

Original Article

Role of Venoplasty of Suboptimal Veins Using Fogarty Embolectomy Catheter In Vascular Access Surgery: A Single Centre

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Data Availability Statement: The anonymised dataset supporting the findings of this study, including patient demographics, pre-operative vessel measurements, six-week vein diameter, fistula flow rates, and complication data, is available from the corresponding author upon reasonable request. Access to the data will be subject to institutional approval and the removal of patient identifiers to protect participant confidentiality.

Institutional Review Board

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Abstract

Objective: In ESRD (End-stage renal disease (ESRD) and superficial veins > 3.0 mm, autogenous arteriovenous fistulas (AVF) have greater patency rates than prosthetic grafts and central lines (1). . This study aimed to assess whether suboptimal veins (less than 2.0 mm) after Venoplasty with Fogarty catheter can yield similar results when used for dialysis access creation.

Methodology: This Quasi-experimental study was conducted at the Department of Vascular Surgery, Holy Family Hospital, Rawalpindi, from June to December 2025.

All candidates with good-sized veins (> 3 mm) were included in group A (control group). All candidates with suboptimal veins (3 mm to 1.5 mm) were included in group B (interventional group). An end-to-side fistula using Prolene 6/0 was created between the cephalic veins of the arm or forearm and the arteries (radial/brachial). In group B, a 3 Fr Fogarty embolectomy catheter was used for venoplasty of at least a 15 cm venous segment for 10 s. Continuous variables were compared using the t-test, and categorical variables were compared using the chi-square test. A P-value of < 0.05 was considered significant.

Results: At six weeks, the average vein diameter across all instances was 4.79 ± 1.14 mm. It was 4.84 ± 1.16 mm in the Fogarty group, while it was 4.73 ± 1.15 mm in the control group. The difference was insignificant ($p = 0.76$). The flow at 6 weeks was higher in the Fogarty group (57.1%) than in the control group (28.6%); however, this was insignificant ($p = 0.061$).

Conclusion: Fogarty catheter-assisted venoplasty appears to be feasible and safe for selected patients with suboptimal cephalic veins undergoing arteriovenous fistula creation. Although the early six-week flow showed a favourable trend in the Fogarty group, the difference was not statistically significant. Larger studies with longer follow-up periods are required to determine the effect of this technique on fistula maturation and long-term patency.

Keywords: Arteriovenous Fistula, Renal Dialysis, Kidney Failure, Chronic, Angioplasty, Balloon, Embolectomy, Balloon, Vascular Patency, Vascular Access Devices, Veins, Treatment Outcome.

Introduction

The NKF KDOQI guidelines recommend creating an autogenous arteriovenous fistula (AVF) whenever possible, instead of placing prosthetic grafts or central venous catheters in patients who require long-term haemodialysis.¹ AVFs are preferred because they usually cause fewer problems and remain patent for a longer period. However, for an AVF to work well, the vein needs to have a reasonable size, mostly around 2.5 mm or more.² When the vein is smaller than this, the fistula may fail early or may not mature properly, as shown in many studies.^{3,4}

In real life, many patients with end-stage renal disease do not have ideal venous access. Their veins often become weak, scarred, or narrowed because of repeated cannulations, blood sampling, and long-term dialysis complications.⁵ In the past, surgeons have avoided such suboptimal veins. Instead, they would create a graft or insert a catheter because they believed that small veins would not support a proper fistula.⁶ However, in

recent years, some new ideas have emerged. Several studies suggest that even small or borderline veins can be used if they are improved during surgery. One such method is performing on-table venoplasty using a balloon. This gentle stretching of the vein can sometimes help the vein open up and mature better than it would otherwise. Similar techniques using Fogarty embolectomy catheters for intraoperative venous dilatation have also been described in previous studies by Li et al. and Jin et al., in which small-calibre cephalic veins were mechanically expanded before AVF creation. These studies suggest that controlled low-pressure venous expansion may improve fistula maturation in selected patients with suboptimal veins.¹⁶

With this background, our study was planned to determine whether venoplasty using a Fogarty embolectomy catheter could help upgrade small cephalic veins enough to create a usable AV fistula. The Fogarty catheter is simple, easily available, and much cheaper than regular angioplasty balloons. Therefore, it may offer a practical option in low-resource setups. This study focused on determining whether this technique can help improve early outcomes in patients with suboptimal veins who still require an AVF for dialysis access.

