

## Original Research Article

# Complications of arteriovenous fistula for haemodialysis access

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## ABSTRACT

**Background:** This study was conducted to determine the complications of arteriovenous fistulae created for haemodialysis access in Christian Medical College, Ludhiana. The complications were classified as early and late complications.

**Methods:** This study was a one year retrospective and one year prospective study conducted in the Department of Surgery and Nephrology, Christian Medical College and Hospital, Ludhiana. After determination of the appropriate limb for surgery, arteriovenous fistulae were done under local anaesthesia in the operation theatre. All anastomosis was end (vein) to side (artery) and were done by using 6'0' prolene. The fistula created was monitored for a good thrill, pulse, and any immediate complication such as bleeding or thrombosis. After four to six weeks, a fistula with a good thrill was considered to be mature and was subjected to cannulation and then haemodialysis. The fistula flow rate was recorded at initiation of haemodialysis and after four weeks of haemodialysis. A nine month follow up study was done, and the late complications of the fistulae were also noted.

**Results:** Early complication was defined as complications arising within one month of creation of fistula, i.e. before maturation. The most common early complication was thrombus (8.5%). The second frequent complication was wound infection (3.4%). The most common late complication was thrombosis (18.6%). The second common late complication was pseudoaneurysm (4.23%). There was a statistically significant correlation between development of late complications with Diabetes Mellitus Type 2, Systemic Hypertension and history of I/V cannulation and IJV insertion in the study population (p value - 0.000).

**Conclusions:** This study has thus demonstrated that the vascular unit of General Surgery in Christian Medical College, Ludhiana is making arteriovenous access for haemodialysis at a rate comparable to other centres in India and worldwide. The early and late complications were also similar to other data available in India.

**Keywords:** Arteriovenous fistula, Early complication, Haemodialysis, Late complication

## INTRODUCTION

Vascular access care is a classic example of multidisciplinary team work between nephrologists, vascular surgeons, interventional radiologists, ultrasound technicians and dialysis nurses. To achieve the best outcome the team must agree on a set of goals, collaborate closely and maintain good mutual

communication. A key player in this multidisciplinary approach is a dedicated access coordinator who acts as a liaison officer between the disciplines and schedules the meetings. The assimilation of recommendations and guidelines into clinical practice is only possible if all parties involved are willing and motivated to cooperate. In 2003, the United States National Vascular Access Improvement Initiative (NVAII) launched Fistula First. This is a large national initiative that offers a set of tools

for physicians and dialysis facilities in order to accelerate increasing AVF use in haemodialysis patients. Eleven change concepts guide the target groups step-by-step to best practice. In The Netherlands, the CIMINO-project (Care Improvement by Multidisciplinary approach for Increase of Native vascular access Obtainment) was initiated as an effort to increase AVF use.<sup>1</sup>

The National Kidney Foundation (NFK) 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 (ESRD). One major focus of KDOQI is optimal arteriovenous (AV) 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 (CKD) who opt for hemodialysis should undergo autologous fistula creation. In order to preserve viable access sites, they recommend a radiocephalic 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 tunnelled 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 survival.<sup>2</sup>

This is a descriptive observational study conducted in the Department of General Surgery of Christian Medical College, Ludhiana. The study is to analyze the outcome of arteriovenous access created for haemodialysis in a specific time period.

## METHODS

This study was a one year retrospective and one year prospective study conducted in the Department of Surgery and Nephrology, Christian Medical College and Hospital, Ludhiana.

The retrospective group included all the cases of arteriovenous fistulae for haemodialysis access, done from 01/11/2009 to 31/10/2010. Details were acquired from the patients' medical record. Among these patients, those who came for regular haemodialysis to our hospital were followed up, for a period of nine months after the initiation of dialysis.

The prospective group included all the arteriovenous fistulae done for haemodialysis access from 01/11/2010 to 31/10/2011. All patients were personally worked up and followed up in the ward or on OPD basis. After the clinical assessment, the site of fistula was determined,

and patients were educated about the need for protecting the selected limb from any type of cannulations or injections. In case of inadequacy of vasculature in both the upper limbs, the same was confirmed by a Duplex examination.

After determination of the appropriate limb for surgery, the procedure was done under local anaesthesia in the operation theatre. Intra operative heparin saline was used in all cases. All arteriovenous anastomosis was end (vein) to side (artery) and were done by using 6'0' prolene. The fistula created was monitored for a good thrill, pulse, and any immediate complication such as bleeding or thrombosis. After four to six weeks, a fistula with a good thrill was considered to be mature and was subjected to cannulation and then haemodialysis. The fistula flow rate was recorded at initiation of haemodialysis and after four weeks of haemodialysis.

