

A STUDY ON FACTORS AFFECTING THE ARTERIOVENOUS FISTULA IN HEMODIALYSIS PATIENTS

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ABSTRACT

Background:

Chronic Kidney Disease (CKD) is a significant global health problem, with many patients eventually progressing to end-stage renal disease (ESRD) requiring haemodialysis. The arteriovenous fistula (AVF) is the preferred vascular access for these patients due to its superior longevity and lower complication rates. However, numerous factors can affect AVF maturation and long-term function, including patient demographics, clinical history, and comorbidities such as diabetes and hypertension.

Methods:

This observational study included 75 haemodialysis patients from the School of Allied Health Sciences, Puducherry, between December 2024 and June 2025. Data were collected on age, gender, AVF type and location, duration of dialysis, comorbidities, cannulation techniques, smoking history, and postoperative care. Social and clinical characteristics were analysed, along with surgical and procedural outcomes. The maturation and failure rates of AVFs were measured and factors associated with dysfunction were statistically evaluated.

Results:

AVF failure occurred in 15 patients, yielding a failure rate of 20%. The majority of failures were associated with comorbid conditions, especially diabetes and hypertension. AVF maturation was achieved within 4–6 weeks in most cases. Radio cephalic and brachiocephalic fistulas were most frequently observed, with cannulation technique and proper fistula care significantly impacting outcomes. Smoking, older age, and poor nutritional status were correlated with increased failure rates.

Conclusion:

Effective AVF maturation and long-term functionality are influenced by patient-related factors and postoperative management. Early identification and intervention for at-risk patients can improve vascular access outcomes and reduce complication rates in haemodialysis.

Keywords:

Chronic Kidney Disease, end-stage renal disease, arteriovenous fistula, haemodialysis, vascular access, AVF failure, risk factors, comorbidities.

INTRODUCTION

The kidneys are two reddish-brown, bean-shaped organs located in the retroperitoneal space, just below the rib cage on either side of the spine. Each kidney measures approximately 10–12 cm in length and weighs 125–170 grams in adults. They receive blood from the paired renal arteries, and blood exits via paired renal veins. The kidneys are connected to the bladder by ureters, tubes that carry excreted urine.

The nephron, the structural and functional unit of the kidney, is present in roughly one million copies per adult kidney. The kidney regulates fluid volume, osmolality, acid-base balance, electrolyte concentrations, and the elimination of toxins. Filtration occurs in the glomerulus, where about one-fifth of the blood volume entering the kidneys is filtered. Substances like solute-free water, sodium, bicarbonate, glucose, and amino acids are reabsorbed in the nephron tubules.(1). Dialysis is a procedure for patients with severe renal failure to remove waste, toxins, and excess fluids, and to

maintain normal blood composition. Haemodialysis uses an external machine and dialyzer filter to clean the blood, maintain electrolyte balance, and regulate blood pressure when kidney function is inadequate.(2)

Vascular access is essential for haemodialysis. The arteriovenous fistula (AVF), a surgically created connection between an artery and a vein, is the preferred permanent vascular access because of its durability and lower complication rates. Temporary access, such as central venous catheters (CVC), is associated with higher rates of infection and thrombosis.(3). chronic kidney disease (CKD) is a major global health issue, with many patients progressing to end-stage renal disease (ESRD), requiring haemodialysis. AVF remains the gold standard for vascular access in ESRD due to its better outcomes. Factors affecting AVF maturation and function include patient characteristics such as age, gender, comorbidities, vessel anatomy, and postoperative care.(4)

