

SURGICAL CHALLENGES IN MANAGING HAEMODIALYSIS ARTERIOVENOUS FISTULA COMPLICATIONS IN TERTIARY CARE CENTRE: OUR APPROACH

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Abstract

Introduction: Arteriovenous (AV) fistula creation is the most common surgical procedure for providing vascular access for haemodialysis in patients with chronic kidney disease (CKD). The functioning of fistula dictates the quality of dialysis and the longevity of patients. The most common circumstances that require surgical takedown of AV fistula are thrombosis and rupture. While some patients undergo elective AV fistula takedown post renal transplantation or for cosmesis, majority of patients presenting with life-threatening rupture require emergency surgery for AV fistula takedown with or without maintaining arterial continuity. This study aims to compile our experience with surgical management of various AV fistula complications.

Methods: This is a retrospective study of 29 patients who underwent Arteriovenous Fistula takedown in our institute over a period of 3 years from May 2021 to May 2024.

Results: The most common cause of fistula takedown in our setup was rupture ($n=25$, 86.21%). AV fistula takedown was done in all cases ($n=29$, 100%). Arterial ligation was done in all infected cases ($n=22$, 75.86%) whereas in non-infected cases arterial continuity was maintained by repair or interposition venous graft. There was no aneurysm or pseudoaneurysm formation or limb ischaemia in a follow up period ranging from 1 month to 3 years. **Conclusion:** Erroneous ways of cannulation and lack of awareness of fistula care were the prime cause of AV fistula complications. Early detection and presentation to healthcare setup could offer a better prognosis for limb salvage in the long term and decrease the incidence of morbidity and mortality.

Keywords: arteriovenous fistula, pseudoaneurysm rupture, fistula takedown, haemodialysis, ligation

INTRODUCTION

Chronic kidney disease (CKD) is the eighth leading cause of death in India.¹ With the decreased renal donation rate of 0.5 per million, haemodialysis remains the mainstay renal replacement therapy.² Arteriovenous fistula (AV fistula) creation provides long-term primary vascular access for haemodialysis. Dialysis access complications has detrimental effect on quality of haemodialysis and in turn impacts the morbidity and mortality of End Stage Renal Disease (ESRD) patients.³

Thrombosis and infection are the most common complications of AV fistula.⁴ Infection causes dehiscence followed by rupture of fistula. Repeated puncture of arterialized vein coupled with high flow due to hypertension

causes pseudoaneurysm, which expands and leads to thinning and erosion of overlying skin prone to rupture, presenting as a surgical emergency with torrential bleeding.³ Proximal stenosis may also contribute to aneurysm formation by increasing the pressure at AV fistula site.⁵ All these complications may warrant AV fistula takedown. The Vascular access: 2018 Clinical Practice Guidelines of the European Society for Vascular Surgery also suggests alternate fistula preserving surgeries in non-infective complications. These options include resection of pseudoaneurysm and interposition or bypass graft, aneurysmorrhaphy with exoprosthesis reinforcement and stent graft exclusion of vascular access aneurysms.⁶ This study analyses the patient profile, cause for AV fistula takedown, various surgical techniques employed and their outcomes.

METHODS

In this retrospective study, the records of 29 consecutive patients who attended our institute's emergency and outpatient department with AV fistula complications and underwent AV fistula takedown in the Department of Cardiothoracic and Vascular Surgery were analysed. All patients' data over 3 years between May 2021 and May 2024 were collected from the patient files from the record section of the institute.

The data obtained were compiled, tabulated, analyzed using Microsoft® Excel® for Windows®. Demographic and clinical characteristics were summarised as mean± standard deviation and median (for continuous variables) or proportions (for categorical variables).

All the patients with infected and ruptured pseudoaneurysm or aneurysm of autologous AV fistula and dehiscence of PTFE vascular graft presented to the emergency department with a history of uncontrolled massive blood loss, pressure bandage on the wound and severe anaemia. Informed consent was taken from all patients and they were explained regarding the risks of surgery including and not limited to limb ischaemia and amputation. These patients underwent emergency fistula takedown, graft explantation and brachial artery ligation as a lifesaving procedure with due consideration for limb salvage. Patients with thrombosed fistula with aneurysmal dilatation of the vein were operated on electively with AV fistula takedown and surgery to maintain vascular continuity of the artery. Post renal transplant patient with tortuous and dilated cephalic vein underwent AV fistula

takedown electively. Preoperative ultrasonography was done in elective cases but skipped in bleeding fistula cases as they presented as surgical emergencies. All patients received empirical antibiotics, with an escalation in the case of patients who presented with sepsis.