A nine month follow up study was done which included monitoring of the fistula flow rate after four weeks of initiation of haemodialysis. The complications were recorded in terms of early (within one month i.e., before maturation) and late complications (complications that arise after cannulation and initiation of dialysis).

The data was entered in Microsoft Excel. The frequencies, proportions and chi square test were done using SPSS software version 17.

## Inclusion criteria

- Patients with chronic renal failure who required a permanent haemodialysis access.
- Patients with chronic renal failure, who already had any other type of haemodialysis access, but needed a permanent arteriovenous fistula.
- Patients with chronic renal failure who had a failed previous arteriovenous access.

## Exclusion criteria

- Patients with inadequate peripheral vascular system in both upper limbs. The exclusion was done by clinical assessment and Duplex study.

## RESULTS

A total of 118 arteriovenous fistulae (AVF) were made during the study period, all by experienced surgeons in the vascular unit of the department. All fistulae were made by end to side anastomosis with 6 'o' or 5 'o' prolene sutures. All cases were followed up for a period of 9 months.

Out of the total number of AVF, 65 belonged to the retrospective group and 53 belonged to the prospective group.

Out of the 118 AVF made, 103 (87.3%) was for patients

with the diagnosis of Chronic Kidney Disease - Stage V.

**Table 1: Grouping of study population.**

| Group               | Number of population |
|---------------------|----------------------|
| Retrospective group | 65                   |
| Prospective group   | 53                   |
| Total no. of AVF    | 118                  |

**Table 2: Diagnosis of the study population.**

| Diagnosis                              | Number | Percentage |
|--|--------|------------|
| Chronic kidney disease (CKD) - Stage V | 103    | 87.3%      |
| CKD -Stage IV                          | 4      | 3.38%      |
| Obstructive uropathy                   | 3      | 2.54%      |
| CKD -Stage III                         | 2      | 1.69%      |
| Wegener's granulomatosis               | 2      | 1.69%      |
| Polycystic kidney disease              | 2      | 1.69%      |
| Post Renal transplant kidney failure   | 2      | 1.69%      |
| Total                                  | 118    | 100%       |

**Table 3: Comorbidities in the study population.**

| Comorbid illness                        | Number | Percentage |
|---|--------|------------|
| Diabetes Mellitus Type 2                | 51     | 43.2%      |
| Systemic Hypertension                   | 87     | 73.7%      |
| Coronary Artery Disease                 | 11     | 9.32%      |
| Respiratory Disease                     | 1      | 0.8%       |
| Congestive Cardiac Failure              | 2      | 1.7%       |
| DM Type 2 + Systemic Hypertension       | 35     | 29.7%      |
| DM Type 2 + Systemic Hypertension + CAD | 5      | 4.2%       |
| Systemic Hypertension + CAD             | 5      | 4.2%       |
| DM Type 2 + CAD                         | 1      | 0.8%       |
| HIV Positive                            | 0      | 0%         |
| HCV Positive                            | 9      | 7.6%       |
| HBsAg Positive                          | 1      | 0.8%       |
| Others                                  | 7      | 5.9%       |
| None                                    | 10     | 8.5%       |

The most common co-morbidity was found to be Systemic Hypertension (73.7%). 43.2% of the population had Diabetes Mellitus Type 2. Out of the total study population 29.7% was found to have co-existing Systemic Hypertension and Diabetes Mellitus.

There was a statistically significant increase in the number of late complications in patients who had Systemic Hypertension, Diabetes Mellitus Type 2 and in patients who had both the co-morbidities co-existing (p value 0.000, chi square test applied).

9 cases were HCV positive and 1 was HbSAg positive. There were no HIV positive cases in the study population

**Table 4: Relevant past history of the study population.**

| Past history                                  | Number | Percentage |
|---|--------|------------|
| Bleeding diathesis                            | 1      | 0.8%       |
| Use of anticoagulants                         | 1      | 0.8%       |
| Previous AVF                                  | 10     | 8.47%      |
| IV cannulation of upper limb veins            | 2      | 1.7%       |
| IV Cannulation + IJV insertion                | 104    | 88.1%      |
| IV Cannulation + IJV insertion + Previous AVF | 8      | 6.8%       |
| Smoking                                       | 5      | 4.2%       |
| Anaemia                                       | 84     | 71.2%      |
| Peripheral vascular disease                   | 0      | 0%         |

A statistically significant correlation was found between the past history of I/V cannulation and IJV insertion with late complications of AVF (p value - 0.000).

However, there was no statistically significant correlation between anaemia and late complications of AVF (p value -0.160).