Methodology

After obtaining approval from the institutional review board and ethics committee, a quasi-experimental trial was initiated at the Department of General and Vascular Surgery for a period of six months from June 2025 to December 2025. This manuscript was prepared in accordance with the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) guidelines. This was a quasi-experimental, non-randomized comparative study. No random sequence generation, allocation concealment, or participant blinding was performed. The sample size was calculated using the WHO calculator. The patency in the non-angioplasty group was P1=92.5%, and in the angioplasty group, it was P2=83.9%. The power of the test was 80% (16). The sample size was calculated to be 21 in each group, making a total sample size of 42.

Patients were consecutively recruited from eligible candidates undergoing first-time native AVF creation during the study period. Group allocation was non-randomized and based on a predefined cephalic vein diameter criterion measured during pre-operative/on-table venous mapping by the operating surgeon. Patients with suitable cephalic veins measuring > 3.0 mm were assigned to Group A (control group) and underwent standard AVF creation without venoplasty. Patients with suboptimal cephalic veins measuring 1.5–3.0 mm were assigned to Group B, the intervention group, and underwent Fogarty catheter-assisted venoplasty before AVF creation. Veins measuring less than 1.5 mm were considered unsuitable for AVF creation and were excluded from the study.

This allocation method was selected because the intervention was specifically intended for suboptimal veins. Therefore, random assignment was not performed. To reduce selection and assessment bias, the same eligibility criteria, operative setting, surgeon-led venous assessment, AVF creation technique, postoperative care protocol, and six-week duplex follow-up protocol were applied to both groups. Six-week postoperative vein diameter and flow were assessed by a consultant radiologist who was blinded to whether Fogarty venoplasty had been performed.

Before surgery, a detailed history will be taken. Clinical examination and on-table venous duplex, along with venous mapping, will be done by the operating surgeon. An end-to-side fistula using Prolene 6/0 will be created between the cephalic veins of the arm or forearm and arteries (radial/brachial). Patency of all veins will be confirmed by checking the free flow of injected heparinised saline into their lumens using 3 or 4 Fr. nasogastric tubes. A straightforward end-to-side fistula without any intervention will be created in group A. In group B, 3 Fr Fogarty embolectomy catheter will be used for Venoplasty. Fogarty's balloon will contain 0.5 ml saline. The Fogarty catheter was not used as a high-pressure angioplasty device. Instead, it was used for gentle low-pressure sequential venous dilatation. This technique was adopted from previously published studies using Fogarty-assisted venous expansion during AVF creation in patients with small-calibre veins. Each venous segment will be distended for 10 sec before moving forward. A total of 15 cm venous segment will be distended sequentially in the same way. After that, an end-to-side AVF will be created like group A. The presence of palpable thrill in the venous segment will indicate a successful procedure. All patients will receive tab Ecasil 600 mg bd for one week and Aspirin 75 mg od for four weeks in post op period. At 6 weeks post op, fistula vein diameter and flow rate will be determined by a consultant radiologist with at least five years of experience in performing fistula duplex studies. The radiologist will be blind to whether angioplasty was done in a specific patient or not.

Statistical Plan: To analyse the characteristics of the two groups, continuous variables were compared using the t-test, and categorical variables were compared using the chi-square test. In all tests, statistical significance was defined as a two-tailed p-value <0.05. Statistical analysis was performed using IBM SPSS ver. 20.0 (IBM Co., Armonk, NY, USA). The analysis mainly focused on comparing pre-operative measurements, post-operative vein diameters, flow rates at six weeks, and the rate of complications in the two groups. This study aimed to determine whether venoplasty with the Fogarty catheter has any advantage over the standard method in the early maturation phase of the AV fistula.

