International Surgery Journal
Rajawat MS et al. Int Surg J. 2025 Nov;12(11):1945-1948
http://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: https://dx.doi.org/10.18203/2349-2902.isj20253452

Original Research Article

Unlocking arteriovenous fistula success: a prospective randomized controlled trial on intraoperative IV heparin for superior vascular access outcomes

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Received: 10 August 2025
Revised: 16 September 2025
Accepted: 01 October 2025

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ABSTRACT

Introduction: End-stage renal disease (ESRD) prevalence is rising globally, making vascular access for haemodialysis increasingly important. Arteriovenous fistula (AVF) remains the gold standard for durable vascular access, but early failure due to thrombosis remains a concern. The use of intraoperative heparin to improve patency is debated. To assess the effect of a single intraoperative intravenous dose of heparin on early AVF patency and postoperative complications.

Methods: This prospective randomized controlled trial was conducted from January to December 2019 at the Institute of Nephrourology, Bangalore. A total of 240 patients undergoing AVF creation were randomized into two groups: Group A received 5000 IU IV heparin intraoperatively (n=130) and Group B underwent surgery without heparin (n=110). Primary outcome was AVF patency on postoperative days 1 and 8. Secondary outcomes included postoperative bleeding, hematoma, infection, and thrombosis. Statistical significance was set at $p<0.05$.

Results: Baseline characteristics and AVF type distribution were comparable between groups. On day 1, RCAVF patency was significantly higher in the heparin group (96.5% vs. 84.2%, p=0.01). On day 8, RCAVF patency remained higher in the heparin group (94.4% vs. 80.2%, p=0.007). BCAVF patency improvement was not statistically significant. Complication rates did not differ significantly.

Conclusions: A single dose of intraoperative IV heparin significantly lowers thrombosis rates and enhances patency in both radiocephalic and brachiocephalic AVFs. Notably, the improvement reached statistical significance in radiocephalic fistulas, highlighting its potential as a simple yet powerful intervention especially in AVFs with small-caliber vessels.

Keywords: Arteriovenous fistula, Heparin, Haemodialysis access, Patency, ESRD

INTRODUCTION

The prevalence of ESRD is increasing worldwide, driven by rising rates of diabetes and hypertension.[1] Haemodialysis is essential for survival in ESRD patients, and vascular access is a critical determinant of patient outcomes.[2] Among available options-catheter-based access, peritoneal dialysis catheters, and AVF is preferred due to superior long-term patency and lower infection risk.[3,4] However, early AVF failure, often due to thrombosis, remains a significant clinical challenge.[5] This has prompted exploration of adjunctive intraoperative measures, including the administration of systemic anticoagulants such as heparin.[6,7] Although some studies have demonstrated improved patency rates with intraoperative heparin, others have reported no benefit or increased bleeding risk.[6-10]

Given the lack of consensus and the clinical importance of preserving early AVF function, this study was

undertaken to assess the impact of a single intraoperative intravenous dose of heparin on early AVF patency and associated complications in a randomized controlled trial setting.

METHODS

This was a prospective randomized controlled trial conducted at the Institute of Nephrourology, Bangalore, between January and December 2019. Out of 270 patients undergoing AVF creation, 240 were included (30 lost to follow-up).

Inclusion criteria

Age ≥18 years. ESRD or advanced CKD requiring dialysis, vessel diameter ≥2 mm.

Exclusion criteria

Known coagulopathy or bleeding disorder, pregnancy, patients on ongoing anticoagulants.

Patients were randomized into

Group A (Heparin group)

130 patients received 5000 IU IV heparin intraoperatively.

Group B (Control group)

110 patients underwent surgery without heparin.

AVFs (radiocephalic or brachiocephalic) were created end-to-side under local anesthesia. All surgeries were performed by experienced surgeons. Primary outcome was clinical patency assessed on postoperative days 1 and 8. Secondary outcomes included postoperative bleeding, hematoma, infection, and thrombosis. Data were analyzed using SPSS v27. Chi-square and t-tests were used. A p value <0.05 was considered significant.

Ethical considerations

The study was reviewed and approved by the Institutional Ethics Committee of the Institute of Nephrourology, Bangalore (Approval No: IEC/INU/2019/47). Written informed consent was obtained from all participants before enrolment.

RESULTS

Baseline demographics were comparable. AVF type and surgical duration were not significantly different. Baseline characteristics of the patients were comparable between the two groups (Table 1). The mean age was 47.36±15.51 years in the heparin group and 48.73±14.89 years in the control group (p=0.48). The distribution of sex, diabetes mellitus, hypertension, ischemic heart disease, and peripheral vascular disease was similar with no statistically significant differences (all p >0.05).

