



Retrospective Analysis of AV Fistulas for Hemodialysis Vascular Access: A Single-Centre Study

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Abstract

Objective: This is a review of Arteriovenous Fistulas (AVF) created for hemodialysis in South Eastern Railway Hospital, Garden Reach, Kolkata from August 2017 to September 2020 in an attempt to decide success factors for improving success in AV fistulas for future endeavours.

Design: A total of 181 AVFs were created in 183 patients. Mean follow-up duration was for 2 years. Retrospective observational study of 183 cases of AVFs was done.

Materials and Methods: Categorical variables were compared using Pearson's chi square test for independence of attributes or fisher's exact test as and when appropriate. Continuous variables have been expressed as mean, median and standard deviation and have been compared across the groups using unpaired t test. Multivariate analysis done using multivariate logistic regression. If any p value is less than 0.05 it has been considered as significant.

Results: There were 158 (87.3%) successful cases and 23 (12.7%) failures. Attempt was abandoned in 2 patients. Basilic vein was used in 15 (8.3%) cases, cephalic vein in 163 (90.1%), and antecubital vein in 3 (1.7%) cases. End of the vein was anastomosed to side of the artery in all the cases. We got bruit in 160 (88.4%) and thrill in 149 (82.3%) cases. During dialysis, flow rate >300 ml/min was obtained in 158 (87.3%) cases.

Conclusion: The presence of bruit and thrill after surgery increase chances of successful AVF.

Keywords: Chronic kidney disease; Hemodialysis; AV fistulas; Success; Predictors

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Introduction

The aim of vascular access for dialysis is to provide definitive access to the circulation for clinical use with as minimal complications as possible associated with either its creation or use. Of the options available, an Arteriovenous Fistula (AVF) represents the best choice for most patients.

The creation of subcutaneous Arteriovenous Fistula (AVF) between the radial artery and a neighbouring vein was first described by Cimino and Brescia in 1966 which are currently regarded as the best mode of access for hemodialysis [1].

Lower morbidity, mortality and better patency rates are achieved with a mature, clinically functional AVF. A higher level of patient satisfaction and quality of life is attained when compared with other alternatives [2].

Generally, surgical arteriovenous fistulas can be sought out of three AVF configurations:

- Radio-cephalic
- Brachio-cephalic
- Brachio-basilic.

When a number of possibilities are available, preference is always given to the forearm over the upper arm [3]. Arteriovenous Fistulas (AVFs) have a limited life span even if maintained and used properly and thus for planning vascular access it is prudent to use distal vessels first so that proximal vessels can be used in the future need of a new access, if required [4]. On the other hand, one may argue that the short life expectancy of chronic renal disease patients on maintenance hemodialysis may not survive as long to need a second AVF [5].

The goal is to allow high blood flow so that the largest amount of blood can pass through the

dialyzer.

Notwithstanding the fact that the prevalence of risk factors like hypertension and hypercholesterolemia is not high in Indians, although we are catching up, but risk factors for atherosclerosis for instance high total cholesterol to high-density lipoprotein cholesterol ratio, high triglyceride levels, obesity and diabetes mellitus are distinctly common in Indians [6]. These may affect the outcomes of AV fistulas.

As we know, there are no set guidelines as to the preoperative requirements and intraoperative manoeuvres to achieve a successful arteriovenous fistula. There are numerous recommendations to guide one towards this endeavour, but one seeks reliable statistics and conclusions to have a consistent and high success rate of creating these fistulas.

This study provides an insight into our experience at South Eastern Railway Hospital, Kolkata of over 180 fistulas to help guide surgeons into having a more favourable outcome towards a now increasingly acceptable conduit of hemodialysis access.

Materials and Methods

This is a retrospective observational study carried out in South Eastern Railway Hospital, Garden Reach, Kolkata between August 2017 and September 2020 where AVF was created in 183 patients and abandoned in 2 patients. Patients considered were

- Patients with Chronic Kidney Disease (CKD) who have been prescribed hemodialysis
- Converting from an alternate renal replacement conduit such as peritoneal dialysis
- Who are on hemodialysis with an ineffective Arteriovenous (AV) access or alternate route of access.

Patients were evaluated for

- Comorbidities
- Arterial and venous system examination was done according to the DOQI guidelines [7].
 - Examination of the arteries
 - A. Peripheral pulses
 - B. Allen test
 - C. Blood pressures of bilateral upper limbs
 - Physical examination of the venous system
 - A. Evaluation for edema
 - B. Assessment of arm sizes and comparability
 - C. Examination for collateral veins
 - D. Evaluation of veins: Palpation after tying a tourniquet
 - E. Examination of prior central or peripheral venous cannulation
 - Examination for arm, chest, or neck surgery/trauma
 - Cardiovascular evaluation

Inclusion Criteria

1. Artery and vein diameter limits were taken to be more than

2 mm as suggested by DOQI 7 and study by Allon et al. [8]. Patients with vessel size less than 2 mm were asked to have an alternate vascular access route.

