

Profile of Arteriovenous Fistula Surgery in Patients with Chronic Kidney Disease at a Tertiary Care Urology Hospital Karnataka, India: A Prospective Interventional Study

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ABSTRACT

Introduction: Haemodialysis (HD) is the most important treatment approach in patients with Chronic Kidney Disease (CKD), awaiting kidney transplantation, demanding the long-term need for dialysis access.

Aim: To study the profile of Arteriovenous Fistula (AVF) surgery in patients undergoing haemodialysis in the Karnataka region, India.

Materials and Methods: This prospective, interventional single-centre study was conducted at the Institute of Nephrology and Urology, KR Hospital Campus, Mysuru, India, from April 2018 to April 2021. All the patients undergoing haemodialysis with AVF aged between 11-90 years were included. Demographic details (age, sex, co-morbidities) and fistula-related complications associated with surgery were examined in the immediate, late, and delayed postoperative period. Categorical variables were presented as numbers and percentages whereas, continuous variables were expressed as mean {Standard Deviation (SD)}. The data was collected in excel sheet and the statistical analysis was performed using Statistical Package for Social Sciences (SPSS), version 20.0.

Results: In total, 200 patients with a mean (SD) age of 48.8 (13.0) years underwent AVF formation and the majority were below <60 years of age (n=154, 77.0%). The incidence of fistula surgery and patency rates was higher in men (n=140, 70.0%). Most patients had left non dominant arm (n=187, 93.5%) and remaining right non dominant arm (n=13, 6.5%). The most common site of AVF was left brachial cephalic (n=135, 67.5%). The most common cause of CKD was diabetes mellitus (n=90, 45.0%). The most common immediately observed complications were bleeding (n=13, 6.5%), pain (n=12, 6.0%) and oedematous limb (n=5, 5.0%). Stitch abscess was the most common late complication observed in 14 patients (7%). Rupture of the aneurysm and AVF failure were delayed complications observed in eight (1.5%) and 17 (8.5%) patients, respectively.

Conclusion: In this study, bleeding, stitch abscess and AVF failure were found to be the most common immediate, late, and delayed postoperative complications, respectively. However, more studies are required to understand the outcome of AVF in Chronic Renal Failure (CRF) patients from India.

Keywords: Aneurysm, Bleeding, Diabetes mellitus, Fistula, Haemodialysis

INTRODUCTION

Chronic Kidney Disease is a major contributor to mortality from non communicable diseases showing an increased mortality rate of 41.5% between 1990 and 2017 [1]. HD is the most important treatment approach in patients with CKD, awaiting kidney transplantation, demanding the long-term need for dialysis access [2]. However, several associated complications hamper dialysis function necessitating the establishment of AVFs [2].

An AVF is an access created by connecting a vein to an artery, where the vein is the accessible channel [3]. Radiocephalic (RC-AVF), Brachiocephalic (BC-AVF), and Brachial-Basilic (BB-AVF) are the primarily used AVFs. An AVF is the preferred mode of vascular access for HD in patients with CKD. It is favoured in most events, over arteriovenous grafts and catheters due to longer patency and lower infection risk [4,5]. An investigation from the United States (N=85, 320) showed that 77.9% of patients underwent AVF for first-time HD access, as compared to 22.1% of patients undergoing arteriovenous grafts [6]. Kidney Disease Outcomes Quality Initiative (KDOQI) suggests a reasonable use of arteriovenous access in patients with HD, provided it is coherent with their end-stage kidney disease life plan and goals of care [7]. It is reported that co-morbidities do not impact the cumulative patency or complication rates of BC-AVF [8].

Overall, there is a low rate of complications with AVF, but not limited to aneurysms, infections, steal syndrome, thrombosis, and venous

hypertension [9]. Cardiovascular complications, ischaemia, and ischaemic polyneuropathy in diabetes are other problems associated with AVF [10]. Nevertheless, a meta-analysis showed significant variability in complication rates, which may be partly attributed to the poor quality of studies, significant variability in sample populations, and uneven definitions [9]. In some cases, such as patients with diabetes mellitus, cardiovascular diseases, obesity, and peripheral vascular disease, the creation of AVF is not feasible and shows a higher rate of failure and low patency rates [11,12].

