Extra-anatomical veno-venous surgical bypass for central vein occlusion in patients with ipsilateral arterio-venous fistula (AVF) for haemodialysis - A single centre experience

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ABSTRACT

Objective: Central vein occlusion is a common complication related to central vein catheter insertion for haemodialysis which can be unmasked by an ipsilateral fistula creation, leading to a dysfunctional arteriovenous fistula (AVF). We describe an extra-anatomical venous bypass surgical procedure performed to maintain vascular access and reduce the symptoms of swelling of the ipsilateral upper limb, neck and face.

Materials and Methods: We report 20 consecutive patients with end-stage renal failure (ESRF) who had central vein occlusion and were not amenable to endovascular intervention. They underwent extra-anatomical vein to vein surgical bypass. The axillary and iliac or femoral veins were approached via infraclavicular and extraperitoneal groin incisions respectively. In all the patients, an externally supported 6 or 8 mm polytetrafluoroethylene (PTFE) graft was used as a conduit and was tunnelled extra-anatomical. All patients had double antiplatelet (Aspirin and Clopidogrel) therapy post-operatively.

Results: Substantial improvement in the facial, neck and upper limb swelling was noticed following this diversion surgery. The vein to vein bypass was patent at 12 months in 10 out of 20 patients. Graft infection occurred in two (10%) cases. Re-thrombectomy or assisted patency procedure (stent/plasty) was done in four (20%) cases. The patients with preoperative fistula flow rate of more than 1500 ml/min and post-operative graft flow rate of more than a 1000 ml/min were patent at 12 months (P=0.025 and p=0.034 respectively).

Conclusion. Axillary to iliac/femoral vein bypass can salvage functioning ipsilateral fistula threatened by occluded upper central vein and relieve their upper limb obstructive venous symptoms.

KEY WORDS:
Arteriovenous fistula, extra-anatomical vein to vein bypass, central vein occlusion, central balloon venoplasty

INTRODUCTION

According to the 22nd report of Malaysian Dialysis and transplant registry 2014, the prevalence of patients requiring dialysis showed an increase from 13 thousand in 2005 to atleast 35 thousand in the year 2014.[1] 9.4 percent of the end stage renal patients choose peritoneal dialysis as the method of renal replacement therapy.[1] Thus haemodialysis is the preferred method of dialysis in Malaysia. This has led to a rise in number of fistula and catheter related complications.

Many patients while waiting for permanent vascular access will require temporary access, which in majority of cases will be a catheter placed in the internal jugular vein. Complication of this neck cannulation includes stenosis or complete obstruction of the central veins. Pathophysiology of this is explained by fibrotic reaction from repeated percutaneous cannulation, delayed catheter removal, hematoma compression and reactive fibroplasia secondary to intraluminal vibration generated by cyclic cardiac contraction.[2] The incidence of central vein stenosis or thrombosis without prior cannulation is around 2% but increased to 12-29% with central vein cannulation.[3,4,5] This is compounded with a functioning ipsilateral fistula which results in high blood flows and venous pressures. This leads to upper limb swelling with resultant difficulty in fistula cannulation, venous congestion, ulceration and even venous gangrene. The easiest method to treat this complication will be to ligate the fistula at the cost of losing an option for dialysis. At present to achieve relief of symptoms and also continued patency of the fistula, an endovascular approach is used initially with balloon venoplasty. Failure of the endovenous approach leaves the surgical procedure as the next option either direct open venoplasty repair or extra-anatomical bypass procedure. Open surgical venoplasty in this group of patients is associated with a higher mortality and morbidity. This article shows our initial attempts at surgical bypass (extra-anatomical vein to vein bypass) as a means to alleviate the symptoms and salvage the use of the ipsilateral arterio-venous fistula with low morbidity and mortality.