Surgical Technique

All the AV fistula (25 brachio-cephalic, one brachio-basilic, 3 radio-cephalic fistula) surgeries were undertaken with at least 2 units of cross-matched blood. There was a case based approach for choice of anaesthesia and surgical strategy. Surgeries were performed under local anaesthesia or Supraclavicular block whereas general anaesthesia was preferred in patients with unstable vitals and poor general condition. Surgical technique was similar in all cases. Torniquet was applied proximally in arm in cases that presented with rupture and bleed. Proximal control of the brachial artery was taken through a separate incision in the mid-arm for the brachio-cephalic and brachio-basilic fistula and at the level of the elbow for the radio-cephalic fistula, and then the area around the AV fistula was carefully dissected, pathology identified and the vein was ligated in close proximity to the fistula site. The artery was repaired with end-to-end anastomosis whenever possible or reconstructed with a reverse saphenous vein interposition graft to maintain arterial continuity.

Management of different types of complications depended on the pathology, condition of surrounding tissues, presence of infection and general condition of patient during presentation. When AV fistula aneurysms/pseudoaneurysms were encountered, the pathological segment was excised, and the same procedure for AV fistula takedown was followed. In this study, brachio-cephalic and brachio-basilic AV fistula preserving surgery for aneurysm and pseudoaneurysm like aneurysmorrhaphy or excision of pseudoaneurysm with vein patch repair could not be performed as most of them were associated with infection and rupture and hence underwent brachial artery ligation as a life saving emergency procedure. The only non-infected brachio-cephalic fistula aneurysm case had grossly dilated (7x3.5cm) and thinned out vessel wall which was not amenable to repair and hence underwent AV fistula takedown with maintenance of brachial artery continuity. The only radio-cephalic aneurysm case in this study was post-renal transplantation, which mandated AV fistula takedown with the maintenance of radial artery continuity. Patients presenting with dilated and tortuous cephalic vein secondary to thrombosis of radio-cephalic fistula sought surgery for the purpose of cosmesis underwent radio-cephalic fistula takedown with brachio-cephalic fistula creation in the same sitting.

In infected cases, wound debridement was done, infected and dehiscenced PTFE AV fistula graft was explanted or the infected segment with pseudoaneurysm/ aneurysm was excised, vein ligated in a healthy area and artery was ligated proximally and distally in close proximity to AV fistula site. Figure 1 shows the site of brachial artery control and its ligation in an infected case of brachio-cephalic AV fistula

Table 1

Basic details of patients who underwent AV fistula takedown

Characteristics	Value
No. of patients	29
Mean age (in years)	41±13
Comorbidities:	
Hypertension	28(96.55)
Type II Diabetes mellitus	4(13.79)
Pulmonary Tuberculosis	4(13.79)
Severe Anaemia	4(13.79)
Hepatitis B	1(3.45)
Hepatitis C	2(6.89)
Sepsis	4(13.79)
Type of Fistula:	
Brachio-cephalic	25(86.20)
Autologous	24(82.76)
PTFE graft	1(3.45)
Brachio-basilic	1(3.45)
Radio-cephalic	3(10.34)

Data expressed as Mean± SD, Number (Percentage)

