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Comparing the outcomes of femoral vein transposition versus lower extremity arteriovenous graft in dialysis patients with exhausted upper extremity access

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Introduction: Finding suitable vascular access for dialysis is a significant challenge in advanced kidney failure. Patients with end-stage renal disease (ESRD) need urgent lower extremity vascular access. This study compares the outcomes of Femoral vein transposition (FVT) and Arterovenous Grafts (AVG) in patients without viable upper limb access, in alignment with KDOQI guidelines and individualized Life Plan strategies.

Materials and Methods: A retrospective study involving 52 patients with end-stage renal disease (ESRD) and no suitable upper extremity access, including those with suitable femoral veins or adequate lower extremity vasculature, analyzed either FVT ($n = 26$) or lower extremity AVG ($n = 26$) over a one-year period. The procedure involved freeing the femoral vein, transferring it to a subcutaneous tunnel in the thigh, and connecting it to the femoral artery. Outcomes measured were success rate, complications, and primary and secondary patency rates over nine months.

Results: In our study, 26 patients were evaluated, comprising 14 (53.8 %) males and 12 (46.2 %) females. The mean age of the patients was 60.32 years. At the 9-month follow-up, successful dialysis was achieved in 92.3 % of FVT cases compared to 53.8 % of AVG cases ($p = 0.001$). Primary patency was significantly higher in FVT (84.6 %) than AVG (50 %) ($p = 0.01$). Notably, no thrombosis or infection occurred in FVT patients, whereas the AVG group experienced 26.9 % thrombosis and 11.5 % infection. Wound healing complications were more frequent in the FVT group (42.3 % vs. 15.4 %, $p = 0.032$), though all resolved with conservative

Discussion: The FVT procedure has shown a high success rate and low complication rate, making it a viable option for patients lacking upper extremity vascular access. However, its complexity and limited familiarity among practitioners have hindered broader adoption. Our findings confirm that with proper training, FVT can significantly benefit patients with advanced chronic kidney disease (CKD) who need reliable dialysis access, highlighting its potential to the medical community.

Conclusion: Our study demonstrated that AVG remains a viable option when FVT is contraindicated. FVT is a low-complication and reliable method for establishing dialysis access in patients with no upper extremity vascular access.

Introduction

CKD is a progressive condition that can lead to ESRD, which may necessitate renal replacement therapies like hemodialysis. Vascular access is a critical component of hemodialysis care, and AVFs in the upper extremity are generally considered the gold standard due to their superior patency and lower infection rates compared to grafts or catheters.[1]

Patients may exhaust upper extremity options due to thrombosis, stenosis, or central venous occlusion, necessitating alternative access

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strategies in cases of repeated attempts.[2,3] The Kidney Disease Outcomes Quality Initiative (KDOQI) 2019 guidelines emphasize a "Life Plan" approach, recommending individualized vascular access strategies that account for a patient's lifetime dialysis needs, anatomy, comorbidities, and expected duration of dialysis therapy.[4] Lower extremity options such as FVT or AVG become necessary for patients with no viable upper limb access.[5]

FVT and lower extremity AVGs are established alternatives for patients with exhausted upper extremity access options.[6] FVT involves mobilizing and subcutaneously transposing the femoral vein to create an autogenous fistula, offering potentially superior long-term patency and lower infection risk, though it is technically demanding and underutilized due to concerns about wound complications and ischemia.[7-10] AVGs, in contrast, use synthetic grafts and are more widely employed but are associated with higher rates of infection and thrombosis.[11-13] Both techniques present unique advantages and risks, and patient-specific anatomical and clinical considerations must guide the choice.[14]

Recent studies have demonstrated encouraging results for FVT, particularly in patients with central venous occlusion who are no longer candidates for upper extremity access.[8,9] Despite this, limited comparative data exist directly evaluating the outcomes of FVT and AVG in the lower extremity.

This study evaluates FVT and lower extremity AVGs in ESRD patients without upper extremity access, aiming to understand these alternative vascular access options better and inform clinical decision-making by assessing success rates, complications, and patency.

Materials and methods

This retrospective cross-sectional study was conducted over one year at a tertiary vascular surgery center. It included patients with ESRD who required long-term hemodialysis and had no remaining upper extremity access options due to prior access failure or complications, such as superior vena cava (SVC) syndrome. The aim was to compare clinical outcomes between patients undergoing FVT and those receiving lower extremity AVG.

