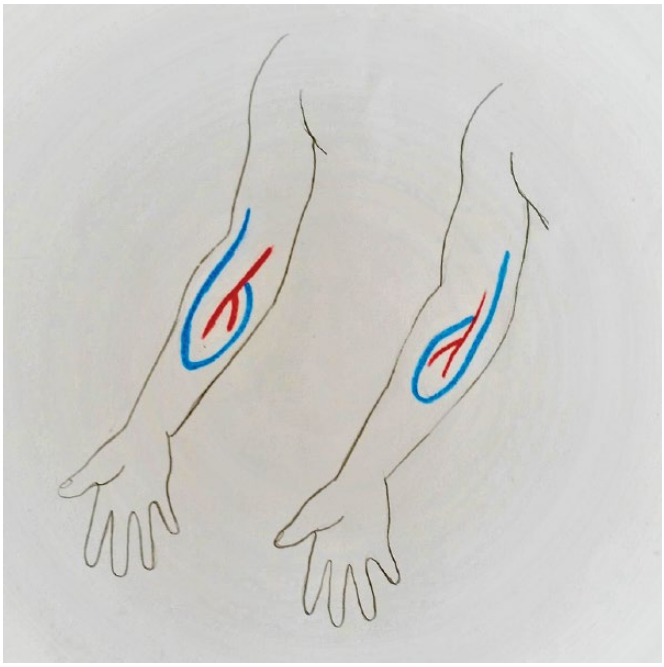

Fig. 1 - Forearm loop arteriovenous fistula (AVF) configurations. Loop cephalic vein (left), and loop basilic vein (right).

Fig. 2 - (**A**) Under brachial block, three interrupted incisions are made along the selected forearm vein. (**B**) Vein is dissected free and its branches are ligated and divided. (**C**) U-shaped subcutaneous tunnel is constructed on the volar aspect of the proximal forearm to the brachial artery.

vein that will be used to anastomose to the brachial artery. It could be the forearm cephalic or basilic vein, depending on its size and quality, to ensure a successful rate for AVF. The artery that is usually chosen is the brachial artery and, on occasions, the proximal radial artery. Multiple interrupted incisions were made over the length of the selected vein (Fig. 2A). The vein is dissected from its bed with its collateral branches isolated and divided to attain just adequate length to facilitate movement to create a loop to anastomose and reach the artery at the antecubital fossa. Hence, the proximal part of the vein need not to be dissected (Fig. 2B). A subcutaneous tunneller was used to create a passage for the dissected vein to pass through for anastomosis. Care was taken to ensure no acute angle, kinking and tethering of the vein at the turning point. Gentle-curve passage was constructed on the volar aspect of the proximal forearm (Fig. 2C). In addition, ventral surface of the vein was marked with ink to prevent twisting during manoeuvre in the tunnel. End-to-side anastomosis was constructed under loupe magnification 3.5x. In this series, the senior author uses 8/0 sutures and interrupted suturing techniques based on his personal preferences. It is believed that a smaller needle inflicts less trauma to the vessel and interrupted suturing technique gives better control and accuracy, especially in diseased artery where intimal dissection is readily seen following arteriotomy. The risk of anastomotic site thrombosis is reduced significantly. The extra time taken for these techniques was minimal in his hand.

A follow-up at 6-8 weeks' post-operation was conducted to assess the maturation of the AVF; and the matured fistula was allowed to be used for dialysis. To avoid major recirculation issues with this group of patients with loop AVF, a clear instruction will be given in the form of diagrammatic representation of the loop AVF showing the flow configuration of the fistula and the anastomotic site. Arrows will be marked on the patient's forearm showing the suggested canullation area for supply and return to be used during dialysis. Subsequently, follow-up will be continued by the nephrologist, and patients who encountered any complications of AVF were referred to our team.

Results

All nine patients who underwent forearm loop AVF have had diabetes mellitus for more than 10 years. Two patients had previous ipsilateral radiocephalic fistula created, which failed to mature. The forearm cephalic vein for the total of six cases was the preferred choice in this series due to its good average size of 3.5 mm (range 3-4.5 mm) (Tab. I). Diameter size of the brachial artery ranges from 3-5 mm (Tab. I). Arteriotomy for the AVF creation was 3-4 mm. The average duration of operative time was 130 minutes, which took longer than the conventional AVF creation.

Eight of the fistulas matured in six weeks. There was only one created loop AVF that failed to mature after that time. The patient refused any salvage procedure. He opted for a new AVF creation in which we performed a brachiocephalic fistula at the same limb as the previously failed loop AVF. He could use the fistula for dialysis after 6 weeks' post-operation.

Two loop AVFs thrombosed at 3 and 5 months, respectively, after the commencement of haemodialysis. Patients refused any salvage procedure as well, and a new AVF creation was successfully performed at the arm.