Table 2 Operative and Postoperative details

Fistula complications	Value
Brachiocephalic	25(86.20)
Rupture	25(86.20)
• Pseudoaneurysm/Aneurysm,	6(20.69)
◦ Infected	5(17.24%)
• Graft dehiscence, infected	1(3.45)
• Post cannulation rent	18(62.06%)
◦ Infected	14 (48.27)
Brachiobasilic	1(3.45)
• Aneurysm, infected	1(3.45)
Radiocephalic	3(10.34)
• Aneurysm (post renal transplantation)	1(3.45)
• Thombosis (tortuous, dilated cephalic vein)	2(6.89)
Procedure performed along with AV fistula takedown	
Radial artery repair	1(3.45)
Brachial artery repair	2(6.89)
Brachial artery interposition graft	2(6.89)
Brachial artery ligation	21(72.41)
New Brachio-cephalic fistula creation	2(6.89)
Post operative wound infection	2(6.89)
Mortality	4(13.79)
Mean operative time (in minutes)	74±30
Mean hospital stay (in days)	7±6
Mean follow up period (in months)	15.09± 17.84

Data expressed as Mean± SD, or Number (Percentage)

pseudoaneurysm. Wound swab and purulent collection in infected cases were sent for culture and sensitivity.

Thorough wound wash and adequate muscle cover for vascular repair were given in all cases. Any erosive and infected skin was excised. Primary closure of skin was attempted wherever possible. Wound closure by flap or split skin grafting was done in cases with significant tissue loss. In patients with delayed presentation with cellulitis and sepsis, wound was left open for secondary closure and fasciotomy incisions were given. Improvement in saturation, indicating revascularisation, was checked in the distal limb by pulse oximeter. Flow in ulnar and radial artery was confirmed bedside with hand-held doppler.

Postoperative management

Patients were shifted to Intensive care unit, serial arterial blood gas monitoring was done for hyperkalemia and metabolic acidosis correction. Close monitoring of the operated limb for early signs of limb ischemia was done in all patients. Intravenous antibiotics were given according to the culture reports. All the patients were evaluated by Nephrologists and scheduled for haemodialysis session in our institute during their hospital stay.

Follow-up

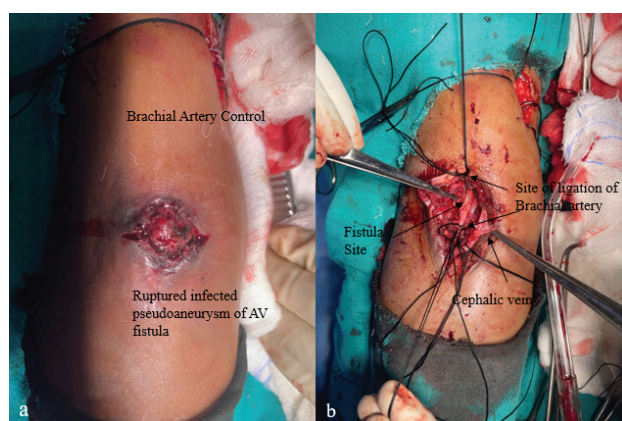
All patients were followed up in the outpatient department of CTVS one week after discharge, then at the interval of one month, 6 months and then yearly as per department protocol. Follow-up data was collected by tracing patients in OPD or telephonically by retrieving phone number from medical records. Patients and their attendants were explained regarding red flag signs of haemodialysis access complications and encouraged to seek early consultation in case of any complications.

Ethical consideration

The study was conducted in accordance with the "Declaration of Helsinki" and adhered to the ICMR guidelines "Policy statement and ethical consideration involved in research on human subjects [1980]". Individual patient consent was waived given this was a de-identified retrospective study.

RESULTS

A total of 29 patients underwent AV fistula takedown over a period of 3 years from May 2021 to May 2024 in


Figure 1

a) Ruptured infected pseudoaneurysm;
b) Site of brachial artery ligation.

our institute. There were 12 females and 17 males with age ranging from 15-71years (Mean= 41 ± 13 years). The most common comorbidity that the patients presented with was hypertension ($n=28$, 96.55%), followed by type II diabetes mellitus, pulmonary tuberculosis and severe anaemia ($n=4$, 13.79% each, respectively). There were 3 seropositive patients; one Hepatitis B (3.45%) and two hepatitis C (6.89%). Eighteen (62.06%) out of 29 patients had fistula on the left and 11(37.93%) had on right upper limb. The patient details are represented in Table No. 1. Three patients (10.34%) had radio-cephalic (RC) fistula, one patient (3.45%) had brachio-basilic (BB) and 25 patients(86.20%) had brachio-cephalic (BC) fistula, out of which 24 were autologous and 1 PTFE ring graft fistula.

