# Different surgical techniques for lower limb permanent vascular access for hemodialysis

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**Background**
Lower limb vascular access is used as a last option after exhaustion of all options and central venous obstruction of both upper limbs.
**Objectives**
This study describes our experience about the different techniques for lower limb permanent vascular access for hemodialysis.
**Patients and methods**
A prospective study from February 2015 till February 2017 was done on patients with end-stage renal disease with exhausted upper limb vascular access and obstructed central veins who underwent lower limb permanent vascular access for hemodialysis. Different techniques were used according to the patient condition either (a) femoral loop graft by Poly-Tetra-Floro-Ethylene (PTFE) graft, (b) saphenous vein transposition loop fistula, or (c) tunneled femoral vein catheter.
**Results**
During the study period, 64 patients were included, with 24 male and 40 female, having a mean age of 63 years. Twenty-two had tunneled femoral vein catheter, 18 had saphenous vein transposition loop fistula, and 24 had femoral loop synthetic graft. The primary patency rate during the first year after access creation was 67, 89, and 67% for the tunneled catheter, saphenous vein transposition loop fistula, and femoral loop synthetic graft, respectively. The infection rate was 22, 11, and 25% for tunneled catheter, saphenous vein transposition fistula, and femoral loop synthetic graft, respectively.
**Conclusion**
Lower extremities vascular access is a suitable and durable procedure in patients with exhausted upper limb vascular access and obstructed central veins. Different techniques are available that fit each patient according to his/her examination and evaluation.

**Keywords:**
central vein obstruction, lower limb, vascular access

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## Introduction

Hemodialysis is the most commonly used modality of dialysis therapy all over the world. Technical advances and better quality of access care have improved survival of patients on long-term hemodialysis. Long-term use of dialysis access together with associated comorbidities, exhausted conventional access sites, and central venous outflow obstruction from previous catheterization often result in difficulties in creating and maintaining a functioning upper extremity vascular access for a long time [1].

The recent advances of angioaccess techniques in the presence of such difficult circumstances had led to the development of arteriovenous access at different anatomical sites, such as the lower extremity. Similar to upper extremity vascular access options, lower extremity arteriovenous autogenous fistula (transposed great saphenous vein or superficial femoral vein) remains a preferred access over arteriovenous synthetic graft (upper or mid-thigh loop configuration). The use of femoral tunneled catheter as a long-term access should be avoided as far as possible, especially with the availability of newer graft-catheter hybrid devices [2].

Lack of surgical technical skills, patient preferences and convenience, fear of complications, the need for delicate and specific dealing with lower limb access, and some patients having associated comorbidities such as diabetes mellitus, peripheral arterial disease, and morbid obesity are factors that make lower extremity



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permanent dialysis access difficult and an infrequently used option [3].

## Aim

The aim of this study was to evaluate the different techniques of lower limb vascular angioaccess for hemodialysis in terms of patency and incidence of complications.

## Patients and methods

A prospective study was carried out between February 2015 and February 2017, with follow-up till February 2018, on 64 patients presented with end-stage renal disease (ESRD) and exhausted veins of both upper limbs and central venous outflow obstruction in need for vascular access for hemodialysis in outpatient clinic in Menoufia University Hospital & in Minia University. Written informed consent was obtained from all patients to be included in this study, and this study was accepted and approved by ethical committee.

All patients were subjected to the following:

(1) History taking about duration of dialysis, previous vascular access, central venous catheter insertion, and associated comorbidities such as diabetes mellitus, hypertension, ischemic heart disease, and peripheral vascular disease.
(2) Clinical examination to rule out the possibility of upper limb access chance and check both groin and peripheral pedal pulses.
(3) Duplex study was done to evaluate patency of peripheral arterial system, deep venous system patency, and saphenous mapping (patency, size, course, and anatomical variation) of both lower limb.

The patients were then divided into groups for vascular access according to the condition of each one as follows.

Twenty-two patients had absent clinical pedal pulses and duplex proved that they had peripheral arterial atherosclerotic occlusive disease, and these patients had femoral vein tunneled cuffed catheter insertion. Eighteen patients had clinically palpable pedal pulse and good saphenous vein at the thigh, and they underwent transposition saphenous vein loop arteriovenous fistula. The last –24 patients had bad saphenous vein (<2 mm in caliber or thrombophlebitis) but good pedal pulse, and they underwent femoral loop synthetic graft.

### Operative methods

Tunneled cuffed femoral vein catheter was done under local anesthesia with the use of fluoroscopy in the operating theater after preoperative vancomycin antibiotic administration. Femoral vein puncture was done at the groin crease, pass the guide wire, insert the dilator then the pealing sheath. We did puncture of the femoral vein at the groin crease, pass the guide wire then insert the pealing sheath over the dilator. Then we passed the catheter through the pealing sheath under fluoroscopy to be at the beginning of the inferior vena cava. Then the sheath was removed and obtained a good blood flow through both limb of the catheter that was filled with heparin solution.

