Long-term results of femoral vein transposition for autogenous arteriovenous hemodialysis access

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Introduction: **When all access options in the upper limbs have been exhausted, an autogenous access in lower limb is a valuable alternative to arteriovenous grafts. We report our experience of transposition of the femoral vein (tFV).**
Methods: **From June 1984 to June 2011, 70 patients underwent 72 tFV in two centers (Paris and Meknès) with the same technique. All patients had exhausted upper arm veins or had central vein obstructions. Patients were followed by serial duplex scanning. All complications were recorded and statistical analysis of patency was performed according to intention to treat using the life-table method.**
Results: **The mean interval between initiation of dialysis and creation of the tFV was 10 years. The sex ratio was even (one female/one male). Mean age was 48 years (range, 1-84 years), and there were no postoperative infections. Duplex measurements in 33 patients indicated high-flow: mean = 1529 ± 429 mL/min; range, 700-3000 mL/min. Two immediate failures were observed and four patients were lost to follow-up soon after the access creation. Ten patients (14%) experienced minor complications (hematoma, five; lymphocele, one; delayed wound healing, two; distal edema, two) and 30 patients (42%) experienced mild complications (femoral vein and outflow stenosis, 16 [treated by percutaneous transluminal angioplasty, 13, or polytetrafluoroethylene patch, three]; puncture site complications, three [ischemia, two; infection, one]; reversible thrombosis, three [two surgical and one percutaneous thrombectomy]; abandoned thrombosis, eight [11%] after a mean patency of 8.1 years). Thirteen patients (18%) experienced major complications necessitating fistula ligation (ischemic complications, five diabetic patients with peripheral arterial occlusive disease [one major amputation included]; lower leg compartment syndrome, one; acute venous hypertension, two; secondary major edema, two; high-output cardiac failure, one; bleeding, two). All the patent accesses (59/72) were utilized for dialysis after a mean interval of 2 ± 1 months (range, 1-7 months) resulting in an 82% success rate. According to life-table analysis, the primary patency rates at 1 and 9 years were 91% ± 4% and 45% ± 11%, respectively. The secondary patency rates at 1 and 9 years were 84% ± 5% and 56% ± 9%, respectively.**
Conclusions: **Femoral vein transposition in the lower limb is a valuable alternative to arteriovenous grafts in terms of infection and long-term patency. Secondary venous percutaneous angioplasties may be necessary. High flow rates are frequently observed and patient selection is essential to avoid ischemic complications. (J Vasc Surg 2012;56:440-5.)**

Lower limb hemodialysis accesses may be necessary when upper limb veins are thrombosed. Few reports of autogenous arteriovenous angioaccess in the thigh have been published. The few reports on saphenous vein superficialization demonstrate poor results.[1] Some authors have described promising results with transposition of the femoral vein (previously named superficial femoral vein), emphasizing the possible superiority of this autogenous access over grafts in the lower limbs that are prone to infection and venous anastomosis stenosis.[2-7] We report our results with 72 femoral transpositions and discuss the importance of patient selection to avoid ischemic complications.

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METHODS

This is a retrospective analysis of 70 patients who had arteriovenous fistula (AVF) constructed in the lower limbs with autologous transposition of the femoral vein (tFV) (n = 72) from June 1984 to June 2011.

Upper limb AVF and arteriovenous graft (AVG) access possibilities had been exhausted in all patients, due to lack of suitable upper arm veins and/or to proximal and central vein occlusion. Autogenous tFV was our first option, and the femoral vein was preferred to the small-caliber saphenous vein.

Major lower limb arterial occlusive disease and vein stenosis were ruled out after clinical examination and duplex scan investigation of the anatomic and hemodynamic patterns of lower limb veins and arteries. Anatomic variations in the femoral vein were assessed, as well as patency of the great saphenous vein and possible sequelae of previous deep venous thrombosis, femoral vein catheter, or kidney transplant.[8] The ankle-brachial index (ABI) was calculated and categorized as normal (0.91-1.39), low (≤0.90), very low (≤0.70), or very high (≥1.40): patients with ABI under 0.6 were considered to be at risk for induced ischemia.