2. KDOQI recommends that referral for dialysis access assessment and creation should be done when eGFR is 15 to 20 mL/min/1.73 m² [7,9]. The same was followed.

Exclusion Criteria

1. Evidence of upper limb venous thrombosis, thrombophlebitis or previous venous cannulation either clinically or radiologically
2. Blood vessel diameter less than 2 mm
3. Severe upper limb oedema
4. Skin disease
5. Advanced peripheral arterial disease with consecutive necrosis
6. Denied consent

A successful AV fistula was set as one which can achieve a flow rate of 300 ml/min through the hemodialysis machine on maturation. A mature fistula is defined as one which can provide dialysis consistently with 2 needles for more than two thirds of dialysis sessions within 4 consecutive weeks [10-12].

Follow up was done in association with dialysis unit staff by visits to the patients in the wards and outdoor basis reviews. We obtained hospital records and gathered data pertaining to patient demographics, co-morbidities, details of previous access, site of AVF, intra-operative findings, current patency status, morbidity and mortality. All the patients were undergoing dialysis at our own centre. Patients lost to follow up have not been included in the study. Follow up was done according to KDOQI guidelines [7]. AVF was evaluated by the author for postoperative complications within 2 weeks of creation and an appropriate member of the vascular access team evaluated AVF maturation at 4 to 6 weeks after AV access creation. Patient was referred for further investigation if not maturing as expected.

Followup was carried on for a mean duration of 2 years.

The study was reviewed and certified by the ethical committee of the Central Hospital, South Eastern Railways.

Statistical Methods

Categorical variables are expressed as number of patients and percentage of patients and compared across the groups using Pearson's Chi Square test for Independence of Attributes/Fisher's Exact Test as appropriate.

Continuous variables are expressed as Mean, Median and Standard Deviation and compared across the groups using unpaired t test.

Multivariate analysis done using multivariate logistic regression.

The statistical software SPSS version 20 has been used for the analysis.

An alpha value of 5% has been taken. Thus, if any p value is less than 0.05, it is significant.

Instructions to Medical and Paramedical Staff

- Earlier referral should occur in patients with unstable and/or rapid rates of eGFR decline (e.g., >10 mL/min/year) [7].
- Non Dominant limb preferred, thus the selected arm was instructed not to be pricked.
- Bilateral colour Doppler of upper limbs was done for all patients.
- KDOQI suggests that while there is no minimum diameter threshold to create an AVF, arteries and veins of less than 2 mm in diameter should undergo meticulous evaluation for feasibility for creation of a functioning AVF [7].

Operative Technique

- Mostly done under local anesthesia using 5 ml 2% lignocaine with 5 ml 0.25% bupivacaine, while proximal fistulas required brachial block initially, but with time and experience even proximal fistulas were done under local anaesthesia.
- Cases were done by a surgeon and an assistant under loupe magnification (x3.5) using microvascular instruments.
- Oblique 2.5 cm to 3 cm long incision was used.
- Vein and artery were mobilized adequately. Arteriotomy size in all cases was 6 mm to 7 mm. Anastomosis was done with interrupted suture using 8-0 or 7-0 polypropylene depending on vessel wall thickness. For all cases, an end of vein to side of artery anastomosis was done.
- Skin closure was done with interrupted 3-0 ethilon.
- Non-compressive dressing was given. Bruit and thrill were appreciated before skin closure.
- Patient was discharged the next day. Appropriate instructions regarding care of operated side arm were given. They were told to avoid AVF arm vein blood collection, avoid blood pressure cuffs, not to use tight clothing or jewellery, and avoid prolong pressure on operated arm. Instructions regarding how to feel for thrill were explained and patients were instructed to report any abnormalities such as coldness, numbness, ulcers or discoloration at the fingertips. Hand ball exercises were shown and taught to the patients and instructed to perform them at regular intervals.

Results

In our study of 181 fistulas (baseline patient characteristics in Table 1),

- 82 were proximal fistulas
- 99 were distal fistulas.

108 patients suffered from diabetes, 168 had hypertension and 37 had atherosclerosis. 174 were done on left and 7 on right upper limb respectively. Basilic vein was used in 15 cases, cephalic vein in 163 cases and antecubital vein in 3 cases. Radial artery was used in 98 cases and brachial artery in 83 cases. End (vein) to side (artery) anastomosis was done in all the cases. Bruit was appreciated in 160 cases and thrill in 149 cases on operation table.

