Factors Affecting the Patency of Arterio Venous Fistula for Dialysis Access
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ABSTRACT

Introduction: End-stage renal disease is a chronic disease requiring treatment with dialysis or renal transplantation. Autologous arteriovenous fistula is the gold standard for vascular access for hemodialysis. The aim of this study is to determine the different factors which play the role for the patency of autologous arteriovenous fistula.

Methods: This is the hospital based prospective study, conducted for the period of 12 months from September 2017 to September 2018 in department of CardioThoracic and Vascular Surgery of Bir Hospital. Autologous vein were used to creat radio cephalic (Brescio-Cimino) or brachio cephalic fistula. Different factors age, sex, size of the vessels, site of the anastomosis, comorbid diabetes Mellitus were taken into consideration.

Results: The total number of patients included in this study was 304. Radio cephalic fistula was made in 175 (57.56%) while brachiocephalic fistula was made in 129 (42.43%), patients. Overall patency rate was 85.85%. We had a most common complication bleeding, thrombosis 30 (9.86%), upper limb edema 26 (8.55%) and infection 19 (6.25%).

Conclusion: Autologous arteriovenous fistula is the better choice for vascular access for hemodialysis in patients with end-stage renal disease. Different factors like site of the anastomosis, female gender, diabetes mellitus and most importantly size of the vessels play an important role in the patency of arterio venous fistula.

Keywords: Arteriovenous fistula, End stage renal disease, Hemodialysis, Patency.

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INTRODUCTION

End-stage renal disease (ESRD) is a chronic disease requiring treatment with dialysis or renal transplantation. It is a major public health problem, the incidence of which is increasing every year. It is associated with significant morbidity and mortality and incurs a huge financial cost, of which a significant portion is directly related to vascular access and management of the complication.1 Arteriovenous fistula (AVF) are constructed using radial artery and cephalic vein in the forearm and brachial artery and cephalic or basilic vein in the upper arm. In order of preference as given in the Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines, the Brescia-Cimino fistula, i.e., radiocephalic (RC) fistulas are the first choice, followed by brachiocephalic and brachiobasilic transposition and synthetic graft fistulas.2

A native AVF (as originally described by Brescia and Cimino) is now considered the first choice vascular access, since the incidence of thrombotic or infectious complications is lower compared with other types of vascular access. Availability of an AVF at the time of commencement of dialysis directly reduces mortality in patients undergoing hemodialysis (HD).3 The patency rates depend on various factors such as site of anastomosis, side of anastomosis, caliber of the vein and artery used for anastomosis, type of anastomosis and patient factors. The levels of glucose level are associated with AVF early failure in ESRD patients. Good control of glucose level can lower the rates of AVF early failure.4 Present guidelines suggest a minimum diameter of artery is 2 mm for successful AVF creation at the wrist.5 This minimal value is evidenced by meta-analysis findings of the fistula success rate being significantly different between radial artery diameters >2.0 mm (59%) and <2.0 mm (40%). Current guidelines suggest minimum venous diameter of 2 mm for a cephalic AVF at the wrist, and no agreed minimum measures exist for other sites to date. These measures have been evidenced by meta-analysis demonstrating significant differences in fistula success rates between cephalic vein diameter >2.0 (71%) and <2.0 mm (29%).6

The patients with ESRD are increasing not only in Nepal but worldwide. The number of patients going for dialysis is rapidly increasing after the Health Ministry of Nepal introduced the free health scheme for the treatment of ESRD patients. Consequently, patients seeking for creation of AV fistula are also increased significantly in our department. There are very few studies done in Nepal about the factors affecting the patency of AV fistula and that also in small volume. So present study was conducted to evaluate the outcome and different factors affecting the patency of arteriovenous fistula created at the department of cardiothoracic and vascular surgery (CTVS), National Academy of Medical Sciences, Bir Hospital, Kathmandu, Nepal.