After the first six procedures (P.B.), which were two-staged, the following one-stage surgical technique was used

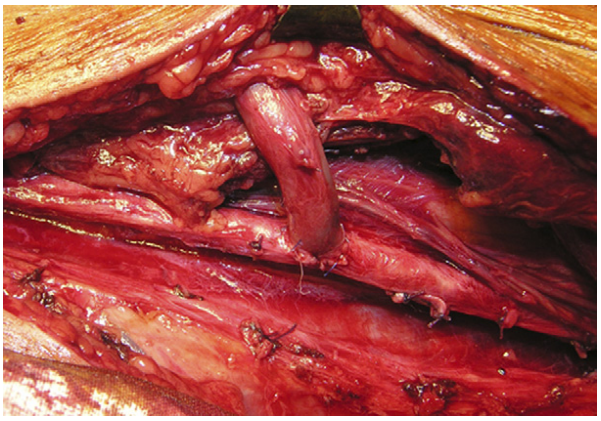


Fig 1. Operative view: femoral artery-femoral vein side-to-end anastomosis.

by all three surgeons: longitudinal incision from the inguinal crease to the knee, mobilization of the femoral vein from the adductor hiatus up to its junction with the deep femoral vein, transposition of the vein in a straight subcutaneous tunnel over the anterior thigh, lateral to the skin incision, and construction of a direct side-to-end anastomosis to the distal superficial femoral artery (Fig 1). Harvesting the femoral vein may be time-consuming when there are many tributaries. The vein was sutured directly onto the superficial femoral artery, without any attempt to enlarge the anastomosis. No tapering or banding of the vein was performed. Postoperative distal edema was avoided by transient or prolonged application of compression stockings at levels of pressure ranging from 20 to 40 mm Hg, as used after varicose vein surgery. An antibiotic (second-generation cephalosporin) was systematically injected preoperatively. Prophylactic anticoagulation with low-dose subcutaneous heparin was used throughout the first 2 postoperative weeks.

The postoperative (2 weeks) result was checked by the surgeon by clinical and duplex examination. Success was defined by availability of the fistula for dialysis sessions and the first puncture was authorized after 1 month.

Long-term surveillance was undertaken by the nephrologist in charge of the patient.

Duplex scans were performed at various intervals in all patients to identify stenosis of the feeding artery or of the veins. Peak systolic velocity (PSV) in the area of main color flow disturbance recorded on spectral analysis over three times the peak systolic velocity of a nearby normal segment (PSV ratio >3) was used to define stenosis >50%.

Access flow rates were calculated in the feeding artery by measuring the time-averaged velocity (TAV) from the Doppler scan and applying the formula: volume flow (mL/mm) = TAV (cm/s) × cross-section (cm^2).

Follow-up was continued until September 2011. The results of the 72 access creations are reported on an intent-to-treat basis, as initial failures were included in the final calculation of cumulative patency rates.

Patency rates after tFV were calculated according to the life-table method, in agreement with the recommended reporting standards of the Society for Vascular Surgery.[2] All statistical analyses were performed using SPSS Statistics 17.0 (SPSS Inc, Chicago, Ill). Primary patency was defined as the interval from the time of access placement to any intervention designed to maintain or re-establish patency, or to access thrombosis or the time of measurement of patency. Secondary patency was defined as the interval from the time of access placement to access abandonment or time of measurement of patency, including intervening manipulations (surgical or endovascular interventions) designed to re-establish access patency.

RESULTS

Seventy patients underwent transposition of the superficial femoral vein to create an autogenous arteriovenous hemodialysis access from June 1984 to June 2011. Two patients had bilateral procedures. All patients had exhausted upper arm veins or had central vein obstructions. The mean interval between initiation of dialysis and creation of the tFV was 10 years. The sex ratio was one female/one male, and the mean age was 48 years (range, 1-84 years). Prior to tFV construction, 13 patients had received their first kidney transplant, three a second transplant, and one a third transplant. After tFV, one patient received his first kidney transplant, five a second transplant, and three a third transplant.

Technical success was achieved in 97% of patients. Immediate failure was observed in two patients when two-stage procedures were used in the early part of our experience. At the second stage, the "normal" vein proved to be too short for transposition due to major juxta-anastomosis intimal hyperplasia and perivenous fibrosis, related to construction of the previous fistula. Four patients were rapidly lost to follow-up, and early major complications (ie, five cases of acute distal ischemia and one of compartment syndrome) were treated by fistula ligation. Finally, all the patent accesses (59/72) were utilized for dialysis after a mean interval of 2 ± 1 months (range, 1-7 months) resulting in an 82% success rate.

Duplex ultrasound evaluation of flow rate during follow-up in 33 patients revealed high values, compared with upper limb fistulas, mean value being 1529 ± 429 mL/min (range, 700-3000 mL/min).

