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Original Research Article

Comparison of Side to Side vs End to Side Arteriovenous Fistula in upper limb for Hemodialysis

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Abstract
Introduction: *Various methods of arteriovenous fistula (AVF) creation are in vogue, each having their own pros and cons. This study is aimed at comparing two most common methods of AVF creation - side to side (STS) and end to side (ETS).*
Materials and Methods: *This retrospective comparative study was conducted between January 2017 to January 2018. 57 patients were included in the study-they underwent AVF creation either by STS or by ETS method.*
Results: *All total primary failure rate in the study was 12.28%, there was no statistically significant difference among two groups in regards to demography, operative time or complications except the finding that ETS has significant lower rate of postoperative venous hypertension than STS group.*
Conclusion: *STS AVF has significantly higher rate of venous hypertension than ETS AVF.*
Keywords: *Arteriovenous fistula, hemodialysis, venous hypertension.*

Introduction

Since initially described in 1966[1] , the surgically created arteriovenous fistula (AVF) has been recommended as gold standard for hemodialysis (HD)[2] over synthetic grafts and double-lumen tunnelled cuffed catheters due to their superior patency rates and lower complications . The most commonly performed techniques for AVF include the following: 1) side of artery to side of vein (STS) & 2) end of vein to side of artery (ETS). The other two less commonly performed techniques are 1) end of artery to side of vein, and 2) end of artery to end of vein. The preferred AVF locations are radiocephalic (wrist), brachiocephalic (elbow), or brachiobasilic transpositions and forearm AV graft respectively[3].

Different studies have reported different incidences of complications among these types of AVF. End-to-end anastomosis has the lowest fistula maturation rate, and arterial end-to-venous side fistula has the Risk of venous hypertension[4]. Vein end-to-arterial side anastomosis (ETS) has the highest proximal venous flow and a relatively low risk of venous hypertension. Side-to-side (STS) anastomosis is the most commonly used technique and has been described to be the easiest

to construct technically[4], however, this procedure has the risk of venous hypertension and carries a high risk of steal syndrome[5].

Material and Methods

Few studies are available regarding comparison of the two methods of AVF creation from Indian subcontinent. Hence the present study was performed to compare the two methods of AVF creation- side to side (STS) versus venous end to arterial side (ETS) and to assess their outcome. The retrospective study was conducted from January 2017 to January 2018. All patients who underwent AVF creation either by STS or ETS method by single surgeon were included in the study. Total 59 patients underwent AVF creation during the study period- 2 patients died after AVF creation due to medical cause and were excluded from the study. Total 57 patients were included in the study. They were divided in two groups according to method of AVF creation- STS OR ETS. Data was obtained from ot register and note, patients outdoor record & register, admission register & record and dialysis unit register & record.

Data was analysed using MICROSOFT excel 2007. Continuous variables were reported as mean ± standard deviation and compared using the independent samples *t*-test (2 tailed). Categorical variables were reported as frequency and percentage of the total group and compared using Pearson's $\chi 2$ test. All *p*-values $\leq$ 0.05 were considered significant.

The procedure (AVF creation) was performed on the wrist of non dominant hand mostly, however unfavourable vascular status or in redo cases AVF was done in dominant hand and/or at elbow. Preoperatively, all patients were assessed clinically using standard methods [6] by palpation of pulses, BP in both arms, Allen test and a pressure cuff application to assess vein. Pre operative duplex scanning was done in obese patients or in whom assessment of vascular status was doubtful. Approximately 2-3 cm longitudinal incision was made after anaesthetising operation site with 2% lidocaine. The artery and vein were dissected. For STS AVF, arteriotomy and venotomy were performed after clamping artery by using bulldog vascular clamp & anastomosis was performed using a single 7-0 running polypropylene suture starting from proximal angle of arteriotomy or by Tellis method[7]. For ETS AVF, vein was transected and was anstomosed to the side of artery in a proper angle[8], suturing was done using a single 7-0 polypropylene suture starting from heel of venotomy. In both techniques, Venous bleeding was controlled by digital pressure- no clamp was applied to vein[9]. Post procedure thrill for was assessed and bleeding was checked.

