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Distal vs proximal arterio venous fistula creation in the upper limb for maintenance hemodialysis in chronic renal failure patients

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Abstract

Purpose: The goal was to share our experience of the proximal and distal types of arteriovenous fistula (AVF) and to ascertain advantage of one over the other and ultimately which has a superior success rate.

Methods: All patients referred to the department of CVTS, for construction of AVF underwent a detailed clinical examination to assess the quality of the venous system of the upper limb of interest. All patients with poor quality veins at the wrist or patients in whom previous AVF at the wrist had failed were taken up for proximal A-V fistula at the antecubital fossa. The surgical complications were analysed in the immediate and late postoperative period. These 230 cases were performed over a span of 12 months with regular follow up and observation for the next 12 months.

Results: The proximal AVFs had only a 5.21% maturation failure cases as compared to the 13.0% in distal AVFs with mean time for maturation being 1.5 months and 2-2.5 months, respectively. The overall primary patency rates at 12 months were 98% for proximal AVFs and 74% for distal AVFs.

Conclusion: The Proximal A-V fistulas for MHD were found to have early maturation and high primary patency rates in comparison to the distal AVFs which inadvertently required new proximal AVF creation in the future due to the observed complications and low maturation rates with only a palpable pulse even after 8 weeks of surgery.

Keywords: AVF failure, end stage renal disease, fistula maturation, primary AVF patency

Introduction

Patients with end stage renal disease need an accurate and effective vascular access for haemodialysis, which is indispensable for end-stage renal disease patients. For this purpose, arteriovenous fistulas (AVFs) are used which is a lifeline for a patient with end-stage chronic renal failure.

Among the native fistulas, Brescia-Cimino distal Radiocephalic AVF (RCAVF) is the most preferred. Radiocephalic fistulas for maintenance hemodialysis access are not feasible in all patients with end-stage renal disease especially in those in whom distal vascular bed is depleted. In such cases, proximal A-V fistulas such as brachiocephalic AVF (BC-AVF) and brachiobasilic AVF (BB-AVF) with basilic vein transposition (basilic vein transposition arteriovenous fistula) can be used for a long-term dialysis. Other options are synthetic graft or transposed basilic vein AVF. The goal was to share our experience of the proximal and distal types of arteriovenous fistula (AVF) and to ascertain advantage of one over the other and ultimately which has a superior success rate.

Data analysis

A Prospective observational study was conducted in the department of CVTS at our institute for this study from December 2019 to December 2021. All the patients fitting in the inclusion criteria were enrolled in the study after convenience sampling, data collected and analysed using SPSS (Statistical Package for Social Sciences) version 28. IBM SPSS statistics (IBM corp. Armonk, NY, USA released 2011)] was used to perform the statistical analysis. The power of this study was 0.7 and using the formula:

$$n = Z^2_{1-\alpha/2} pq / d^2$$

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Where

n is the required sample size.

Z is the standard normal deviate, which is equal to 1.96.

At 5% level of significance and 33% of anticipated proportion with 10% of margin of error, the total sample size is 130.

Inclusion criteria

Patients with Chronic Renal Failure presenting for an A-V Fistula creation in the OPD and as IP admissions.

Exclusion criteria

- Septicaemia
- Needle prick/ IV cannulation for sample collection on the arm of interest in the past 2 weeks
- Refusal of consent
- Presence of upper limb venous thrombosis

Limitations

- This is a prospective study, randomisation was not used.
- The follow up period is short at 1 year.

