COMPARATIVE STUDY OF END TO SIDE VERSUS SIDE TO SIDE ARTERIOVENOUS FISTULA: A TERTIARY CARE CENTER EXPERIENCE

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Abstract

Background: Arteriovenous Fistula creation is one of the commonly performed procedure among Plastic surgeons. There is always an argument regarding various techniques of the fistula with lack of conclusive evidences in the past literature to recommend any of the anastomosis type. With this study we aimed to compare the two different common techniques of fistula - end to side (ES) and side to side (SS).

Material and Methods: Total 80 patients were included for the retrospective analysis from January 2018 to January 2020 who were divided into two groups as ES (proximal end of the transected vein to the side of the artery anastomosis) and SS (side of the artery to the side of the vein anastomosis) groups. Each group was containing 40 patients. Follow up was done at 3 and 6 months.

Results: Statistical analysis of demographic, preoperative, complications and follow-up data did not show any statistically significant difference. However, post operative complications like venous hypertension and steal syndrome were found only in SS group.

Conclusion: With our study we can conclude that after comparing for a follow up period of 6 months we found statistically no significant difference between the two techniques. However, possibility of better insight in regard of patency rate, complications and other parameters after a longer duration of follow up could not be ruled out.

Keywords: Arteriovenous, complications, fistula, patency, technique

Introduction

A 2018 estimate put the number of patients on chronic dialysis in India at about 175,000, giving a prevalence of 129 per million population¹ and the dialysis population is growing at the rate of 10–20% annually.² An Autogenous AVF is the procedure of choice for the venous access for hemodialysis with an overall success rate of about 84.0%.³ AVF creation can be performed in various ways :End of the artery to end of the vein, terminal stump of vein to lateral side of the artery(ES),lateral side of artery to lateral side of vein (SS) and lastly side to side anastomosis with distal vein ligation. The second and third type are the two most common anastomosis type for AVF. The locations which are commonly preferred are radiocephalic in wrist, brachiocephalic or brachio basilic AVF in elbow, and in forearm as forearm AV graft.⁴ An access with flow rate of 350-400 mL/min is an indication for a functional and matured AVF.⁵ The common complications of fistulae include thrombosis, venous hypertension, steal syndrome, aneurysm formation, bleeding and seroma accumulation. There is always an argument in regard of comparison of various techniques of the AVF with lack of conclusive evidences in the past literature to recommend any of the anastomosis type as not much guidelines are available . European Society for Vascular Surgery (ESVS) had

proposed the guidelines that favoured a ES anastomosis but with the paucity of evidences.^{7,8}

With this study we aimed to compare the two techniques of AVF i.e ES and SS in terms of maturation, complications, primary patency and operative time.

Material and Methods

With this study a retrospective analysis was carried out in tertiary care centre in the department of Plastic surgery from January 2018 to January 2020. Data for retrospective analysis was obtained from pre-operative, OT and follow up records, Inclusion criteria comprised of referred patients with age >18 years, in pre-dialysis or dialysis status needing an ES or SS arteriovenous fistula for hemodialysis, patients with no history of injection or blood sampling

during the last two weeks and controlled systolic blood pressure more than 100 mmHg. Exclusion criteria comprised of previous arteriovenous accesses in the same elbow or more proximal AVF, forearm native loops, arteriovenous grafts or previous access repairs, previously documented deep venous thrombosis or arteriopathy, noncompliance for follow up visits, or failure to create

the AVF during surgery (Table-1). Total 80 patients were included for the study who were divided into two groups as ES (proximal end of the transected vein to the side of the artery anastomosis) and SS (side of the artery to the side of the vein anastomosis) group according to the techniques of AVF creation. Each group was containing 40 patients. Follow up data was collected for 3 and 6 months follow up from the time of surgery. Pre-operatively, data where the artery and venous patency rates were evaluated using history, physical examination and arterial and venous duplex ultrasound imaging were collected. The minimal acceptable venous diameter for use was reported to be 2 to 3 mm, whereas optimal arteries had a three plus positive pulse or an arterial diameter of greater or equal to 2mm throughout the course with a patent palmar

arch as an essential criterion.⁵ For ES radiocephalic AF the arteriotomy size was limited by diameter of transected end of vein wherein the size of the vein had to be more than 2 mm for fistula to be functional was determined pre operatively by physical examination and arterial and venous duplex ultrasound, If the venous diameter was less than 2-3 mm then the SS anastomosis technique was decided.