MATERIALS AND METHODS

This study was carried out at our vascular unit. We analysed our first 20 patients with end-stage renal failure (ESRF) who had complex renal access problems and with central vein occlusion from November 2009 to April 2012. They were not

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Table I: Characteristics of the study cohort and patency at 12-month follow-up

Study Characteristics N=20	Patency at 12-month; n (%)	
	Yes	No
Gender		
Male	7 (35.0)	7 (35.0)
Female	4 (20.0)	2 (10.0)
Age(years)		
>55	4 (20.0)	2 (10.0)
<55	7 (35.0)	7 (35.0)
Type of Bypass		
Axillo-femoral vein	4 (20.0)	1 (5.0)
Cephalic-femoral vein	1 (5.0)	1 (5.0)
Cephalic-external iliac vein	4 (20.0)	5 (25.0)
Subclavian-ext. iliac vein	0 (0.0)	1 (5.0)
Axillary-ext. iliac vein	2 (10.0)	1 (5.0)
Level of Venous Obstruction		
Left Brachiocephalic vein	4 (20.0)	2 (10.0)
Right Brachiocephalic vein	3 (15.0)	6 (30.0)
Right Subclavian vein	2 (10.0)	0 (0.0)
Left Subclavian vein	2 (10.0)	1 (5.0)

Table II: Comparison of various flow rates and patency status at 12-month follow-up

Flow rate (ml/min) N=20	Patency at 12 months. (%)		
	Yes	No	p-value
Pre-op fistula flow rate			0.025
500-1000	3 (15.0)	5 (25.0)	
1001-1500	4 (20.0)	4 (20.0)	
1501-2000	4 (20.0)	0 (0.0)	
Post-op fistula flow			0.067
500-1000	2 (10.0)	6 (30.0)	
1001-1500	4 (20.0)	6 (30.0)	
1501-2000	4 (20.0)	3 (15.0)	
> 2000	1 (5.0)	0 (0.0)	
Graft flow rate			0.034
101-500	0 (0.0)	3 (15.0)	
501-1000	4 (20.0)	6 (30.0)	
1001-1500	4 (20.0)	1 (5.0)	
1501-2000	2 (10.0)	0 (0.0)	

amenable for further endovascular balloon venoplasty and underwent extra-anatomical surgical vein-to-vein bypass under general anaesthesia. All patients were assessed pre-operatively with duplex ultrasound and in some patients, a venogram of upper and lower limbs was done when there were doubts about their diagnosis or patency of the recipient's vein. The cephalic or axillary veins were approached via the infra-clavicular incision and the external iliac vein via extra-peritoneal route and femoral vein via standard longitudinal groin incisions. The patients either had a 6 or 8 mm supported polytetrafluoroethylene graft (Atrium Advanta VS, Hudson, USA) as a conduit and all had double antiplatelet (Aspirin and Clopidogrel) therapy post-operatively for the first six months then for single antiplatelet. The grafts were tunnelled extra-anatomically, initially from axilla under the pectoralis major muscle and then subcutaneously from the around the subcostal margin to the retro-peritoneal space or groin depending on the recipient's vein.

The data for a period of two years was analysed and all information were entered into a standard proforma. Post-operatively, patients were followed up in the vascular clinic at 3rd, 6th, 9th and 12th months. However, some patients were followed up outside HKL and phone calls were made to enquire about the status of the patients. The fistula and graft patency and flow rates were assessed using a duplex ultrasound machine. During the follow-up if the fistula flow dropped below 600 ml/min or graft flow rate drop was more than 20% of baseline, the patient was subjected to a repeat fistulogram and completion venogram to assess the patency of the graft and if possible endo-venous intervention.

Statistical analysis was performed with SPSS (V17.0) software. Descriptive variables were compiled and association of flow rates with patency was assessed using a Mann-Whitney U test (non-parametric). Kaplan-Meir survival analysis curves were also drawn to determine the probability of graft patency at the 12- and 24-month follow-up as well as sub-group analyses for assessing the effects of differing flow rates on graft patency at 12- month. Statistical significance was set at $P < 0.05$.

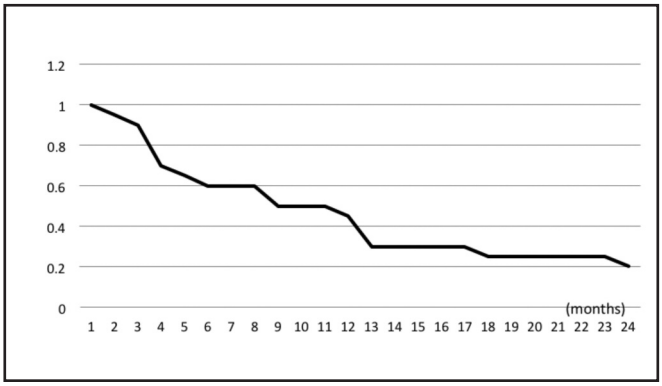

Fig. 1: Kaplan Meier survival curve: at 24 month follow up.