METHODS AND METHODOLOGY

This prospective observational study was designed to identify and evaluate the factors affecting arteriovenous fistula (AVF) failure and maturation in patients undergoing haemodialysis. The investigation was conducted from December 2024 to June 2025 in the Dialysis unit of the Department of Nephrology, Mahatma Gandhi Medical College and Research Institute, including a total of 75 patients diagnosed with end-stage renal disease (ESRD) and receiving maintenance haemodialysis through an AVF. The inclusion criteria targeted adult patients (aged 18 and above) on maintenance haemodialysis with a functioning AVF. Individuals with central venous catheters or arteriovenous grafts as their primary vascular access were excluded from the analysis. Comprehensive data were collected using structured questionnaires designed for the study. The variables recorded comprised demographic information (age, gender), clinical history (comorbidities such as diabetes, hypertension, cardiovascular disease, vascular disease, and smoking status), surgical details (type and anatomical location of AVF—radio cephalic, brachiocephalic, or brachioradialis), and cannulation techniques employed during haemodialysis. Postoperative monitoring focused on AVF maturation time, defined as the duration until successful use for dialysis. Complications such as thrombosis, stenosis, and infection were systematically documented throughout follow-up. These robust methodological steps ensured the reliability and validity of the study outcomes, facilitating the identification of risk factors relevant to clinical management of vascular access in ESRD patients

STATISTICAL ANALYSIS

The statistical analysis for this prospective observational study focused on determining the factors contributing to arteriovenous fistula (AVF) failure and maturation in haemodialysis patients. Descriptive statistics were employed to summarize demographic and clinical characteristics such as age, gender, duration of dialysis, comorbidities, smoking history, AVF type, cannulation technique, and complications. Frequency distributions and percentages provided a clear understanding of the study population: for instance, 74% of patients were male and 26% were female, with the majority aged 45–55 years .Categorical variables like AVF maturation time, type, cannulation techniques, and complication rates were analysed using proportions. AVF maturation within 4–6 weeks was observed in 63% of patients, while 37% took longer. Radio cephalic fistulas were present in 36% of cases and brachiocephalic in 44%, with the remaining 20% having both types. Techniques such as area puncture, rope ladder, and buttonhole were evaluated for their association with AVF failure. Area puncture showed the highest failure rate at 12%, consistent with previous studies .For

complication analysis, poor blood flow and thrombosis emerged as the most frequent problems, accounting for 38% and 26%, respectively. The overall AVF failure rate was calculated at 20%. Associations of AVF failure with risk factors—such as older age, diabetes, smoking history, and cannulation method—were explored through cross-tabulation and comparative percentages. This approach allowed identification of high-risk subgroups and procedural factors linked to adverse outcomes, informing targeted strategies to improve vascular access in haemodialysis patients.

RESULT

This observational study included 75 patients undergoing hemodialysis with factors affecting arteriovenous fistula (AVF). The results are presented based on various factors including age, gender, smoking history, AVF maturation time period, type of AVF, cannulation techniques, and complications.

CHARACTERISTICS	NO.OF. PATIENTS
AGE	
20 - 35 Years	8
35 - 45 Years	25
45 - 55 Years	31
55 - 70 Years	11
GENDER	
MALE	51
FEMALE	24

