ORIGINAL ARTICLE

Evaluation and comparison of patency rate and complications of synthetic arteriovenous grafts in the groin and upper extremities among hemodialysis patients

Abbas Saroukhani[1], Mohammad Tohidi[1], Mohammad Javad Tarrahi[2]

[1]Department of Surgery, School of Medicine, Al-Zahra Hospital, Isfahan University of Medical Sciences, Isfahan, Iran, [2]Department of Epidemiology and Biostatistics, School of Health, Isfahan University of Medical Sciences, Isfahan, Iran

Background: Arteriovenous (AV) grafts are frequently used for hemodialysis when an AV fistula is not feasible. Recent improvements in prosthetic materials have led to comparable performance of upper and lower extremity grafts. We aimed to evaluate the patency rate (the time from initial placement to failure or intervention) and complications of groin versus upper extremity AV grafts. **Materials and Methods:** In this cross-sectional study, conducted from October 2018 to October 2020 at a tertiary referral center, patients with either a lower extremity (groin) or upper extremity AV graft were included and followed for at least 2 years. Graft adequacy was defined as the ability to deliver a blood flow ≥350 mL/min with two-needle cannulation in ≥5 dialysis sessions in 1 month. Outcomes included infection, ischemia, neuropathy, and thrombosis. Statistical tests (Chi-square for categorical variables and *t*-test for continuous variables) were used, with $P < 0.05$ considered statistically significant. **Results:** Among 213 hemodialysis patients (mean age: 54.4 ± 17.4 years, 68.5% of males), 183 had upper extremity AV grafts and 30 had groin AV grafts. No significant differences were observed between the two groups for patency duration ($P = 0.088$) or rates of infection, ischemia, neuropathy, thrombosis, and graft adequacy (all $P > 0.05$). **Conclusion:** In this cohort, groin AV grafts had similar patency and complication profiles compared to those in the upper extremities. Groin placement can be a viable alternative when upper extremity access is not suitable. Further studies using standardized graft materials and longer follow-up intervals are recommended.

Key words: Arteriovenous shunt, hemodialysis, patency, renal dialysis, surgical, vascular access devices

How to cite this article: Saroukhani A, Tohidi M, Tarrahi MJ. Evaluation and comparison of patency rate and complications of synthetic arteriovenous grafts in the groin and upper extremities among hemodialysis patients. J Res Med Sci 2026;31:16.

INTRODUCTION

End-stage renal disease (ESRD) patients require dependable vascular access for hemodialysis. Although arteriovenous (AV) fistulas generally offer superior longevity and fewer complications, some patients have unsuitable vessels or require urgent access. In such instances, AV grafts – commonly made of polytetrafluoroethylene (PTFE) – provide an effective alternative. These grafts can be placed in either the upper or lower extremities, with placement often guided by anatomical suitability and prior access history.[1,2]

Earlier research suggested that lower extremity grafts have higher infection and lower patency rates. However, modern surgical techniques and improved graft materials have narrowed these differences, making groin-based grafts a viable option, especially when upper extremity vessels are compromised by central vein stenosis, recurrent thrombosis, or other factors.[3,4] Long-term outcomes of lower-extremity AV grafts have since demonstrated acceptable patency over several years."[5,6] "Indeed, despite these favorable results, leg grafts remain underutilized in many centers."[7,8] "Although this study focuses on adults, evolving paradigms in

Access this article online

Quick Response Code:

Website: https://journals.lww.com/jrms

DOI: 10.4103/jrms.jrms_243_24

Address for correspondence: Prof. Abbas Saroukhani, Department of Surgery, School of Medicine, Al-Zahra Hospital, Isfahan University of Medical Sciences, Isfahan, Iran.
E-mail: a.saroukhani@med.mui.ac.ir

Submitted: 10-May-2024; **Revised:** 03-Feb-2025; **Accepted:** 18-Mar-2025; **Published:** 29-Jul-2026

pediatric hemodialysis access further underscore the need for versatile graft options."[9]

This study employed a cross-sectional design with a minimum 2-year observational follow-up to evaluate primary patency and complications, recognizing that such a design cannot fully establish causation but does allow for meaningful between-group comparisons. The primary goal was to compare the patency rate and complications (infection, ischemia, neuropathy, and thrombosis) of synthetic AV grafts placed in the groin with those in the upper extremities. The secondary objectives included examining graft adequacy and any related morbidity over 2 years.