Moreover, individualised approaches to therapy, early detection, and treatment of these complications will prevent further severe events and healthcare costs [13]. Studies have reported the benefits of AVF procedure in CKD in all age groups, including paediatric and elderly patients [14,15]. Despite this, there is limited literature describing the outcomes of AVF placement in end-stage kidney failure patients; especially in the Indian population, with conflicting results. Therefore, the present study describes the profile of AVF surgery in patients undergoing HD in the Karnataka region, of India.

MATERIALS AND METHODS

This prospective, interventional single-centre study was conducted at the Institute of Nephrology and Urology, KR Hospital Campus, Mysuru, India, from April 2018 to April 2021. Patients with Modified Diet for Renal Disease estimated Glomerular Filtration Rate (GFR) below 15 mL/min were advised AVF surgery. The study was

approved by the Ethics Committee (Ethics Committee of Institute of Nephrourology: 2018/RS/005, 21 March 2018). All the patients undergoing haemodialysis with AVF during the stated period of study form the sample population.

Inclusion criteria: All the patients undergoing haemodialysis with AVF and who gave consent to participate in the study were included.

Exclusion criteria: Patients who did not give consent and underwent other types of vascular access or secondary fistula formation were excluded from the study.

Study Procedure

The dominance of the arm was determined by evaluating for functional or paralysed arm, previous vein puncture or oedema, and trauma. The non dominant hand was preferred for the creation of vascular access. Preoperative colour doppler ultrasound was performed in upper limb veins and arteries, to check for size and patency. It was done in patients showing inadequate clinical findings such as those with obesity, several preceding surgeries, lacking or feeble pulses, and indwelling dialysis catheters on the same side.

The patients undergoing AVF procedure were admitted on the day of surgery. All the AVF operations were done under local anaesthesia. The patient was kept hydrated and blood pressure was maintained within normal limits. The brachial artery, basilic, and cephalic vein were exposed by giving a transverse incision in the antecubital fossa and a further vertical incision was done in the forearm for the radial artery and cephalic vein. Based on the mobility of the target vein, anastomosis was created in end to side or side-to-side manner and a prolene 6/0 suture was employed. Haemostasis was monitored and the skin was closed using prolene 3/0. The non circular dressing was utilised, and postoperative hand exercises were advised. After dressing, bruit was heard, and thrill was felt to verify for fistula patency. If bruit and/or thrill were absent with decent venous filling, anticoagulation with low molecular weight heparin was given subcutaneously for 3-5 days, along with aspirin 75 mg once a day for 3-5 days.

Procedure failure occurred, if the fistula did not mature effectively, if dialysis was not feasible via this site, or if the intervention was required to maintain fistula function. Patients were discharged on the same or the next day after giving proper instructions about the care of hand, and feeling the thrill, and were asked to report any numbness or discolouration at the fingertips. The complications associated with surgery were examined in the immediate (after 1 week), late (after 4-6 weeks) and delayed (after 6 weeks) postoperative period. The patency of the fistulas was evaluated using either palpation, auscultation, or a doppler probe during the follow-up period.

STATISTICAL ANALYSIS

The data was collected in excel sheet and the statistical analysis was performed using SPSS, version 20.0. Categorical variables were presented as numbers and percentages whereas continuous variables were expressed as mean (SD).

RESULTS

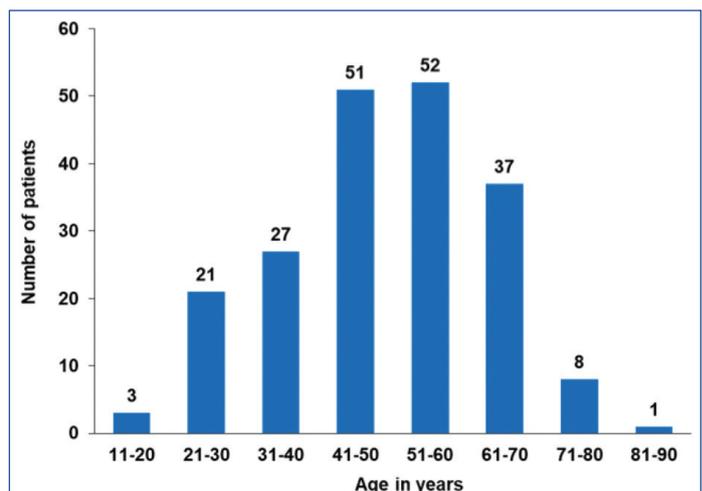
In total, 200 patients underwent AVF formation. The mean age of enrolled patients was 48.8 years [Table/Fig-1]. Majority were below <60 years of age (n=154, 77.0%) [Table/Fig-2].