**Table 5: Type of arteriovenous fistula.**

| Type of fistula       | Number | Percentage |
|-----------------------|--------|------------|
| Left Radiocephalic    | 52     | 44.1%      |
| Left Brachiocephalic  | 44     | 37.3%      |
| Right Radiocephalic   | 11     | 9.3%       |
| Right Brachiocephalic | 8      | 6.8%       |
| Left Brachiocephalic  | 1      | 0.8%       |
| Right Brachiocephalic | 1      | 0.8%       |
| Left Brachiocephalic  | 1      | 0.8%       |
| Total                 | 118    | 100%       |

The most common type of AVF made was the Left Radiocephalic fistula (44.1%). This was followed by the Left Brachiocephalic fistula (37.3%). This predominance of left sided fistulae in the population was due to fact that left was the non-dominant limb in all cases in the study population.

**Table 6: Immediate post operative pulse and thrill.**

| Immediate post operative evaluation | Number | Percentage |
|-------------------------------------|--------|------------|
| Good thrill                         | 115    | 97.5%      |
| Good pulse                          | 3      | 2.5%       |

97.5% of cases (115 out of 118) demonstrated a good thrill in the immediate post operative period. 2.5% (3 out of 118) had only demonstrable pulse.

Early complication was defined as complications arising within one month of creation of fistula, i.e. before maturation. The most common early complication was thrombus (8.5%). The second frequent complication was

wound infection (3.4%). One case was lost to follow up after creation of AVF.

**Table 7: Early complications.**

| Complication                    | Number | Percentage |
|---------------------------------|--------|------------|
| Haematoma                       | 3      | 2.5%       |
| Thrombus                        | 10     | 8.5%       |
| Bleeding                        | 3      | 2.5%       |
| Wound infection                 | 4      | 3.4%       |
| Haematoma + bleeding + thrombus | 2      | 1.7%       |
| No early complication           | 95     | 80.5%      |
| Total                           | 117    | 99.1%      |

**Table 8: Early RE - exploration of AVF.**

| Early re-exploration                 | Number | Percentage |
|--------------------------------------|--------|------------|
| Fistula working post exploration     | 10     | 8.5%       |
| Fistula not working post exploration | 5      | 4.2%       |
| Total                                | 15     | 12.7%      |

Out of the 15 AVFs requiring re-exploration before maturation, 10 were done for thrombus at the anastomotic site. Thrombectomy was done and 6 of them started working. The rest of the 5 re-explorations were done for wound haematoma. The haematoma was removed, the anastomotic leak was repaired and 4 of them started working again. The primary failure rate, i.e. the total number of fistulae in the study population which failed before maturation was 4.2%.

**Table 9: Time taken for maturity of AVF.**

| Time        | Number | Percentage |
|-------------|--------|------------|
| 3-3.9 weeks | 4      | 3.4%       |
| 4-5.9 weeks | 80     | 67.8%      |
| 6-7.9 weeks | 19     | 16.1%      |
| ≥8 weeks    | 1      | 0.8%       |

5 (4.2%) out of the total AVFs failed to mature. 12 patients expired at different time periods during the study. One case was lost to follow up.

The most common late complication was thrombosis (18.6%). The second common late complication was pseudoaneurysm (4.23%). There was a statistically significant correlation between development of late complications with Diabetes Mellitus Type 2, Systemic Hypertension and history of I/V cannulation and IJV insertion in the study population (p value - 0.000).

Late Re-exploration was done for 19 AVFs. Out of these 19, 4 of them required creation of new fistula at another site. 3 of them remained non functional even after the re-exploration. Ulno basilic interposition graft with saphenous vein was put for one case. Saphenous

interposition graft was put for 5 radiocephalic fistulae during their re-exploration. Transposition of brachiocephalic fistulae were done in 6 cases.

**Table 10: Late complications.**

| Complication                           | Number | Percentage |
|--|--------|------------|
| Wound infection                        | 2      | 1.7%       |
| Thrombosis                             | 22     | 18.6%      |
| Pseudoaneurysm                         | 5      | 4.23%      |
| Seroma                                 | 1      | 0.8%       |
| Distal venous hypertension             | 1      | 0.8%       |
| Accessory vein                         | 2      | 1.7%       |
| Stenosis                               | 2      | 1.7%       |
| Stenosis + Accessory vein              | 2      | 1.7%       |
| Thrombosis + Pseudoaneurysm            | 1      | 0.8%       |
| Subclavian vein stenosis               | 2      | 1.7%       |
| Post cannulation rent in cephalic vein | 1      | 0.8%       |
| Lymphaedema                            | 0      | 0%         |
| Steal syndrome                         | 0      | 0%         |
| Neuropathy                             | 0      | 0%         |
| Pulmonary hypertension                 | 0      | 0%         |
| Congestive cardiac failure             | 0      | 0%         |