MATERIALS AND METHODS

Study design and patient selection

This cross-sectional study took place in the department of vascular surgery at a university-affiliated teaching hospital. Patients undergoing AV graft placement in the groin (lower extremity) or upper extremity for hemodialysis were recruited from October 2018 to October 2020. Preoperative assessments commonly included duplex ultrasound for venous mapping and, when clinically indicated, computed tomography angiography to evaluate vascular anatomy. Patients with documented peripheral vascular disease posing a high risk of distal ischemia were excluded from receiving groin grafts.

Adult patients (≥18 years) with ESRD requiring chronic hemodialysis were included if they were ineligible for a native AV fistula or had a prior fistula failure. Patients with venous insufficiency or deep vein thrombosis (DVT) in the proposed limb were excluded, as were individuals who died, received a kidney transplant, or switched to peritoneal dialysis within 3 months postoperatively. Overall, 31 patients were excluded based on these criteria: 21 for venous insufficiency, 6 for DVT, and 4 for early mortality/transplant. All participants provided written informed consent. The study was approved by the institutional ethics committee (Code: IR.MUI.REC.1400.301).

Surgical procedure

Groin (lower extremity) grafts were fashioned using PTFE in either a loop or a straight configuration, typically connecting the superficial femoral artery and the common femoral vein. A longitudinal incision of 6–8 cm was made near the inguinal crease to expose the vessels, and the graft was carefully tunneled subcutaneously to avoid any sharp bends. Due to hospital supply constraints, PTFE grafts from different manufacturers were used; the choice of graft did not differ by the patient group.

Upper extremity grafts were placed between the brachial artery and an appropriate vein (e.g., brachial or basilic), also employing standard tunneling methods. Two senior vascular surgeons, each with more than 10 years of experience, performed all operations. One gram of intravenous cefazolin was administered prophylactically before skin incision to reduce infection risk.

Follow-up and definitions

All patients were followed for a minimum of 24 months. Scheduled outpatient visits occurred 1, 3, and 6 months after surgery and then every 6 months. Several parameters defined outcomes in this study. Primary patency was considered the duration from graft creation to the first required intervention (e.g., thrombectomy and angioplasty) or definitive access failure. Graft adequacy denoted a capability of maintaining a blood flow of at least 350 mL/min with two-needle cannulation for five or more dialysis sessions within a month. Infection was identified by local signs of inflammation or systemic fever in the absence of an alternative source; these symptoms were monitored continuously throughout the 24-month period. Ischemia, which could present in either extremity graft location, included signs such as distal coldness, reduced peripheral pulses, or sensory/motor impairment. Neuropathy described any new onset of numbness, tingling, or pain subsequent to graft placement. Thrombosis was confirmed via duplex ultrasound or clinical evidence such as an absent thrill or an inability to cannulate.

Statistical analysis

Data analysis was performed using SPSS version 25 (IBM Corp., Armonk, NY, USA). Continuous variables are expressed as mean ± standard deviation, while categorical variables are presented as frequency (percentage). The Chi-square test was applied for between-group comparisons of categorical variables (e.g., infection vs. no infection), and Student's *t*-test was used for continuous variables (e.g., age and patency duration). $P < 0.05$ was considered statistically significant.

RESULTS

Patient characteristics

A total of 213 patients requiring hemodialysis via an AV graft met the inclusion criteria. Of these, 183 (85.9%) had grafts in the upper extremities, and 30 (14.1%) had grafts placed in the groin. The average patient age was 54.4 ± 17.4 years, and 146 (68.5%) of the study participants were male. The prevalence of diabetes (23.0%), hypertension (23.9%), and cardiac disease (70.1%) was similar between the groups, and no significant differences were detected in baseline characteristics. Table 1 details demographic and clinical factors.

