International Surgery Journal
Singh G et al. Int Surg J. 2019 Feb;6(2):537-541
http://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: http://dx.doi.org/10.18203/2349-2902.isj20190399

Original Research Article

To study the factors responsible for causing complications of arteriovenous fistula surgery: a retrospective observational study

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Received: 27 November 2018
Accepted: 02 January 2019

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ABSTRACT

Background: To study the pre-operative and intra-operative factors responsible for complications of arteriovenous fistula (AVF) surgery.
Methods: A retrospective analysis of prospectively maintained database of AVF's created from January 2016 to October 2018 was carried out to look for the post-operative complications. Chi- square test or fisher's exact test was applied to assess any association between pre-operative and intra-operative factors versus various complications.
Results: During the 2-year study period, 549 AVF were created including revision AVF surgeries. There were 306/435 (70.3%) men and the mean age of study population was 41.14 years. The number patients with hypertension, diabetes, peripheral vascular disease and congestive cardiac failure was 381/435(87.6%), 86/435 (19.8%), 36/435 (8.3%) and 8/435 (1.8%) respectively. 280/435 (64.3%) patients had undergone radiocephalic AVF. The primary failure rate was 19.3%. The other postoperative complications were postoperative bleed in 3.9%, thrombosis in 13.8%, pseudo aneurysm in 2.8%, dilated collateral veins in 1.1%, surgical site edema in 4.8% and surgical site infection in 6%. Pseudo aneurysm occurred in 7 women and 5 men; further, it was found to be statistically significant (P=0.048).
Conclusions: In present study population, the rate of postoperative complication following an AVF surgery was 32.4% and the females were significantly associated with pseudo aneurysms when compared to men.

Keywords: Arteriovenous fistula, Complications in AVF

INTRODUCTION

An Arteriovenous fistula (AVF) is the most preferred type of vascular access for maintenance haemodialysis (MHD).[1] The main problem after AVF formation is a failure of maturation. The AVF needs to mature into a low resistance circuit that can undergo repeated cannulation.

The number of patients requiring AVF surgery has increased owing to the burgeoning number of patients with chronic kidney disease (CKD).[2] In addition, there is increase in proportion patients in extreme age group, diabetes mellitus, and peripheral vascular disease.[2]

A functioning AVF is a major requirement for successful long term MHD. However, any AVF complication may lead to hospitalization that may increase the cost of AVF maintenance. There should be adequate knowledge about the complications of AVF leading to timely measures to prevent deterious consequences ranging from morbidity to death. Immediate post-operative complications include hemorrhage, low flow rate in draining vein, edema and hematoma.

Late onset complications include infection, aneurysm (either true or false), stenosis, steal syndrome, ischemic neuropathy and thrombosis.[3] AVF care should be a priority for the entire team involved in CKD patients on maintenance haemodialysis. Early referral should be done for AVF formation so that any post-operative complications can be taken care of before patient needs to start haemodialysis. Therefore, complications related to AVF surgery need careful evaluation to reduce the rate of postoperative complications.

METHODS

A retrospective analysis of prospectively maintained database of all the patients' undergone AVF surgery between January 2016 to October 2018 in Department of Surgical Disciplines, All India Institute of Medical Science, New Delhi was collected. The study population was CKD-5 patients. All the inpatient and outpatient hospital records were reviewed, and data were tabulated in MS Excel 2016.

Inclusion criteria

- CKD-5 patients,
- Both male and female
- And all age patients.

Exclusion criteria

- Patients who died
- Patients having psychiatric disorders.

All the pre-operative factors and intra-operative findings were collected from operation theater data registry. The data regarding medical comorbidities and examination findings like, blood pressure, compressibility of the vessel, and previous venous punctures was collected from out patient's record sheet.

All the operations were performed in the Department of Surgical Disciplines, AIIMS, New Delhi.

The details of postoperative (scheduled at day 1, 14, 60) follow up visits after the creation of AVF scheduled were also collected from the out patients record sheet. The AVF was assessed clinically for the presence or absence of bruit and thrill during follow up. Post-operative complications and appropriate intervention undergone by the patients were also recorded. The data was analyzed to assess the relation between various pre-operative and intra-operative factors to the complication rate following AVF surgery.

Statistical analysis

Statistical analysis was done using the SPSS IBM software (Version 20). Categorical data were compared using Chi square test, nominal data were compared using Student t test, and the statistical significance was set at $P < 0.05$.