**Table 11: Late RE - exploration.**

| Procedure                                  | Number |
|--|--------|
| Saphenous vein interposition graft         | 5      |
| Transposition of brachiocephalic fistula   | 6      |
| Ulno-basilic saphenous interposition graft | 1      |

## DISCUSSION

This study was conducted in the Department of General Surgery and Nephrology, Christian Medical College and Hospital, Ludhiana to observe the outcome of AVFs made in the department from the period of 1<sup>st</sup> November 2009 to 31<sup>st</sup> October 2011. All the AVFs made from 1<sup>st</sup> November 2009 to 31<sup>st</sup> October 2010 were studied retrospectively, whereas fistulae made between the time period 1<sup>st</sup> November 2010 and 31<sup>st</sup> October 2011 were studied prospectively. All cases were followed up for a period of nine months as per protocol.

In this study, 87.3% of the AVF were made in patients with Chronic Kidney Disease (CKD) - Stage V. 3.38% of the study population was in CKD IV stage and 1.69% in Stage III. A small amount of population had Obstructive Uropathy (2.54%), Wegener's Granulomatosis (1.69%) and Polycystic Kidney (1.69%) as the cause of End Stage Renal Disease.

A brief report on the incidence of End Stage Renal Disease (ESRD) published by Gopesh Modi (Samparpan Kidney Institute and Research Centre, Bhopal, India) and Vivekanand Jha (Department of Nephrology, Post

Graduate Institute of Medical education and Research, Chandigarh, India) in the Kidney International 2011 showed that out of the 84 new cases of ESRD in 2006, 8 had arteriovenous fistula as the initial access. Among 81 new cases in 2007, 11 had AVF as the initial access. In 2008, there were 91 new cases of ESRD, out of which 12 had AVF as the initial access.<sup>3</sup>

The most common co-morbidity was found to be Systemic Hypertension (73.7%). 43.2% of the population had Diabetes Mellitus Type 2. Out of the total study population 29.7% was found to have co-existing Systemic Hypertension and Diabetes Mellitus.

There was a statistically significant increase in the number of late complications in patients who had Systemic Hypertension, Diabetes Mellitus Type 2 and in patients who had both the co-morbidities co-existing (chi square test used, p value - 0.000).

Out of the 118 cases in this study, 9 cases were found to be HCV positive and 1 was HbSAg positive. There were no HIV positive cases in the study population.

A study was conducted in 2005, in Geneva, in which data of all patients who underwent creation of an AVF at the Geneva University Hospital from January 1998 to December 2002 were reviewed. 119 patients underwent the creation of AVF, out of which 48 (32.4%) fistulae were created in diabetic patients. In a multiple logistic regression analysis, diabetes mellitus (aOR = 3.19, 95% CI = 1.17-8.71, p = 0.024) was one of the significant predictive factors of early failure of AVF.<sup>4</sup>

There was a statistically significant correlation between the past history of I/V cannulation and IJV or subclavian vein cannulation with the development of late complications (p value - 0.000, chi square test used).

In this study, 8.47% of the population had history of previous arteriovenous access. 0.8% gave history of use of anticoagulants in the past. 0.8% also had bleeding diathesis in the past. There were no cases of Peripheral Vascular Disease in the study population.

The most common type of AVF made was the Left Radiocephalic fistula (44.1%). This was followed by the Left Brachiocephalic fistula (37.3%). This predominance of left sided fistulae in the population was due to fact that left was the non-dominant limb in all cases in the study population. The Right Radiocephalic fistula comprised 9.3% of the AVF made, followed by the Right Brachiocephalic fistula which constituted 6.8% of the AVF. There was one Left Brachiocephalic fistula, one Right Brachiocephalic fistula and one Left Brachiocephalic fistula made during the study period.

In a study done in Brazil, 52.5% of the study population was Distal Radiocephalic fistulae, 16% was Proximal Radiocephalic, 15% was Brachiocephalic fistulae. It was a

descriptive transversal observational study conducted on April to May 2008, in the dialysis unit of the Department of Nephrology of the Faculdade de Medicina do ABC, in the Padre Anchieta Teaching Hospital and in the Mario Covas Hospital. The sample consisted of 219 patients.<sup>5</sup>

Out of the total, 97.5% of cases (115 out of 118) demonstrated a good thrill in the immediate post operative period whereas 2.5% (3 out of 118) had only demonstrable pulse.