Table 1: Demographic and clinical characteristics

Variable	Overall (*n*=213), *n* (%)	Upper extremity (*n*=183), *n* (%)	Groin (*n*=30), *n* (%)	*P*
Age (years), mean (SD)	54.4 (17.4)	53.7 (18.3)	57.4 (11.1)	0.31
Male	146 (68.5)	127 (69.4)	19 (63.3)	0.53
Diabetes, *n* (%)	49 (23.0)	42 (22.9)	7 (23.3)	0.23
Hypertension, *n* (%)	51 (23.9)	45 (24.6)	6 (20.0)	0.16
Cardiac disease, *n* (%)	151 (70.9)	128 (69.9)	23 (76.6)	0.24

SD=Standard deviation

Patency and complications

Although primary patency was evaluated at 6 months, each participant was monitored for at least 24 months postoperatively. The mean patency duration did not differ significantly between groin and upper extremity grafts ($P = 0.088$). Overall, graft adequacy was achieved in 64.8% of patients, with no statistically meaningful difference by graft location ($P = 0.15$).

Infection was observed in 9.8% of the entire cohort. In the groin group, the infection rate was 6.6%, whereas 10.4% of upper extremity graft recipients experienced infections ($P = 0.57$). Ischemia occurred in 7.5% of the total population, with one case (3.3%) in the groin group and 15 (8.2%) in the upper extremity group ($P = 0.38$). Neuropathy was noted in 34.2% of patients, again showing no significant disparity between groin and upper extremity placements ($P = 0.34$). Thrombosis was documented in 15 patients (7.0%), all of whom had upper extremity grafts ($P = 0.12$). Mortality data, though not a primary endpoint, revealed no significant difference between the two groups. Key outcomes are summarized in Table 2.

DISCUSSION

The rising prevalence of ESRD and the accompanying need for stable hemodialysis access has led clinicians to explore a range of AV graft sites, including the groin. Earlier studies raised concerns about lower extremity grafts due to perceptions of higher infection rates,[10] suboptimal patency, and technical difficulties in salvaging access. However, subsequent developments in surgical methods, including refined tunneling techniques and improved PTFE technology, have likely contributed to more favorable outcomes. Some research cites infection rates in lower extremity grafts as exceeding 20%, while other investigations have shown rates comparable to those in the upper extremities.[5,11-13] Our study found relatively low infection rates overall, with no significant difference between groin-based and upper extremity grafts.

Ischemia can arise in either the upper or lower extremity following AV graft placement, and hand ischemia and peripheral neuropathy have been more frequently associated with upper limb grafts due to the higher blood-flow demands in the arm.[4,14-16] In this research, both ischemia and neuropathy showed no significant difference between groups, suggesting that modern operative techniques and a careful preoperative evaluation may minimize these complications regardless of graft location.

Thrombosis, commonly driven by intimal hyperplasia and stenotic lesions, remains a critical cause of graft failure.[7,17-21] Investigations indicate that up to 90% of thrombosed grafts exhibit underlying stenosis related to endothelial damage and turbulent blood flow at the anastomosis.[22-24] In the present study, no groin graft thromboses were recorded, whereas 15 cases emerged in the upper extremity group. Although this difference was not statistically significant, it mirrors findings that well-selected femoral grafts can maintain acceptable patency and may have a lower thrombosis rate.[25]

Mortality associated with AV graft placement in different anatomical sites is inconsistently reported. Some studies link thigh-based grafts to increased mortality, while others show no significant variation.[4] Our data suggest no clear mortality differences, implying that other patient-level factors—such as global comorbidity burdens, intradialytic hemodynamic stability, and dialysis adequacy—may have a stronger influence on survival than graft location alone.

Emerging vascular access therapies—including early-cannulation grafts and bioengineered conduits—have been reviewed and show promise for expanding access options.[2,20,25] Simulation-based training of dialysis nurses has been shown to reduce cannulation-related adverse events.[26] Permanent lower-extremity access also requires careful consideration of limb function and patient quality of life.[26]

This study has certain limitations. It was conducted at a single center, and the relatively small sample size in the groin cohort may limit the generalizability of results. The 2-year cross-sectional design captures early and midterm outcomes but might not fully represent the long-term durability or complications that could emerge beyond 24 months.[4] Furthermore, graft materials from different manufacturers were employed due to supply considerations, and the study did not standardize nurse

