The femoral artery–femoral vein polytetraflouroethylene graft for haemodialysis patients: when should it be implemented?

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Background

Patients who are no longer candidates for upper-extremity haemodialysis arteriovenous (AV) grafts or fistulae present a difficult problem. The vascular surgeons at Mansoura University Hospital used a loop AV graft in the thigh in 30 patients with end-stage renal failure during the period from January 2008 to January 2011.

Patients and methods

Patients in this retrospective study underwent femoral AV loop graft placement when there was no alternative access to the upper extremity. The primary and secondary patency rates were determined using the Kaplan–Meier method.

Results

The 30 patients who underwent a femoral AV loop polytetrafluoroethylene (PTFE) graft in the upper thigh had a mean follow-up of 18 months (range 4–36 months). Early access failure due to thrombosis was reported in two patients in the superficial femoral artery ($n = 26$) inflow group and due to infection in one patient in the common femoral artery group ($n = 4$).

The cumulative graft survival was calculated using the Kaplan–Meier analysis method and it was 93% in the sixth month, 87% at the end of the first year, and 71% after 24 months to reach 30% at the end of our study. There were no cases of limb amputation (0%) in our study, nor any incidences of operative deaths in our series.

Although strict aseptic procedures were adopted, the incidence of infection among the studied patients was 16.7% and it was responsible for final graft failure at the end of the study.

Conclusion

Finally, we found that the thigh PTFE graft had the advantage of long length, which enables different cannulation sites, easy use, and high flow, which reduces the thrombosis rate. It was a good alternative to exhausted upper-extremity access. Choice of the lower-extremity femoral AV graft should take into account the patient's comorbidities and peripheral vascular disease. Further research with randomized studies is required to consolidate our results.

Keywords:

haemodialysis, lower-extremity graft, vascular access

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Introduction

The access procedures and complications related to dialysis are important causes of morbidity and hospitalization among chronic haemodialysis patients. The number of complicated patients on dialysis is increasing, and creating a successful vascular access for these patients is a challenge [1].

An arteriovenous (AV) fistula remains the preferred choice for initial access, but polytetrafluoroethylene (PTFE) grafts have became an accepted alternative as they are easy to use and revise and withstand repeated cannulations for many years [2,3]. However, in the light of the ever-increasing number of patients with end-stage renal disease, the ageing dialysis population and their prolonged longevity, surgeons are increasingly encountered with difficult access problems, such as exhausted upper-extremity access sites and central venous outflow obstruction resulting from previous catheterization [4].

Patients who are no longer candidates for upper-extremity haemodialysis AV grafts or fistulas present a difficult problem. These patients usually have had multiple previous access surgeries, have been in renal failure for extended periods of time, and have multiple, severe medical comorbidities. Surgeons generally agree that upper-extremity haemodialysis options are preferred. There are encouraging reports of good results with femoral AV grafts for haemodialysis as well as reports of relatively poor outcomes with these grafts [5,6].

In January 2008 a femoral artery vein (saphenofemoral junction) loop PTFE graft was first used in our unit in HD patients. This retrospective study details the clinical results obtained in 30 thigh grafts performed until January 2011.

The purpose of this study was to review and analyse the patency rate and specific adverse events complicating lower-extremity vascular access, as identified by the Society for Vascular Surgery and the American Association for Vascular Surgery, to assess safety and durability and patient factors that influence outcome.

Patients and methods

The Mansoura Vascular Surgery Unit used a loop AV graft in the thigh in 30 patients with end-stage renal failure over a 3-year period (from January 2008 to January 2011); the lower extremity was used when no other permanent access site was available (exhausted upper limbs).

Exclusion criteria

(1) Presence of proximal aortoiliac occlusion.
(2) Presence of diabetic femoropopliteal and tibioperoneal ischaemia.
(3) Previous ipsilateral femoral vein catheterization or a history of DVT.
(4) Patient refusal.