Surgery was performed on non dominant hand over the wrist mostly whereas in cases of unfavourable vascular status, previous distal AVF on non dominant hand and same side subclavian temporary vascular access for hemodialysis had enforced us to perform the surgery in dominant hand and /or at elbow region. All cases were operated by the same team of Plastic surgeons.

Table 1: inclusion and exclusion criteria for the study groups

Inclusion criteria
Referred patients with age >18 years
In pre-dialysis or dialysis status needing an ES or SS arteriovenous fistula for hemodialysis
Patients with no history of injection or blood sampling during the last two weeks
Controlled systolic blood pressure more than 100 mmHg
Exclusion criteria
Previous arteriovenous accesses in the same elbow or more proximal AVF
Forearm native loops
Arteriovenous grafts or previous access repairs
Previously documented deep venous thrombosis or arteriopathy
Non-compliance for follow up visits, or failure to create the AVF during surgery

Surgical technique:

After cleaning and draping of surgical site under loupe magnification, a longitudinal or S shaped incision of approximately 3-4 cms was made under local anesthesia using 2% lidocaine. The vein and artery were mobilized and dissected out. For SS group, direct side-to-side anastomosis was done using single continuous running 8-0 polypropylene suture. The size of anastomosis was measured between 10 to 15 mm in case of radiocephalic SS anastomosis.^{5,9} Whereas, for proximal level the size was kept between 4-5 mm for side to side anastomosis. The perforating vein were ligated in these cases. In ES group, longitudinal arteriotomy was done and vein was transected. Then the proximal end of the transected vein was anastomosed to the side of the artery using the end to side method with interrupted 8-0 polypropylene suture. At wrist, the anastomosis was fashioned between radial artery and distal cephalic vein whereas at elbow region, end to side anastomosis was performed between brachial artery and cephalic vein and side to side anastomosis between brachial artery and basilic vein. Owing to unfavorable vascular status of hand and forearm, a brachiocephalic elbow fistula was fashioned with end-to-side anastomosis between the cephalic vein and brachial artery. The fact that the brachiocephalic elbow fistula might not be the best option

for patients with poor forearm radial artery but good cephalic vein condition supported the basilic vein for side to side anastomosis. In addition the topographical characteristics of elbow region provide a good access to brachial artery and basilic vein which are lying not far from each other suitable for side to side anastomosis. In case of brachiocephalic anastomosis, before the anastomosis was completed, distal vein was dilated using venous dilator in order to break the first valve distally toward the wrist end so that the forearm veins would develop due to retrograde flow, a technique described by Sahasrabudhe P et al.¹⁰

A patent fistula was confirmed by the presence of an audible bruit or a palpable thrill clinically. Maturation of AVF was established when it had been cannulated successfully with two needles, over a period of atleast 6 dialysis sessions during a 30 day period⁷ and by a capacity of delivering a flow rate of 350 to 400 mL/min of hemodialysis access.⁹ Primary failure was described as thrombosis of AVF, or inability to mature for hemodialysis at 6 weeks.¹¹ Three and six months primary patency were confirmed as intervention free access survival.¹¹

Analysis of various descriptive parameters (i.e. mean and standard deviations) and frequencies (number and %) derived from demographic, preoperative, complications

and follow-up data was done using the Statistical Package for Social Sciences (SPSS), Version 24. Pearson Chi-Square or *t*-test for independent samples were used for the comparisons of categorical and continuous variables between the two groups respectively. *P*-value < 0.05 was considered to be statistically significant. Patency rates were analysed by Kaplan –Meier survival curve calculated at 3 and 6 months (Figure-1). Differences between curves were compared by means of a log-rank test.

