

## Impact of Intraoperative Cephalic Vein Dilation on Radiocephalic AV Fistula Outcomes: A Retrospective Study

Naveen Kumar<sup>1</sup>, Abhishek Raman<sup>2</sup>, Parvez Ahmad<sup>3</sup>, Prabhat Ranjan<sup>4</sup><sup>1</sup>Assistant Professor, Department of Urology, All India Institute of Medical Sciences, Patna, Bihar, India<sup>2</sup>Consultant, Department of Nephrology, Jayprabha Medanta Superspeciality Hospital, Patna, Bihar, India<sup>3</sup>Senior Resident, Department of Urology, All India Institute of Medical Sciences, Patna, Bihar, India<sup>4</sup>Director, Department of Urology, Jayprabha Medanta Superspecialty Hospital, Patna, Bihar, India

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Corresponding Author: Dr. Naveen Kumar

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### Abstract:

**Background:** End-stage renal disease (ESRD) poses a significant global healthcare challenge, particularly in the context of hemodialysis, where arteriovenous fistulas (AVFs) are the preferred vascular access. The radiocephalic fistula, created by anastomosing the radial artery to the cephalic vein, is often considered the gold standard due to its long-term patency and reduced morbidity. This study investigates the impact of intraoperative cephalic vein dilation on short-term outcomes of radiocephalic AVFs in ESRD patients.

**Methods:** A retrospective observational study was conducted using medical records from 200 patients who underwent radiocephalic AV fistula surgery. Patients were divided into two groups: those who received intraoperative cephalic vein dilation (Dilation group, n=100) and those who did not (Non-Dilation group, n=100). Data on demographics, surgical details, and postoperative outcomes were collected and analyzed using chi-square tests and t-tests.

**Results:** The Dilation group showed significantly higher fistula maturation rates (85% vs. 70%), better primary patency at 6 months (75% vs. 60%), and lower complication rates (20% vs. 35%) compared to the Non-Dilation group. These benefits were consistent across subgroups with different comorbidities, including diabetes and hypertension.

**Conclusion:** Intraoperative cephalic vein dilation during radiocephalic AV fistula surgery in ESRD patients was associated with improved short-term outcomes. This technique may offer a significant advantage in enhancing the success rate of fistula maturation and patency while reducing postoperative complications.

**Recommendations:** Based on these findings, intraoperative cephalic vein dilation should be considered a standard practice in AV fistula surgeries for ESRD patients. Further research is recommended to explore long-term outcomes and to validate these findings in larger, multicentric studies.

**Keywords:** End-Stage Renal Disease, Arteriovenous Fistula, Cephalic Vein Dilation, Hemodialysis.

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### Introduction

End-stage renal disease (ESRD) represents a significant global healthcare burden, necessitating various forms of renal replacement therapy, including hemodialysis [1]. For patients requiring hemodialysis, arteriovenous fistulas (AVFs) are the preferred vascular access choice due to their durability and lower complication rates compared to arteriovenous grafts and central venous catheters. Among AVFs, the radiocephalic fistula, created by anastomosing the radial artery to the cephalic vein, is considered the gold standard, offering long-term patency and reduced morbidity [2]. However, the successful creation and function of a radiocephalic AVF can be challenging, and intraoperative factors play a pivotal role in its outcomes.

One intraoperative factor that has garnered recent attention is cephalic vein dilation, which involves enlarging the cephalic vein during the AVF creation procedure. This technique is aimed at improving AVF maturation and function by increasing the vessel's diameter to accommodate higher blood flow rates [3]. While the concept of cephalic vein dilation seems promising, its effect on the short-term outcomes of radiocephalic AVFs in ESRD patients is a subject of ongoing research and debate.

The aim of this retrospective study is to investigate the impact of intraoperative cephalic vein dilation on short-term outcomes, including primary and secondary patency rates, complications, and overall arteriovenous fistula (AVF) success, in end-stage

renal disease (ESRD) patients who underwent radiocephalic AVF creation.

### Methodology

**Study Design:** This study is a retrospective observational study.

**Study Setting:** The study was conducted using medical records from a tertiary care centre in India, spanning between 2 years.

**Participants:** 200 Participants were selected from the hospital's database of patients who underwent radiocephalic AV fistula surgery for hemodialysis access.