Results

There were 42 patients in total, with 21 patients in each group. The mean age of the study population was 53.47 ± 11.84 years old. There were 23 males (54.8%) and 19 females (45.2%) in the study. The mean duration of dialysis was 2.62 ± 1.44 months. Twenty-seven patients (64.3%) had hypertension, 21 (50.0%) had diabetes mellitus, and 16 (38.1%) had ischaemic heart disease. A permcath was present on the right side in 32 patients (76.2%) and on the left side in 10 (23.8%). Nineteen patients (45.2%) were receiving antiplatelet therapy at the time of the surgery. Nineteen (45.2%) and 23 (54.8%) patients underwent radiocephalic and brachiocephalic AVF creation, respectively. All fistulas included in this study were first-time vascular access procedures. The group-wise distribution of these variables is presented in Table 1. During the course of the trial, there was no perioperative mortality or morbidity. Throughout the whole trial period, a total of 15 patients (71.4%) had complications of any kind. In the Fogarty group, there were 9 (42.9%) problems, compared to 6 (28.6%) in the control group. Bruising and bleeding were unaffected by this change (p values = 0.259 and 1.00, respectively). Figure 1 shows further distribution of different types. The percentage of aided operations carried out in the Fogarty group was substantially greater (61.9% vs 19%, value=0.003). At six weeks, the average vein diameter across all instances was 4.79 ± 1.14 mm. It was 4.84 ± 1.16 mm in the Fogarty group, while it was 4.73 ± 1.15 mm in the control group. (p -value = 0.76) The difference was insignificant. The flow at 6 weeks was higher in the Fogarty group (57.1%) when compared to the control group (28.6%); the difference was insignificant (p value = 0.061). Further distribution is shown in Table II. Follow-up in this pilot study was primarily focused on early AVF maturation outcomes assessed at six weeks after surgery. Long-term follow-up beyond this period was not consistently available for all patients.

Table 1: Demographic and baseline characteristics of patients in both groups (n = 42)

S. No.	Variable	Fogarty venoplasty group (n = 21)	Control group (n = 21)	p-value
1	Age, years	54.52 ± 13.29	52.43 ± 10.41	0.570
2	Male gender, n (%)	12 (57.1%)	11 (52.4%)	0.757
	Female gender, n (%)	9 (42.9%)	10 (47.6%)	
3	Dialysis duration, months	1.95 ± 0.80	3.29 ± 1.65	0.002
4	Diabetes mellitus, n (%)	10 (47.6%)	11 (52.4%)	0.758
5	Hypertension, n (%)	15 (71.4%)	12 (57.1%)	0.334
6	Ischemic heart disease, n (%)	10 (47.6%)	6 (28.6%)	0.204
7	Radiocephalic AVF, n (%)	9 (42.9%)	10 (47.6%)	0.757
	Brachiocephalic AVF, n (%)	12 (57.1%)	11 (52.4%)	
6	Arterial diameter, mm	2.59 ± 0.45	2.60 ± 0.48	0.890
7	Right-sided permcath, n (%)	15 (71.4%)	17 (81.0%)	0.469
	Left-sided permcath, n (%)	6 (28.6%)	4 (19.0%)	
8	On antiplatelets, n (%)	10 (47.6%)	9 (42.9%)	0.757
9	Vein diameter, mm	2.18 ± 0.42	2.23 ± 0.47	0.730

AVF: arteriovenous fistula.

Table 2: Vein diameter and flow in two groups at 6 weeks (n=42)

S.no	Variable	Fogarty Group n= 21	Control group n=21	p value
1	Vein diameter (mm)	4.84 ± 1.16	4.73 ± 1.15	0.76
2	Flow			0.061
	<600 ml	9(42.9%)	15 (71.4%)	
	≥600 ml	12 (57.1%)	6(28.6%)	

Discussion

The NKF KDOQI recently relabeled its “fistula first initiative” as “Fistula First Catheter Last Initiative.”⁷ The foundation greatly stresses that, whenever possible, autogenous AVF’S should be preferred over grafts and central catheters.⁸ The selection of a suitable calibre vein remains one of the most significant determinants of successful fistula creation.⁹ Several studies suggest that veins of at least 2.0 mm at the wrist and 2.5 mm at the elbow should be chosen.² Unfortunately, patients with ESRD belong to a frail population. Regular blood sampling and intravenous injections can severely thrombose or inflame the arm and forearm veins. Traditionally, vascular access surgeons have avoided such thick-walled suboptimal veins and resorted to grafts or catheter placements.¹⁰