The most common immediately observed complications were bleeding (n=13, 6.5%) and pain (n=12, 6.0%). Stitch abscess (n=14, 7.0%), persistent oedema (n=11, 5.5%) and aneurysm (n=8, 4.0%) were late presenting complications and rupture of aneurysm

and AVF failure were delayed complications observed in 1.5% and 8.5% patients, respectively [Table/Fig-3]. The presence of a palpable thrill and/or an audible bruit was utilised to confirm the fistula patency. Immediate patency and a palpable distal radial pulse were present in all the patients.

Parameters	Number of patients (n=200)
Age, years, mean (SD)	48.8 (13.0)
Age-wise distribution (years)	
≤60	154 (77.0)
>60	46 (23.0)
Sex	
Men	140 (70.0)
Women	60 (30.0)
Side of AVF	
Left	187 (93.5)
Right	13 (6.5)
Site of AVF	
Left Brachial Cephalic (L-BC)	135 (67.5)
Left Radiocephalic (L-RC)	27 (13.5)
Left Brachial Basilic (L-BB)	23 (11.5)
Right Brachial Cephalic (R-BC)	11 (5.5)
Right Brachial Basilic (R-BB)	2 (1.0)
Brescia-Cimino Radiocephalic (B-RC)	1 (0.5)
AVF created	1 (0.5)
Causes of chronic kidney failure	
Diabetes mellitus	90 (45.0)
Immunodeficiency	36 (18.0)
Hypertension	21 (10.5)
Both diabetes and hypertension	9 (4.5)
Glomerulonephritis	4 (2.0)
Polycystic kidney disease	4 (2.0)
Others	36 (18.0)

[Table/Fig-1]: Baseline characteristics. AVF: Arteriovenous fistula; Data is presented as n (%) unless specified



[Table/Fig-2]: Age-wise distribution of AVF surgery.

Complications	Frequency n (%)
Immediate	
Bleeding	13 (6.5)
Pain	12 (6.0)
Oedematous limb	10 (5.0)
Thrombosis	9 (4.5)
Haematoma	6 (3.0)

Late	
Stitch abscess	14 (7.0)
Persistent oedema	11 (5.5)
Aneurysm	8 (4.0)
Delayed	
Rupture of aneurysm	3 (1.5)
AVF failure	17 (8.5)

[Table/Fig-3]: Complications of arteriovenous fistula.
Data is presented as n (%)

DISCUSSION

In this study, majority of the patients undergoing AVF were between the age group of 41-60 years which corroborates with the study reported by Aljuaid MM et al., [16]. Although, other age groups had fewer patients undergoing AVF; its usability was not affected by age and is safely used in elderly and paediatric patients [14,15]. Conversely, a meta-analysis demonstrated that age was significantly associated with failure of AVF and establishing proximal autologous BC-AVF has been beneficial [17]. Additionally, increasing age is also an important factor in increasing the complication rate [18]. Salahi H et al., reported a 35% difference in complicated cases in patients >50 years and those <18 years [18].

In this study, predominantly men underwent AVF surgery as compared to women. Although, Aljuaid MM et al., reported almost similar percentages of men (49.5%) and women (50.5%), other Indian and global studies have reported male predominance [16,19-21]. It is observed that the smaller veins in women give poorer patency of distal forearm and wrist AVFs than in men hence proximal fistula is preferred for women [22]. However, Monroy-Cuadros M et al., found no significant association between gender and outcome of AVF, despite adjusting for age, diabetes mellitus, hypertension, peripheral vascular disease, smoking history, and the procedure used [23].