METHODS

This is the hospital based prospective study, conducted for the period of 12 months from Sept 2017 to September 2018 in CTVS, department of surgery Bir Hospital

Patients with ESRD requiring HD who were referred to CTVS department for access were recruited. Vascular assessment was done by Allen’s test, evaluation for venous thrombosis from previous cannulation and venous size was performed clinically by palpation. An elastic band was tied below elbow to distend the vein in distal forearm for assessment of venous system by palpation. In all fistulas autologous vein were used. Radio cephalic (Brescio-Cimino) or Brachio cephalic fistula were made in a non-dominant arm most of the time. When there were not suitable vessels in non dominant hand , other hand was used. We excluded patients who had thrombosed cephalic veins in distal forearm, or patients with uremic symptoms and with negative Allen’s test.

Procedure details. After evaluating the patients in Out Patient Department (OPD), all the needed investigations were performed. Patients were counseled about the study and a written informed consent was taken.

Total of 304 cases underwent AV fistula surgery in the hospital during data collection time. Approval from Subject Committee and Institutional Review Board of National Academy of Medical Sciences taken prior to study. Written consent was taken from all the patients. Data were collected by using interview schedule for demographic and comorbidities information and by observing during surgery. Privacy was maintained by taking the interview separately. Confidentiality was assured by not disclosing the information and maintained by coding the data with number.
RESULTS

The age of the patient ranges from 15 to 78 years, with the mean age 56 ± 16.12 years. Male dominant 205 (67.43%), female 99 (32.56%). RC fistula created in 173 (56.90%) patients, BC fistula created in 129 (42.43%) patients. (Table 1)

Table 1. Age Distribution According to Gender & Type of Fistula

<table>
<thead>
<tr>
<th>Age</th>
<th>Male N= 205</th>
<th>Female N= 99</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 – 25</td>
<td>7 (2.3 %)</td>
<td>3 (.98 %)</td>
<td>10 (3.28%)</td>
</tr>
<tr>
<td>26 - 35</td>
<td>24 (7.89%)</td>
<td>8 (2.63%)</td>
<td>32 (10.52%)</td>
</tr>
<tr>
<td>36 - 45</td>
<td>32 (10.2%)</td>
<td>17 (5.59%)</td>
<td>49 (16.11%)</td>
</tr>
<tr>
<td>46 – 55</td>
<td>41 (13.48%)</td>
<td>26 (8.55%)</td>
<td>67 (22.03%)</td>
</tr>
<tr>
<td>56 – 65</td>
<td>54 (17.76%)</td>
<td>24 (7.89%)</td>
<td>78 (25.65%)</td>
</tr>
<tr>
<td>&gt;66</td>
<td>47 (15.46%)</td>
<td>21 (6.9%)</td>
<td>68 (22.36%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of fistula</th>
<th>Male N= 205</th>
<th>Female N= 99</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC fistula</td>
<td>134 (76.57%)</td>
<td>41 (23.42%)</td>
<td>175 (57.56%)</td>
</tr>
<tr>
<td>BC fistula</td>
<td>71 (55.03%)</td>
<td>58 (44.96%)</td>
<td>129 (42.43%)</td>
</tr>
</tbody>
</table>

RC : Radiocephalic, BC : Brachiocephalic

Out of 304 patients, 43 (14.1%) had AV fistula failure, out of those 22 (54%) were male and 19 (46%) were female. (Table 2). It showed that overall AV fistula failure was more in male patients, but gender wise, male patients had a patency rate of AV fistula was 89.26% where as a female patients had a patency rate of 80.81%. (Table 2)

Twenty six (8.55%) patients had upper limb edema, 30(304) (9.86%) had bleeding which were managed immediately or in the emergency basis, 19 (6.25%) had a infection which was managed with antibiotic, regular dressing and wound gaps were treated by secondary suture. (Table 2)