Assessment

All patients referred to the department of CVTS, for construction of AVF underwent a detailed clinically examination to assess the quality of the venous system of the upper limb of interest. Examination included inspection and palpation of the cephalic vein at the wrist and upper arm and the basilic vein at the elbow, after proximal compression using a tourniquet in the upper arm. Distal dual Arterial blood supply was confirmed by Allen's test. A Duplex ultrasound scanning of the upper limb was performed when physical examination failed to appreciate adequate caliber veins or there was uncertainty regarding the quality or continuity of the vein for arteriovenous access. If a subclavian catheter had been inserted in the past, doppler assessment of the same was mandatory to rule out any proximal venous stenosis/ thrombosis. All patients with poor quality veins at the wrist or patients in whom previous AVF at the wrist had failed were taken up for proximal A-V fistula at the antecubital fossa. All patients were educated regarding active arm and hand exercises in the postoperative period to aid in fistula maturation.

Surgical procedure

In all cases, under local anaesthesia, after skin incision and subcutaneous layer dissection, the vein was dissected first and if found suitable, i.e., patent, of adequate calibre and adequate length for mobilisation and anastomosis, only then was the artery dissected. After disconnection, the vein was distended and flushed with heparinized saline solution. If the saline infusion was without resistance, only then the vein was selected for anastomosis. If veins were not suitable, the procedure was abandoned and artery was not exposed.

Anastomosis was carried out in an end to side fashion using 7-0 prolene double arm sutures, continuous fashion, in a single layer.

Fistula patency was confirmed on table by presence of a palpable thrill and/or a bruit and arterial pulsations distal to the anastomosis were appreciated in all cases intraoperatively.

The surgical complications were analysed in the immediate and

late postoperative period. During the follow-up tenure of this study, the patency of the fistulas were assessed by clinical examination and by a Doppler study.

Early fistula failure was defined as failure to access the vein for haemodialysis within three months. Delayed fistula failure was defined as those who were successfully accessed initially within three months but failed later.

This prospective comparative study comprises of 230 AVFs (115 RC-AVF AND 115 proximal AVFs, i.e., BC-AVF/BB-AVF) with end-stage chronic renal disease. These 230 cases were performed over a span of 12 months with regular follow up and observation for the next 12 months (December 2019-December 2021). The postoperative complications, patency rates, vessels used, advantages and disadvantages of these fistulas were studied and recorded.

Results

Between December 2019 and December 2021, 230 patients underwent AVF creation. The mean age of these patients (131 men and 99 women) was 43.7 ± 21.7 years and 95% underwent procedure on the non-dominant left upper limb. The proximal AVFs had only a 5.21% maturation failure (6 patients) cases as compared to the 13% (15 patients, 9 early & 6 late failures) in distal AVFs (Fig. 1) with mean time for maturation being 1.5 months and 2-2.5 months, respectively. The overall primary patency rates at 12 months were 92% for proximal AVFs and 74% for distal AVFs.

In the 12 months follow up and observational duration of patients who underwent proximal AVFs (BC-AVF/BB-AVF), lymphoedema and Pseudoaneurysm proximal to the anastomosis following needle trauma during haemodialysis access developed in 3.47% (4 patients each) of the cases, hematoma in 7.8% (9 patients) and Partial wound dehiscence with infection was seen in (5 patients) 4.3% of the diabetics managed with regular dressings and closed secondarily. 3.47% (4 patients) developed a vascular steal syndrome (Fig. 2) which required take down and neo-creation of distal AVF in the opposite limb. Rest of the cases recovered without any complications.

Likewise, in patients who underwent distal AVFs (RC-AVF), 7.8% (9 patients) developed hematoma formation, 6% (7 patients) of the wounds in diabetic patients got infected with resultant partial wound dehiscence, managed with regular dressings and secondary suturing. Rest recovered uneventfully.

The analysis was taken as a general consideration for proximal AVFs, for both brachiocephalic AVF (BC-AVF) and brachio basilic AVF (BB-AVF) and not independently.

(48 patients) 20.8% were Diabetics and these few of these patients in general showed more susceptibility to wound infections/ partial dehiscence as compared to non-diabetic patients hence leading to delayed recovery and delayed maturation rates (Table 1.).

The most common complication was Fistula thrombosis leading to fistula failure. The immediate post-operative/ early complications were bleeding/ hematoma formation leading to wound infection and wound dehiscence. The late complications included steal syndrome, lymphoedema, and aneurysm formation.