The most common type of AVF used in this study was left and right BC-AVF (73.0%). In contrast, other prospective hospital-based studies have reported RC-AVF as the most common type of AVF (62.6%, 54.4%) [21,24]. The major cause of CKD was diabetes mellitus (45.0%) which corroborates with other studies [19,25]. Diabetes is responsible for a variety of macrovascular and microvascular damages and has a significant association with AVF failure [26]. Nevertheless, this study does not describe any association between diabetes and AVF outcome. Nawaz S et al., reported poor outcomes for AVF in patients with diabetes [21]. Monroy-Cuadros M et al., also reported that diabetes was independently associated with loss of primary patency ($p=0.007$) [23]. Flow rates are lower in patients with diabetes as compared to patients without diabetes ($p<0.001$) [19]. However, Aljuaid MM et al., reported hypertension (41.7%) as the most prevalent associated chronic illness and more than 30.6% had multiple chronic illnesses [16]. This study also showed immunodeficiency and hypertension as common causes of CKD and some patients had both diabetes and hypertension. A study by Manne V et al., showed that hypertension was associated with reduced patency rates but age, gender, diabetes, and type of construction did not impact the patency rate [27].

The most common immediate complication reported in this study was bleeding, pain and oedematous limb. Furthermore, lately observed complications were stitch abscess, persistent oedema and aneurysm. Rupture of aneurysm and AVF failure were delayed complications. Studies commonly reported ischaemic neuropathy, aneurysm, thrombosis and infection at the site of AVF, stenosis, steal syndrome [10,16]. Nawaz S et al., reported infection and burst fistulae (4.9%), pseudo aneurysm (3.2%), and fever (4.9%) as the most frequent complications [21]. An Indian study conducted in 443 patients undergoing AVF reported steal syndrome in

6.5% patients which was not observed in the present study [19]. Another retrospective observation study reported oedema and steal phenomenon to be greater in proximal (9.3% and 16.3%, respectively) than in distal (4.4% and 10%, respectively) fistula [28]. Indeed, Salahi H et al., reported that complications frequently occurred more in patients with elbow and right-side AVFs but no significant difference was observed between the complications in patients with diabetes or hypertension as the underlying cause of kidney failure [18].

The occurrence of vascular steal syndrome is less in RC-AVF as compared to BC-fistulae. As demonstrated by Kumar A et al., [25]. RC-AVF is safe and better than BC-AVF since, it dilates both cephalic and the basilic veins and does not cause vascular syndrome; however, patency and flow rates are comparable between the two [25]. Nawaz S et al., reported AVF failure in 23 patients within first month without dialysis and failing AVF and it was managed by employing new AVF. Further, he reported poor outcome for AVF in patients of either sex having diabetes [21].

A retrospective study showed a 30% incidence of primary failure and also a significant association between diabetes (odds ratio=3.5, $p=0.001$) with loss of primary patency [29]. The multicentre, haemo study analysed the factors associated with the prevalence of AVF in a series of 1824 patients with fistulas or grafts at 45 dialysis units. The findings suggested that the prevalence of fistulas was lower in females, patients with peripheral vascular disease, blacks, patients with obesity and elderly patients [30]. Another long-term study from India showed a patency rate of 78.81% at the end of one year and patency lowered to 14.81% at the end of five years in 505 AVFs in patients with CKD [19]. Thus, these findings indicate that different factors influence the AVF prevalence and its patency and it should be considered when patient are undergoing AVF. Most of the reported studies were from Western world, while the present study from India showed similar finding with previously reported Western data. However, more studies are needed to understand the pattern of distribution and outcome of AVF in CRF patients from India.

Limitation(s)

The present study was limited by small sample size. This was a prospective interventional study from a single institution. Real-world studies with larger sample sizes and longer follow-ups are necessary to conclude robustly the pattern of distribution and clinical outcomes associated with AVF surgery.

CONCLUSION(S)

Vascular access is a major cause of morbidity and mortality for patients with CKD undergoing haemodialysis. The most common immediate, late and delayed postoperative complications were bleeding, stitch abscess and AVF failure, respectively. However, knowledge about the potential complications of AVFs will help in timely detection, permit actions to prevent deleterious events and improve both patients' quality of life and survival.

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