RESULTS

Demographic data

The study population consisted of CKD patients requiring AVF for MHD. During the 2-year study period, 549 AVF were created in 435 patients including the revision surgery. The mean age of the study population was 41.14 years (Range: 15-76). There were 306/435 (70.3%) men and 129/435 (29.7%) were women. The medical comorbidities with in the study population were hypertension (HTN) in 381/435 (87.6%), diabetes mellitus (DM) in 86/435 (19.8%), peripheral vascular disease (PVD) in 36/435 (8.3%) and congestive cardiac failure (CCF) in 8/435 (1.8%) patients.

Pre-operative dialysis

Patients undergoing haemodialysis via catheters before AVF surgery were 345/435 (79.3%); moreover, this proportion did not know the reason for the need of AVF's. Further, 92/435 (21.1%) had pre-operative knowledge regarding the preservation of veins.

Operative data

The distribution of site of AVF surgery showed 280/435 (64.3%) patients had undergone radio-cephalic AVF, 150/435 (34.4%) had brachiocephalic fistula (34.4%) and 5/435 (1.14%) brachiobasilic AVF (performed in two stages). The exteriorized of brachiobasilic AVF was performed after 6 weeks. 421/435 (96%) of the AVF's were in the non-dominant limb. Intra-operative atherosclerosis was found in 24/435 (5.5%).

Follow-up

The patients were followed up for post-operative complications.

Table 1: Complications.

Different complications (n=435)	No. (percentage)
Absence of thrill/bruit immediate post-operative	30 (7.3%)
Failure to mature (primary failure)	84 (19.3%)
Post-operative bleed/ hematoma	10 (2.3%)
Post-operative thrombosis	60 (13.8%)
Post-operative pseudoaneurysm	12 (2.8%)
Dilated collateral veins (distally)	5 (1.1%)
Post-operative edema	21 (4.8%)
Post-operative surgical site infection	26 (6%)

The major post-operative complications are summarized in Table 1, and the various causes for primary failure of AVF are listed in Table 2. Also, all patients with postoperative complications had undergone various treatment modalities (Table 3). 11/84 (13.1%) patients from primary failure group underwent endovascular intervention in the form of angioplasty for the stenosed low flow AVF; further, leading to a functional AVF.

Table 2: Causes of primary failure in which new AVF was created (N = 73).

Causes	N
Postoperative thrombosis	56
Postoperative hematoma	2
Postoperative surgical site infection	2
Pseudo aneurysm	6
Deep vein	7

The relation between different pre-operative and intra-operative factors was assessed using Chi-square test and Fisher's exact test. The relation between different pre-operative and intra-operative factors was assessed using Chi-square test and Fisher's exact test. A statistically significant correlation was found between gender and pseudo aneurysm formation (5 were men and 7 were women; P = 0.048). Diabetes mellitus was associated with intra-operative atherosclerosis in 15/24 (62.5%) patients; although not statistically significant (P = 0.08) (Table 4).

Operational definition

Primary failure was defined as an AVF that did not develop or failed to mature before the first successful cannulation for MHD treatment, eventually leading to abandonment of AVF. Maturation was defined as the fistula that had the potential for being used clinically as an AVF for MHD.

Table 3: Management of different types of complications.

Complication	Non-operative management	New AVF formation	Catheter insertion	Revision surgery	Re-intervention	Debridement	Endovascular intervention
Absence of thrill bruit immediate post-operative (30)	-	30	-	-	-	-	-
Failure to mature (84)	-	73	-	-	-	-	11
Post-operative bleed/ hematoma (10)	-	2	-	-	8 (ligation of bleeding accessory vessel)	-	-
Post-operative thrombosis (60)	-	44	8	4	-	-	4
Post-operative pseudoaneurysm (12)	-	6	-	4	-	-	2
Distal Collateral vein dilation (5)	-	-	-	-	5 (ligation of accessory vein)	-	-
Post-operative edema (21)	19	-	-	2	-	-	-
Post-operative surgical site infection (26)	6	2	-	-	-	18	-
Deep vein (7)	-	-	-	-	7 (exteriorization of vein)	-	-

DISCUSSION

Overall, complications were 141/435 (32.4%). The primary failure rate (Table 1 and 2) in this study population was 84/435 (19.3%). The major cause for primary failure was post-operative thrombosis which if corrected early can result in salvage of the AVF. Primary failure continues to be a major complication, ranging

from 25-43% according to some studies.[4,5] Detailed pre-operative evaluation of the risk factors and a dynamic approach to detect early thrombosis is needed to deal with the primary failure of AVF.[6]

Pseudoaneurysm (Figure 1) rate in this study population was 12/435 (2.8%); among this, 10/12 had undergone surgical treatment. The management of pseudoaneurysm is mostly surgical; however, a few reports of endoprosthesis used as treatment of pseudo-aneurysm is mentioned in the literature.[9] Only two patients in this study were managed using endovascular intervention leading to stenting of the aneurysm site and rest were managed surgically. Pasklinsky et al, reported 29 cases with true aneurysms and 43% of these were managed surgically.[10]

Table 4: Correlation between pre-operative, intra-operative factors and complications (Number, P value).