In the recent past, balloon-assisted maturation was introduced as a possible salvage procedure for such patients with suboptimal veins.^{3,11} Less than 3 mm veins underwent pneumatic dilation using angioplasty balloons. This barotrauma-induced injury to venous endothelium converted veins into collagen-lined fibrous conduits for dialysis. Although not ideal, such conduits can buy some time for a sick patient before their permanent dependence on grafts and a central venous catheter.^{12,13} In 2013, Veroux et al. suggested that before fistula formation, primary balloon angioplasty of less than 2 mm cephalic veins dramatically improved primary patency and maturation time. It also decreased procedures for assisted maturation.³ They used a standard angioplasty balloon 4 into 150 mm to dilate the whole segment of cephalic vein from wrist to elbow (PBA Group). The control group underwent traditional hydrostatic dilatation (HD Group) ($p < 0.04$). Fistula maturation time was 32 days in the PBA GROUP and 55 days in the HD group. This coincided with our findings, where, despite initial suboptimal diameters, 6 weeks after intervention, group B had similar outflow (p value 0.061) and comparable diameter (p value 0.76) to group A. 18 out of 42 patients (12 from the Fogarty group and 6 from the control group) had a flow rate of less than 600ml/sec at the sixth week. All of these were radio-cephalic fistulae. As per standard texts, the expected maturation time of radio-cephalic fistulae is 12 weeks. Flows of 600ml or less in such a fistula in the sixth week do not indicate failure or warrant any intervention in this time frame.

Garcia et al. performed balloon angioplasties in sixty-two patients through venous ends for a segment of 8 cm. All patients underwent sequential BAM. This combination of peroperative angioplasty followed by sessions of BAM can lead to a success rate of more than 90 percent success rate in autogenous fistulas.¹⁴

A few years ago, Jinn et al. introduced another novel technique in which a Fogarty embolectomy catheter was used instead of a standard angioplasty balloon.^{15,16} First introduced in 1890, these balloon catheters are safe for all vessel-related manoeuvres. Compared to angioplasty balloons, Fogarty catheters are more cost-effective and easily available.¹⁵ Using them also circumvents the need for sophisticated equipment, such as guide wires and image intensifiers. In a study by Jin et al., the Fogarty group also had smaller incisions and shorter procedural time.

In this study, the average age of participants was 53.44±11.84 years. All patients were undergoing fistula creation surgery for the first time. Radiocephalic AVF was the first choice in all cases, but many patients had less than 1.5 mm forearm cephalic veins. In this subset, brachiocephalic fistulas were created. In a study by Jinn et al., more brachiocephalic than radiocephalic fistulas were created for similar reasons. Patients were closely followed for complications like bruising, haematoma, or pseudo-aneurysm formation. In accordance with existing literary evidence, no significant difference in post op complications was noted.¹⁷⁻¹⁹ At the 6th week follow-up, despite incongruity in preoperative venous diameters, no significant differences were found in both groups in terms of fistula vein diameter and flow rate. This indicated that peroperative Venoplasty using Fogarty embolectomy catheter can improve primary maturation rates in suboptimal veins.²⁰

The main limitation of this pilot study was its small sample size and short follow-up period. Outcomes were mainly assessed at six weeks after AVF creation, and complete long-term follow-up data beyond this period were not consistently available. Therefore, the long-term patency and durability of assisted fistula maturation could not be assessed.

Conclusions

Fogarty catheter-assisted venoplasty appears to be a feasible and safe intraoperative adjunct for arteriovenous fistula creation in selected patients with suboptimal cephalic veins. In this pilot study, six-week vein diameter was comparable between the Fogarty venoplasty and control groups, while a higher proportion of patients in the Fogarty group achieved flow ≥ 600 mL/min; however, this flow difference did not reach statistical significance. Larger, adequately powered studies with longer follow-up are required to determine whether this technique improves fistula maturation, functional patency, and long-term access outcomes.

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