Table 2: Outcomes and complications of arteriovenous grafts

Outcome/ complication	Upper extremity (*n*=183), *n* (%)	Groin (*n*=30), *n* (%)	*P*
Patency (mean days)	307.6 (261.0)	183.9 (198.2)	0.088
Infection	19 (10.4)	2 (6.6)	0.57
Ischemia	15 (8.2)	1 (3.3)	0.38
Neuropathy	65 (35.5)	8 (26.6)	0.34
Graft adequacy	115 (62.8)	23 (76.6)	0.15
Thrombosis	15 (8.2)	0	0.12

expertise or needling techniques (e.g., rope-ladder vs. buttonhole cannulation). Socioeconomic and educational disparities that may influence hygiene or treatment adherence were also not specifically controlled for.

In summary, our findings contribute to a growing body of evidence that femoral (groin) AV grafts can achieve patency rates and complications comparable to those seen in the upper extremities. Such grafts may serve as a valuable option when upper limb access is not feasible or has been repeatedly compromised. Comparative analyses with longer follow-up support the long-term viability of femoral AV grafts.[22] Future research involving larger, multicenter populations; consistent graft materials; extended follow-up intervals; and comprehensive data on dialysis practices could further clarify the optimal strategies for vascular access in ESRD patients.

CONCLUSION

In this 2-year, cross-sectional analysis, synthetic AV grafts placed in the groin showed patency and complication rates akin to those in the upper extremities. This suggests that the groin is a viable site for patients who are unsuitable for upper extremity grafts. Moving forward, larger prospective studies with longer follow-up periods and more controlled variables are recommended to confirm these results and refine best practices in vascular access management.

Authors' contributions

All three authors participated in conception and design, data acquisition, interpretation, drafting, critical revision, and final approval of the manuscript. In addition, MJT performed the statistical analyses and drafted the Results section.

Acknowledgments

We extend our gratitude to all participating patients and to the dedicated nursing staff who supported this research.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethical approval and consent to participate

This study was conducted with approval from the institutional ethics committee (IR.MUI.REC.1400.301). All participants provided written informed consent.

Consent for publication

Not applicable.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Maytham GG, Sran HK, Chemla ES. The use of the early cannulation prosthetic graft (Acuseal™) for angioaccess for haemodialysis. J Vasc Access 2015;16:467–71.
2. Al Shakarchi J, Houston G, Inston N. Early cannulation grafts for haemodialysis: A systematic review. J Vasc Access 2015;16:493–97.
3. Antoniou GA, Lazarides MK, Georgiadis GS, Sfyroeras GS, Nikolopoulos ES, Giannoukas AD. Lower-extremity arteriovenous access for haemodialysis: A systematic review. Eur J Vasc Endovasc Surg 2009;38:365–72.
4. Beathard GA, Spergel LM. Hand ischemia associated with dialysis vascular access: An individualized access flow-based approach to therapy. Semin Dial 2013;26:287–314.
5. Coentrão L, Van Biesen W, Nistor I, Tordoir J, Gallieni M, Marti Monros A, *et al*. Preferred haemodialysis vascular access for diabetic chronic kidney disease patients: A systematic literature review. J Vasc Access 2015;16:259–64.
6. Han S, Song D, Yun S. Long term outcomes of arteriovenous grafts for hemodialysis in lower extremities. Vasc Specialist Int 2016;32:180–85.
7. Miller CD, Robbin ML, Barker J, Allon M. Comparison of arteriovenous grafts in the thigh and upper extremities in hemodialysis patients. J Am Soc Nephrol 2003;14:2942–47.
8. Allon M. We underutilize the leg graft. Semin Dial 2016;29:281–83.
9. Chanchlani R, Young C, Farooq A, Sanger S, Sethi S, Chakraborty R, *et al*. Evolution and change in paradigm of hemodialysis in children: A systematic review. Pediatr Nephrol 2021;36:1255–71.
10. Akoh JA. Vascular access infections: Epidemiology, diagnosis, and management. Curr Infect Dis Rep 2011;13:324–32.
11. Kilic A, Arnaoutakis DJ, Reifsnyder T, Black JH 3rd, Abularrage CJ, Perler BA, *et al*. Management of infected vascular grafts. Vasc Med 2016;21:53–60.
12. Lazarides MK, Tzilalis VD. Acute ischemia of the upper extremity following graft arteriovenous fistula. In: Vascular Surgery: Cases, Questions and Commentaries. London, UK: Springer; 2011. p. 431–37.
13. Collins MJ, Li X, Lv W, Yang C, Protack CD, Muto A, *et al*. Therapeutic strategies to combat neointimal hyperplasia in vascular grafts. Expert Rev Cardiovasc Ther 2012;10:635–47.

