

THREAT ANALYSIS OF REASONS LEADING TO FAILURE OF PERMANENT HEAMODIALYSIS ACCESS

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ABSTRACT

Objective: To analyze the commonest threats which lead to the failure of a permanent vascular haemodialysis access.

Study Design: Prospective observational study.

Place and Duration of Study: Department of Vascular Surgery, Combined Military Hospital Rawalpindi, from Nov 2018 to Nov 2019.

Methodology: All patients who presented with arteriovenous fistula (AVF) or arteriovenous graft (AVG) related complications which can potentially fail an access were included. The frequency, with which these complications occurred, was noted.

Results: A total of 158 patients were included, 73 (46.20%) were male and 85 (53.80%) were females. The complications observed in order of frequency were arteriovenous fistulathrombosis (anastomotic or draining vein) in 60 (38%), pseudo aneurysms in 39 (24.68%), stealing veins causing non-maturity of the access in 14 (8.86%), venous hypertension causing extremity edema in 14 (8.86%) (7 due to stealing veins and 7 due to central venous stenosis), AVF anastomotic or draining vein stenosis in 8 (5.06%), wound hematoma in 5 (3.16%), wound infection in 5 (3.16%), true aneurysm of the draining vein in 4 (2.56%), steal syndrome in 3 (1.9%), wound seroma in 3 (1.9%), post op arm edema(not related to central vein stenosis or stealing veins) in 2 (1.26%) and compression neuropathy in 1 (0.6%) of the patients.

Conclusion: Complications of vascular access are the potential threats to the life of a permanent vascular access. Early diagnosis and timely intervention can help in fistula salvage.

Keywords: Arterio-venous fistula, Arterio-venous graft, Fistula complications, Threat to viability of an access.

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INTRODUCTION

Renal replacement therapy is the mainstay of treatment for patients with chronic kidney disease. It may be in the form of kidney transplant, haemodialysis or peritoneal dialysis.

Haemodialysis needs a good functioning vascular access to the patient blood circulation in order to deliver blood into the dialyzer machine. The commonly used vascular accesses include central venous catheters, autogenous arterio-venous fistulas (AVF) and arterio-venous grafts (AVG). Among them an autogenous AVF is the preferred option due to its long-term patency, durability, and low morbidity¹. An autogenous AVF can be a radio-cephalic, brachio-cephalic or staged brachio-basilic and it usually takes 4-6 weeks for maturation. A mature AVF is the one which is ready for cannulation and at this stage the draining vein should be at least 6mm in diameter with an average blood flow of 600 ml/min².

AVF and AVGs has some specific complications related to them although the rate of these complications is far less than those associated with central venous lines. The importance of these complications

lies in the fact that a good functioning, complication free access acts as a life line for these patients. Any complication arising is the potential threat to the viability of an access and it can ultimately fail the access. A failed access has significant psychological effect on the patients as they again have to go through the long process of getting a matured arterio-venous access. Proper monitoring in the maturation, pre and post cannulation phases is vital in recognizing any potential complications and treating them in time. This is the only way to pick and salvage a failing access. Some of the early threats include bleeding, surgical site infections, wound hematomas, seromas, wound disruption, early thrombosis, technical errors, inflow issues, edema, steal syndrome and stealing veins leading to non-maturity or venous hypertension. Late complications/threats include pseudo-aneurysms, true aneurysms, stealing veins or central vein occlusion causing venous hypertension, prick site bleed, cardiac problems, nerve compression, stenosis, thrombosis and distal ischemia^{3,4}.

The objective of this study was to observe the different potential threats that can endanger an arterio-venous access and to see with what frequency they develop. By picking the complications at an early stage, strategies can be devised to tackle them promptly

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thus preventing the access from failure. In this way, valuable accesses can be salvaged and the associated financial and psychological problems linked with failed accesses can be minimized.

METHODOLOGY

This prospective observational study was carried out at the department of Vascular Surgery, Combined Military Hospital Rawalpindi, from November 2018 to November 2019. Approval was taken from the hospital ethics review board (ref ltr no: 9/07/20(32)). Written informed consent was taken from all the patients. All patients (sample size calculation needed) of any age or gender who presented with AVF or AVG related complications which were potentially access threatening, in the early or late post op period either in the pre or post cannulation phase were included. Complications free accesses were not included in the study. The frequency with which these complications occurred was noted. The complications observed included wound infection, hematoma, seroma, pseudo or true aneurysms, thrombosis, failure of the access to mature secondary to steal-

ing veins, extremity edema, venous hypertension secondary to reverse stealing veins or central venous stenosis, distal ischemia, stenosis and compression neuropathies. The data was collected on a proforma and analyzed. Percentages were calculated for different complications observed.