	Age	Gender		Pre-operative education		DM		HTN		CCF		PVD	
Intra-operative findings													
		M	F	+	-	+	-	+	-	+	-	+	-
Intra-operative atherosclerosis	P =o.158	16	8	4	20	15	9	22	2	0	24	10	6
		P= 0.658		P = 0.580		P = 0.08		P = 0.533		P =0.63		P = 0.887	
Complications													
Post-operative bleed/ hematoma	P =0.231	8	2	2	8	1	9	9	1	0	10	0	10
		P = 0.499		P = 0.918		P = 0.433		P = 0.815		P = 0.611		P = 0.359	
Post-operative thrombosis	P =0.404	40	20	12	48	9	51	50	10	0	60	3	57
		P = 0.502		P = 0.814		P = 0.318		P = 0.282		P = 0.253		P = 0.321	
Post-operative pseudoaneurysm	P =0.447	5	7	4	8	2	10	11	1	1	11	0	12
		P = 0.048		P = 0.295		P = 0.784		P = 0.549		P = 0.202		P = 0.291	
Collateral vein dilation	P = 0611	4	1	0	5	2	3	5	0	0	5	1	4
		P = 0.634		P = 0.589		P = 0.253		P = 0.397		P = 0.911		P = 0.339	
Post-operative edema	P=0.456	9	12	5	16	16	5	17	4	0	21	3	18
		P = 0.179		P = 0.782		P = 0.739		P = 0.357		P = 0.518		P = 0.291	
Post-operative surgical site infection	P =0.295	12	14	2	24	4	22	24	2	0	8	2	24
		P = 0.089		P = 0.083		P = 0.563		P = 0.451		P = 0.472		P = 0.911	

+ = Present, - = Absent.

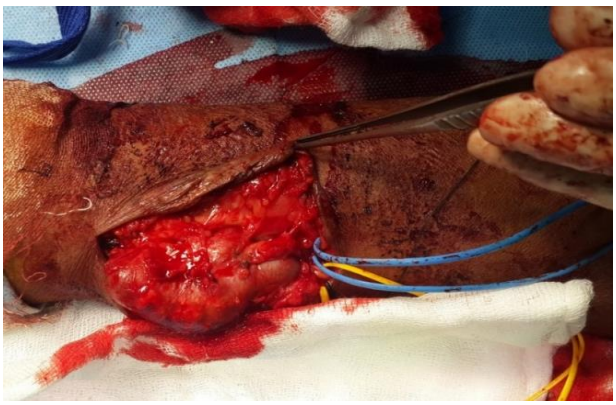

Figure 1: AVF pseudoaneurysm.

The proportion of patients with postoperative thrombosis (Table 1 and 3) was 60/435 (13.8%). It resulted in failure of maturation of AVF in 56/60 (93.3%) cases; however, in 4/60 cases were salvaged using radiological intervention leading to angioplasty with dilation of the thrombosed segment.

A new AVF was created in 56/60 (93.3%) at a proximal site. A study by Yiltok et al, reported a thrombosis rate of 8% and a study by Marcus et al, reported a thrombosis rate of 10.9%.[7,8]

The management options reported in the literature are based on expert opinions rather than evidence-based studies. Therefore, there is a lack of literature regarding

the definitive management options of various complications. In patients with DM, 15/24 (62.5%) patients had intra-operative finding of atherosclerosis (P = 0.08). There was a statistically significant relationship between female gender and pseudoaneurysm formation (P = 0.048). Surgical site infection was found to be more in patients who did not have pre-operative education 24/26 (P = 0.083).

There are several limitations to this study. This is a retrospective study. This study includes data from a single centre. Therefore, cannot be generalized to an entire population. This study was restricted only to the frequencies of the complications and their management options. The effectiveness of the management options for complications could not be assessed. There was poor compliance to follow up.

CONCLUSION

Overall complication rate following AVF surgery was 32.4%; further, primary failure rate was the most common complication observed in this study population.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Singh G, Pol MM, Sumandatta AR. To study the factors responsible for causing complications of arteriovenous fistula surgery: a retrospective observational study. Int Surg J 2019;6:537-41.