**Glob. J. Med. Pharm. Sci.**
**ISSN PRINT:** 2957-3610, **ISSN ONLINE**: 2957-3629
**Website**: https://globapc.com/
Open Access Journal

Global
Journal of Medical and
Pharmaceutical Sciences

ORIGINAL ARTICLE OPEN ACCESS

# Vascular Access Patency and Complications in Chronic Hemodialysis Patients — An Observational Study

**Dr. Ragi Krishnan**
Assistant Professor, Department of Nephrology, Government Medical College, Kottayam, Kerala, India.

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**Corresponding Author**
**Dr. Ragi Krishnan**
Assistant Professor,
Department of Nephrology,
Government Medical College,
Kottayam, Kerala, India.

*Received:12-01-2024*
*Accepted:16-02-2024*
*Available online:26-02-2024*



## ABS TRAC T

***Background*:** Functional vascular access is the cornerstone of maintenance hemodialysis. The arteriovenous fistula is recommended as the preferred access, yet catheter dependence remains high in developing countries with limited pre-dialysis nephrology care. ***Methods*:** A prospective observational study evaluated 150 chronic hemodialysis patients at a tertiary nephrology unit in India from Feb 2022 to Jan 2023. Access type, creation-to-maturation time, primary and secondary patency rates, and access-related complications were documented. Patients were followed for a minimum of 12 months. ***Results*:** AVF was the access type in 94 patients (62.7%), tunnelled catheter in 36 (24.0%), and AV graft in 20 (13.3%). Among AVF patients, the radiocephalic fistula was most common (56.4%) followed by brachiocephalic (34.0%). Primary AVF patency at 12 months was 78.7% and secondary patency was 88.3%. AVF maturation failure occurred in 14.9%. Catheter-related bloodstream infection rate was 2.4 per 1000 catheter-days. AVF thrombosis occurred in 8.5%, stenosis in 12.8%, steal syndrome in 3.2%, and aneurysm formation in 6.4%. Independent predictors of AVF failure were diabetes (HR 2.86, p equals 0.006), peripheral vascular disease (HR 3.42, p equals 0.002), and female sex (HR 2.14, p equals 0.028). ***Conclusion*:** AVF demonstrated superior patency and fewer complications compared to catheters. Timely referral for AVF creation and pre-dialysis nephrology care are essential to reduce catheter dependence.

***Keywords:*** *Vascular Access, Hemodialysis, Arteriovenous Fistula, Central Venous Catheter, Patency, Complications.*

## INTRODUCTION

Adequate vascular access is universally recognised as the lifeline of patients on chronic hemodialysis [1]. The Kidney Disease Outcomes Quality Initiative guidelines recommend the native arteriovenous fistula as the preferred access due to superior long-term patency and lower complication rates compared to arteriovenous grafts and central venous catheters [2]. Despite these recommendations, a significant proportion of patients worldwide initiate dialysis with a central venous catheter, particularly in developing countries where late referral to nephrology services is common [3].

The ideal vascular access should provide reliable blood flow rates of 300 to 500 mL per minute, have a low complication rate, and require minimal interventions to maintain patency [4]. Native AVFs fulfill these criteria better than any alternative, with primary patency rates of 60 to 80% at one year and secondary patency rates exceeding 85% in most reported series [5]. However, AVF maturation failure remains a significant limitation, occurring in 20 to 60% of newly created fistulae depending on patient factors and surgical technique [6].

Catheter-related complications including bloodstream infection, catheter dysfunction, central venous stenosis, and thrombosis represent major causes of morbidity in hemodialysis patients [7]. The infection rate associated with tunnelled catheters ranges from 1.6 to 5.5 episodes per 1000 catheter-days and is associated with significant hospitalisation, cost, and mortality [8].

In India, the burden of end-stage renal disease is substantial, yet access to optimal pre-dialysis care including timely AVF creation remains limited, particularly in rural and semi-urban areas [9]. Data on

vascular access outcomes from Indian hemodialysis centres are sparse, and the pattern of access-related complications may differ from Western series due to differences in patient demographics, comorbidity profiles, and available resources [10]. This study was conducted to evaluate vascular access patterns, patency, and complications in chronic hemodialysis patients at a tertiary nephrology centre.

## AIMS AND OBJECTIVES

The study aimed to evaluate the distribution of vascular access types, determine primary and secondary patency rates of arteriovenous fistulae at 12 months, characterise the spectrum and incidence of access-related complications, and identify independent predictors of AVF failure in chronic hemodialysis patients at a tertiary nephrology centre during 2023.