RESULTS

A total of 158 patients were included in this study. Among them 73 (46.20%) were male and 85 (53.80%) were females. The age range was 14-80 years. Among the patients presenting with AVF related complications, 106 were having brachio-cephalic, 22 having brachio-basilic, 18 having radio-cephalic AVFs and 12 were having AVGs. The complications observed in order of frequency along with their percentages are shown in (table). According to the data collected the commonest AVF related complications observed were thrombosis, pseudo-aneurysm formation, and stealing veins either causing non-maturity of the access or venous hypertension leading to extremity edema as shown in fig-1, 2 & 3.

Table: Potential threats to the viability of a permanent vascular access.

Threats to a Vascular Access	No	Percentage	Intervention
Thrombosis (anastomotic or draining vein)	60	38%	Thrombectomy
Pseudo-aneurysm	39	24.68%	Ligation/aneurysmorrhaphy
Non-maturity of AVF due to stealing veins	14	8.86%	Stealing vein ligation
Venous hypertension with limb edema (due to reverse stealing veins or central venous stenosis)	14	8.86%	Stealing vein ligation Central venoplasty Central veno-venous bypass
Stenosis (anastomotic or draining vein)	8	5.06%	Resection & anastomosis Revision of AVF
Hematoma	5	3.16%	Drainage
Wound infection	5	3.16%	Debridement/dressing
True aneurysm	4	2.56%	Aneurysmorrhaphy
Steal syndrome	3	1.9%	RUDI (Revision using distal inflow)/ AVF Ligation
Seroma	3	1.9%	Observation/aseptic aspiration
Isolated arm edema	2	1.26%	Elevation/conservative treatment
Compression neuropathy	1	0.6%	relief by draining pseudo-aneurysm



Figure-1: Vein thrombosis.



Figure-2: Pseudo-aneurysm.



Figure-3: Right arm venous hypertension.

DISCUSSION

A mature well-functioning vascular access is the lifeline of haemodialysis patients. It is very important to take all the necessary measures to keep the access, complications free. However, being a surgical procedure and altering the hemodynamics by creating a shunt between the artery and vein, an arterio-venous fistula is associated with some complications which cannot be avoided all together despite taking all the adequate measures. The complications are either non-specific, associated with any other surgical procedure, including wound infection, hematoma/seroma formation, wound disruption and bleeding or specific complications related to AVF, such as thrombosis, aneurysms and ischemia⁵.

All the complications related to AVF have the potential to ultimately fail the access if they are not picked and treated in time. It is important to educate the patient from the very start about care of the access and to know about the early and serious complications related to it. Along with this, a strict surveillance of the access by a health care worker using clinical examination and if necessary, assessment with ultrasound is mandatory to see for potential threats to the access⁶.

In our study we included all those patients who presented with any AVF related problem and noted which complications presents more frequently. The commonest complications in order of frequency which we observed were access thrombosis, pseudo-aneurysms, stealing veins causing non-maturity of the access, venous hypertension, stenosis, wound hematoma, infection, true aneurysm, wound seroma, post op wound edema and compression neuropathy.

We observed that access thrombosis was the commonest complications in our series (38%). Access thrombosis may occur in the immediate post op period due to technical issues, an episode of hypotension or hypercoagulability. The access may thrombose later on due to repeated pricks for haemodialysis. Localized aneurysm with mural thrombus may form due to buttonhole technique of pricking and this thrombus can then extend to involve the whole vein. Stenosis and/or neointimal hyperplasia at the anastomotic site can also lead to thrombosis. It is important to recognize and intervene access thrombosis in time. Access thrombectomy and correction of underlying cause of thrombosis (stenosis, aneurysm) can have good results when performed in time usually within 1 week of onset. This can be performed by open as well as endovascular approach⁷. Girerd *et al*⁸ observed 278 AVF and

94 AVG thrombosis in their series of 2439 AVF/AVG patients (15.25%). Our observed thrombosis rate was almost two times as compared to Girerd *et al*.