Results and Discussion

A total 80 patients were included in the study. Forty patients were divided equally in SE and SS groups. Demographic and preoperative data were compared in Table-2. While operative outcomes and follow up data were compared in Table-3. Age and gender distribution between SE and SS group were statistically non significant. 25 patients (62.5%) in ES group had hypertension as compared to 28 (70.0%) in SS group ($p=0.478$), 13 (32.5 %) patients in ES group suffered from diabetes whereas 16 (40.0 %) patients in SS group suffered with diabetes ($p=0.485$). 7(17.5%) patients in ES and 6 (15.0%) patients in SS group were having previously diagnosed cardiac disease ($p=0.762$). 10 patients had a history of previous hemodialysis by central venous catheter in ES (25.0 %) group whereas, 09 patients in SS (22.5 %) group had previous hemodialysis by central venous catheter ($p=0.793$). 8 patients in ES group (20 %) underwent previous distal AVF creation and 9 patients in SS group (22.5%) had previous distal AVF creation ($p=0.785$).

There was no statistically significant difference was found in regard of the diameter of brachial artery (4.2 ± 0.72 vs 4.0 ± 0.80 , *P*-value = 0.244) and proximal cephalic vein (3.4 ± 0.72 vs 3.2 ± 1.10 , *P*-value = 0.339) near elbow region between ES and SS group respectively. Similarly, no statistically significant difference was found in regard of the diameter of radial artery (2.0 ± 0.70 vs 1.9 ± 0.52 , *P*-value = 0.4704) and distal cephalic vein (3.0 ± 0.56 vs 2.85 ± 0.60 , *P*-value = 0.2513) in forearm between ES and SS group respectively.

Radiocephalic anastomosis was mostly preferred as it is associated with ease of creation, preservation of proximal vein for the future hemodialysis, lesser risk of vascular complications. But it may be associated with low flow rate and low maturation rate.³⁴ Whereas Brachiocephalic/brachio basilic AVF are usually associated with high flow rate and high maturation rate but have the disadvantages of difficulty in surgery and risk of vascular complications.³⁴ 30 patients had radiocephalic AVF in ES group whereas 31 patients had radiocephalic AVF in SS group whereas 10 patients in ES group and 9 patients in SS group had brachiocephalic and brachio basilic AVF respectively. Brachiocephalic/brachio basilic AVF were created in the patients who either had a previous distal AVF or poor status of cephalic vein in the wrist. There were 5 cases of primary failure in ES group and 4 cases in SS group that didn't differ significantly with *P* value as

0.723. Probable causes for the primary failure could be the vessel thrombosis resulting from iatrogenic intimal injury to the vessels, calcification or poor condition of vessel wall, kinking or tension of the vessel.

Complications including post-operative bleeding, seroma formation, pseudoaneurysm/ aneurysm formation, steal syndrome and venous hypertension didn't show statistically significant difference among the two groups. Post-operative bleeding and seroma was managed by re- exploring the wound and controlling the bleeding points, draining the seroma if present with fistula remained functional in all those cases thereafter. Among total of 3 cases of pseudoaneurysm / aneurysm formation, 2 cases (one in each group) required surgical closure of fistula while one case in ES group was managed conservatively. In our study, steal syndrome was observed at 1 month in 2 cases and at 8 weeks in 1 case. It was belonged to stage-1 where retrograde inflow of blood into the access during diastole occurs – it is usually without complaints with clinically cold fingers without discoloration. Diagnosis was made by clinical examination, digital blood pressure measurement (<50 mmHg), duplex ultrasonography and eventually transcutaneous PO₂ measurement (<20-30 mmHg). Since it was belonging to stage 1, No active intervention was required and were managed conservatively but patients were kept for longer follow up.

Venous hypertension occurred in 4 patients in SS group. Venous hypertension was observed at 2 and 3 months in two cases and at around 5 months in another two cases. They were diagnosed clinically, and with computerized tomography and digital subtraction angiography. The symptoms were not severe. Conservative management consisting of limb elevation, physiotherapy and using crepe bandage had alleviated the signs and symptoms.