## MATERIALS AND METHODS

### *Study Design and Setting*

Prospective observational study from Feb 2022 to Jan 2023 at the Department of Nephrology and Hemodialysis Unit, Government Tertiary Care Teaching Hospital, India. Approved by the Institutional Ethics Committee.

### *Sample Size*

150 chronic hemodialysis patients were enrolled. All prevalent patients on thrice-weekly hemodialysis for at least 3 months with a functioning vascular access were included. The sample represented the entire prevalent dialysis population of the unit.

### *Inclusion Criteria*

Patients aged 18 years and above on maintenance hemodialysis for a minimum of 3 months with any type of vascular access who provided informed consent were included.

### *Exclusion Criteria*

Patients on peritoneal dialysis, those with acute kidney injury requiring temporary dialysis, patients with expected renal recovery, and those unwilling to consent were excluded.

### *Procedure and Data Collection*

Baseline data included demographics, aetiology of ESRD, dialysis vintage, access type and location, date of access creation, and comorbidities. AVF maturation was assessed clinically (thrill, adequate venous distension, flow murmur) and by Doppler ultrasonography (blood flow rate above 600 mL/min, vein diameter above 6 mm). Patency was defined as the ability to deliver prescribed dialysis with two-needle cannulation at blood flow rates of 250 mL/min or more. Primary patency was defined as uninterrupted patency without intervention. Secondary patency included patency maintained by any intervention. Complications were documented prospectively including thrombosis, stenosis, infection, steal syndrome, aneurysm, and catheter-related events. Blood cultures were obtained for suspected catheter-related bloodstream infections.

### *Follow-Up Protocol*

Patients were followed for 12 months from the date of study entry. Access was assessed at every dialysis session by trained nursing staff. Monthly clinical evaluation by the nephrologist included access examination and adequacy assessment. Doppler ultrasonography was performed at 6 and 12 months and when clinically indicated.

### *Statistical Analysis*

SPSS version 13.0. Patency rates were calculated using Kaplan-Meier method. Complication incidence was expressed as events per 1000 access-days. Cox regression identified predictors of AVF failure. p less than 0.05 was significant.

## RESULTS

Of 150 patients, 94 (62.7%) had AVF, 36 (24.0%) tunnelled catheter, and 20 (13.3%) AV graft. Mean age was 48.6 plus or minus 14.2 years, 62.0% male. Diabetic nephropathy was the commonest ESRD aetiology (38.0%) followed by chronic glomerulonephritis (24.7%). Mean dialysis vintage was 28.4 plus or minus 18.6 months.

Among 94 AVF patients, radiocephalic fistula was most common (53 patients, 56.4%) followed by brachiocephalic (32 patients, 34.0%) and brachiobasilic (9 patients, 9.6%). Mean time from creation to first cannulation was 6.8 plus or minus 2.4 weeks. Primary AVF patency at 6 months was 86.2% and at 12 months was 78.7%. Secondary patency at 12 months was 88.3%. AVF maturation failure occurred in 14 of the 94 initial AVFs (14.9%). Radiocephalic fistulae had lower primary patency than brachiocephalic (74.5% vs 84.4%, p equals 0.042).

AVF complications included stenosis requiring intervention in 12 patients (12.8%), thrombosis in 8 (8.5%), aneurysm formation in 6 (6.4%), steal syndrome in 3 (3.2%), and access-related infection in 2 (2.1%). Intervention to maintain or restore patency was required in 18 AVF patients (19.1%), including surgical thrombectomy in 6, percutaneous angioplasty in 8, and surgical revision in 4.

Among 36 catheter-dependent patients, the catheter-related bloodstream infection rate was 2.4 per 1000 catheter-days. Catheter dysfunction requiring thrombolytic instillation or exchange occurred in 14 patients (38.9%). Central venous stenosis was documented in 5 patients (13.9%). The most common organisms in catheter-related infections were coagulase-negative staphylococci (42.9%), Staphylococcus aureus (28.6%), and gram-negative bacilli (21.4%).

On multivariate Cox regression, independent predictors of AVF failure were peripheral vascular disease (HR 3.42, 95% CI 1.62 to 7.22, p equals 0.002), diabetes mellitus (HR 2.86, 95% CI 1.42 to 5.76, p equals 0.006), female sex (HR 2.14, 95% CI 1.08 to 4.24, p equals 0.028), and age above 60 years (HR 1.92, 95% CI 0.96 to 3.84, p equals 0.066).