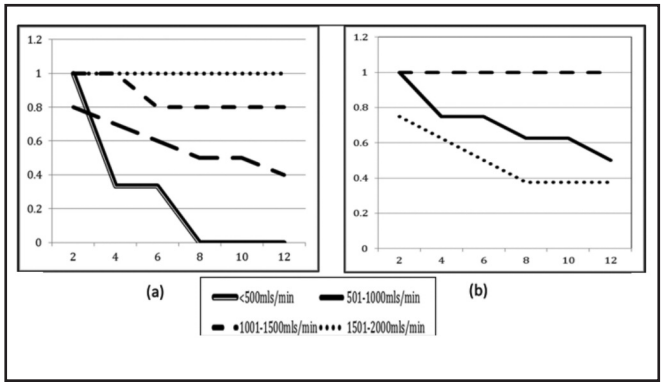

Fig. 2: Kaplan-Meier curve: Probability of 12-month graft patency at a) various pre-op fistula flow rates and b) various graft flow rates.

RESULTS

A total of 20 patients, 14 males (70%) and six females (30%) underwent surgical bypass for symptomatic central vein occlusion in our centre during the study period. The majority of our patients were of the older age group >55 years old. All patients had a functioning native upper limb arterio-venous fistula. At the time of the bypass creation, these patients were not amenable for further venoplasty attempts and in some cases even contralateral fistula creation. The obstruction was in the ipsilateral subclavian vein in five patients and brachiocephalic vein in 15 patients. Table I details the characteristics of the study cohort.

The venous bypass configuration was as follows; axillary to femoral vein five patients, cephalic to femoral vein two patients, axillary to external iliac vein three patients, cephalic to external iliac vein nine patients and subclavian to external iliac vein one patient. All of the patients had PTFE bypass graft of size 8 mm except two cases which required 6 mm due to the smaller calibre of the inflow proximal vein. All patients had symptomatic improvement of their upper limb, face and neck swelling after the bypass surgery. The swelling of the face and limb was assessed by clinical inspection alone. On average the patients were observed in the hospital for six days with ipsilateral limb elevation. No compression bandage was applied to the upper limb. The bypassed lower limb vein leg did not show clinically significant oedema or signs of venous hypertension. However, no venous pressure studies were performed to confirm the findings in these legs. Graft infection was noted in two patients (10%). One of the patients developed graft infection complicated with myocardial infarction six weeks post bypass operation in another hospital. He subsequently died of cardiac complications. A swab from the wound grew MRSA. The graft was not explanted as the patient was too ill and the family refused further intervention. The second patient had to have her graft explanted after about two weeks due to sepsis and her blood cultures grew acinetobacter species. This patient also underwent the ipsilateral fistula ligation and continued her dialysis via a cuffed femoral catheter. Two out of three patients in total died during follow-up due to cardiac-related complications. One patient had his fistula ligated due to persistent life-threatening bleeding post dialysis at another hospital. There were 10 (50%) grafts still patent at the 12-month follow-up period. Two out of this 10 (patent graft) patients had successful assisted patency with balloon venoplasty and stenting done. Two patients despite re-thrombectomy procedure developed occlusion at three and eight months post bypass procedure.

Table II details the associations between various flow rates and graft patency at 12-month. Pre-op fistula flow rates and post-op graft flow rates were significantly associated with post-op patency at levels of p=0.025 and p=0.034 respectively. Post-op fistula flow rates, however, were not significantly associated with graft patency (p=0.067). A Kaplan-Meier analysis of graft patency at 12 and 24-month is shown in Figure 1. Overall the procedure had a patency rate of 50% at 12-month and 20% at the 24-month follow-up. Sub-group analyses of probability of graft patency at different flow rates for pre-op fistula flow rates and post-op graft flow rates are shown in Figure 2. Patients with a pre-op fistula flow rate of more than 1500 ml/min as well as those with a post-op graft flow rate of more than 1000 ml/min had significantly higher probabilities of having patent grafts.

