

Study of Factors affecting Outcomes of Arteriovenous Fistula

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ABSTRACT

Introduction: There are very limited data available in the literature showing causal relationship of various factors on arteriovenous fistula (AVF) patency. This study was designed to find out the causes of AVF failure at Seth Gordhandas Sunderdas (GS) Medical College and King Edward Memorial (KEM) hospital, Mumbai.

Materials and methods: We have done a prospective interventional study in the Department of Urology of Seth GS Medical College and KEM hospital, Mumbai, for patients of end-stage renal disease (ESRD). We enrolled 83 patients serially referred for AVF. These patients were evaluated with an interval of 1 month, for a duration of 6 months after AVF creation.

Results: A single surgeon performed and assisted surgery to avoid technical bias. Out of 83 patients, 7 patients were lost to follow-up, so statistical analysis was done with the remaining 76 patients. Sixty (of 76) patients developed good vein for hemodialysis (HD) access at the end of 6 months; 16 patients failed to develop the vein for HD. We found that the fistula patency rate was higher in patients with low body mass index (BMI; less than 30 kg/m²), age < 50 years, vessel diameter of more than 2.5 mm at the forearm, and in patients who were not on HD at the time of fistula creation. The fistula patency rate could not be correlated to factors like sex and diabetes. We had only 5 proximal fistulas and, hence, subgroup analysis between distal and proximal fistula was not done. We had a primary failure rate of 69% (11 patients) and a secondary failure rate of 31% (5 patients). In our study, 8 patients developed wound infection; 10 patients developed mild edema of the forearm. We had no major complications.

Conclusion: The AVF created with smaller artery and vein has a high failure rate. Increased BMI was associated with early failure. The longevity of AVF can be increased by early AVF creation when the patient is still not on HD.

Keywords: Arteriovenous fistula, End-stage renal disease, Hemodialysis, Patency.

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INTRODUCTION

The native AVF is the gold standard of vascular access (VA) for HD, as it is associated with less infection and offers good dialysis adequacy.¹ Chronic renal failure patients may have unsuitable veins for the native AVF. Severe arteriosclerosis, edema of the arm, vascular calcification, and multiple vein puncture are usual problems.² The AVF has a failure rate of 30% in the forearm.³ As many as 25% of hospital admissions in the dialysis population have been attributed to VA problems, including fistula malfunction and thrombosis.⁴ Three aspects of primary failure are important—recognition of risk factors, screening, and intervention. The pathogenesis of AVF failure is poorly understood and probably diverse. Hemodynamic problems at local vascular (insufficient feeding artery) and systemic (hypotension, heart failure) level have been associated with AVF failure.⁵ Venous damage from excessive venipuncture or cannulation prior to AVF formation, as well as traumatic vein manipulation during surgery, has also been implicated. The AVF failure is more likely in the forearm compared with the upper arm AVF, as the smaller caliber radial artery results in lower blood flow.⁵

There are very limited data available in the literature showing the causal relationship of various factors on AVF patency. So, this study was done with intent to analyze different factors' outcome on AVF surgery.

MATERIALS AND METHODS

This prospective interventional study was carried out in the Department of Urology, Seth GS Medical College and KEM hospital, Mumbai, from September 1, 2015 to January 31, 2017. Institutional ethical committee approval was taken from the institutional ethical committee, KEM hospital, Mumbai. Patients of ESRD who were on HD with age more than 12 years, patients with chronic kidney disease stage V who were expected to be ESRD and presently not on HD were enrolled for the study. Patients with age less than 12 years were excluded from the study. We have serially enrolled patients in our study, referred to us for AVF creation during the 2-year period.

Patient's age, gender, BMI, medical ailments, such as diabetes, hypertension, cardiovascular problem, a history of addiction, physical examination and investigations, such as hemoglobin, complete blood count, blood urea nitrogen level, serum creatinine, serum electrolyte, lipid

profile, size of artery, size of vein, distance between the artery and vein, and the distance between the skin and vessels in each patient with duplex ultrasound were noted in the case record form (CRF).

