

Arteriovenous Fistula Creation for Hemodialysis: Evaluation of Complications

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Abstract:

Background: Vascular access care is a classic example of multidisciplinary team work among nephrologists, vascular surgeons, duplex specialists, dialysis nurses and dialysis staff. The objectives of this study were to determine the complication of arteriovenous fistula (AVF) for hemodialysis (HD) and to find out the role of duplex study for the management of fistula complications.

Methods: This was a prospective type of study done on 121 arteriovenous fistulas. All operations were done in different hospitals in Dhaka city. After duplex study of upper limb vessels, the site of fistula creation was determined. All Radio-cephalic, ulnar-basilic and brachio-cephalic fistulas were done under local anesthesia. Other fistula of the series was done under brachial block. Immediate postoperative bruit, thrill and distal pulses were monitored. Fistulas were considered mature after at least 6 weeks of fistula creation with good visualization of arterialized vein and good thrill. Patients were advised to report if any complication arises.

Results: The most common fistula was Radio-cephalic fistulas (72.73%) and then Brachio-cephalic fistulas

(19.84%). The left upper limb was the first choice for fistula creation as a non-dominant limb. Most fistula was created in left upper limb (76.86%). The most common complication was stenosis of arterialized veins (4.13%) and another type of stenosis was found at anastomotic site (2.48%). Second most common complication was cannulation site infections (3.31%). Another common type of infection was found at the site of fistula creation (2.48%). Thrombosis, aneurysm and pseudoaneurysm were identified as the most detrimental complications.

Conclusion: Arteriovenous fistula is an important issue for hemodialysis patient as the life line. Dialysis nurses and technician should have knowledge about antisepsis and potential complication of AVFs. Early diagnosis and early treatment prevent loss of vascular access and reduce serious morbidity and mortality. Both the patients and dialysis staffs should give highest care for the AVF to reduce the complications.

Key Words: Arteriovenous fistula, Haemodialysis, Duplex study, Complications.

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Introduction:

As the population ages and the incidence of diabetes rises, chronic kidney disease (CKD) and end-stage renal disease (ESRD) are increasingly common diagnoses all over the world. In 2015, data from the United States Renal Data System (USRDS) showed that 117,162 new patients began therapy for ESRD, whereas the prevalence of

dialysis population reached 661,648¹. The main treatment of ESRD is hemodialysis. The high prevalence of CKD necessitates adequate vascular access for hemodialysis and hence creation of arterio-venous fistulas for these ESRD patients. Creating long standing good quality AV fistula is thus a challenging job for the surgeons.

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The National Kidney Foundation of USA began the Dialysis Outcomes and Quality Initiative (DOQI) in 1995, now referred to as the Kidney Disease Outcomes and Quality Initiative (KDOQI), which published a large evidence-based set of clinical guidelines to help improve healthcare outcomes among patients with end stage renal disease. One major focus of KDOQI is optimal arteriovenous access management, which has led to the creation of the National Vascular Access Improvement Initiative (NAVII) and its Fistula First campaign. KDOQI makes it clear that all patients with stage IV or stage V chronic kidney disease who opt for hemodialysis should undergo autologous fistula creation².

In order to preserve viable access sites, they recommend a radio-cephalic arteriovenous fistula (RCAVF) as the first and best option. If not feasible, then a brachiocephalic arteriovenous fistula, followed by a basilic vein transposition should be created in the non-dominant arm. Prosthetic arteriovenous bridge grafts and tunneled dialysis catheters are mentioned as last resorts in patients with no autologous options. These recommendations are based upon available data that suggests that AVF have superior patency, fewer complications, require fewer reinterventions, and ultimately improve patient survival².

The quality of vascular access for hemodialysis should be suitable for repeated puncture and allow a fast blood flow rate for high-efficiency dialysis with minimal complications. Therefore, long-term functioning AVF needs a well-trained surgeon to create it and enough time allowed for maturation. The dialysis staff must be well versed in cannulation of the AVF, and there should be a minimal need for corrective interventions. Yet it must be recognized that, under the present circumstances, an ideal approach really does not exist^{3,4}. Current literature suggests the arteriovenous fistula to be the preferred type of vascular access for hemodialysis. Once established, fistulas have longer patency and lower rates

of complications compared with arteriovenous grafts and catheters. Fistula complications are associated with morbidity, mortality, and a high economic burden⁵.

Objectives of our study were to understand the complications after fistula creation, long term follow up during dialysis and also to figure out the management techniques of these complications. The objectives also include understanding the role and importance of Duplex study for fistula creation and for evaluation of complications. We present our experience on facing complications and management technique of AVF.