The studied patients were identified through a review of their medical records. Data obtained included demographic information (age and sex), baseline clinical information (type of disease leading to end-stage renal failure, medical comorbidities, number of previous access operations, the reason for femoral access), data on the access operation (date of operation, inflow vessel used, outflow vessel used, size of graft used), and information on the postoperative course (complications, date and reason for graft failure, number and efficacy of graft salvage procedures).

Primary graft failure requires an intervention to restore patency at an access site, including surgical interventions such as thrombectomy. Final graft failure precipitates abandoning an access site. Primary patency continues until primary graft failure. Secondary patency continues until final graft failure.

The median patency values were calculated for 36 months following access construction. Graft patency and patient survival were determined using the Kaplan–Meier method. Groups were compared with the log-rank test.

Graft survival was defined as the period of time from grafting until failure of the graft due to any reason or until patient death. In our study no differentiation was made between primary and secondary patency. Surgical thrombectomy was performed whenever needed and the graft patency rate was determined according to the reporting standards set by the committee of reporting standards for AV haemodialysis access [7].

Grafts that were functioning on last follow-up examination but were discontinued for reasons other than failure, such as death (three patients) or transplantation (one patient), were censored in the survival analysis.

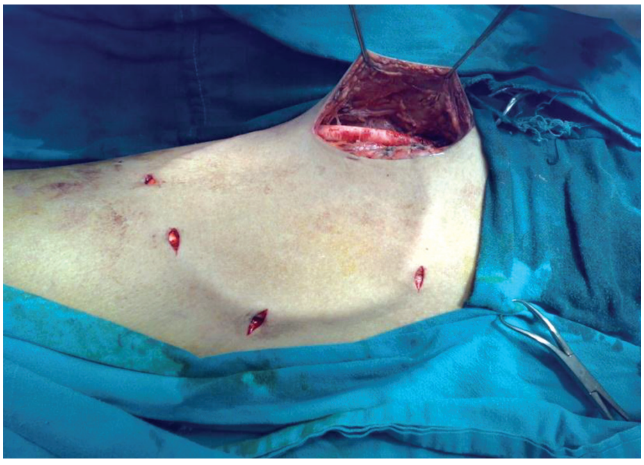
Surgical procedure

All procedures were carried out under either spinal anaesthesia (n = 28) or local anaesthesia. The lower abdomen and the thigh down to the ipsilateral knee were prepared. A bolus of 1 g vancomycin was given 1 h before surgery.

The surgical procedure is as follows: a longitudinal incision of the skin (~6 cm) is made below the inguinal ligament over the anteromedial aspect of the thigh. The superficial femoral artery, below its exit from the common femoral artery, and the saphenofemoral and its branches are exposed. A lateral longitudinal arteriotomy (1–15 mm long) is made into the superficial femoral artery. A PTFE graft (internal diameter 6 mm) is cut obliquely, and its end positioned to the arteriotomy opening. The graft is then tunnelled inferiorly in the subcutaneous plane. The distal end of the loop lies ~8–10 cm superiorly to the knee. At this area a further skin incision is made to ensure that no kinks are present in the graft. The graft is then turned superiorly in the subcutaneous plane until it reaches the exposed saphenofemoral junction. The average length of the loop is ~25–30 cm. The graft is cut obliquely, and a venograft anastomosis is made in an end-to-side manner with the saphenous vein stump at the sapheno-femoral junction and superficial femoral artery (SFJ) (Fig. 1).

After both venous and arterial clamps are removed, immediate thrill should be palpated over the entire graft to assure success of the technique.

Figure 1



A loop arteriovenous (AV) femoral artery–femoral vein polytetrafluoroethylene graft.

In our study, complete aseptic techniques were performed and a bolus of vancomycin (1 g) was given 1 h before surgery and maintained for 2 days postoperatively.

Cannulation of the graft is recommended after 10–14 days, but immediate cannulation can be performed without anticoagulation.