Catheters of 15.5-Fr jet free flow (medcomb) with variable length from 36 to 55 cm were used. The catheters were used for hemodialysis from the first day of insertion.

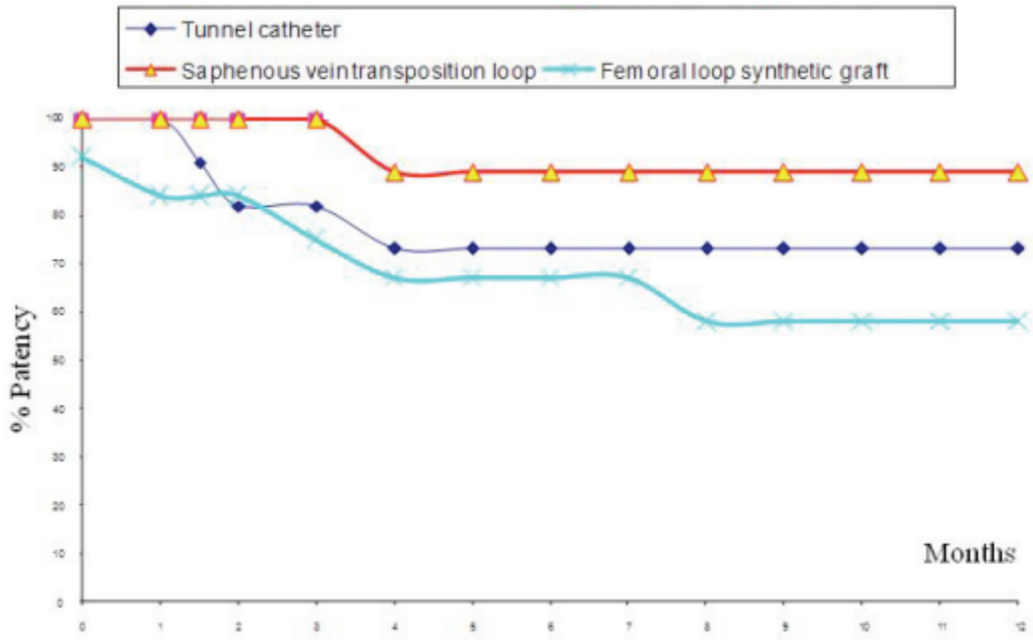
#### *Transposed saphenous vein loop A–V fistula*

The procedure was done under spinal anesthesia. The patients received third-generation cephalosporin prophylactic antibiotic. Transverse groin incision was done over the femoral artery in all patients. The saphenous vein was identified and dissected till lower end of the incision, and another two or three separate incisions were made to dissect and harvest the saphenous vein till knee joint as shown in Fig. 3. The superficial femoral artery was identified and dissected for a sufficient length to allow easy anastomosis. The lower end of the saphenous vein was cut, passed through a subcutaneous loop tunnel after good orientation to avoid kink or twist of the vein and anastomosed with the superficial femoral artery with 6/0 polypropylene as shown in Fig. 4. Hemostasis was maintained, and closure of subcutaneous tissue was done by vicryl 3/0 and skin by prolene 2/0. Postoperative oral antibiotic was given to the patients for 10 days, and stitches were removed 2 weeks after surgery. The thrill was felt in all patients postoperatively, but the distal pedal pulse was not felt immediately postoperatively in one patient but regained the second day. The fistula was used for dialysis 6 weeks after surgery.

#### *Femoral loop synthetic graft A–V fistula*

The procedure was done under spinal anesthesia. The patients received a third-generation cephalosporin prophylactic antibiotic. A transverse groin incision over femoral artery was done. The saphenous vein was identified and its upper end near saphenofemoral junction was dissected as well as superficial femoral artery. A 6-mm Poly-Tetra-Floro-Ethylene (PTFE)

**Figure 1**




Kaplan–Meier survival analysis of lower limb angioaccess for hemodialysis.

**Figure 2**

Anastomosis of the synthetic graft with upper end of great saphenous vein.

synthetic graft was tunneled subcutaneously in the lateral aspect of the thigh through three separate incisions taking care that no kink or twist had occurred and anastomosed with the upper end of saphenous vein by 5/0 polypropylene whereas the other end of the graft was anastomosed to the upper end of superficial femoral artery by 5/0 polypropylene as shown in Figs 2 and 5. Hemostasis was done, and subcutaneous tissue was closed by vicryl 3/0 and skin by 2/0 prolene. The patients received postoperative oral antibiotics for 14 days, and stitches were removed 2 weeks after surgery. The graft was used for dialysis 2 weeks after surgery.

**Figure 3**

Identification and dissection of the great saphenous vein from the groin to the knee.