Methods:

This was a prospective type of study done from January,2013 to December,2019. The total number of arteriovenous fistulas created was 121. All AV fistulas were created in different Hospitals of Dhaka city. Patient details were recorded for data collection with personal address and phone number. All patients were personally worked up and followed up. After taking detailed history and clinical examination, all patients had undergone duplex study of upper limb vessels (arteries and veins) for the site of fistula creation.

Technique

Complete informed written consent was taken before beginning of each procedure. All radio-cephalic, brachio-cephalic and ulnar-basilic fistula were created under local anesthesia. All brachio-basilic transposition fistula and brachio-basilic straight graft fistula with PTFE graft was done under brachial block. Arteriovenous anastomosis was done using either 6-0 or 7-0 prolene double ended round body needle. Immediate postoperative bruit, thrill and distal pulses were monitored. Every patient was followed up at 1st, 5th and 10th (postoperative day) POD for bruit, thrill and wound examination. Fistula was considered matured after at least 6 weeks of fistula creation with good visualization of arterialized veins and good thrill. Patient was advised to attend if any complication arise.

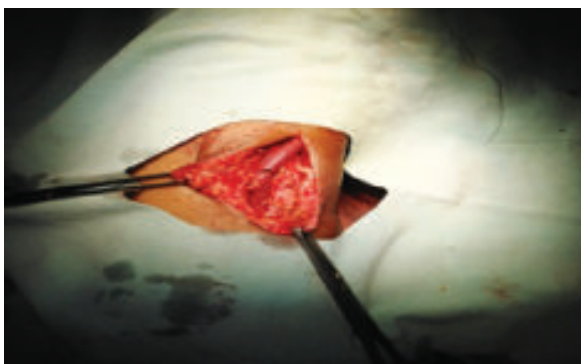


Fig.-1 A & B: Distal Radio-Cephalic Fistula & Brachio-Cephalic Fistula.

Inclusion criteria

- a. Chronic renal failure patient who need permanent hemodialysis access.
- b. Patient on hemodialysis with temporary dialysis catheter.
- c. Failed arteriovenous fistula.

Exclusion Criteria

- a. Moderate to severe atherosclerotic artery (exclusion was done by duplex study)
- b. Inadequate caliber of upper limb veins that will be used for fistula creation(exclusion was done by duplex study)
- c. Fistula creation for renal transplantation

Results:

A total of 121 arteriovenous fistula were created from the period of January 2013 to December 2019 all by a single vascular surgeon in different hospitals of Dhaka city.

Table-I
Type of arteriovenous fistula (n=121)

Type of fistula	Number	Percentage
Radio-cephalic	88	72.73%
Brachio-cephalic	24	19.84%
Brachio-basilic	07	5.77%
Ulnar-basilic	01	0.83%
Brachio-axillary straight graft fistula	01	0.83%
Total	121	100%

The most common type of arteriovenous fistula was Radio-cephalic fistula (72.73%) and the next common type of fistula was Brachio-cephalic fistula (19.84%). Brachio-basilic transposition fistulas (5.77%) were created when there was no option for creation of Radio-cephalic, Brachio-cephalic and ulnar-basilic fistula. In this study one Brachio-axillary straight graft fistula was created with 5 mm diameter PTFE graft.

Table-II
Choice of Upper Limb for Fistula Creation(n=121)

Choice of Upper limb	Number	Percentage
Left Upper Limb	93	76.86%
Right Upper Limb	28	23.14%
Total	121	100%

Left Upper Limb was first choice for fistula creation in right-handed patients as a non-dominant limb. When there was no good quality vessel or repeatedly failed

fistula creation in left side than right upper limb was chosen for fistula creation. In our series left upper limb was used in 93 cases (76.86%). In case of CVD patients paralyzed upper limb was used as a first choice for fistula creation.

Table-III
Causes of Renal Failure(n=121)

Diagnosis	Number	Percentage
CKD	118	97.52%
Obstructive Uropathy	2	1.65%
Polycystic Kidney disease	1	0.83%
Total	121	100%

Almost all the patients were referred by Nephrologist for fistula creation with confirmed diagnosis. Most of the patients (97.52%) were suffering from Chronic Kidney Disease.