Maturation time also did not differ significantly between the two groups. The maturation rate in our study was found to be 87.5% in ES groups and 90% in SS group after 6 weeks. There was no statistically significant difference at 3 (89.2% vs 86.5%) and 6 (74.2% vs 61.3%) months primary patency rates between ES and SS groups (*P* value = 0.8066, Log-rank Mantel-Cox test). A functional and patent AVF has been considered as gold standard for vascular access in patients needing HD.¹² When we reviewed the past literature for the similar studies from India and Indian subcontinent to compare the two most common techniques of AVF creation by Plastic surgeons, we had found out a severe paucity of such studies and evidences. This very fact had led us to conduct a study to compare the two technique in Plastic surgery. The end-to-side anastomosis technique has been favoured in forming AVF despite the lack of proper evidence to support the same.¹³ But, Lynn et al. found in a retrospective analysis of 432 fistulas in patients receiving home HD that the STS configuration was significantly superior to ETS (*P* = 0.0001) regardless of the side or site of the AVF.¹⁴ In our study we had found out that end to side anastomosis technique was less demanding

when compared to the side to side AVF technique which is also supported by the study of Bashar K et al.¹⁵

Cassiounis et al. reported that early patency rates did not differ significantly between the ETS group (90%) and the STS group (88%).¹⁶ Same study had shown that the STS group had superior patency rates after 3 months of follow-up when compared to the ETS group, (85% vs 79%), and similarly after 12 months (80% vs 66%). Khan et al. in a study had reported a survival rate of 89.3% in the ETS group when compared to 85.1% in the STS group ($p = 0.253$).¹⁷ Similarly, Ganie et al. reported a 90% patency rate in AVFs based on the brachial artery by the ETS technique after 12 months from creation.¹⁸ All these findings are comparable to the findings obtained in our study.

O'Banion et al. reported that the vein diameter of those in the ETS group (2.6 ± 0.68 mm) was significantly larger in comparison to the STS group (1.9 ± 0.59 mm), ($p < 0.001$).¹⁹ In contrast, no significant difference was found in our study.

Primary failure was noted in 12.5 % of cases in ES group compared to 10% of cases in SS group ($p = 0.723$). Primary failure incidence is much lower in our study when compared to that reported in previous studies.^{20,21} Also, In a study by Wedgwood et al, 4/39 (10.3%) of fistulae created by the ETS technique failed primarily compared to 3/32 (9.4%) in the STS group.²² Common causes for the primary failure could be vessel thrombosis leading to failure of dilatation, iatrogenic intimal injury to the vessels, kinking or tension of the vessel, hypotension, thickened subcutaneous tissue.²³

Galic et al found that threatening complications (infections, steal syndrome, thrombosis, haemorrhage and aneurysms) occurred less frequently in the STS (18.88%) group in comparison to the ETS group (62.5%).²⁴ In our study venous hypertension was diagnosed in four of the fistula formed using a SS technique, all in RCF cases. This is also supported by the previous study²⁵ where it has been described that venous hypertension is more common in

distal AVF that is, RCF. In case where anastomosis is created in side to side fashion, there may be retrograde flow in the draining vein leading to edema of the hand distal to the anastomosis site. Venous hypertension following AVF creation can be distressing and may necessitate closure of fistula if endovascular procedures fail.²⁶ The symptoms of venous hypertension includes edema, pain, pigmentation, ulceration, dermatosclerosis, dilated superficial vein over the chest and shoulder and digital gangrene.²⁷

Valenti D et al. had classified AVF Aneurysm and pseudoaneurysms.²⁸ Their management

ranges from observation in stable aneurysm to emergency surgical ligation in pseudoaneurysm

with impending rupture.²⁹ In our study we had observed three cases of Aneurysm /pseudoaneurysms. 2 cases of pseudoaneurysms (one in each group) required surgical closure of fistula. Tordoir JH et al. had classified the AVF-related steal syndrome in four stages.³⁰ In a previous study, it was reported that the incidence of steal syndrome varies between 1–2% in distal radio-cephalic AVF to 5–15% in brachiocephalic/basilic fistulae and grafts.³¹ In our study, steal syndrome was seen in three of cases of SS group, all in brachiocephalic AVF belonging to stage-I steal syndrome that did not need any active intervention and were managed conservatively.