The most common cause of AV fistula takedown was rupture ($n=25$,86.20%). All patients presenting with rupture had brachiocephalic AV fistula. 4 (13.79%) out of 25 ruptured Brachio-cephalic fistula cases had rent in the fistula and were non-infected. Rest 21(72.41%) cases were infected which included 14(48.27%) cases with rent in fistula, 6 (20.69%) cases of aneurysm or pseudoaneurysm with average size of 4cm x 3cm and one(3.45%) case of dehiscence of PTFE graft. One (3.45%) case of BB AV fistula presented as an aneurysm with impending rupture and infection at the puncture site. One (3.45%) out of 3 patients with radio-cephalic fistula was post renal transplantation and presented with aneurysm and the other 2(6.89%) cases presented with dilated, tortuous cephalic vein with thrombosed AV fistula. The duration between fistula creation and rupture ranged between 6days-3yrs (median-60days).

One case (3.45%) of non-infected brachio-cephalic fistula aneurysm and 22 patients (75.86%) with infected AV fistula (21 brachio-cephalic + 1 brachio-basilic) including 6 cases AV fistula aneurysm or pseudoaneurysm (5 brachio-cephalic + 1 brachio-basilic) and one case (3.45%) of PTFE graft dehiscence underwent emergency brachial artery ligation along with AV fistula takedown/ AV graft explantation. Aneurysmal repair was not attempted in the non-infected case

as the aneurysm was grossly dilated (7x3.5cm) with a thinned-out vessel wall, and in the setting of infection, it was fraught with complications of recurrence and rebleed. There were four patients with non-infected rupture of AV fistula; two (6.89%) out of four underwent brachial artery repair by end to end anastomosis and the rest two patients(6.89%) underwent interposition vein graft reconstruction to maintain arterial continuity after fistula takedown. Three patients presented with radio-cephalic fistula complications and underwent fistula takedown with maintenance of radial artery continuity. One patient with Radio-cephalic aneurysm was post renal transplant, underwent aneurysm excision with radial artery repair and rest 2 radiocephalic thrombosed fistula with dilated and tortuous cephalic vein underwent brachiocephalic fistula creation after AV fistula takedown in the same sitting. The operative details of patients are shown in table no. 2. The mean operative time was 74 ± 30 mins. All patients had good distal perfusion post-surgery, confirmed by a Doppler study. The mean duration of hospital stay was 7 ± 6 days. All the patients underwent, on an average, 2 cycles of haemodialysis at our institute during their hospital stay. Two patients (6.89%) had wound infection postoperatively but none had any signs or symptoms of limb ischaemia or recurrent aneurysm on follow-up. There was a mortality of 13.79%($n=4$) in patients who presented late to the hospital with an infected AV fistula and succumbed to septic shock. All the patients who underwent emergency surgery were scheduled for AV fistula creation at a later date. However, two patients (6.89%) were lost to follow-up. The mean follow-up period of the rest 23 patients (79.31%) was 15.09 ± 17.84 months (1-69 months).

DISCUSSION

There are three main types of vascular accesses for haemodialysis: arteriovenous fistula, arteriovenous graft and tunneled haemodialysis catheters.⁷ Arteriovenous fistula creation is the most preferred vascular access.³ As important as it is in determining the quality of haemodialysis and, in turn, longevity of CKD patients, it is associated with complications of its own. The various complications include thrombosis, aneurysm or pseudoaneurysm, infection and rupture.^{3,4} Diabetic nephropathy, utilising AV fistula before its maturation, faulty cannulation techniques were frequently associated with AV fistula infection and rupture similar to findings of Lok et al³ and Saxena et al⁸. Constant site technique of cannulation leads to AV fistula pseudoaneurysm and should be avoided, button hole technique should be preferred.³ In this study, incidence of aneurysm or pseudoaneurysm was high in proximal AV fistula because of high flow rate consistent with findings of Saxena et al.⁸ This should be borne in mind while creating a new fistula and preference should be given to more distal site first.