The thrill and the distal pedal pulse were felt immediately postoperative in all patients.

All patients were followed up at outpatient clinic for wound healing; follow-up of thrill and presence of peripheral pulsation was done for 2 weeks and then for at least 1 year for patency and complications.

Primary patency rate was defined as period from vascular access creation till any malfunction that indicates intervention for its correction. A survival function chart was maintained for all procedures during the first year of follow-up.

## Results

During this study, 64 patients with ESRD, exhausted both upper limb veins and central venous outflow obstruction, had permanent lower limb angioaccess for hemodialysis. Twenty-two patients had tunneled cuffed femoral vein catheter, 18 had transposed saphenous vein loop fistula, and 24 had femoral loop synthetic graft. The mean age of patients was 63 years and ranged from 35 to 84 years. Twenty-four (37.5%) male and 40 (62.5%) female. Moreover, 48 (75%) patients were diabetic, 12 (18.75%) patients had cardiovascular disease, 40 (62.5%) patients were hypertensive and 20 (31.25%) patients had peripheral atherosclerotic ischemic disease, as most of the patients in this study had more than one pathology as shown in Table 1.

Regarding tunneled cuffed femoral vein catheter (22 patients) (Table 2), all catheters were functioning well after insertion with no immediate technical problem. During follow-up period, four (18%) patients developed deep venous thrombosis in the ipsilateral limb, but with no affection of catheter function, which is left in place, and patients received anticoagulant treatment.

Thrombosis of the catheter occurred in six (27%) patients during the first 5 months after insertion. Four cases were managed by streptokinase injection at both catheter limbs whereas the other two catheters were managed by exchange of the catheters over guide wire after failure of thrombolytic therapy.

Four (18%) patients devolved catheter-related infection, two responded to vancomycin injection inside the catheter, whereas the other two catheters were removed after failure of antibiotic injection, and this happened on the ninth month after insertion.

Regarding follow-up of transposed saphenous vein loop fistula (18 patients) (Table 3).

Groin hematoma occurred in two (11%) patients after the operation, which responded to conservative treatment; wound infection occurred in two (11%) patients, which responded to medical treatment; three (16.7%) patients developed puncture site pseudoaneurysm after 4 months of the fistula creation, which was managed by surgical excision of the aneurysm and primary repair of the vein; thrombosis of the fistula occurred in two (11%) patients after 5 months of fistula creation, and thrombectomy was done in one case but failed whereas it was not trialed in the other case owing to late presentation of the patient; and no (0%) patients developed steal syndrome.

**Figure 4**

Subcutaneous tunneling of the great saphenous vein in the thigh.

**Table 1 Patients characteristics and associated comorbidities**

| Characteristics | *N* |
|---|---|
| Total patients | 64 |
| Sex, male | 24 |
| Age [mean (range)] (years) | 63 (35–84) |
| Associated comorbidities | |
| Diabetes mellitus | 48 |
| Hypertension | 40 |
| Cardiovascular disease | 12 |
| Peripheral ischemic disease | 20 |

**Table 2 Follow-up of tunneled cuffed femoral catheter (22 patients)**

| | |
|---|---|
| Number of patients | 22 (100) |
| DVT | 4 (18) |
| Obstruction | 6 (27) |
| Infection | 4 (18) |

DVT, deep venous thrombosis. Values are presented as *n* (%).

**Table 3 Follow-up of saphenous vein loop fistula (18 patients)**

| | |
|---|---|
| Number of patients | 18 (100) |
| Groin hematoma | 3 (16.7) |
| Groin wound infection | 2 (11) |
| Puncture site pseudoaneurysm | 3 (16.7) |
| Thrombosis | 2 (11) |
| Steal syndrome | 0 (0) |

Values are presented as *n* (%).

**Table 4 Follow-up of femoral loop synthetic graft (24 patients)**

| | |
|---|---|
| Number of patients | 24 (100) |
| Groin wound infection | 6 (25) |
| Graft thrombosis | 8 (33) |
| Steal syndrome | 2 (8) |

Values are presented as *n* (%).

Regarding the follow-up of femoral loop synthetic graft (24 patients) (Table 4), six (25%) patients had groin infection, four responded to medical treatment and two were removed after failure of medical treatment 7 months after fistula creation. Steal syndrome developed in two (8%) patients which necessitated ligation of the graft. Graft thrombosis occurred in eight (33%) patients during the first 8 months after fistula creation. Two cases were managed by graft thrombectomy alone, two cases by graft thrombectomy and balloon angioplasty at the graft venous anastomotic site, one by vein patch angioplasty of the graft venous anastomotic stenosis, whereas the graft thrombectomy had failed in the last case (Fig. 1).