Inclusion criteria

Patients were included in this study if they had exhausted upper extremity vascular access options, defined by either a history of access placement in both arms with no remaining suitable site due to prior complications or the presence of SVC obstruction confirmed during access planning. At least one of these two criteria was required for inclusion.

Exclusion criteria

Exclusion criteria were established to ensure both anatomical feasibility and patient safety. Patients were excluded if they had the possibility for persistent upper extremity access, severe lower extremity atherosclerosis verified by duplex ultrasonography or angiography, an ankle-brachial index (ABI) below 0.85, or absent or markedly decreased lower extremity pulses. Supplementary exclusion criteria encompassed verified inferior vena cava (IVC) or iliac vein obstruction via venography, a history of previous surgical or radiotherapeutic interventions to the thigh, current or past intravenous drug use, central obesity characterized by a prominent overhanging abdomen, left ventricular ejection fraction below 20 %, prior excision of the great saphenous vein, or a femoral vein diameter <6 mm as determined by preoperative Doppler ultrasonography. These criteria were established to guarantee suitable patient selection for lower extremity access and to reduce the likelihood of access-related problems.

Preoperative evaluation

Patients with ESRD who cannot access the upper limb due to superior vena cava syndrome or previous access complications were evaluated for femoral vein transposition. A thorough examination was conducted for central venous obstruction, chronic arterial disease, and exclusion criteria. Patients underwent arterial and venous ultrasounds, aortography, lower limb angiography, venography of femoral and iliac veins, and IVC. Patients with a femoral vein diameter <6 mm were excluded. The right mid-thigh area was chosen as the patient's leg, and the left leg was used for FVT if the right side was unsuitable.

Surgical technique

The procedure was conducted on patients under general anesthesia and prophylactic antibiotics. The patient was positioned in a V configuration, and the surgeon situated themself between the patient's legs (Fig. 1). Following the identification of the deep femoral vein separation by ultrasound, a longitudinal incision was executed on the medial and anterior thigh to investigate the femoral vein. The deep femoral vein was retained, while the other branches were ligated and excised. The sartorius muscle was retracted laterally, medially, and inferiorly to enhance visibility. The superficial femoral artery was dissected and managed, maintaining all branches. The popliteal vein was occluded and severed, and the distal end was secured with a Prolene suture. The vein was entirely liberated. The liberated femoral vein was traversed via a subcutaneous tunnel and anastomosed to the femoral artery in the mid-thigh region. If the vein's diameter is enlarged, the anastomosis is constricted to around 5 mm. The process was completed with the assessment of the distal pulse and indications of acute ischemia (Fig. 2-Fig. 3).

Postoperative care and follow-up

Patients on oral antibiotic therapy are released one to two days post-procedure. They are observed for wound healing, indications of ischemia, limb edema, and fistula functionality during routine follow-up appointments. Two to three months after the fistula placement and wound healing, patients can use the access and are followed up for complications and dialysis methods at three-month intervals. Patients who do not satisfy the criteria for FVT or have had AVG in the lower extremities during the preceding two years have their characteristics

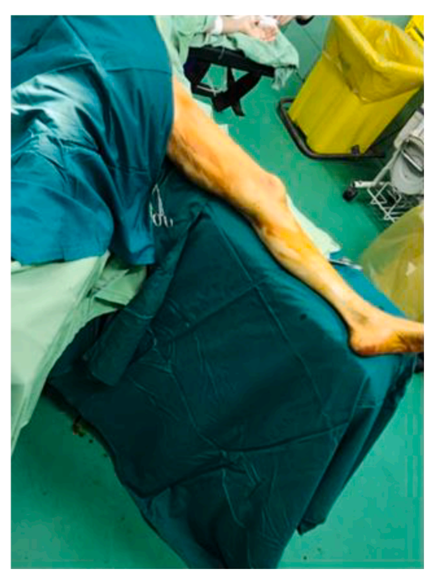

Fig. 1. positioned in a V-configuration for FVT with the surgeon standing between the patient's legs.

Fig. 2. Simultaneous exploration and control of the superficial femoral artery without mobilization, preserving all branches.

Fig. 3. send the liberated femoral vein through an appropriate subcutaneous tunnel and, after injecting heparin end-to-side, we anastomose it to the femoral artery in the mid-thigh.

and outcomes documented and compiled.

Data collection and statistical analysis

Patient data were collected retrospectively from hospital records and follow-up visits. Variables included demographics, comorbidities (diabetes and hypertension), history of vascular access procedures, surgical outcomes, complications (infection, thrombosis, and wound issues), and patency rates.