We abandoned creation of AVF in 2 patients after finding poor access of vein and poor condition of artery intraoperatively

Table 1: Baseline characteristics of patients.

Total AVF	181	
Successful	158	
	Mean	Standard deviation
Age	62.1	11.44
	Frequency	Percent
Female	72	39.8
Male	109	60.2
HTN	168	92.8
DM	108	59.7
Atherosclerosis	37	20.4

HTN: Hypertension; DM: Diabetes Mellitus

Table 2: Logistics regression analysis of significant variables.

	Coefficient	p Value	Odds Ratio	95% CI for Odds Ratio	
				Lower	Upper
DM	-2.098	0.156	0.123	0.007	2.22
On table bruit	5.126	<0.001	168.385	10.593	2676.612
On table thrill	2.586	0.019	13.276	1.539	114.508
Atherosclerosis	-1.402	0.171	0.246	0.033	1.834
Artery used	1.867	0.148	6.467	0.514	81.306
Constant	-3.105	0.229	0.045		

DM: Diabetes Mellitus; CI: Confidence Interval

respectively.

In complications, 3 patients developed hematoma, 4 suffered from post operative bleeding which subsided on conservative management, and 2 developed aneurysms. None required any significant intervention.

Causes of 23 failures were not known (reported).

During hemodialysis, a flow rate >300 ml/min was achieved in 158 cases. This was sufficient to perform successful hemodialysis as it supported 4 h of hemodialysis. The flow rate >300 ml/min was the flow rate obtained on the blood pump during HD, which was taken as an indicator of success.

Fistulas are more likely to be successful when both bruit and thrill were felt on the operation table. (p<0.001 for both) (Table 2)

- It was observed that
- Proximal fistulas were more successful (90.24%) than distal fistulas (84.85%), although the difference was not significant (p=0.278).
- Brachial artery more successful than the radial artery (90.36% vs. 84.69%),
- Failure rate in atherosclerotic patients was more than non atherosclerotic patients (35.14% vs. 6.94%).
- Failure rates in diabetic patients were greater than diabetic (4.11% vs. 18.52%).
- Age, sex, side, hypertension and the vein used were not significant factors in determining success of AV fistulas.

We have an 87.3% primary success rate and 12.7% primary failures which is comparable to medical literature.

Discussion

The number of people requiring hemodialysis approaches half a million-people worldwide with roughly 100,000 new cases of end-stage renal disease annually [13]. Arteriovenous fistulas have proven to have remarkable clinical and economic advantages amongst the myriad of techniques available for dialysis access. National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (KDOQI) and the Fistula First Initiative recommend that autogenous arteriovenous fistulas should be considered as the initial access for hemodialysis in patients with ESRD [14]. The creation of fistulas is part of the long-term planning of access for hemodialysis in patients with ESRD. An interprofessional approach manages the planning, creation, and maintenance of the fistula.

Our study does not find age to be a significant factor in AV fistula success, which corroborated by a study by Gaur et al. [4] similarly, gender was not found to be related to success of AV fistulas in our study. Similar findings were given by Rooijens et al. [15] and Siddiqui et al [16]. We did not find hypertension as a major significant factor for AV fistula success. This has been corroborated by other studies as well [17,18].

Atherosclerosis and diabetes determines the success of AV fistulas with poorer outcomes in patients with the disease. This is also evident in other studies [19-22]. Our study also shows that proximal fistulas and the ones done with brachial artery are more successful. This has been supported by numerous studies [19,23].

On table bruit and thrill are major determinants of success and has been proven numerous times [19,24].

Most large-volume centers report 15% to 30% primary failure rates for distal radio cephalic AVF [25,26]. In spite of the routine use of colour Doppler, the failure rate in the multicenter Dialysis Access Consortium Fistula study approached as much as 60% [26]. Majority large-volume centers record 15% to 25% primary failure rates for radio cephalic AVF [19,25]. The incidence of primary failure in medical literature ranges from 9% to 40%. Our contemporary knowledge is restricted to retrospective single-center studies [27-29]. We have a success rate of 87.3%.

Mozaffar et al. [30] compared side-to-side with end-vein-to-side-artery anastomosis. Primary AVF failure at 6 months was not significantly different from side-to-side (20%) versus end-to-side anastomosis (17%). We have thus done all of our anastomoses in an end to side fashion.

Conclusion

In conclusion we found that

1. Age, Sex and limb side have no significance on fistula success.
2. Patients suffering from diabetes and atherosclerosis have a higher failure rate.
3. Hypertension does not affect success.
4. Proximal fistulas are more successful than distal, although the difference is not significant.
5. Brachial artery promises more success than radial, but again, difference is not significant. Veins do not have much significance other than diameter.

6. On table bruit and thrill are major determinants of success.

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