In a retrospective study by Sahasrabudhe et al, STS technique showed improved maturation rate (76%) when compared to the ETS technique (70%); however, the difference was not statistically significant.³² In our study the maturation time did not differ significantly between the two groups ($5.72 \text{ weeks} \pm 0.22$ for SE group, $5.80 \text{ weeks} \pm 0.25$ for SS group, $P \text{ value} = 0.1327$).

Operating time between the two groups did not show any statistically significant difference which is in contrast to the study by Mestres G et al. who showed that Side-to-end anastomoses were faster to create compared to side to side anastomoses.³³

Table 2: analysis of demographic and pre- operative data between groups

	ES (n= 40)	SS (n= 40)	P VALUE
AGE (IN YEARS)	47.34 ± 10.43	46.84 ± 11.56	0.839
GENDER			
MALE	21(52.5%)	23(57.5%)	0.653
FEMALE	19(47.5%)	17(42.5%)	
COMORBIDITIES			
HYPERTENSION	25(62.5%)	28(70.0%)	0.478
DIABETES MELLITUS	13(32.5%)	16(40.0%)	0.485
CARDIAC DISEASE	07(17.5%)	06(15.0%)	0.762
PREVIOUS DISTAL AVF	08(20.0%)	09(22.5%)	0.785
PREVIOUS CVC	10(25.0%)	09(22.5%)	0.793
PRE-OP DUPLEX MEASUREMENT OF VESSEL DIAMETER (MEAN AND SD) IN MM			

BRACHIAL ARTERY	4.2± 0.72	4.0±0.80	0.244
PROXIMAL CEPHALIC VEIN	3.4±0.72	3.2 ± 1.10	0.339
BASILIC VEIN	4.25± 0.82	4.5 ±1.10	0.253
RADIAL ARTERY	2.0 ± 0.70	1.9± 0.52	0.4704
DISTAL CEPHALIC VEIN	3.0± 0.56	2.85 ±0.60	0.2513

Table 3: analysis of operative outcomes and follow up data between groups

OPERATIVE OUTCOMES	ES(n= 40)	SS(n= 40)	P VALUE
SITE			
BRACHIOCEPHALIC	10 (25%)	0	
BRACHIOBASILIC	0	09(22.5%)	
RADIOCEPHALIC	30(75%)	31(77.5%)	
OPERATIVE TIME(IN MINUTES)	57.76 ± 5.63	58.24 ±4.52	0.6753
COMPLICATIONS			
PRIMARY FAILURE	5(12.5%)	4(10%)	0.723
POST- OP BLEEDING	2(5%)	3(7.5%)	0.644
SEROMA FORMATION	3(7.5%)	3(7.5%)	1.000
ANEURYSM/PSEUDOANEURYSM	2(5%)	1(2.5%)	0.556
VENOUS HYPERTENSION	0	4(10%)	0.116
STEAL SYNDROME	0	3(7.5%)	0.241
FOLLOW UP			
MEAN TIME FOR MATURATION(WEEKS)	5.72 ± 0.22	5.80 ± 0.25	0.1327
MEAN MATURATION RATE AT 6 WEEKS	87.5%	90%	0.723
MEAN PATENCY RATE AT 3 MONTHS	89.2%	86.5%	
MEAN PATENCY RATE AT 6 MONTHS	74.2%	61.3%	0.8066

Figure 1: Kaplan meier curves of comparison of primary patency rates between ES and SS anastomosis groups.

Conclusion

With our study we can conclude that after comparing the two anastomosis techniques of AVF for a follow up period of 6 months we found statistically no significant difference between the two. However, possibility of better insight in regard of patency rate, complications and other parameters after a longer duration of follow up could not be ruled out. In our study we noted venous hypertension and steal syndrome in side to side anastomosis and none in end to side anastomosis technique.

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