Statistical analysis was performed using SPSS v22.0. The study was conducted following the Declaration of Helsinki and was approved by the Ethics Committee of Guilan, as per the Local Ethical Committee of Guilan University of Medical Sciences, Rasht, Iran (Approval No: IR.GUMS.REC.1401.540). Informed consent was obtained from all patients.

Results

A total of 52 patients with ESRD and no viable upper extremity access underwent lower extremity vascular access creation: 26 with FVT and 26 with AVG placement. Among patients undergoing FVT, 14 were male and 12 were female. In the AVG group, 20 patients were male and 6 were female. There was no statistically significant difference in gender distribution between the two groups (Pearson Chi-Square, $p = 0.080$)

Table 1
Gender distribution and comparison of patients in the study.

Main Variable	Gender			P-value
	Female	Male	Total	
FVT	12 (46.2 %)	14 (53.8 %)	26 (100 %)	0.080
AVG	6 (23.1 %)	20 (76.9 %)	26 (100 %)	
Total	18 (34.6 %)	34 (65.4 %)	52	–

(Table 1). The average age in the FVT group was 60.50 ± 12.01 years, while in the AVG group, it was 60.15 ± 10.73 years. The groups had no significant age difference (Mann–Whitney U test, $p = 0.776$). Importantly, 75 % of patients in the FVT group were over 55 years old (Table 2). Furthermore, no statistically significant difference in BMI was noted between the groups (Mann–Whitney U test, $p = 0.318$). Additionally, the two groups had no significant difference in mean ejection fraction (FVT: 48.84 ± 7.39 % vs. AVG: 45.96 ± 6.16 %; $p = 0.099$) (Table 2).

In the FVT group, 12 patients (46.2 %) had diabetes, while 11 patients (42.3 %) in the AVG group were affected, showing no statistically significant difference (Chi-square test, $p = 0.78$). Hypertension was noted in 80.8 % of patients in the FVT group and in all patients (100 %) in the AVG group, revealing no statistical significance (Fisher's exact test, $p = 0.51$).

History of prior vascular access and associated complications

There was no significant difference in the frequency of previous vascular accesses between the two groups. Prior AVF had been attempted in 76.9 % of patients in the FVT group and 80.8 % in the AVG group. Prior AVG had been used in 46.2 % of FVT patients and 76.9 % of those in the AVG group.

The primary cause of failure in previous fistulas was thrombosis in both groups, with rates of 90 % in the FVT group and 90.5 % in the AVG group ($P = 1.0$, Fisher's exact test). Similarly, thrombosis was the most common reason for previous AVG failure in both groups, followed by infection. There was no statistically significant difference between the groups in terms of failure causes ($P = 1.0$).

All patients in both groups had a history of percutaneous placement. SVCS was present in 100 % of patients undergoing FVT and in 92.3 % of those in the AVG group ($P = 0.49$).

Table 2
Age and BMI and EF.

Variable		Age				P-value
		$\overline{X} \pm$ S.D	Median (IQR)	Min	Max	
FVT	$n =$ 26	60.50 ± 12.01	62 (55.75, 67)	24	81	0.776
AVG	$n =$ 26	60.15 ± 10.73	61 (55, 69)	35	75	
Total	$n =$ 52	60.32 ± 11.27	62 (55.25, 68.75)	24	81	–
		BMI				
		$\overline{X} \pm$ S.D	Median (IQR)	Min	Max	
FVT	$n =$ 26	26.31 ± 3.99	26.21 (22.90, 29.83)	17.58	32.32	0.318
AVG	$n =$ 26	25.37 ± 3.37	25.39 (22.80, 27.39)	16.41	31.22	
Total	$n =$ 52	25.84 ± 3.69	62 (55.25, 68.75)	16.41	32.32	–
		EF				
		$\overline{X} \pm$ S.D	Median (IQR)	Min	Max	
FVT	$n =$ 26	48.84 ± 7.39	50 (45, 55)	35	60	0.099
AVG	$n =$ 26	45.96 ± 6.16	45 (40, 50)	30	60	
Total	$n =$ 52	47.40 ± 6.89	47 (45, 50)	30	60	–

As per the study protocol, the right lower extremity was prioritized unless anatomically contraindicated. FVT was performed on the right leg in 53.8 % of cases, and AVG was placed on the right side in 57.7 %. The difference in laterality was not statistically significant ($P = 0.78$).

Surgical complications and outcomes

There were no instances of early ischemia, compartment syndrome, or significant lower limb edema in the FVT group during follow-up. Consequently, no fasciotomy or amputation was required in this group.