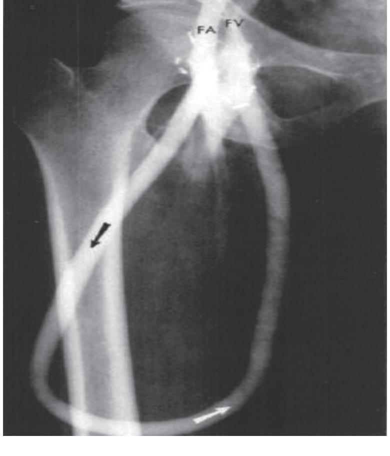
Postoperative low-dose aspirin (81 mg) was given to all patients. Postoperative follow-up after discharge was carried out in the outpatient clinic of the Vascular Surgery Unit, and a failing graft was suspected when venous pressures were high or when prolonged bleeding after decannulation was noted. In such cases a colour duplex screening and CT angiography were performed (two cases) (Fig. 2).

Results

Patient characteristics

In this study, 30 patients underwent femoral AV graft placement: in 29 (96.7%) because of lack of upper-limb venous outflow and in one patient (3.3%) because of lack of arterial inflow as determined on duplex study. The mean age at the time of operation was 50 years (range 35–70 years). Of the 30 patients, 21 were male (70%) and nine were female (30%). The mean follow-up duration was 18 months (range 4–36 months). The mean number of previous access operations was 3.93 (interquartile range 2–6), and 20% (six patients) of patients had undergone five previous procedures and six patients (20%) had undergone three previous procedures (Table 1).

Figure 2



Postoperative CT angiography showing a patent polytetrafluoroethylene graft between the femoral artery and the femoral vein.

In 26 operations the SFA was the inflow for the graft and in 30 operations (100%) the outflow vein was SFJ.

In our study early access failure due to thrombosis was reported in two patients (in the sixth and seventh months) in the common femoral artery (CFA) inflow group (n = 4) and due to infection in one patient (3.8%) in the SFA group (n = 26).

In this study, 22 patients (73.3%) had no ischaemic symptoms postoperatively, nor during the follow-up period, in both groups. In contrast, eight patients (26.7%) suffered from ischaemic symptoms, which were severe and was life-threatening in one patient (3.3%) in the CFA group (n = 4).

No intraoperative mortality and no limp amputation was needed.

Re-exploration was carried out in three patients (10%): because of bleeding in two patients and because of threatened ischaemia in one (3.3%). Graft thrombectomy was carried out successfully for 14 grafts (46.7%) with a mean time of 10 months (range 1–24 months).

Graft survival

Accordingly, the cumulative graft patency was 93% at the end of 6 months, 87% at the end of the first year and 71% after 2 years. Finally it reached 30% at the end of 3 years (Kaplan–Meier, Fig. 3).

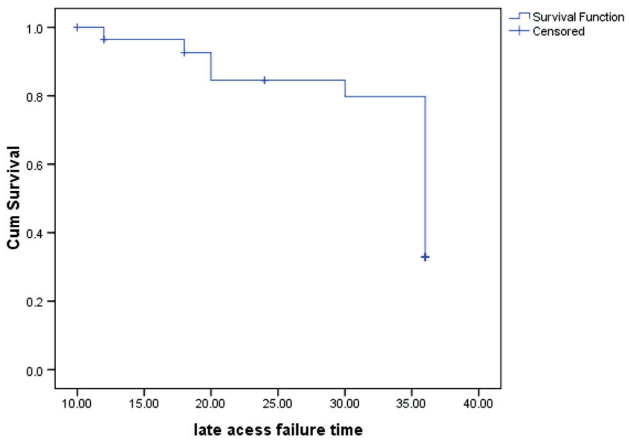
Statistical methods

(1) Clinical data were collected from the patients' clinical records and analysed using statistical package for social sciences, version 11. (IBM SPSS Software http://www.ibm.com/us/en/).

Table 1 Characteristics of the studied patients

Item	n (%)	
Age (years) [mean (SD)]	50.9 (9.6)	
Follow-up [mean (SD)] (months)	18.4 (8.8)	
Number of previous accesses [mean (SD)]	3.9 (0.9)	
Sex		
Males	21 (70)	
Females	9 (30)	
Reason for femoral AV graft	No venous outflow in the upper limb 29 (96.7)	No arterial inflow in the upper limb1 (3.3)
Inflow artery		
SFA	26 (86.7)	
CFA	4 (13.8)	
Outflow vein		
SFJ	30 (100)	

Figure 3



Survival function.