TABLE 5.1: SOCIAL CHARACTERISTICS OF THE PATIENTS

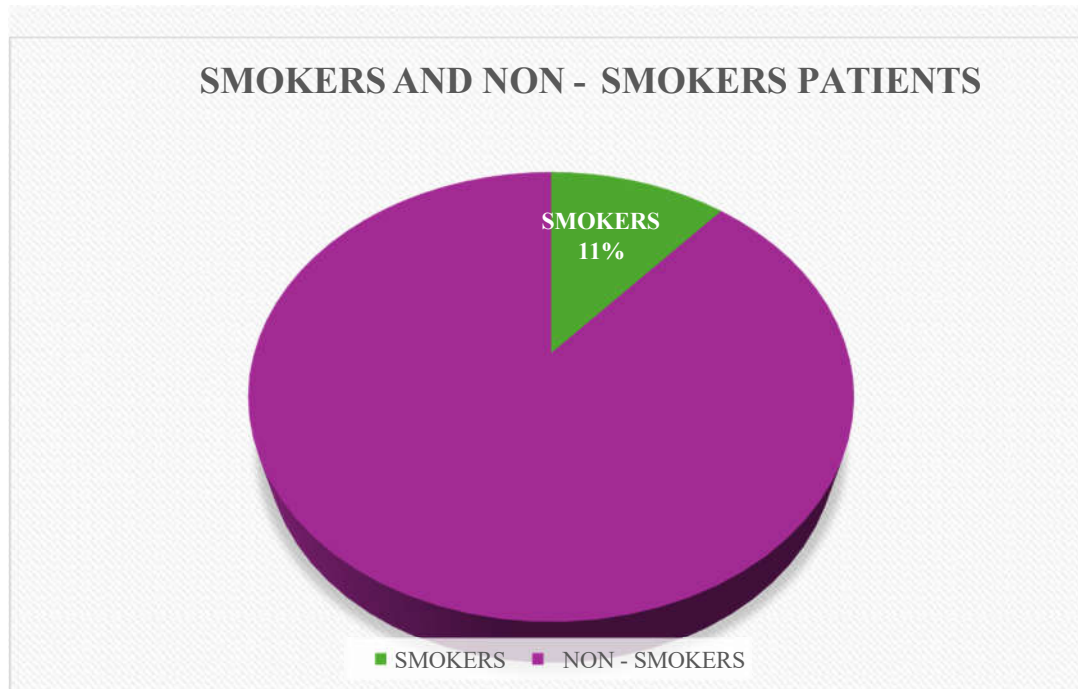
SOCIAL CHARACTERISTICS OF THE PATIENTS: The study included a age group of patients, the majority being between 45 - 55 years and the sample consists of men 74% and women 26.%

CHARACTERISTICS	NO. OF. PATIENTS
DURATION OF DIALYSIS	
LESS THAN 6 MONTHS	9
6 - 12 MONTHS	12
1 - 2 YEARS	33
More than 2 years	21
COMORBIDITIES OF PATIENTS	
DIABETES MELLITUS	60
HYPERTENSION	
CARDIOVASCULAR DISEASE	12
PERIPHERAL VASCULAR DISEASE	3

TABLE 5.2: CLINICAL DEMOGRAPHICS OF THE PATIENTS

CLINICAL DEMOGRAPHICS OF THE PATIENTS:

Patients were selected for the study based on the duration of hemodialysis less than 6 months 12%, 6 - 12 months 16%, 1 - 2 years 44%, More than 2 years 28%. The most of the 60 patients were associated with Hypertension and Diabetes mellitus are 80%, heart disease 16% and Peripheral vascular disease 4%

**CHART 5.1: SMOKING HISTORY OF THE PATIENTS**

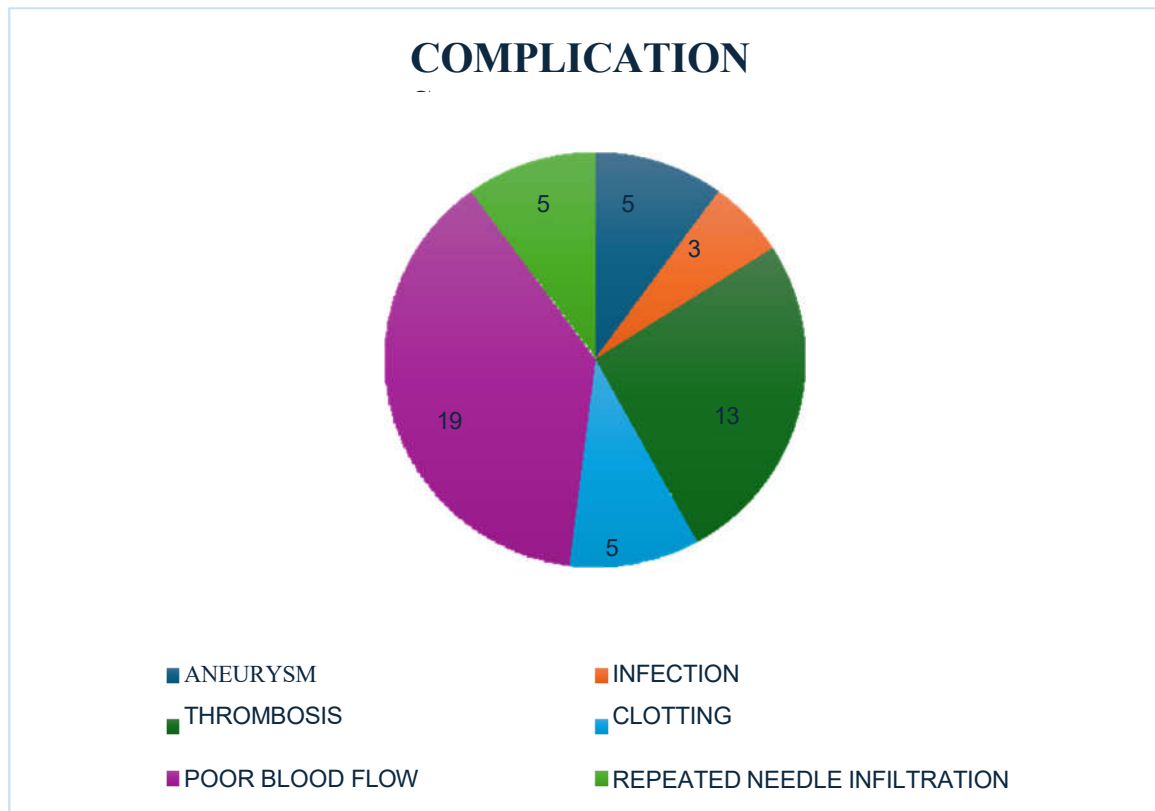
SMOKING HISTORY OF THE PATIENTS: Among the 75 patients 8 (11%) had a history of smoking and 62 (83%) are non- smokers.