One postoperative death occurred in each group (3.8 %). In the FVT group, the patient died within a few days after the procedure due to cardiac complications, while in the AVG group, the patient expired three weeks postoperatively due to graft infection. This difference was not statistically significant ($P = 1.0$).

The most frequent complication following FVT was delayed wound healing, observed in 11 patients (42.3 %), which was significantly more common than in the AVG group (15.4 %) ($P = 0.032$). Hematoma was noted in 5 FVT patients (19.2 %) and 4 AVG patients (15.4 %), showing no significant difference.

During follow-up, pseudoaneurysm was detected in 4 % of FVT cases and 7.7 % of AVG cases ($P = 1.0$). No infections occurred in the FVT group, while 11.5 % of AVG patients developed graft infection ($P = 0.235$). No thrombosis was reported in the FVT group, whereas 26.9 % of AVG patients experienced thrombosis, which was statistically significant ($P = 0.01$).

Dialysis success and major complications

Successful dialysis via the access was achieved in 92.3 % of FVT patients, significantly higher than in the AVG group (53.8 %) ($P < 0.05$).

Major access-related complications (infection, thrombosis, or pseudoaneurysm, excluding mortality) occurred in only 4 % of FVT patients compared to 46.2 % in the AVG group ($P = 0.001$, Chi-square test) (Table 3)

Patency outcomes

Primary patency at 9 months was significantly higher in the FVT group (84.6 %) compared to the AVG group (50 %) ($p = 0.01$).

Secondary patency rates were similar: 92.3 % for FVT and 76.9 % for AVG ($p = 0.08$).

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There was one early postoperative death in each group (3.8 %). In the FVT group, the patient died from unrelated cardiac causes; in the AVG group, death was due to graft infection and sepsis.

Discussion

The increasing longevity of dialysis patients and the length of dialysis therapy, combined with the expanding use of central venous catheters and their associated complications, such as central vein stenosis and occlusion, have necessitated the use of lower extremity vascular access (VEA) as an alternative when upper extremity sites are exhausted.[4] Given the disparities in patency rates and complication profiles among existing lower extremity access procedures, dependable access approaches that deliver improved patency while reducing adverse events are critical.[15]

This study aimed to assess the patency and complications of FVT and compare these outcomes with lower-extremity AVG for hemodialysis access in patients with exhausted upper-extremity options, demonstrating that FVT provided significantly higher initial patency (84.6 % vs. 50 %, $p = 0.01$) and higher dialysis success rate (92.3 % vs. 53.8 %, $p < 0.05$) at 9 months. Unlike most previous studies that focused solely on FVT, this study directly compared FVT and AVG, performed concurrently at our center. Demographic and baseline characteristics of the two groups were comparable, strengthening the validity of our comparative analysis. Furthermore, FVT was associated with significantly fewer major complications, particularly thrombosis and infections. These findings are consistent with the 2019 KDOQI Vascular Access Guidelines, which emphasize a life-planning approach and recommend autogenous access options whenever possible, especially in complex or exhausted vascular access scenarios.[4]

The FVT group in our study had a considerably higher primary patency rate at nine months than the AVG group (84.6 % vs. 50 %, $p = 0.01$). This result is in close agreement with other research, including Farber et al.'s study from 2020, which found that in a similarly complex group with central venous occlusion, the one-year primary patency was 65.9 % and the secondary patency was 94.7 % after FVT. In contrast, AVG patency rates in the literature are generally below average; depending on the patient's characteristics and the graft site, one-year primary patency might range from 37 % to 68.5 %..[7,11]Our data confirm this trend, reinforcing the well-documented durability advantage of autogenous conduits over synthetic grafts.

Ahmed K Allam et al.'s study has demonstrated acceptable patency rates but is frequently complicated by thrombosis and the need for multiple secondary interventions. In contrast, our findings indicate that FVT offers superior primary patency and significantly fewer major complications, including thrombosis and infection, resulting in higher dialysis success rates.[16] Our findings align with the broader recognition of this clinical shift. Our data reveal a significantly higher primary patency and dialysis success rate and fewer infections and thrombotic events in FVT than AVG.[17]

Similarly, Natarajan and Jagan Sebastian demonstrated a 71 % primary and 86 % secondary patency one year following upper thigh loop AVG. Our results confirmed acceptable patency rates and dialysis efficacy in lower limb grafts, though FVT offered superior one-year patency and a lower infection rate than thigh and upper arm AVGs.[18]