14. MacRae JM, Dipchand C, Oliver M, Moist L, Yilmaz S, Lok CE, *et al*. Arteriovenous access: Infection, neuropathy, and other complications. Can J Kidney Health Dis 2016;3:271–78.
15. Covarrubias DA, Tan CS, Qaqish SS, Ramani K, Lerma EV, Batuman V, *et al*. Arterial stenosis affecting arteriovenous fistulae and grafts in hemodialysis patients: Approach to diagnosis and management. In: Lerma EV, editor. Interventional Nephrology. Cham, Switzerland: Springer; 2022. p. 165–175. [doi: 10.1007/978-3-030-81155-6_23].
16. Bachleda P, Kalinova L, Utikal P, Kolar M, Hricova K, Stosova T. Infected prosthetic dialysis arteriovenous grafts: A single dialysis center study. Surg Infect (Larchmt) 2012;13:366–70.
17. Ravari H, Kazemzade GH, Modaghegh MH, Khashayar P. Patency rate and complications of polytetrafluoroethylene grafts compared with polyurethane grafts for hemodialysis access. Ups J Med Sci 2010;115:245–48.
18. Honda A, Michihata N, Iizuka Y, Uda K, Morita K, Mieda T, *et al*. Risk factors for severe lower extremity ischemia following venoarterial extracorporeal membrane oxygenation: An analysis using a nationwide inpatient database. Trauma Surg Acute Care Open 2022;7:e000776.
19. Lin CH, Chien V. Arteriovenous loop graft for lower extremity reconstruction. In: Chang EI, Levin LS, editors. Recipient Vessels in Reconstructive Microsurgery: Anatomy and Technical Considerations. Cham, Switzerland: Springer; 2021. p. 271–78.
20. Murea M, Gardezi AI, Goldman MP, Hicks CW, Lee T, Middleton JP, *et al*. Study protocol of a randomized controlled trial of fistula versus graft arteriovenous vascular access in older adults with end-stage kidney disease on hemodialysis: The AV access trial. BMC Nephrol 2023;24:43.
21. Guillouet E, Tomadesso C, Flores BA, Henri P, Lanot A, Morello R, *et al*. Impact of simulation-based training in addition to theoretical training versus theoretical training of nurses alone in the occurrence of adverse events related to arteriovenous fistula puncture in chronic hemodialysis patients: study for a cluster randomized controlled trial (SIMFAV2). Trials 2023;24:500.
22. Li B, Abdelmasih M, Eisenberg N, Lok CE, Roche-Nagle G. Long-term outcomes following thrombolysis of arteriovenous grafts. J Vasc Access 2024;25:753–58.
23. Zhang R, Zhang J, Xue X, Sun Z, Du N, Chen N, et al. Comparison of lower and upper extremity arteriovenous graft: A retrospective clinical analysis with 5-year Follow-Up. Ann Vasc Surg 2024;98:235-43.
24. DeSilva RN, Patibandla BK, Vin Y, Narra A, Chawla V, Brown RS, *et al*. Fistula first is not always the best strategy for the elderly. J Am Soc Nephrol 2013;24:1297-304.
25. Lawson JH, Niklason LE, Roy-Chaudhury P. Challenges and novel therapies for vascular access in haemodialysis. Nat Rev Nephrol 2020;16:586–602.
26. Murea M, Geary RL, Houston DK, Edwards MS, Robinson TW, Davis RP, *et al*. A randomized pilot study to evaluate graft versus fistula vascular access strategy in older patients with advanced kidney disease: Results of a feasibility study. Pilot Feasibility Stud 2020;6:86.