CHARACTERISTICS	NO. OF. PATIENTS
MATURATION PERIOD OF AVF	
4 - 6 WEEKS	47
MORE THAN 6 WEEKS	28
AVF TYPE	
RADIOCEPHALIC	27
BRACHIOCEPHALIC	33
BOTH RADIOCEPHALIC AND BRACHIOCEPHALIC	15
CANNULATION TECHNIQUES USED FOR HD	
AREA PUNCTURE	14
BUTTON HOLE	15
ROPE LADDER	30
ALL OF THE ABOVE	16

TABLE 5.3: SURGICAL AND PROCEDURAL DATA OF THE PATIENTS

SURGICAL AND PROCEDURAL DATA OF THE PATIENTS:

Among 75 patients the time period for AV fistula maturation are 4 - 6 weeks for 47 (63%) and more than 6 weeks for 28 (37%). They are were under AV fistula types are radiocephalic consisted by 27 (36%), brachiocephalic 33 (44%) and both radio cephalic and brachiocephalic are 15(20%). The cannulation techniques are used for the patients are area puncture - 14 (18%), button hole - 15(30%), rope ladder 30(40%) and all the three techniques were used for 16(32%)

**CHART 5.2: COMPLICATION****COMPLICATIONS AT AV FISTULA SITE:**

Among 75 patients the complications related to the AV fistula were observed in 50 patients. The distribution of complication was as follows. Majority of AVF failure is due to poor blood flow rate (38%) and thrombosis (26%) and followed by aneurysm (10%), clotting (10%), repeated needle infiltration (10%) and infection (6%).