The complications are summarized in the Table: 10 patients (14%) experienced minor complications requiring minor procedures, 30 patients (42%) had mild complications mostly treated by percutaneous transluminal angioplasty (PTA), and 13 patients (18%) had major complications necessitating fistula ligation.

Two cases of delayed wound healing associated with incision skin necrosis were successfully treated by debridement with fistula preservation. One lymphocele and five hematomas required surgical drainage. Acute distal ischemia occurred postoperatively in five patients. The first patient had diabetes associated with lower limb occlusive arterial disease: despite fistula ligation, below-knee ampu-

Table. Complications

	Number of complications	*Complications percentages/72 tFV*	*Treatment*
Minor complications			
Hematoma	5	0.07	Drainage
Delayed wound healing	2	0.03	Debridement
Lymphocele	1	0.01	Drainage
Distal edema	2	0.03	Conservative
Total	10	0.14	
Mild complications			
Femoral vein and outflow stenosis	16	0.22	PTA, 13 PTFE patch, 3
Puncture site skin ischemia	2	0.03	Aneurysmorrhaphy + flap + PTA, 2
Puncture site skin infection	1	0.01	PTFE derivation
Reversible thrombosis	3	0.04	Surgery, 2 Percutaneous thrombectomy, 1
Abandoned thrombosis	8	0.11	
Total	30	0.42	
Major complications			
Acute distal ischemia	5	0.07	Fistula ligation, 4 + below-knee amputation, 1
Acute venous hypertension	2	0.03	Fistula ligation
Lower leg compartment syndrome	1	0.01	Fistula ligation + fasciotomies
Bleeding	2	0.03	Fistula ligation
Major edema	2	0.03	Fistula ligation
High-output heart failure	1	0.01	Fistula ligation
Total	13	0.18	

PTA, Percutaneous transluminal angioplasty; *PTFE*, polytetrafluoroethylene; *tFV*, transposition of the femoral vein.

tation was necessary. The four remaining patients, who were also diabetic, had total regression of symptoms after early fistula ligation. One case of acute lower leg compartment syndrome related to distal venous hypertension occurred immediately after tFV and required leg fasciotomies combined with fistula ligation, resulting in lower limb preservation with acceptable function. Postoperative leg edema was observed in four other patients, two of whom had early mild edema that was treated conservatively. Two had late (2 and 8 months postoperatively) major edema associated with calf skin ulceration related to outflow stenosis and were treated by fistula ligation. Secondary stenosis of the superficialized femoral vein and of outflow iliac veins occurred and was successfully treated by PTA in 13 patients in Paris (Fig 2) and by polytetrafluoroethylene (PTFE) patch angioplasty in three patients in Meknès. Three thromboses were successfully treated by surgical (two cases) and percutaneous (one case) thrombectomy. Thrombosis was considered permanent in eight patients after a mean patency of 8.1 years. Aneurysmal degeneration of the superficialized femoral vein was observed in four patients, resulting in skin necrosis at puncture sites: it was successfully treated by skin flap combined with aneurysmorrhaphy in association with PTA for treatment of outflow stenosis in two patients and by emergency ligation for massive bleeding in two. No postoperative infection was observed. One infection at the puncture site required antibiotics, drainage, and PTFE derivation. Finally, fistula ligation was necessary in one patient who developed high-output heart failure 9.6 years after tFV creation.

Primary patency rates at 1 and 9 years were 91% ± 4% and 45% ± 11%, respectively. Secondary patency rates at 2 and 9 years were 84% ± 5% and 56% ± 9%, respectively (Fig 3).

DISCUSSION

When an upper limb autogenous arteriovenous hemodialysis access is no longer possible, PTFE grafts in the body wall or lower limb are usually considered. Peritoneal dialysis or kidney transplantation can be an alternative. For most authors, lower limb PTFE grafts are the first option.[9-11] However, prosthetic grafts are frequently complicated by infection and venous anastomosis stenosis. The use of the saphenous vein has been advocated, but it is rarely used for angioaccess due to its usually small caliber, lack of dilation, and poor patency.[1,12] Transposition of the femoral vein has seemed to us the best option since 1984.

The first two reports concerning tFV were published in 2000, one by Huber (one patient) and one by Jackson (two patients).[3,4] The latter pointed out that flow rates were substantially higher (2000 mL/min) than those generally observed in upper-arm grafts, but congestive heart failure did not develop in either patient. Moreover, the risk of steal complications had been minimized by careful selection after ruling out pronounced lower-limb occlusive arterial disease.