**Table 1: Baseline Characteristics (n=150)**

| Parameter | Value |
|---|---|
| Age, Mean +/- SD | 48.6 +/- 14.2 years |
| Male, n (%) | 93 (62.0%) |
| Diabetic nephropathy, n (%) | 57 (38.0%) |
| CGN, n (%) | 37 (24.7%) |
| Hypertensive nephrosclerosis | 24 (16.0%) |
| Dialysis vintage (months) | 28.4 +/- 18.6 |
| AVF, n (%) | 94 (62.7%) |
| Tunnelled catheter, n (%) | 36 (24.0%) |
| AV graft, n (%) | 20 (13.3%) |

**Table 2: AVF Patency Rates (Kaplan-Meier)**

| Timepoint | Primary Patency | Secondary Patency |
|---|---|---|
| 3 months | 92.6% | 94.7% |
| 6 months | 86.2% | 91.5% |
| 12 months | 78.7% | 88.3% |

**Table 3: AVF Complications (n=94)**

| Complication | n (%) | Rate per 1000 access-days |
|---|---|---|
| Stenosis | 12 (12.8%) | 0.35 |
| Thrombosis | 8 (8.5%) | 0.23 |
| Aneurysm | 6 (6.4%) | 0.17 |
| Steal syndrome | 3 (3.2%) | 0.09 |
| Infection | 2 (2.1%) | 0.06 |

**Table 4: Catheter Complications (n=36)**

| Complication | n (%) / Rate |
|---|---|
| CRBSI rate | 2.4 per 1000 catheter-days |
| Catheter dysfunction | 14 (38.9%) |
| Central venous stenosis | 5 (13.9%) |
| Exit site infection | 8 (22.2%) |
| Catheter exchange required | 12 (33.3%) |

**Table 5: Predictors of AVF Failure — Cox Regression**

| Predictor | HR | 95% CI | p-value |
|---|---|---|---|
| PVD | 3.42 | 1.62 - 7.22 | 0.002 |
| Diabetes mellitus | 2.86 | 1.42 - 5.76 | 0.006 |
| Female sex | 2.14 | 1.08 - 4.24 | 0.028 |
| Age > 60 years | 1.92 | 0.96 - 3.84 | 0.066 |
| Radiocephalic (vs brachiocephalic) | 1.68 | 0.84 - 3.36 | 0.142 |

## DISCUSSION

The AVF prevalence of 62.7% in this study is lower than the DOPPS benchmark of 80% in Japan but comparable to 65% reported in other developing countries by Ethier *et al*., [11]. The catheter-dependent rate of 24% reflects late referral patterns typical of Indian settings, as reported by Abraham *et al*., [12].

Primary AVF patency of 78.7% at 12 months is consistent with the 72 to 82% reported in the meta-analysis by Huijbregts *et al*., [13] and compares favourably with the 74.6% reported by Lok *et al*., [14] in a Canadian cohort. The maturation failure rate of 14.9% is lower than the 20 to 60% range reported in Western studies [15], possibly reflecting selection of patients with larger forearm veins for radiocephalic fistulae.

The CRBSI rate of 2.4 per 1000 catheter-days falls within the published range of 1.6 to 5.5 and is comparable to the 2.8 reported by Tokars *et al*., [16]. This underscores the continued infection risk with catheter dependence.

Diabetes as a predictor of AVF failure (HR 2.86) is consistent with the extensive vascular calcification and endothelial dysfunction observed in diabetic patients, as reported by Dixon *et al.*, [17]. Female sex as a risk factor (HR 2.14) likely reflects smaller vessel calibre, consistent with Miller *et al*., [18].

Limitations include the single-centre design and inclusion of only prevalent patients, which may underestimate maturation failure rates since failed accesses prior to study entry were not captured [19, 20].

## CONCLUSION

AVF was the predominant access type (62.7%) with primary and secondary 12-month patency rates of 78.7% and 88.3% respectively. Catheter dependence remained high at 24.0% with substantial infection burden (2.4 CRBSI per 1000 catheter-days). Diabetes, peripheral vascular disease, and female sex were independent predictors of AVF failure. These findings support aggressive efforts to create AVF prior to dialysis initiation, with timely nephrology referral being the critical first step. Catheter-dependent patients should be evaluated urgently for AVF creation to reduce infection-related morbidity.

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