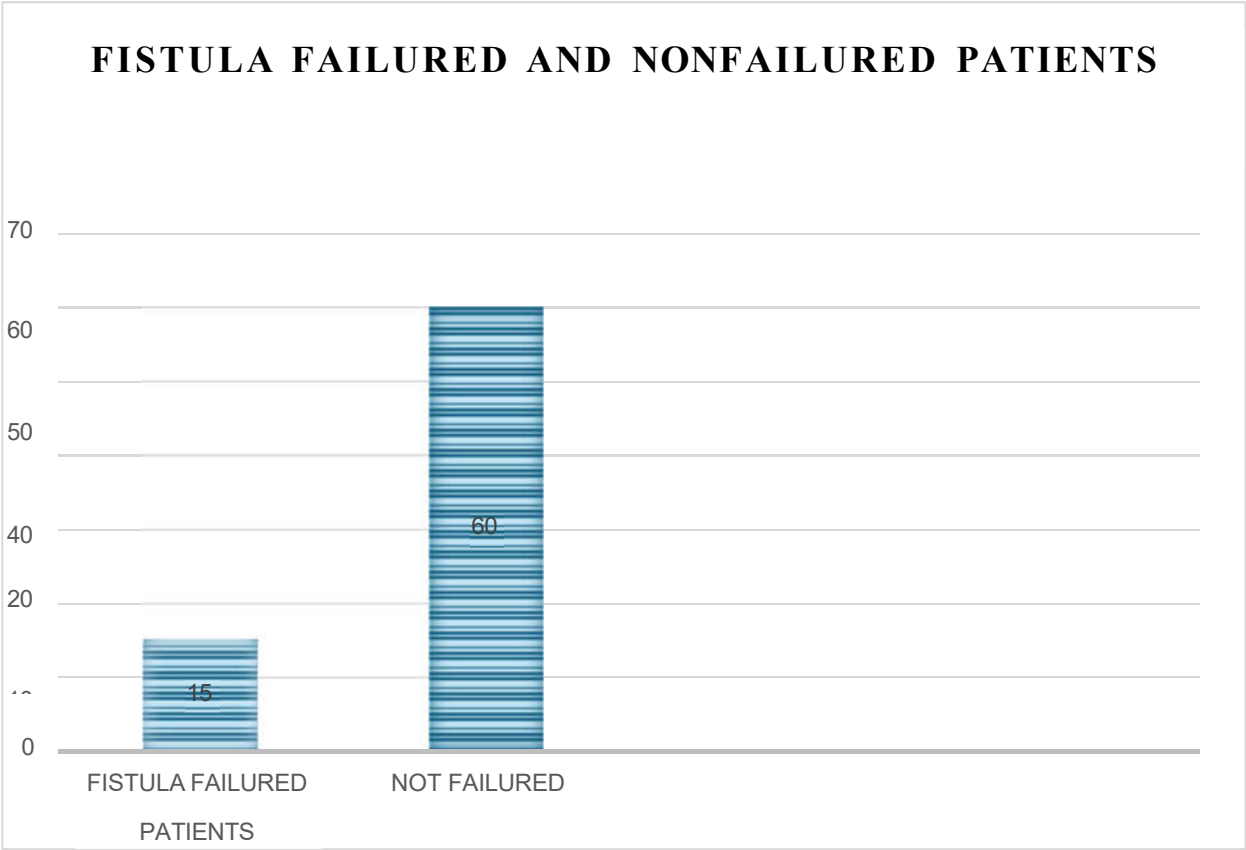


CHART 5.3: FISTULA FAILED AND NON FAILED PATIENTS
A total of 75 patients 15 have experienced a AVF failure, resulting in a failure rate of 20%.
AVF Failure Distribution by Factor