All surgeries were performed under local anesthesia. Standard procedures for distal as well as proximal AVF were followed. The fistula size was maintained at 1 cm. The major branch to the cephalic vein was tied prior to anastomosis. Hemostasis was checked and secured. All patients postoperatively were advised 3rd-generation cephalosporin for 5 days, aspirin 75 mg for 14 days, and peripheral vasodilator drug Pentoxifyllin for 14 days. Soft sponge ball exercises after 24 hours of surgery were advised. All operations were performed or assisted by a single surgeon and supervised by the senior consultant.

Patients were assessed on day 3, and on day 14 when suture removal was done. Thereafter, the patients were followed up with an interval of 1 month for 6 months. General and systemic examination findings were entered in the CRF in all visits. Patients were followed up for 6 months with physical examination of fistula, for the presence of thrill and complications related to surgery, such as infection, thrombosis, suture line problems, venous hypertension, aneurysm, and hand edema. The primary failure was defined if there was no thrill at 30 days, suggestive of inadequate maturation of fistula, and secondary failure was labelled when the fistula failed after the initial use for HD.

The data of the study were analyzed on computer using GraphPad software version 3.10. The parameters were analyzed using appropriate parametric test, i.e., Fisher's exact test. Statistically significant probability value (p) was set at 0.05.

RESULTS

In our study, among 83 patients, 58 (70%) were male and 25 (30%) were female. The mean age of the patient was 45 years and the standard deviation was 11. Most of the patients were from the age group of 31 to 50 years (32 out of 83). Diabetes was present in 30 patients and 9 patients had a BMI of more than 30 kg/m². Of these 83 patients, 23 were already on HD. We performed distal radio cephalic fistula in 78 patients and proximal brachiocephalic fistula in 5 patients; 7/83 (7 out of 83) patients were lost to follow-up before the outcomes of fistula could be determined. Hence, these 7 patients have been excluded from the final statistical analysis and the results were calculated for 76 patients. The venous diameter was less than 2.5 mm in 12/83 (12 out of 83) patients, and the radial artery diameter was less than 2.5 mm in 27/83 patients, and 71/83 had a venous diameter of more than 2.5 mm, and 59/83 had a radial artery diameter of more than 2.5 mm. Patients who underwent proximal AVF all had arterial and venous diameter of more than 2.5 mm at cubical fossa.

Sixty patients out of 76 had good veins suitable for HD at the end of 6 months, while 16/76 had failure, of which 11/83 had primary failure and 5/83 had secondary failure.

The association of patency of fistula with respect to age, gender, the presence of comorbidity, such as diabetes, BMI, status of HD at the time of fistula creation, and the size of vessel diameter were analyzed with Fisher's exact test for significance using GraphPad software. The results are tabulated in Flow Chart 1 and Table 1.

We found that the fistula patency rate was higher in patients with low BMI (p = 0.02), age less than 50 years