DISCUSSION

The complication of central vein obstruction in patients with ipsilateral arteriovenous fistula and prior central vein cannulation is not uncommon. The less invasive endovascular approach with balloon angioplasty with and without stenting is the first line of treatment in many centres especially when only stenosis is present. Restenosis rates are high with Haage and Vesely having a primary patency rate at one year of angioplasty and stenting around 25-56%.[4,6] Bakken et al. had a 29% primary patency rates for primary angioplasty.[7] Reasonable assisted primary and secondary rates were achieved in most studies but required further and repeated angioplasties or stenting to maintain patency. Arteriovenous fistula (AVF) Inflow reduction (MILLER technique) to reduce the burden on the outflow has been described by Miller et al., however the long-term results showed repeat intervention was still necessary to salvage the fistula. This procedure also requires the presence of notable venous outflow collaterals.[8]

Surgical bypass of the obstructed venous system is another option should the endovascular procedure fail. Options for surgical bypass include bypass to ipsilateral unobstructed central venous outflow such as external or internal jugular vein, contralateral venous outflow such subclavian or internal jugular vein, lower extremity venous outflow such as femoral or popliteal vein and intrathoracic or intraabdominal vena cava or right atrium. In a 12-month follow-up by Dammers et al., patients who underwent surgical bypass had 75% versus 63% patency rate than for those treated with angioplasty.[8] However, being more invasive and associated with use of general anaesthesia the open procedure exposes the patient to a higher initial risk of cardiovascular morbidity and graft infection rates. Direct repair of stenotic segment requires major surgical approach and does not offer added advantage over bypass procedure.[9] Primary surgical bypass treatment had an acceptable outcome of symptomatic relief in 75% of the patients.[8] Majority of our patients (95%) experienced symptomatic relief.

The choice of axillo to femoral or iliac vein bypass instead of a necklace (axillo-axillo) or jugular vein bypass was mainly due to previous multiple temporary catheter placements mainly in the upper central veins bilaterally with relative sparing of the femoral veins in our group of patients. The choice of PTFE graft instead of a native vein is due to compressibility and kinking of the vein (along the long course from axilla to groin), lack of suitable size vein (larger diameter) and coexisting lower limb peripheral arterial disease in these patients (possible future conduit or poor wound healing at harvest site). The availability of landing zone/site that is patent and with good run off in our patients is determined with colour duplex and in some patients with equivocal duplex examination, a lower limb venogram is done especially in patients with previous history of cannulation.

In our series of patients, the 12-month patency rate was assisted by concurrent use of double anti-platelet and regular three monthly follow-up with duplex ultrasound surveillance and intervention if needed. The graft infection rate in our study was 10%. The routine use of prophylactic antibiotic (vancomycin in all cases) up to additional three doses post operatively and dialysis performed in larger centres (hospital based) with regular surveillance for puncture site infections may be the reason for lower incidence of graft related infection.

There was a significant association between pre-op fistula flow rates and post-op graft flow rates with 12-month graft patency as seen in the study findings. Sub-group analyses showed that the probability of 12-month graft patency was higher when the flow rate through the fistula was higher than 1500 ml/min (pre-op) and the graft flow more than 1000 ml/min. These findings were similar to that of Jennings et al. who showed in their series that a fistula flow rate of <800 ml/min had a poor patency rate at 12-month. This study found that post-op fistula rates were non-significantly associated with post-op graft patency, although only marginally so. However, the p value remains marginally significant as it remains clinically correlated and the strength of the association indicates that the observed difference is unlikely to be due to chance.[10] It is possible that there may be a larger strength of association between post-op fistula rates and graft patency, however, the small number of patients in this series may have underscored the strength of this relationship.

The 24-month follow-up showed a rather dismal patency rate of only 20%. Although in our study the graft patency was poor but in these group of patients with dysfunctional fistula the grafts provided a necessary lifeline in prolonging their usage. Further audit would be carried out to see if better surgical techniques, aggressive follow-up and further endovascular interventions would improve the patency rates in a later cohort of patients as experience is gained.

CONCLUSION

The surgical extra-anatomical bypass can be used as a salvage procedure in those patients with occluded upper limb central vein, which is not amenable to endovascular approach. There is a significant reduction of the swelling in the ipsilateral limb post bypass. A pre-op upper limb fistula flow of more than 1500 ml/min and a bypass graft flow rate more than 1000ml/min has a significant improvement in patency rates of more than 12 months.

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