The type of AVF created and the mean surgery duration were also comparable (Table 2). Radiocephalic AVFs were the most commonly performed, with 90 cases in the heparin group and 76 in the control group, while brachiocephalic AVFs accounted for 40 and 34 cases, respectively (p=0.91). The mean duration of surgery was nearly identical (55±12 minutes vs. 54±13 minutes, p=0.67).

AVF patency rates showed clear differences between the groups (Table 3). On postoperative day 1, radiocephalic AVF patency was significantly higher in the heparin group (96.5%) compared to the control group (84.2%, p=0.01). This benefit persisted on day 8, with patency of 94.4% in the heparin group versus 80.2% in the control group (p=0.007). Although brachiocephalic AVFs also showed numerically higher patency rates in the heparin group on both day 1 (97.5% vs. 91.1%) and day 8 (97.5% vs. 88.2%), these differences were not statistically significant (p>0.05).

Prior AVF history was similar between groups (Table 4). Fifteen patients in the heparin group and 12 in the control group had undergone previous AVF surgery (p=0.79). Postoperative complication rates were low and did not differ significantly between the groups (Table 5).

The incidence of bleeding (3% vs. 4%, p=0.78), hematoma (2% vs. 3%, p=0.69), infection (1% vs. 1.5%, p=0.88), and thrombosis (3.5% vs. 5.4%, p=0.41) was comparable, indicating that intraoperative heparin administration did not increase adverse events.

Table 1: Baseline characteristics.

Variable	Heparin group (n=130)	Control group (n=110)	P value
Age (in years)	47.36±15.51	48.73±14.89	0.48
Male (%)	70	71.8	0.82
Diabetes mellitus (%)	47.7	44.5	0.63
Hypertension (%)	56.9	57.3	0.95
IHD (%)	5	6	0.76
PVD (%)	3	2	0.88

Table 2: AVF type and surgery duration.

Variable	Heparin group	Control group	P value
RCAVF	90	76	0.91
BCAVF	40	34	0.91
Mean surgery duration (min)	55±12	54±13	0.67

Table 3: AVF patency.

Time point	Heparin group	Control group	P value
Day 1-RCAVF	96.5%	84.2%	0.01
Day 1-BCAVF	97.5%	91.1%	0.327
Day 8-RCAVF	94.4%	80.2%	0.007
Day 8-BCAVF	97.5%	88.2%	0.173

Table 4: Previous AVF history.

Previous AVF	Heparin group	Control group	P value
Present	15	12	0.79
Absent	115	98	—

Table 5: Postoperative complications.

Complication	Heparin group	Control group	P value
Bleeding	3%	4%	0.78
Hematoma	2%	3%	0.69
Infection	1%	1.5%	0.88
Thrombosis	3.5%	5.4%	0.41

DISCUSSION

In this study, intraoperative intravenous heparin significantly improved early patency rates for radiocephalic AVFs, with day 1 and day 8 results showing statistical significance (p=0.01 and p=0.007, respectively). This aligns with findings by Ravari et al and Farzaneh et al who also demonstrated improved early patency without increased complications.[6,7] For brachiocephalic AVFs, patency rates were higher in the heparin group but not statistically significant, possibly due to larger vessel diameter and higher baseline flow, consistent with reports by Al-Jaishi et al and Allon et al Robbin et al.[5] The lack of significant increase in postoperative bleeding, hematoma, or infection suggests that 5000 IU of intraoperative heparin is safe in this population, in agreement with Bhomi et al.[9] However, the results contrast with those of D'Ayala et al and Wang et al who found increased bleeding risk associated with heparin.[10]

Strengths of this study include its randomized controlled design, adequate sample size, and clinically relevant endpoints.

Limitations include the absence of duplex ultrasonography for patency assessment and relatively short follow-up duration.

CONCLUSION

A single dose of intraoperative IV heparin significantly lowers thrombosis rates and enhances patency in both radiocephalic and brachiocephalic AVFs. Notably, the improvement reached statistical significance in radiocephalic fistulas, highlighting its potential as a simple yet powerful intervention especially in AVFs with small-caliber vessels.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Rajawat MS, Shivakumar V, Keshavamurthy R. Unlocking arteriovenous fistula success: a prospective randomized controlled trial on intraoperative IV heparin for superior vascular access outcomes. Int Surg J 2025;12:1945-8.