Patients with ESRD have platelet dysfunction and impaired haemostasis which also renders them prone to bleeding diathesis.⁹ In this study, type II diabetes mellitus, tuberculosis and severe anaemia was responsible for the poor general condition of the patients rendering them

prone to infection and delayed wound healing. Our hospital being a government tertiary care centre, majority of the patients referred here, belong to the low socio-economic strata; some patients were even referred from other states. Given the lack of resources and sometimes practical challenges, there was a substantial delay in the time of presentation and therefore more complications.¹⁰ Four patients (13.79%) who had delayed arrival to the hospital presented with ruptured AV fistula with severe anaemia due to exsanguination and sepsis.

Patients usually referred to our centre presented with aneurysm or pseudoaneurysm with average size of around 4 cm with overlying skin thinning or erosion. Therefore, healthcare workers administering haemodialysis should be vigilant to such changes and refer patients in time to avoid horrendous complications. Patients who presented with sepsis, were electively intubated before surgery and underwent emergency fistula takedown with brachial artery ligation. Although distal perfusion was restored and patients received haemodialysis postoperatively, these patients succumbed to septic shock and eventually died. It is therefore important to educate the patients regarding the first aid measures, should an AV fistula rupture, identify signs of infection and seek medical help in time to avoid significant bleeding.

In cases of unruptured fistula, post renal transplant, tortuous and dilated cephalic vein following thrombosis of AV fistula attempts were made to maintain arterial continuity by brachial artery and radial artery repair by end-to-end anastomosis or interposition graft reconstruction. Various fistula-preserving surgical techniques have been suggested in the literature, including aneurysm plication, partial aneurysmectomy, autologous vein remodelling over a Hegar dilator and reduction aneurysmoplasty by firing staple lines.^{5,11,12,13} Even fewer studies exist on alternate management of AV fistula pseudoaneurysm. In a case report by Witz et al.¹⁴, ultrasound-guided compression of pseudoaneurysm for 45 minutes caused thrombus formation in pseudoaneurysm while preserving AV access patency. Other alternatives include covered stent deployment across the pseudoaneurysm neck, coil embolisation and ultrasound-guided percutaneous direct thrombin injection with balloon inflation to transiently obstruct flow across the pseudoaneurysm neck to avoid non-target embolisation.^{6,15,16} However, in our setup, where patients present late with sepsis and are often lost to follow-up due to low socioeconomic background, any arterial or venous repair was deferred to avoid the dreaded complication of a blowout of anastomosis.

CKD patients have poor general condition and are prone to bleeding diathesis due to uraemia, any attempts to do vascular reconstruction surgery would prolong operative time and increase morbidity and mortality.¹⁷ Brachial artery ligation was safely performed with good surgical outcomes in such cases. None of these patients complained of pain, muscle wasting, cold limb, neurological deficits or exercise-induced ischaemia, consistent with the findings of Tan et al

¹⁸ and Chandrashekhar et al.¹⁹. Brachial artery ligation at the cubital fossa level had a good prognosis owing to the presence of arm collaterals, which in the long term provided satisfactory flow to the forearm. Brachial artery ligation in AV fistula PTFE graft infection was a safer alternative, it avoided complex revascularisation and anastomotic dehiscence without causing ischemia or bleeding.^{18,19}

Two (6.89%) of 29 patients had developed wound infection post-surgery. There were no dehiscence, bleed or redo surgery. Wound infection is a known complication of CKD. A wide range of uraemic toxins affect the local mechanism of wound healing, as is evident in our study.⁷ Infection subsided after wound debridement and daily dressing.

CONCLUSION

The appraisal of the knowledge and skills of healthcare providers in the dialysis setup for safe cannulation and patient awareness regarding fistula care and complications is paramount. Rupture of AV fistula aneurysm or pseudoaneurysm portends a severe and imminent threat to already chronically anaemic CKD patients dependent on haemodialysis. While various studies advocate aneurysmal repair and preservation of arterial continuity, dreading the grave complication of anastomotic blowout in infected cases, brachial artery ligation should be included in a surgeon's armamentarium. Early detection and timely management of complications may reduce the incidence of both morbidity and mortality.

Conflict of interest

The authors have no conflicts of interest to declare.

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