### Inclusion Criteria

- Patients diagnosed with ESRD.
- Patients who underwent radiocephalic AV fistula surgery.
- Age 18 years or older.

### Exclusion Criteria

- Patients with other forms of renal replacement therapy (e.g., peritoneal dialysis).
- Previous history of AV fistula or graft.
- Incomplete medical records.

**Study Size:** The study size for assessing the effect of intraoperative cephalic vein dilation on short-term outcomes of radiocephalic AV fistula in ESRD patients was determined through a power analysis, which indicated that 86 patients per group were needed to detect a significant difference with an expected increase in fistula maturation rate, at an alpha of 0.05 and a power of 0.80. To accommodate potential data loss and incomplete records, this number was increased by approximately 15%, leading to a total of 100 patients per group. Participants were selected from a hospital database of ESRD patients who underwent radiocephalic AV fistula surgery, using a computer-generated randomization process to ensure unbiased representation. This process involved applying inclusion criteria (patients aged 18 years or older with ESRD who underwent the specified surgery) and exclusion criteria (patients on other renal replacement therapies, with previous AV fistula or graft, or with incomplete medical records), resulting in a final sample size of 200 patients, divided equally into Dilation and Non-Dilation groups.

**Bias:** Selection bias was minimized by including all eligible patients within the specified timeframe.

Information bias was reduced through the use of standardized definitions and protocols for data extraction.

**Variables:** Key variables included Intraoperative cephalic vein dilation (presence or absence), Short-term outcomes, including fistula maturation, primary patency, and complication rates within the first 6 months post-surgery.

**Data Collection:** Data was collected on patient demographics, surgical details, postoperative follow-up notes, and complications. This included both qualitative (e.g., surgeon's notes) and quantitative data (e.g., patency rates).

**Methodology:** The methodology involved identifying eligible patients from the hospital database, extracting relevant data, and analyzing the impact of intraoperative cephalic vein dilation on the specified outcomes. Patient records were reviewed to extract data on demographics, comorbidities, details of surgery (including vein dilation), and postoperative outcomes. Patients were grouped based on whether they received intraoperative cephalic vein dilation.

**Statistical Analysis:** Statistical analysis included descriptive statistics for demographic data. Comparative analysis between the two groups (with and without vein dilation) was performed using chi-square tests for categorical variables and t-tests for continuous variables. A p-value of <0.05 was considered statistically significant.

**Ethical Considerations:** The study adhered to ethical guidelines, ensuring confidentiality and anonymity of patient data. The study protocol was reviewed and approved by the Institutional Review Board to ensure compliance with ethical standards.

### Results

The study retrospectively analyzed 200 patients who underwent radiocephalic AV fistula surgery for hemodialysis access. Patients were divided into two groups: those who received intraoperative cephalic vein dilation (Dilation group, n=100) and those who did not (non-dilation group, n=100). The mean age of patients in the Dilation group was 62.3 years (SD  $\pm$  10.5), and in the non-dilation group, it was 61.8 years (SD  $\pm$  11.2). The distribution of gender, diabetes, hypertension, and Body Mass Index (BMI) were comparable between the two groups, as shown in Table 1.

**Table 1: Baseline Characteristics of the Study Population**

Characteristics	Dilation Group (n=100)	Non-Dilation Group (n=100)	p-value
Age (years)	62.3 $\pm$ 10.5	61.8 $\pm$ 11.2	0.74
Gender (M/F)	60/40	58/42	0.82
Diabetes (%)	45%	48%	0.69
Hypertension (%)	80%	78%	0.76
BMI (kg/m <sup>2</sup> )	25.4 $\pm$ 3.2	24.9 $\pm$ 3.5	0.55

The primary outcomes assessed were fistula maturation, primary patency, and complication rates within the first 6 months post-surgery.

**Table 2: Short-term Outcomes**

Outcomes	Dilation Group (n=100)	Non-Dilation Group (n=100)	p-value
Fistula Maturation (%)	85%	70%	0.03
Primary Patency at 6 mo (%)	75%	60%	0.04
Complications (%)	20%	35%	0.02

The Dilation group showed a significantly higher fistula maturation rate (85%) compared to the non-dilation group (70%), with a p-value of 0.03. The primary patency at 6 months was also significantly higher in the Dilation group (75%) compared to the non-dilation group (60%), with a p-value of 0.04. Complication rates, including thrombosis, infection, and need for secondary interventions, were significantly lower in the Dilation group (20%) compared to the non-dilation group (35%), with a p-value of 0.02 (Table 2).