## Discussion

Patients with ESRD on hemodialysis require permanent vascular access that delivers an efficient blood flow rate for hemodialysis, has a superior patency rate and a low complication rate. The recent expansion of renal replacement therapy has been associated with an increase in the number and complexity of patients requiring permanent vascular access [4].

Owing to the long-term survival of patients on dialysis that may extend for many years, the high cost and delay in renal transplantation, the treatment of such patients may depend primarily on the availability of long-term functioning vascular access [5,6].

The distal radio cephalic arteriovenous fistula at wrist of the nondominant upper extremity is the gold standard venous access for patients who require long-term hemodialysis. When the distal forearm veins are exhausted or unsuitable, arteriovenous fistula can be performed more proximally in the upper extremity in the elbow region or in the upper arm using cephalic or basilic veins [7].

After exhausting the aforementioned options in both upper extremities, synthetic graft is used in the upper extremity. In case of primarily unsuitable or secondarily surgically exhausted arm sites, lower limb arteriovenous fistula, either autogenous (transposed saphenous or superficial vein) or as a bridge synthetic (PTFE) graft in the thigh between the femoral artery and saphenous vein, can be performed [7].

**Figure 5**

Subcutaneous tunneling of the synthetic graft in the thigh.

Our study was done to evaluate the result of the different surgical techniques of lower limb vascular angioaccess for hemodialysis at our department. Regarding tunneled cuffed femoral vein catheter, four (18%) patients had developed Deep Venous Thrombosis (DVT), which is better than that reported by Maya and Allon [8] who had 26% of DVT. This difference may be owing to the routine duplex ultrasound follow-up examination for all patients with tunneled femoral catheter in the study by Maya and Allon [8], but in our study, we did duplex to patients with clinical suspension of DVT only, so there may be missed cases of undiagnosed DVT. We agreed with Maya and Allon [8] in that the catheters were not removed and left in place in spite of DVT and the patient received anticoagulant treatment for DVT, as DVT did not affect its function.

Falk [9] reported in their study on lower limb femoral permanent catheter, the incidence of 30% thrombosis during the first 6 months of insertion compared with 27% thrombosis during the first 5 months in our study, which is nearly similar. In our study, the catheter-related infection was 18% compared with 10% in the study by Falk [9]. This higher rate of infection may be owing to septic conditions during dialysis at our dialysis centers and bad personal hygiene.

For saphenous loop fistula, in our study, two (11%) patients developed thrombosis compared with 25% thrombosis in the study by Moussavi and Tofigh [10]. This may be owing to longer duration of follow-up of 3 years in their study compared with 1 year in our study.

For prosthetic thigh Arterio-Venous (AV) access, the studies differ dramatically in the outcome and results. Some suggest that thigh prosthetic 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 syndrome [5].

The study did by Freedman *et al.* [11] on 43 patients over a 10-year period showed that median synthetic graft survival time was 28 months, and 63% remained functional at the end of the study or until death from unrelated causes. It showed that the presence of comorbidities, like diabetes, hypertension, or prior surgical access revisions, did not affect shunt survival time and that lower extremity vascular access provides a reasonable option when upper extremity access sites are unavailable [11].

In our study, the graft primary patency rate at 1 year was 67% compared with 71% 1-year primary patency rate in the study by Tashjian *et al.* [5] on 37 patients using prosthetic thigh graft between 1990 and 1998. The infection rate was 22% in the study by Tashjian *et al.* [5], which is nearly similar to our study at 25%.

In the study by Taylor and Eaves [12] on lower limb synthetic grafts, the infection rate was 18% and distal limb ischemia was 16%.

In our study, we did the loop graft in the upper thigh between superficial femoral artery and great saphenous vein near saphenofemoral junction, but Scott *et al.* [13] described a modified technique that was loop mid-thigh Arterio-Venous Graft (AVG) as a variation of thigh AVG. It was created by anastomosing the PTFE loop to the mid superficial femoral artery and vein, preserving the proximal femoral vessels for future graft revision. It avoids the lymph node-bearing tissue and cannulation of the groin and provides easy access for cannulation away from the groin, so lowers the risk of infection. The 1-year primary patency rate in their study was 75%, which is better than the patency in our study (67%). Moreover, the rate of infection in their study was 10%, which was much lower than the infection rate in our study (25%). These results denoted that a mid-thigh loop is superior to upper thigh loop graft in terms of patency, survival time, and infection rate and should be considered before placement of upper thigh loop AVG [13].

Our total primary patency rate for the 64 patients was 71%, and infection rate was 18%.

## Conclusion

Lower extremity vascular access can be used as an alternative access site in patients with unsuitable or surgically exhausted sites for upper extremity access creation. Our study has shown that it has acceptable results with fair primary patency rate and acceptable range of complications. Different surgical techniques are available that can fit every patient condition, according to their condition. Large number of patients and longer period of follow-up are needed for better evaluation and recommendation.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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