(2) Qualitative data were presented as number and percentage.
(3) Quantitative data were presented as mean and SD.
(4) The Kaplan–Meier method was used to estimate the patency rate for the group. A *P* value less than 0.05 was considered significant.

Discussion

Haemodialysis is dependent upon the construction, maintenance and preservation of a good vascular access. As the longevity of the haemodialysed patient has increased, and as increasing numbers of both elderly and diabetic patients are being chronically dialysed, the problems associated with vascular access have grown. As a result, ~25% of hospitalized days in haemodialysis patients are now related to vascular access malfunction [8].

Unfortunately, autogenous access is often impossible because of the obliteration of important superficial veins by prior medical intervention. After exhausting the other possibilities in the two upper extremities, we used a synthetic graft in the upper extremity. In patients with primarily unsuitable or secondarily surgically exhausted arm sites, a thigh fistula, either native with a saphenous vein or as a bridge graft, can be performed. We have used an alternative by way of a PTFE AV access graft placed in the thigh between the femoral artery and the saphenous vein.

The first PTFE loop femoral AV fistula was performed in January 2008 in our unit and was a success. This was considered when planning for alternative access for failed native AV fistula.

The majority of authors of the reviewed papers agree that vascular access in the lower extremities should be attempted only in select patients, when all other access sites in the upper extremities have been exhausted, there is severe pathology in the central vein trunks and, possibly, when patients are not suitable candidates for peritoneal dialysis. Nevertheless, some authors used patient's preference as one of the criteria for lower-extremity AV access construction, as it allows two-handed self-cannulation, leaves both hands free during dialysis and provides a better cosmetic appearance, especially for young women as the dialysis site is hidden under their skirt [9,10].

In our series, all patients were selected after all upper-limb trials had been exhausted – that is, no venous outflow (29 patients) or poor inflow arteries (one patient). They had to have an intact lower limb arterial and deep venous system and unsuitable long saphenous vein (atretic) due to previous attacks of thrombophlebitis or due to a previous harvest.

Several recently published studies have reported the outcome of prosthetic thigh AV access. The conclusions drawn by these studies differ dramatically. Some suggest that thigh AV access is safe, with excellent long-term patency, whereas others consider it a procedure of last resort, because of the high rate of complications, such as infection and arterial steal [6,11,12].

In a study published in 2006, the secondary patency rate was only 41% at 1 year with more than half of the patients requiring reoperation for graft salvage. These results were attributable to patient selection and referral patterns and severe medical comorbidities. Almost half of the patients had a significant perioperative surgical complication with graft thrombosis (17%); these patients were morbidly obese, which has been reported to be a risk factor for thrombosis and early access failure; 27% of grafts were lost because of infection [13].

The most prohibitive reported shortcomings associated with lower-extremity vascular access are infection and ischaemic complications. In an attempt to avoid placement of a prosthetic material in the potentially contaminated area of the groin and preserve proximal femoral vessels for later use, the upper-thigh loop technique was further modified by placing the graft along a subcutaneous loop channel over the anterior mid-thigh region, increasing the distance to the groin and the urogenital area [14,15].

However, in a recent study by Antoniou *et al.* [16] there was no difference in infection rates between upper and mid-thigh groups of AV access. In our study all grafts were placed in the groin, and mid-thigh loop grafts may need to be studied further.

In our study, the infection rate was 16.7% (five patients) and graft thrombectomy was performed in 14 patients (46.7%). Re-exploration for graft salvage was performed in three cases: in two cases because of bleeding, which was managed successfully by redo in the veno-anastomotic suture line, and in one patient because of threatened limb ischaemia and steal syndrome, which was managed by refashioning the arterial anastomosis.

There was no amputation related to our thigh graft in any of our patients, and no operative death in our series.

The National Kidney Foundation Guidelines do not favour catheters for haemodialysis access, stating that fewer than 10% of chronic haemodialysis patients should be maintained on catheters [17]. The reason for such disfavour is the poor blood flow through the catheter with resultant inadequate haemodialysis and an increased rate of systemic infection with the need for hospitalization compared with AV grafts [18].