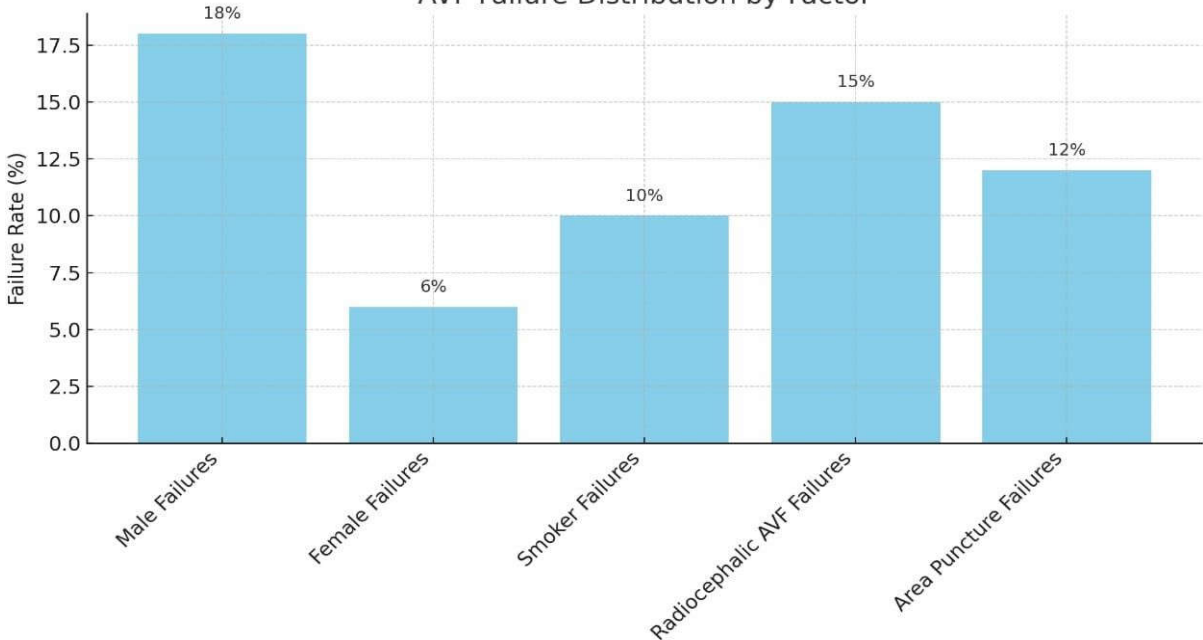


CHART 5.4: AVF FAILURE DISTRIBUTION BY FACTOR
In this the males were (12/15) 18% and (3/15) 6% were females. Smoking patients were (8/15) 10%. Failure rates were higher in radiocephalic AV fistula type (11/15) 15%. In the cannulation technique the area puncture group had the highest failure rate of (9/15) 12%. In the complications thrombosis and poor blood flow was the most complications.

DISCUSSION

This observational study evaluated factors influencing arteriovenous fistula (AVF) outcomes in haemodialysis patients, finding key associations. AVFs are favoured for vascular access due to durability, lower infection rates, and cost-effectiveness, but success relies on patient demographics, comorbidities, and procedural techniques. Most patients were aged 45–55 with a male predominance (74%), consistent with Al-Jaishi et al. (2017)(5), who noted men's larger vessel calibers support AVF placement. Gender disparities exist, with females showing higher failure rates; this study reported 6% failure in females versus 18% in males. Hypertension and diabetes were prevalent in 80%, echoing Ravani et al. (2016)(6) identifying these as major predictors of AVF outcomes. Smoking history was lower (11%), but smokers had a 10% AVF failure rate, confirming Dember et al. (2008)(7) linking smoking to endothelial dysfunction and access failure. Sixty-three percent of AVFs matured within 4–6 weeks, slightly earlier than the 6–8 weeks recommended by NKF-KDOQI guidelines, possibly due to patient or vascular factors. Brachiocephalic fistulas were more common (44%) than radiocephalic (36%), with higher failure rates in radiocephalic (15%), supporting Lok et al. (2006)(8) showing their preference for lower infection risk but increased failure in diabetics and elderly. The rope ladder technique prevailed (40%), followed by buttonhole (30%) and area puncture (18%), with the latter having the highest failures (12%), aligning with Marticorena et al. (2015)(9) associating rope ladder and buttonhole with better outcomes due to reduced trauma. Complications affected 67% of patients, mainly poor blood flow (38%) and thrombosis (26%), identified by Roy Chaudhury et al. (2014)(10) as major causes of AVF dysfunction. The overall failure rate was 20%, within the 20–30% range typical for similar studies, emphasizing the multifactorial nature of AVF success and highlighting modifiable risk factors like smoking cessation, diabetes control, and cannulation technique as essential for improving AVF longevity.

CONCLUSION

This observational study identified several key factors influencing AVF outcomes in hemodialysis patients. Older age, diabetes, smoking, and use of the area puncture cannulation technique were significantly associated with increased AVF failure. Complications like thrombosis and stenosis were common with early or improper cannulation. Skilled staff and proper technique significantly reduced the complication rates. A multi-disciplinary approach is essential for improving AVF outcomes in hemodialysis patients. Efforts should be made to optimize improve patient education, minimize complications, and promote the use of favorable cannulation techniques such as rope-ladder or buttonhole. Close monitoring of patients with risk factors can further reduce AVF failure and improve dialysis outcomes.

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