The superior performance of FVT also manifested in dialysis success rates, with 92.3 % of FVT patients undergoing successful dialysis by nine months, compared to only 53.8 % in the AVG group. This marked difference highlights the clinical relevance of patency beyond mere vessel patency, emphasizing functional access maturity and usability for efficient dialysis. These results echo findings from Yimkosol, who observed a 93.3 % one-year patency for FVT relative to 70.3 % and 68.5 % for upper arm and thigh AVGs, respectively, with no significant increase in mortality.[19] Similarly, the ORION study highlighted the safety and effectiveness of FVT in patients with complex vascular histories[8]

Patient demographics in age, comorbidities, and prior access history are comparable to those described in Farber et al. and the ORION study, confirming a complex patient population often referenced in vascular access literature.[7,8] Our exclusion of patients with an ABI < 0.8 or prior deep vein thrombosis reflects the stringent selection criteria recommended by KDOQI to minimize ischemic complications and optimize outcomes.[4,9].The absence of steal syndrome, compartment syndrome, or limb ischemia in our FVT cohort underscores the efficacy of this selection process and surgical technique, including femoral vein tapering and preservation of arterial flow, as also described by Gradman et al.[9]

Wound complications were more frequent in the FVT group (42.3 %), primarily due to prolonged healing and wound discharge, yet were managed conservatively without major interventions. These rates are

Table 3
Major complications in FVT and AVG groups.

Main Variable	Major Complications			
	Yes	No	Total	P-Value
FVT	1(4 %)	24(96 %)	25(100 %)	0.001
AVG	12(46.2 %)	14(53.8 %)	26(100 %)	
Total	13(25.5 %)	38(74.5 %)	51	–

comparable with previous reports and are likely influenced by patient factors such as obesity.[7,20] Obesity and other comorbidities likely contribute to delayed wound healing, highlighting the need for meticulous perioperative care in this population. Hematomas were relatively common but comparable across both groups (19.2 % in FVT vs. 15.2 % in AVG).

Importantly, no infections or thrombotic events occurred in the FVT group, in contrast to AVG patients who experienced thrombosis in 26.9 % and infection in 11.5 %, consistent with synthetic graft vulnerabilities.[11,12] In contrast, the AVG group faced significant challenges, with 11.5 % infection rates and 26.9 % thrombotic events, reflecting the inherent vulnerabilities of prosthetic material. These complications often precipitate graft failure and re-intervention, underscoring the critical need for vigilant surveillance in AVG patients.[21]

No ischemic or steal syndrome events occurred in the FVT group, underscoring the safety of the procedure with appropriate selection and surgical technique, as emphasized by KDOQI.[4]

The maturation rates of FVTs were significantly superior to those of upper extremity AVFs, consistent with earlier meta-analyses, which reported 26–29 % maturation rates for upper limb fistulas.[12,22] This likely stems from the femoral vein's favorable anatomical and hemodynamic characteristics, including a larger diameter and higher flow, facilitating faster and more reliable maturation. Additionally, the superficial transposition of the femoral vein allows easier cannulation and monitoring, contributing to successful dialysis initiation.

Although FVT is a surgically complex procedure, it provides distinct benefits for suitable patients, in line with current guidelines that advocate for autogenous access whenever possible[4] AVG remains a secondary option when anatomy or comorbidities preclude FVT, but it requires careful monitoring due to higher complication rates.

Conclusion

In conclusion, although creating an FVT can be complex and wound healing may require time, it offers an efficient and convenient access point with suitable patency for the patient. Furthermore, it has fewer complications and more durability than lower limb AVG. Therefore, patients without permanent access to the upper extremity should consider this type of FVT.

Statement

There was no financial support for the project, and it had no funding.

Patient consent statement

The patient provided written consent for the publication of this report.

Compliance with ethical standards

Ethical approval

All participant data were kept confidential, and results were presented in aggregate form. This thesis's ethics code is IR.GUMS.REC.1401.540.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

CRediT authorship contribution statement

Hossein Hemmati: Project administration, Conceptualization. **Mohammad Taghi Ashoobi:** Validation, Supervision. **Seyyed Mostafa Zia Ziabari:** Investigation, Data curation. **Habib Eslami Kenarsari:** Methodology, Formal analysis. **Mohaya Farzin:** Resources, Methodology. **Sepideh Atef Rad:** Writing – review & editing, Writing – original draft.

Declaration of competing interest

There's no conflict of interest to be shared. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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