Aneurysms which are localized dilatation of vessels may be true or false. In AVF they usually occur at the draining veins or at the anastomosis. The mechanism is usually high blood flow induced vessel remodeling or a wall defect due to repeated needling. There may be associated pre or post aneurysmal stenosis. Aneurysms may have adherent mural thrombi which can lead to access thrombosis or thrombophlebitis. The main fear associated with these aneurysms is gradual enlargement and rupture. A pseudo-aneurysm if associated with infection requires complete excision of the infected part and either ligation of the access or re-routing the outflow vein/ graft in an infection free area. A non-infected aneurysm may be excised and re-constructed in situ. True aneurysm needs aneurysmorrhaphy and downsizing of the vein^{9,10}. We observed 24.68% pseudo-aneurysms and 2.56% true aneurysms in our series. The reported incidence of aneurysms in the literature is variable ranging from 5-60%¹¹.

Maturation of AVF is important after its creation, so that it can be used successfully for haemodialysis. A significant number of AVFs fail to mature due to different reasons which include arterial, venous or anastomotic stenosis, excessive depth from the skin and large competing collateral stealing veins. Literature review shows that 10% of brachio-cephalic and 30% of radio-cephalic AVFs fails to mature¹². In our series we found that 8.86% of the AVF failed to mature secondary to large stealing veins which required ligation. Kumar *et al*¹³ documented good results after ligation of large competing stealing veins that was the cause of the non-maturity of AVF.

Another important complication of AVF is venous hypertension. This means increased pressure in the venous channels of the limb leading to varying degree of limb swelling. Sometimes it can lead to severe distressing swelling which makes the life of the patient miserable. The cause in the majority cases is central venous occlusion due to previously placed central catheters. Another cause may be reverse large collateral stealing veins causing reverse venous blood flow and distal arm swelling. The treatment options include central venoplasty, central veno-venous bypass, ligation of AVF and ligation of stealing veins¹⁴. We observed that 8.86% of our patients had this complication. Half of them were due to central venous occlusion and half due to large stealing veins. Mittal *et al*¹⁵ found

good results in venous hypertension after ligation of the stealing veins. Sometimes there is edema of the arm in the immediate post-op period that responds to elevation and it is not associated with any central venous occlusion or reverse stealing veins. We encountered this type of edema in 1.26% of our patients.

Stenosis can develop at the arterio-venous anastomosis site due to neointimal hyperplasia or it can develop in the draining vein leading to failure of the AVF. Treatment include endovascular approach using balloon dilatation/stenting or open resection of the stenosed segment and repair¹³. We Encountered this complication in 5.06% of our patients.

Wound infection, if develops at the vascular access site has important clinical significance, as it can ultimately jeopardize the function of the AVF. Incidence of infection varies from 0.5-5% per year in autogenous AVF and 4-20% in AVGs¹⁶. Post-operative wound hematoma can accumulate causing pressure on the AVF and skin necrosis. It can later on infect and form abscess. We observed wound infection in 3.16% and hematoma in 3.16% of our patients.

Seroma is a sterile fluid collection which is rarely encountered in AVFs and is more common with AVGs. Small collections may be observed and resolve spontaneously. Needle aspiration can be done for large collection. The main concern is that they may get infected and endanger the AVF. 1.9% of our patients presented with seroma and all of them resolved spontaneously. Dauria *et al*¹⁷ found 1.7% seroma in patients with AVGs.

Access related steal syndrome occurs because of decreased blood supply to the limb distal to the AVF. It can occur in patients with diabetes, peripheral vascular disease, arterial inflow issues, increasing age and proximal fistulas. If it is associated with rest pain and tissue gangrene, it can endanger the limb that's why urgent intervention is necessary. Multiple salvage procedures are available which corrects the underlying limb ischemia and saves the AVF at the same time. As a last resort the AVF may be ligated to save the limb. Proper pre-op evaluation and post-op surveillance can help avoiding and identifying this problem in time¹⁸. 1.9% of our patient had access related steal syndrome.

After formation of aneurysm or pseudo-aneurysm, the pressure effect can lead to compression neuropathy. We encountered one patient (0.6%) with pseudo-aneurysm post brachio-cephalic AVF who presented with median nerve palsy. The treatment is to relieve the pressure by correcting the underlying cause.

Cleveland *et al*¹⁹ reported a case of median neuropathy secondary to true brachial artery aneurysm after ligation of brachio-cephalic AVF.

CONCLUSION

It is important to have a strict surveillance of the vascular access to see for any developing complications in the immediate post op and late period. Any AVF related complication has the potential to ultimately fail the access. Failure of the access can only be avoided by timely intervention in any AVF/AVG related complication.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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