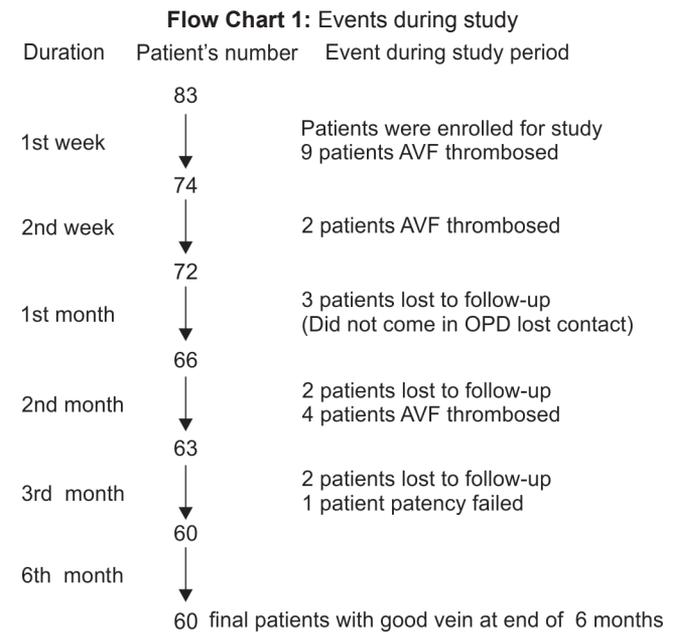


Table 1: Variables' effect on patency of fistula in the studied patients

	Total patients	Patent fistula	Failed fistula	p*-value
<i>Gender</i>				
Male	56	47	9	0.1088
Female	20	13	7	
<i>Age (years)</i>				
<50	58	49	9	0.04
>50	18	11	7	
<i>Patient on hemodialysis</i>				
Yes	23	12	11	0.0004
No	53	48	05	
<i>Body mass index (kg/m²)</i>				
<30	67	57	10	0.0021
>30	09	03	06	
<i>Diabetes</i>				
Yes	30	21	09	0.1544
No	46	39	07	
<i>Arterial diameter (mm)</i>				
<2.5	25	12	13	0.0001
>2.5	51	48	03	
<i>Venous diameter (mm)</i>				
<2.5	11	06	05	0.0469
>2.5	65	54	11	

*p-value <0.05 considered significant, calculated with GraphPad software



($p = 0.04$), arterial and venous diameter of more than 2.5 mm ($p = 0.0001$, $p = 0.04$) at the forearm, and in patients who were not on HD at the time of fistula creation ($p = 0.001$) in distal radiocephalic fistula. The fistula patency rate could not be correlated to factors like diabetes ($p = 0.1554$) and gender ($p = 0.1018$) in our study.

We had only 5 proximal fistulas, hence, subgroup analysis between distal and proximal fistula was not done. We had a primary failure rate of 69% (11 patients) and a secondary failure rate of 31% (5 patients). In our study, 8 patients developed wound infection; 10 patients developed mild edema of the forearm. We had no major complications.

DISCUSSION

Early failure is the condition of being unable to perform HD because of an obstructed anastomotic site and insufficient blood flow within 1 month after the AVF. The possible causes of early failure include the use of inappropriate vessels and lack of dilatation due to perivascular fibrosis, intraoperative vessel intimal injury, low blood pressure, or thick subcutaneous fat tissue.⁶

In our study, the outcome of fistula was not affected by gender. Wong et al⁷ described that there was a poor outcome of fistulas in women, which may be partly explained by their smaller vessels.

We found a higher patency rate in patients with age less than 50 years. In our study, patients dependent on HD had lower patency rate; the reason behind this could be blood pressure fluctuation while on HD. Sheth et al⁸ found that main causes of failure were strong history of cerebrovascular accident and ischemic heart disease as well as higher age and dependency on HD during surgery.

We found a significantly higher patency rate in patients with a larger arterial and venous diameter. The previously published data suggested that the lower the radial artery diameter, the higher the statistically significant risk of fistula nonmaturation and of fistula functioning disturbances at a later time.⁹ The preoperative diameter of the cephalic vessel is important for the future functioning of the venous access. The larger diameter of the cephalic vein is connected with a lower resistance to blood flow and an increased blood flow rate in the fistula, lower risk of thrombotic and postinflammatory lesions.¹⁰

In our study, patients with BMI of more than 30 have a higher failure rate; however, the study done by Chan et al¹¹ suggests that an increased risk of AVF failure to mature was found only in the highest BMI quartile (≥ 35 kg/m²). Kats et al¹² and Vassalotti et al¹³ found that AVF prevalence was equivalent (obese 44%, nonobese 37%) and primary failure was similar (obese 46%, nonobese 41%) with preoperative ultrasound mapping of the limb.

In our study, we have done only 5 proximal fistulas; hence, we have not compared the proximal fistula patency rate with distal fistula survival in this study. Despite

being a major cause of nephropathy, in our study, diabetes has not caused any significant effect on the survival of fistula. This could be due to a large representation of nondiabetic patients in our study.⁵

CONCLUSION

- The AVF longevity can be increased by doing fistula prior to the requirement of dialysis, i.e., "Fistula First Initiative" should be used.
- The AVF with a vessel diameter of less than 2.5 mm was associated with failure.
- Distal AVF in obese patients has a significant failure rate; hence, proximal fistula should be opted in such patients.

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