Table-IV
Complications of Arteriovenous fistula(n=121)

Complicaion	Number	Percentage
Haematoma	02	1.63%
Bleeding	02	1.63%
Seroma	02	1.63%
Infection	03	2.48%
Ischaemic Steal Syndrome	00	0%
Thrombosis	04	3.31%
Pseudoaneurysm	02	1.63%
Aneurysm	03	2.48%
Anastomotic Rupture	00	0%
Anastomotic stenosis	03	2.48%
Arterialized vein stenosis	05	4.13%
Canulation site infection	04	3.31%
Venous Hypertension	01	0.83%

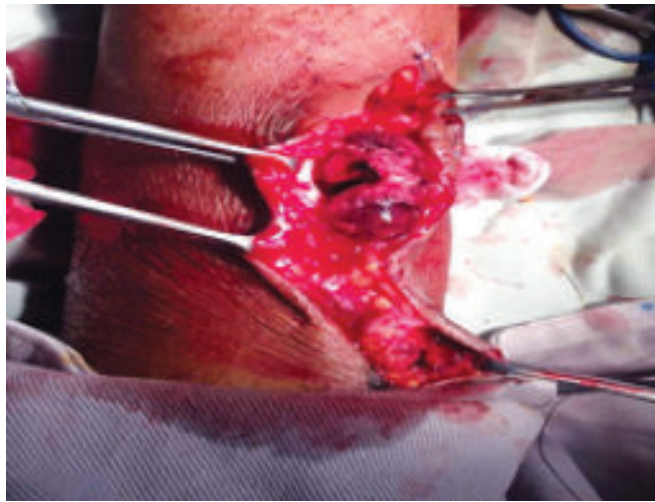
In this study, the most common complication was stenosis of arterialized vein (4.13%). Repeated use of cannulation for dialysis followed by inflammation and fibrosis was the leading cause of stenosis. Stenosis was also commonly found at the anastomotic site (2.48%). Probably anastomotic stenosis occurred due to venous intimal hyperplasia. All stenoses was managed successfully by endovascular intervention with balloon angioplasty. The

second most common complication was infection. Cannulation site infection (3.31%) was followed by infection at the site of fistula creation (2.48%). These were managed successfully by regular careful dressing and proper use of antibiotics after culture sensitivity test.

Thrombosis was found in 4 cases and fistula was found non-functioning at the time of presentation. Two of them were thrombosed at the anastomotic sites. Thrombectomy was done and fistula became functioning. Two other thrombosed fistulae were abandoned from dialysis due to multiple site aneurysm with thrombus.

Two cases of hematomas were found. One was in brachio-basilic transposition fistula wound. Exploration

was done on the 1st post-operative day and bleeding tributaries from skeletonized basilic vein were identified and ligated, the fistula became functioning. Another hematoma was found in Radio-cephalic fistula wound, which was conservatively managed. Pseudoaneurysm was an important complication of arteriovenous fistula. Two pseudoaneurysms were about to burst, but functioning. It was managed by excision of aneurismal sac and ligation of both arterial and venous end. A true aneurysm in arterialized vein was managed by interposition saphenous vein graft. One venous hypertension was found in our series. This occurred due to central vein stenosis and managed by stenting in central vein.



A

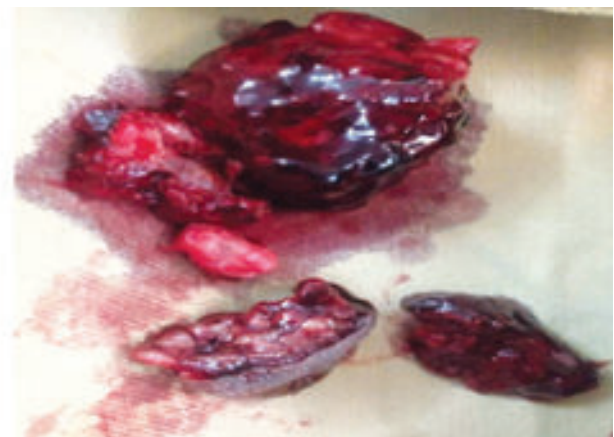


B

Fig.-2 A & B: Thrombosis of AVF & Aneurysm of brachio-cephalic AVF



A



B

Fig.-3 A & B: Pseudoaneurysm of Brachio-Cephalic Fistula & Thrombus & wall of Pseudoaneurysm.

Discussion:

Creation of Arteriovenous fistula is an important surgery for the vascular surgeons. Almost all AV fistulas were done with local anesthesia, but Brachio-basilic transposition fistula and one graft fistula (PTFE) was done under brachial block. Distal radio-cephalic fistula gives more length and more patency rate than others, so surgeons as well as patients first choice was distal radio-cephalic fistula. In a study done in Brazil, 52.5% of the study population was Distal Radio-cephalic fistulae, 16% was Proximal Radio-cephalic, 15% was Brachio-basilic fistulae⁶.