In a study, 245 patients were included in a program for the first time AVF access from 22 November 2005 to 22 November 2006. Most of the fistulae had appropriate functions (good pulse or thrill) immediately after the operation (83.7%), 5.7% had poor function and 1.2% showed no function.<sup>6</sup>

Early complications were defined as the complications arising in the fistula within one month of creation of the AVF. 80.5% (95/118) of the population had no early complications. The most common early complication was found to be thrombosis (8.5% i.e., 10/118). The 2<sup>nd</sup> common early complication was wound infection (3.4%), which was followed by haematoma and bleeding (2.5% each). Two cases in the study population had haematoma and co-existing bleeding and thrombosis.

Early complication causes include inflow problems such as small or atherosclerotic arteries, or juxta-anastomotic stenosis. The etiology of this acquired lesion is not entirely clear, but may be related to manipulating the free end of the vein, torsion, poor angulation, or loss of the vasa vasorum during anatomic dissection. This lesion often can be adequately treated with angioplasty or by surgical revision. Outflow problems may include accessory veins that divert blood flow from the intended superficial vessel to deeper conduits, or central venous stenosis in patients with prior central venous catheters. Accessory veins can be ligated if they appear clinically significant. Vessels smaller than one-fourth of the fistula diameter are usually not hemodynamically relevant. Juxta-anastomotic stenosis and accessory veins are the most common causes for early failure AVFs when pre-operative evaluations for suitable access sites have been performed.<sup>7</sup>

Out of the 15 arteriovenous fistulae which required exploration before maturation, 10 worked after the exploration whereas 5 did not work post exploration. This gives the primary failure rate of AVF in the study population i.e. 4.2%.

In a retrospective study of all chronic hemodialysis patients followed by the Southern Alberta Renal Program from January 1, 2005 to June 30, 2008, the incidence of primary failure was 10% (81 of 831). Demographic and clinical variables and initial intra-access blood flow (IABF) were compared between those with and without loss of primary functional patency.<sup>8</sup>



Most of the AVF (67.8%) matured between 4 to 6 weeks. 16.1% matured between 6 to 8 weeks. 3.4% matured before 6 weeks and 0.8% after 8 weeks. 5 (4.2%) out of the total AVFs failed to mature. 12 patients expired at different time periods during the study. One case was lost to follow up.

Fistula maturation is defined by the determination of both vascular surgeon and nephrologist that an access is patent and ready for cannulation based on adequacy of blood flow through the fistula and the adequacy of vein dilation with respects to length (>10 cm segment), depth (<6 mm), and diameter (>6 mm). This can be based on physical examination with or without postoperative duplex ultrasound (DUS) evaluation. Functional maturation is defined as successful cannulation of the fistula with the ability of the access to deliver a flow rate of 350 to 400 ml/min and maintain dialysis for 4 hours or less. Primary fistula failure is defined as fistula abandonment prior to cannulation regardless of patency status.<sup>9</sup>

Late complications were defined as the complications arising after maturation of AVF. The most common complication was thrombosis (18.6%) followed by pseudoaneurysm (4.23%). Anastomotic stenosis, accessory vein, wound infection and subclavian vein stenosis followed with 1.7%. Seroma, distal venous hypertension and post cannulation rent in cephalic vein constituted 0.8%. There were no cases of lymphoedema, steal syndrome, neuropathy, pulmonary hypertension or congestive cardiac failure in the study group.

In a study conducted in Shanghai First People's Hospital Affiliated to Jiaotong University, the most frequent late complications seen were thrombosis (13.86%), followed by aneurysm (12.23%), anastomotic stenosis (2.17%); arterial steal syndrome (1.63%); infection (0.54%); and venous hypertension (0.27%). Pseudoaneurysm was more common in the elbow group (66.67%) than in the wrist group (9.43%) ( $p < 0.01$ ).<sup>10</sup>

Late Re-exploration was done for 19 AVFs. Out of these 19, 4 of them required creation of new fistula at another site. 3 of them remained non functional even after the re-exploration. Ulno basilic interposition graft with saphenous vein was put for one case. Saphenous interposition graft was put for 5 radiocephalic fistulae during their re-exploration. Transposition of brachiocephalic fistulae were done in 6 cases.

12 patients in the study population expired during the study period. 10 of them expired within 1 month of creation of fistula and 2 of them expired after 4 months of creation of the fistula.

The primary success rate of 466 patients for 2 years was

about  $54\% \pm 4$ , while in a study published in the International Journal of Clinical and Experimental Medicine, in 2012, the primary patency rate for two and four years were 65% and 48%.<sup>6</sup>

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