Table 2. Complications of AV Fistula

<table>
<thead>
<tr>
<th>Variables</th>
<th>Male N= 205</th>
<th>Female N= 99</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edema</td>
<td>12 (46.15%)</td>
<td>14 (53.84%)</td>
<td>26 (8.55%)</td>
</tr>
<tr>
<td>Bleeding</td>
<td>19 (63.33%)</td>
<td>11 (36.66%)</td>
<td>30 (9.86%)</td>
</tr>
<tr>
<td>Infection</td>
<td>12 (63.15%)</td>
<td>7 (36.84%)</td>
<td>19 (6.25%)</td>
</tr>
<tr>
<td>AV fistula Failure</td>
<td>22 (54%)</td>
<td>19 (46%)</td>
<td>41 (13.48%)</td>
</tr>
</tbody>
</table>

Overall failure rate was 41 (13.48%). Among them radio cephalic fistula comprises 26 (63.41%) and brachio cephalic fistula comprised 15 (36.58%). (Table 4) AVF failure was in 22 (54%) diabetic patients and in 19 (46%) non diabetic patients.

Table 3. Distribution of AV Fistula Failure According to Size of the Vessels (n=41)

<table>
<thead>
<tr>
<th>Variables</th>
<th>&lt; 2mm</th>
<th>&gt;2mm</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of the Artery</td>
<td>28 (68.29%)</td>
<td>13 (31.70%)</td>
<td>41</td>
</tr>
<tr>
<td>Size of the vein</td>
<td>23 (56.09%)</td>
<td>18 (43.90%)</td>
<td>41</td>
</tr>
</tbody>
</table>

Regarding distribution of AV fistula failure according to size of the Artery & vein < 2mm was 28 (68.29%) & 23 (56.09%) respectively. (Table 3)
DISCUSSION

Most patients with end-stage renal failure still spend an appreciable amount of time on haemodialysis (HD), either as a definitive treatment or waiting for transplants. The creation of AVF surgery is an important intervention for the outcome of patient on HD as it has a significant impact on survival. There is no consensus on the optimal timing of fistula surgery. The DOQUI guidelines recommend to establish vascular access when the serum creatinine concentration exceeds 4 mg/dl and the estimated GFR is > 25 ml/min.

In our study the age of the patient ranges from 15 to 78 years, with the mean age 56 ± 16.12 years. In the article by Mittal et al., the median age was 43 years, which is 10 years younger than our patients. But in the study of Shah et al, the patients age varied from 25 to 76 years with the mean age of 55 ± 20 years, which was similar to our study.

There are three different types of vascular access: autologous arteriovenous fistula, graft and catheter but when article by Brescia and Cimino in 1966 revolutionized the creation of the vascular access, the Cimino fistula was used in almost all dialysis patients. An AV fistula is preferred and has proven to be the most successful type of vascular access because it lasts longer, has low rate of complications and easy handling. As in our study we never used a graft to create an AV fistula, but when the vessels were not suitable, we inserted a permanent catheter in Internal Jugular vein.

Maturation times of 1–4 months must elapse following creation of an autologous fistula before it can be used. The fistula should, therefore, preferably be created several months in advance of the anticipated need for dialysis or an alternative temporary method of vascular access must be used while the fistula develops. But in our study only the 37 (12.13%) patients created AV fistula before starting haemodialysis. Where as 267(87.82%) patients were referred for vascular access after starting haemodialysis. This percentage is high than that reported from Australia and USA (28%, 78% respectively ).

There are different types of fistula according to type of anastomosis like, Radiocephalic, Brachiocubital, Brachiocephalic, Brachiobasilic, Radiocubital, Cubitocephaic. But according to The National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF KDOQI) recommendation, Radiocephalic and Brachioccephalic are most preferred ones. In the study of Dekhilaia et al type of AV fistula was Radiocephalic 69 (60%) and Brachiocephalic 15 (13% ) which was similar to our study where radio cephalic fistula was made in 175 (57.56 %) while brachiocephalic fistula was made in 129 (42.43%), patients. Regarding the type of the anastomosis, in the study done by Dekhilaia et al AVFs were side-to-side fistulas and 29 (19.3%) end-to-side fistulas. In contrary to that study, we used the side to end technique in 293 (96.38%) patients and side to side technique in 11 (3.68%) which was similar to study done by Shah et al where they used the end to side technique in all cases. We used the end to side technique because it was easier to approach the artery and vein for the anastomosis.