Hazinedaroğlu reported 15 patients, five of whom had wound infections necessitating wound drainage in five and requiring amputation in one, with 87% 1-year primary patency.[7] Scollay also reported 15 patients (including three

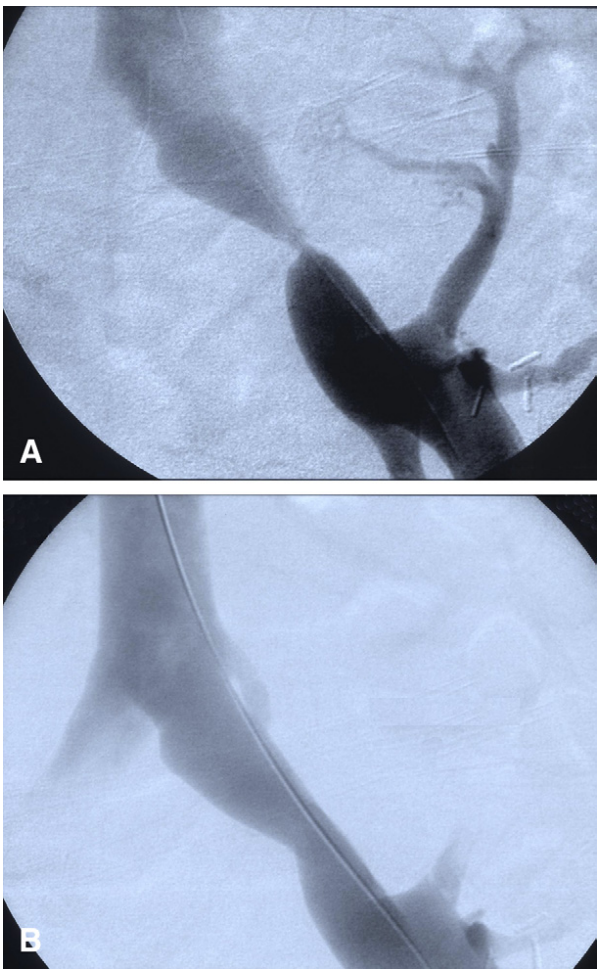


Fig 2. Secondary stenosis of outflow iliac veins, before **(A)** and after **(B)** percutaneous transluminal angioplasty.

transfers to the upper arm), 11 of whom had wound complications (three requiring application of a vacuum dressing) and two of whom had postoperative lower limb ischemia with amputation.[13] Our report compares favorably with these two recent publications for higher patient numbers, with a lower rate of wound complications and longer follow-up duration.

In their first publication, Gradman et al reported a high incidence of ischemic limb complications among 25 tFV patients (seven had composite PTFE-femoral vein fistulas).[5] Primary and secondary patency rates at 1 year were 73% and 86%, respectively. In their second report involving 22 new patients, the incidence of ischemic complications declined to zero, and this was attributed by the author to improved selection of patients by excluding individuals with significant occlusive arterial disease and to selective performance of femoral vein tapering.[6] The secondary patency rate at 2 years was 94%, and no infection occurred. Surprisingly, no flow measurements were reported in either publication.

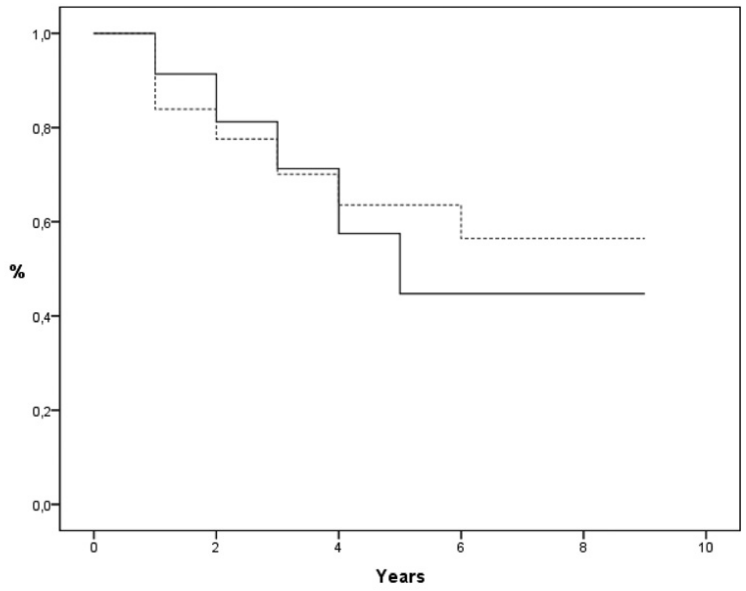
Our first experience with tFV involved an 8-year-old boy who had started hemodialysis at the age of 18 months. He had bilateral central vein occlusion, and the transplanted kidney was failing after 2 years. The surgical procedure was performed in two stages, as was usual for basilic vein superficialization in the upper arm: it remained patent for the next 7 years. A few years later, in view of the larger size of the femoral vessels compared with the brachial vessels, we moved to a one-stage procedure.