Most of the arteriovenous fistula (97.52%) in our series were made for Chronic Kidney Diseases[. Other causes of End Stage Renal Disease were obstructed uropathy (1.65%) and polycystic kidney disease (0.83%).

The most common complication was arterialized vein stenosis (4.13%). The risk of thrombosis increases with the degree of stenosis. The National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (NKF/KDOQI) guide lines defines significant stenosis of the vessel lumen as a reduction by more than 50%⁷. Clinical suspicion of stenosis is confirmed by the presence of several factors: Reduced flow to dialysis machine, problems with puncture, such as prolonged bleeding after AVF puncture, pain in the area of the fistula or increased venous pressure. Recirculation is an important issue since it appears to be a significant cause of inadequate hemodialysis. The most common cause is the presence of the high-grade venous stenosis, which obstruct venous outflow, leading to back flow into the arterial needle. Recirculation is diagnosed when the dialyzed blood returning through the venous side reenters the dialyzer through the arterial needle rather than returning to the systemic circulation, and as a result, the efficiency dialysis is reduced⁷.

The etiology of arterialized vein stenosis is not clearly known but repeated cannulation for long time during dialysis period may be the cause. Continuous inflammation and fibrosis were the cause for stenosis. Another type of outflow stenosis was found in these series was anastomotic stenosis (2.48%). Intimal hyperplasia was the cause for anastomotic stenosis. All causes preoperatively diagnosed as stenosis by duplex study and successfully managed endovascularly by balloon angioplasty.

In a prospective hospital based study conducted in Taif city, Saudi Arabia with the total number of 196 patients infections were found as about 20% of all AVF

complications. The most common infections include perivascular cellulitis, which manifests as localized erythema and edema and is easily treated. Much more serious is an infection associated with anatomical abnormalities, such as aneurysms, hematomas or abscesses, which require surgical excision and drainage⁸.

Thrombosis was leading cause of non-functioning arteriovenous fistula. Severe pain feels at the site of thrombus formation of AVF and patient can feel the thrombus. By duplex study all thrombosed AVF was diagnosed as fistula was not working. Two anastomotic site thrombosed fistulas were reverted as working fistulas after thrombectomy, but two others had multiple site thrombosis with aneurysm. They were abandoned from dialysis. The most common cause of vascular access thrombosis is venous neointimal proliferation that causes vascular stenosis, leading to fistula thrombosis⁹.

We found aneurysm (2.48%) and pseudoaneurysm (1.63%) of AVF as a complication during this study period. They were the most devastating complications of AVF fistula. An aneurysm is a pathological enlargement of the blood vessel wall resulting from repetitive puncture¹⁰. Diffuse and progressive degeneration of the vascular access site occurs. Patient may present with signs of bleeding, infection or ulceration^{7,11}. False aneurysms are hematomas located outside the vessel wall, formed due to a leaking hole in the artery or vein, most often due to iatrogenic trauma – primarily repeated needle punctures¹². Color Doppler ultrasound can differentiate false-aneurysm expansion from a hematoma, the presence of a thrombotic mass swirling of blood within cavity which enables a decision to be made on possible surgical correction. Surgical intervention is recommended when there is a risk of perforation and ulceration if there are elements of bleeding or if there is a limited place for puncture because of the size of the aneurysm¹³. Both the aneurysms of AVF were managed by excision and interposition graft by saphenous vein and fistula was working after reconstruction. Two pseudoaneurysm presenting fistulas were managed by excision of sac with ligation of both arterial and venous ends.

Two bleeding fistulas were found in immediate postoperative period within one and half hours of Brachio-cephalic fistula creation. Re exploration was done. Bleeding point was identified and proper hemostasis was done. There was no ischemic steal syndrome and anastomotic ruptured AVF in our series, but there was found a case of venous hypertension. Diagnosed

clinically by the signs of upper limb swelling and edema and was confirmed by venography. This venous hypertension of AVF complication was managed by stenting in central venous stenotic site.

Conclusion:

Arteriovenous fistula is an important issue for the hemodialysis patients. It gives more length and easy to cannulation, easy to hemostasis after completion of dialysis. Any complication during dialysis like low flow in machine, abnormal dilatation of access that is aneurysm, pseudoaneurysm or color changes around puncture site called extravasation of blood etc should be addressed and consulted with vascular surgeons immediately. Because early diagnosis and early treatment prevent loss of vascular access as well as avoid serious morbidity and mortality. Both the patient and dialysis staff should give highest care for the AVF to reduce the complications. A good quality vascular access provides good length for repeated puncture and allow a high blood flow rate to dialysis machine with minimal complication.

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