In the subgroup analysis focusing on patient comorbidities, the study further explored the outcomes of fistula maturation, primary patency, and complication rates in patients with diabetes and hypertension. Among diabetic patients, those in the Dilation group exhibited a fistula maturation rate of 82%, compared to 68% in the non-dilation group. The primary patency at 6 months in diabetic patients was 72% for the Dilation group and 58% for the non-dilation group. The complication rate was also lower in the dilation group (22%) compared to the non-dilation group (38%) among diabetic patients.

Similarly, in patients with hypertension, the dilation group showed a higher fistula maturation rate of 86%, as opposed to 71% in the non-dilation group. The primary patency at 6 months was 77% in hypertensive patients who received vein dilation, compared to 61% in those who did not. The complication rates in hypertensive patients were 18% for the Dilation group and 33% for the non-dilation group.

## Discussion

In this retrospective study evaluating the effect of intraoperative cephalic vein dilation on radiocephalic AV fistula outcomes in ESRD patients, significant differences were observed between the Dilation and Non-Dilation groups. Out of 200 patients, those in the Dilation group demonstrated a higher fistula maturation rate (85% vs. 70%), better primary patency at 6 months (75% vs. 60%), and lower complication rates (20% vs. 35%) compared to the Non-Dilation group. These differences were statistically significant, indicating a clear benefit of vein dilation in the surgical creation of AV fistulas. Furthermore, subgroup analysis revealed that these benefits were consistent across patients with varying comorbidities, such as

diabetes and hypertension. Diabetic patients in the Dilation group showed better outcomes in all measured parameters compared to their counterparts in the Non-Dilation group, and similar trends were observed in patients with hypertension.

The results indicated a clear advantage of intraoperative cephalic vein dilation in improving the short-term outcomes of radiocephalic AV fistula surgeries in ESRD patients. The improved rates of fistula maturation and primary patency, along with reduced complication rates in the Dilation group, highlight the potential benefits of this technique. The consistency of these results across subgroups with different comorbidities further strengthens the evidence for the efficacy of vein dilation.

Recent studies in the field of arteriovenous fistula management for hemodialysis patients offer valuable insights that complement the findings on the impact of intraoperative cephalic vein dilation [4-7]. A study explored non-invasive blood flow detection in arteriovenous fistulas using deep denoising autoencoders, a technique that could be pivotal in monitoring post-surgical outcomes in fistulas with vein dilation [4]. Another study developed a patient-specific 3D fistula model to simulate blood flow, providing a framework that could enhance understanding of hemodynamic changes following vein dilation [5]. Research conducted computational analyses of hemodynamics in arteriovenous fistulas, which could shed light on flow dynamics in fistulas post dilation [6]. Furthermore, a study introduced a convolutional network for biomedical image segmentation, potentially useful in evaluating imaging data of fistulas after surgery [7]. Additionally, a study investigated deep learning techniques for needle detection in cannulation simulators, a study that might have implications for training in procedures like cephalic vein dilation [8]. These studies collectively provide a comprehensive view of the advancements in arteriovenous fistula management and the potential impact of surgical techniques like vein dilation.

## Conclusion

Intraoperative cephalic vein dilation during the creation of radiocephalic AV fistulas in ESRD patients was associated with significantly better short-term outcomes, including higher fistula

maturation rates, improved primary patency, and reduced complication rates. These findings suggest that vein dilation should be considered as a standard practice in AV fistula surgeries for ESRD patients.

**Limitations:** The limitations of this study include a small sample population who were included in this study. The findings of this study cannot be generalized for a larger sample population. Furthermore, the lack of comparison group also poses a limitation for this study's findings.

**Recommendations:** Based on these findings, intraoperative cephalic vein dilation should be considered a standard practice in AV fistula surgeries for ESRD patients. Further research is recommended to explore long-term outcomes and to validate these findings in larger, multicentric studies.

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#### List of abbreviations:

ESRD - End-Stage Renal Disease

AVF - Arteriovenous Fistula

BMI - Body Mass Index

SD - Standard Deviation

mo - months

M - Male

F - Female

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