The AVF patency study and influencing factors help in determining the high-risk population for vascular access failure. Study done in Tunisia by Zouaghi et al showed that the actual failure rate was 18% at six months, 22% at one year. Similarly study done in Indonesia by Yanto showed that overall failure rate was 12 % at 6 months and 15% at 12months. Our study finding resembles to these findings having vascular access failure of 13.48 % at 2 months, though our follow up were short.

The result in a study confirm that patient age is not a factor in the success of procedure and arteriovenous fistula should not be withheld from patients on the basis of age as observed by Lok et al. Although male gender is more prone to smoking the patency rate was better among the male gender. In the study done by Yanto et al the 6- and 12-month primary patency rates of arteriovenous fistula created for male hemodialysis patients were 92% and 89%; the rates for female patients were 81% and 78%, respectively (P = .027). There was similar findings In our study, male patients had a patency rate of AV fistula was 89.26% where as a female patients had a patency rate of 80.81%. One possible explanation is that female patients have smaller vessels than males, thereby decreasing the chance that a new fistula will mature adequately for dialysis.

Though creation of autologous radio cephalic fistula is recommended at first, its not always feasible to do so. In the study done by Ates et el, AV fistula...
failure rate was less in brachio cephalic (2.7%) than radiocephalic (19%) at six month. In our study we found that failure rate was 11.62% in brachio cephalic fistula and 14.85% in radio cephalic fistula. We presume that a wider vessel lumen, higher flow rate and easy surgical approach for fistula creation were the most important advantages of the brachio cephalic over Radio cephalic AV fistula.

Inadequate diameter of the vessels used to create AVFs are another cause of AVF failure. In the study of Misskey et al outflow vein diameter <3mm is strongly predictive of autogenous access patency. Radial artery diameter < 2mm was predictive of radio cephalic AVF to mature but only in diabetic patients. Khavanin et al conducted a cross-sectional study using a sample of 96 patients on hemodialysis with native AVF to determine the relation between diameter and maturation of AVF. Study results found an association between vein diameter (mean vein diameter was 2.40 mm) and the success rate of fistula development; however, a similar connection was not observed between fistula maturation and artery diameter (mean diameter of artery was 2.57 mm). In our study, AV fistula failure according to size of the Artery & vein < 2mm was 28 (68.29%) & 23 (56.09%) respectively. So, Allon and Robbin have proposed the use of pre-surgery ultrasound assessment to ensure that the chosen vessels can support the construction of an AVF.

Diabetes mellitus (DM) is a risk factor for atherosclerosis in hemodialysis patients, which could explain the increased risk of AVF patency loss in patients with diabetes. Our study showed that DM among the AVF failure patients were 22 (54%) and non diabetic 19 (46%).

In the study done by Susan, 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%). In the study done by Thabet in Egypt, of the 239 patients, 57 (23.8%) presented with infected AV access, 42 (17.6%) with thrombosed AV accesses, 33 (13.8%) with bleeding, and 31 (12.9%) with pseudoaneurysms. Venous hypertension was the presenting complication in 26 (10.9%) patients, whereas aneurysmal dilatation, hematoma, and ischemic steal were the presenting complications in 25 (10.5%), 20 (8.4%), and 5 (2.1%) patients, respectively. But in our study the most complication was bleeding, thrombosed 30 (9.86%), infection19 (6.25%) and upper limb edema.26 (8.55%) which were similar to other studies. We didn’t find the complication like steal syndrome, pseudoaneurysm which may be due to the short follow up of the patients.

**CONCLUSION**

Autologous arteriovenous fistula is the better choice for vascular access for hemodialysis in patients with end-stage renal disease having good result for patency. It is designed to improve the effectiveness of dialysis with fewer risks and complications than other vascular accesses. However there is still a failure rate. Different factors like site of the anastomosis, female gender, diabetes mellitus and most importantly size of the vessels play an important role in the patency of arterio venous fistula.

**REFERENCES**