In contrast to the risks of infection after thigh PTFE grafts, which result in loss of the access for 18% of the patients, the rarity of infection after tFV, already noted by Gradman and confirmed by our series, is remarkable.[1,13,14] However, although no infection leading to access or limb loss was noted in our series, minor infection may have been missed in the eight abandoned thrombosis cases or in the two cases presenting with massive bleeding.

As emphasized by Sidawy et al, venous obstructive complications, ranging from mild distal edema to compartment syndrome, are minimized when harvesting of the vein is limited to the anatomic segment proximal to the popliteal vein.[2] On the other hand, the incidence of late secondary venous outflow stenosis after tFV, necessitating PTA or PTFE-patch angioplasty to prevent thrombosis, must not be underestimated. Such stenoses are probably related to trauma to the venous intima induced by excessive and turbulent flow.

Distal ischemic complications, related to high-flow combined with distal arterial disease, plagued our initial experience with tFV. The need for ligation of the fistula in several cases and one amputation in a 50-year-old diabetic woman prompted us to limit our indications: we currently exclude diabetic patients and patients with significant peripheral arterial occlusive disease, diagnosed by palpation of distal pulses and duplex ultrasound evaluation, and ABIs. No conclusion about a specific ABI value under which tFV is contraindicated can be drawn from our study, as it is retrospective and nonrandomized. However, our findings are similar to Gradman's change in indications between his first and his second reports. As a consequence, among patients referred for difficult angioaccesses who frequently lived far away, selection progressively favored younger patients in good general condition.

The risk of congestive heart failure is another drawback of high-flow tFV. One case of cardiac failure occurred, and fistula ligation was necessary after 9 years' patency, as it would have been excessively difficult to achieve a reduction in flow. During selection for tFV, patients at risk of high-output cardiac failure must be ruled out. Echocardiographic surveillance is necessary in high-flow patients. However, prevention of high flow is difficult, as arteriovenous fistula flow mostly depends on the diameter of the inflow artery, as demonstrated by Wixon.[14] The efficacy of venous tapering for prevention of high flow and distal ischemia was suggested by Gradman in his second publication, but his patient selection was also modified following publication of his "princeps" report.[5] Finally, our negative experience with banding and the fear that a too small



	Number of patients at risk			
Years	1	3	6	9
Primary patency	58	24	3	1
Secondary patency	62	31	9	4

Fig 3. Primary (*solid line*) and secondary (*dashed line*) patency rates after transposition of the femoral vein (n = *72*) according to the life-table method, and numbers of patients at risk.

anastomosis would subsequently be complicated by intimal hyperplasia and thrombosis led us to avoid tapering.[15]

The primary (91%) and secondary (84%) patency rates observed 1 year after tFV compare favorably with the mean 1-year primary (48%) and secondary (69%) patency rates after creation of thigh arteriovenous accesses reported by Antoniou et al in their review.[1] Finally, this is the first publication reporting long-term results of tFV, which may be considered excellent in the long term with primary and secondary patency rates after 9 years of 45% and 56%, respectively.

We emphasize that this was a retrospective, nonrandomized study with a strong degree of selection bias. Some patients were lost to follow-up, a certain number soon after access creation. Although all accesses were created using the same surgical technique, the long-term surveillance was undertaken by different nephrologists and minor or slight complications may have been overlooked. Moreover, thrombosis might in some cases have been wrongly considered to be permanent, and the number of patients at risk after 6 years is low.

CONCLUSIONS

Our report supports the use of a transposed femoral vein at the thigh as an alternative to arteriovenous bypass grafts, because it is an autogenous arteriovenous hemodialysis access with a low risk of infection and reasonable long-term patency. High-flow may occur, with the risk of distal ischemia and cardiac failure, and careful selection of patients is therefore essential.

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AUTHOR CONTRIBUTIONS

Conception and design: PB, MR, OVL, GF
Analysis and interpretation: PB, MR, OVL, GF
Data collection: PB, MR, OVL, GF
Writing the article: PB, MR, OVL, GF
Critical revision of the article: PB, MR, OVL, GF
Final approval of the article: PB, MR, OVL, GF
Statistical analysis: PB
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Overall responsibility: PB

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