Discussion

Diabetes mellitus plays a major role in renal failure, accounting for about 58% of cases in Malaysia (2). Patients with long-standing diabetes mellitus are shown to have atherosclerotic disease of the arteries (3). The diameter of the distal

TABLE I - Results of forearm loop arteriovenous fistula

Configuration	n	Average diameter size (mm)	Maturation (n = 9)	Long-term result (failed)	Complications
Cephalic vein - brachial artery	6	Vein = 3.5 (range 3-4.5) Artery = 4.5 (range 4-5)	6 (100%)	1 (16.7%)	Nil
Basilic vein - brachial artery	3	Vein = 2.8 (range 2.5-3) Artery = 3.8 (range 3-4.5)	2 (67%)	1 (50%)	Nil

artery lumen of the forearm, which is smaller compared to the proximal arm artery, will further reduce in size with atherosclerosis (3). Poor augmented blood flow from the atherosclerotic artery to the vein reduces the efficacy of dilatation and arterialisation of the vein. This will lead to a failure of maturation as well as thrombosis of the vein. This condition makes it unfavourable to create the conventional AVF at the distal site of the forearm, despite the forearm vein being satisfactory (4).

In 1983, Moris and Kinnaert (5) introduced the technique of brachial artery-forearm vein fistula. Transposed forearm loop fistula is ideally used as it will receive an inflow from the larger artery at the antecubital fossa without sacrificing the usage of the forearm vein (4, 6). The upper arm veins can be preserved for future use if needed, and this will provide more assurance of availability of access for dialysis in the long term. Moreover, with the long length of the vein from the forearm, there is no need to puncture the upper arm veins for in and out flow during dialysis (4). Therefore, this technique will not hinder the creation of a secondary fistula in the upper arm if needed later. The puncture for dialysis can be made along the length of the loop.

Loop AVF creation may reduce the need for arteriovenous grafts made from polytetrafluoroethylene (PTFE). Synthetic grafts are usually employed as a last resort, when the availability of good quality veins has been exhausted, to provide an adequate functioning AVF. Autologous loop arteriovenous fistula is more beneficial as it is known to have a favourable, long-term patency and is more cost effective. However, it carries a higher early failure rate compared to the arteriovenous graft. There is less risk of infection in using an autologous vein in contrast to a graft (7).

The duration of operative time for loop AVF may take longer than the operative time for conventional arteriovenous fistula. This is due to the need to dissect an adequate length of vein to loop it up to the proximal artery. However, the duration of the operative time is dependent on both the surgeon and the technique. Multiple incision sites will be needed to dissect the whole length of the chosen forearm vein. In this case, nylon 8/0 interrupted was the surgeon's preference for better accuracy and optimal outcome. This technique causes less injury to the vessels during the anastomosis. It did not prolong the time of anastomosis (mean duration of 10 minutes).

With evolution, endoscopic vein harvesting may play a role in harvesting the forearm vein, which will reduce the number of incisions, wound problems, risk of seroma and inflammatory changes within the forearm (8).

The duration of fistula maturation is the same as the conventional AVF. Care of the fistula post-operation is also similar. The arm is to be propped up to reduce swelling, the elbow is kept straight to avoid kinking and clotting of the vessels and carrying heavy weights post-operation should be avoided (1). Hand-squeezing exercises using a soft ball would encourage fistula maturation by vasodilatation of the artery and vein around the fistula, which is in accordance with the Kidney Disease Outcome Quality Initiative Guidelines (1).

Patients who are chosen for this loop AVF are those with severe atherosclerosis of the radial or ulnar artery but with satisfactory veins. Although the number of patients in this study is small, we found that there were a few benefits of having a loop AVF. The technique can conserve the upper arm veins for future use if the distal artery is severely atherosclerotic. Upper arm veins are still usable for creation of a secondary fistula in the upper arm if needed later. There will be less risk of arterial steal syndrome by making a loop configuration AVF as compared to the conventional AVF (9). By creating a loop AVF, there will be adequate length for the dialysis nurse to puncture at the forearm region, not requiring puncture of the upper arm veins for dialysis.

There are a few disadvantages of having a loop AVF. The technique is fairly new to most dialysis nurses; therefore, they would not know where to pierce in the dialysis needles. With numerous dissections, there is a higher chance of developing seroma and the risk of the vein kinking at the swinging point.

Conclusion

Distal forearm arteries in diabetic patients may be severely atherosclerotic. No consensus has been reached on identifying the precise criteria for the selection of upper extremity arteries and veins. Forearm loop AVFs can be considered as the primary access in cases decided as inconvenient for fistula creation due to severe occlusive atherosclerotic disease of the forearm arteries; in order to preserve upper arm veins for future access procedures.

Disclosures

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Conflict of interest: None of the authors has financial interest related to this study to disclose.

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