In our experience, the only option is a femoral AV graft or a cuffed tunnelled catheter. The AV graft is generally a better option owing to high rates of infection in chronic indwelling femoral catheters.

In addition, several preventive measures have been proposed to keep infection rate at low levels, including perioperative prophylactic antibiotics and meticulous attention to an aseptic technique at the time of cannulation [19].

In our study a complete aseptic technique was implemented and a bolus of vancomycin (1 g) was given 1 h before surgery and it was maintained for 2 days postoperatively.

It has been suggested that preoperative screening for peripheral arterial disease with a detailed clinical evaluation and duplex ultrasound scanning and/or arteriography, when required, be performed in all patients scheduled for lower-extremity vascular access construction [20].

In our study, eight patients (26.7%) suffered from different grades of ischaemia postoperatively, which was severe and limb threatening in one patient (SFA group) and was re-explored and dealt with by refashioning the arterial anastomosis. Postoperative CT angiography was performed and the patient showed a patent graft and restoration of the infrapopliteal flow in the immediate postoperative period; however, the graft was removed later because of reanastomosis ischaemic symptoms.

In our study, all grafts used were 6 mm in diameter to decrease the incidence of ischaemia especially in diabetic patients. Other series used the 4–7 mm stepped graft where the 4 mm limb to the artery and 7 mm end to the vein, but we used the 6 mm diameter PTFE graft in all our patients. In our series we did not use the split 4–7 mm PTFE grafts.

Finally, we found that the thigh PTFE graft had the advantage of long length, which enabled different cannulation sites, easy use and high flow, which reduces graft thrombosis. The loop technique helps to dissipate high arterial pressure throughout the graft, and this also reduces thrombosis. The disadvantage of this technique includes the high risk of amputation if the graft is excised because of infection as the possibility of risk of arterial ligation is higher than that of repair of the arteriotomy.

Conclusion

Lower-extremity vascular access is increasingly used as an alternative access site in patients unsuitable for upper-extremity AV access creation and when the saphenous veins are unsuitable for femoral artery saphenous vein fistula creation. Our review has shown that it has acceptable results in terms of patency. Autogenous access was also found to be associated with fewer infective complications compared with prosthetic AV access, although at the expense of increased ischaemic complication rates. It seems that the type of lower-extremity vascular access should be chosen by taking into account the patient's comorbidities, such as peripheral arterial disease. However, because of the retrospective nature of most of the studies included in this systematic review and the great variability in the reporting outcomes, our results should be approached with caution. Further research with randomized controlled trials is required in the future.

Finally, we found that thigh PTFE graft has the advantage of long length, which enables different cannulation sites, easy use and high flow, which reduces the thrombosis rate. It is a good alternative to exhausted upper-extremity accesses; choice of the lower-extremity femoral AV graft should take into account the patient's comorbidities and presence of peripheral vascular disease. Further research with randomized studies is required to consolidate our results (Tables 2–4).

Table 2 Patients' medical comorbidities and causes of renal failure in our studied group

Causes of renal failure (%)	
DM	20
Hypertension	20
Obstructive uropathy	16.7
Unknown	16.7
Polycystic kidney	10
Glomerulonephritis	3.3
Systemic lupus erythromatosis (SLE)	13.3
Patients comorbidity (%)	
Hypertension	46.7
DM	36.6
Coronary artery disease	16.6
Obesity (BMI>40)	6.6

DM, diabetes mellitus.

Table 3 Graft salvage procedures

Procedures	*n* (%)
Graft thrombectomy	14 (46.7)
Lymphocele drainage	2 (6.7)
Re-exploration	3 (10)

Table 4 Causes of graft removal (late access failure)

Graft removal cause	*n* (%)
Rethrombosis with failed thrombectomy	6 (20)
Infection	5 (16.7)
Excess bleeding	2 (6.7)
Threatened ischaemia	1 (3.3)

Acknowledgements

Conflicts of interest

None declared.

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