Fig 1: Distal end to side radio-cephalic arterio-venous fistula



Fig 2: Steal syndrome post proximal arterio-venous fistula creation

Table 1: Tabulation of statistical observations between Distal AVF and Proximal AVF cases.

	Distal AVF	Proximal AVF
Maturation failure	13.0%	5.21 %
Mean time for maturation	2-2.5 months	1.5 months
Steal syndrome	Nil	3.4%
Aneurysm	3.4%	Nil
Hematoma	7.8%	7.8%
Gangrene/ ischaemia	Nil	Nil
Wound infection Diabetics	6%	4.3%
Wound infection Non-diabetics	2%	1%
Chronic pain	Nil	Nil
Lymphoedema	Nil	3%

Conclusion

In our study, both proximal and distal AVFs have been found to have their preferable advantages and complications. In our study, healing at the incision site was excellent except in a few diabetics who had partial wound dehiscence and infection secondary to poor glycemic control. The Proximal A-V fistulas for MHD were found to have early maturation and high primary patency rates, preventing long term hemodialysis catheter related complications and should be made gold standard in patients with multiple co-morbidities in comparison to the distal AVFs which inadvertently required new proximal AVF creation in the future due to the observed complications and low maturation rates, intra-operative evidence of atherosclerosis distal vessels in the elderly and with only a palpable pulse even after 8 weeks of surgery. However, Cimino radiocephalic

arteriovenous fistula at the wrist remains the most preferred AVF along with the advantage of minimal venous anomalies, lesser complications of hyperdynamic circulation such as heart failure as compared to proximal AVF and moreover it would preserve the proximal limb for future AVF creation if case of distal AVF failure. Hence, there exists specific instances where a proximal AVF may be preferable than a distal AVF and vice versa, depending on a number of variables, including, patient general condition, presence of co-morbidities and vein calibre.

Discussion

Vascular access has continued to be a problem for patients receiving chronic haemodialysis ever since the first surgically made arteriovenous fistula for hemodialysis was reported four decades ago. The ideal vascular approach for hemodialysis

continues to be arteriovenous fistula using autogenous vein. The alternate hemodialysis methods, like long-term central venous catheters and synthetic shunts, cause an increased incidence of thrombosis and infection. The most preferred vascular access technique is still the Brescia-Cimino radiocephalic arteriovenous fistula at the wrist. However, other solutions must be taken into account in individuals with poor quality distal veins or wrist AV fistula failure.

The following requirements for vascular access for chronic hemodialysis should be met, long-term patency rate, low complication rate, and acceptable patient acceptance.

Compared to the elbow crease incision used for brachiocephalic fistula, the distal AVF incision site has poor healing and is not very aesthetically pleasing. Dilated veins, however, have a similar visual significance at the elbow or immediately below it. Only a few patients in our study experienced wound problems after satisfactory healing at the incision site.

High flow rates are possible with brachiocephalic fistulae, and hemodynamic problems including steal syndrome and high output cardiac failure occur more frequently than the wrist fistulas.

Compared to proximal AVFs, where vascular steal syndrome can occur up to 20% of the time, distal AVFs have a far lower incidence (0.3%). In both cases, the fistula must be closed in case of vascular steal phenomena.

A few pointers for a better results

- Vessel calibre more than 2.5 mm.
- Use of a proximal artery when the distal artery is not suitable.
- Preference for a longitudinal incision for better exposure.
- End to side anastomosis.
- Use of surgical loupe.
- Use of prolene 6-0 for proximal anastomosis and 7-0/8-0 for distal anastomosis.

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No funding was received for conducting this study.

Consent

Informed consent has been obtained from the subjects of the study.

Conflicts of interests

The authors have no relevant financial or non-financial interests to disclose.

Ethical approval

All procedures performed in this study involving human participants were in accordance with ethical standards of the institution and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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