Results

During January 2017 to January 2018, 57 patients underwent AVF creation for HD. Demographic data of them are presented in table 1.

28 patients underwent ETS AVF and 29 patients underwent STS AVF. There was no statistically significant difference between ETS & STS group regarding age distribution (52.93±16.23 vs 50.62±15.08 respectively, p=0.580), minimum & maximum age for AVF in ETS group was 18 and 85 respectively and in STS group was 19 & 83 respectively. There was no significant statistical difference between two groups regarding male/female preponderance. Among comorbid conditions, 12 patients (42.86%) in ETS group had diabetes as compared to 14 (48.28%) among STS group (p=0.681) and 20 (71.43%) patients in ETS group suffered from hypertension whereas 18 (62.07%) patients in STS group had hypertension (p=0.454). 13 patients in ETS (46.43%) group had earlier HD by central dual lumen catheter and 14 patients in STS (48.28%) group had earlier HD by central dual lumen catheter (p=0.889). 7 among ETS group (25%) underwent Previous AVF creation and 7 among STS group (24.4%) had Previous AVF creation (p=0.940).

Operative outcome between 2 groups is presented in table 2.

19 patients among ETS group had radiocephalic AVF (67.86%) whereas 20 patients among STS group had radiocephalic AVF (68.97%), brachiocephalic AVF was done in redo cases or in cases where cephalic vein in wrist wasn't good enough for AVF creation. AVF site choice didn't show any statistically significant difference. Operating time for ETS group and STS group didn't show any statistically significant difference (55.61±9.92 vs 57.03±9.44 respectively, p=0.580). Primary failure rate didn't differ between 2 groups. All total primary failure rate was 12.28% in our study (7 among 57 patients). Post operative bleeding, pseudoaneurysm formation, steal syndrome, seroma formation didn't differ significantly among 2 groups. Post operative bleeding was managed by reexploration and securing the bleeding points, in all cases bleeding points were found to be from subcutaneous vessels & fistula remained functional. Among 4 cases of pseudoaneurysm / aneurysm formation, 2 needed surgical closure of AVF and 2 were observed in our study. In our study, steal syndrome wasn't severe and did not need any active intervention. In our study, we explores the wound and drained the seroma, post operatively light pressure bandage was applied- in all cases fistula could be saved. Venous hypertension didn't occur in any patient in ETS group, however it occurred among 6 patients among STS group and that was statistically significant (p=0.024). In our study, venous hypertension wasn't severe and was managed conservatively- however long term follow up wasn't done which could have shown different management strategies. Maturation time was similar among ETS and STS group (5.67±0.48 weeks vs 5.66±0.48 weeks, p=0.855).

Table 1 Demographic data of patients

		End to side(ETS) (n=28)	Side to side(STS) (n=29)	P value
Age		52.93±16.23	50.62±15.08	0.580
Sex	Male	15 (53.57%)	16 (55.17%)	0.903
	Female	13 (46.43%)	13 (44.83%)	
Diabetes Mellitus		12 (42.86%)	14 (48.28%)	0.681
Hypertension		20 (71.43%)	18 (62.07%)	0.454
Earlier hemodialysis by central dual lumen catheter		13(46.43%)	14 (48.28%)	0.889
Previous Arterio-venous fistula		7 (25%)	7 (24.4%)	0.940

Table 2 Operative outcome of patients

		End to side (n=28)	Side to side(n=29)	P value
Location	Brachiocephalic	9 (32.14%)	9 (31.03%)	0.928
	Radiocephalic	19 (67.86%)	20 (68.97%)	
Operation time (minutes)		55.61±9.92	57.03±9.44	0.580
Primary failure		3 (10.71%)	4(13.79%)	0.723
Post operative bleeding		2(7.14%)	1(3.45%)	0.532
Pseudoaneurysm/aneurysm		2(7.14%)	2(6.90%)	0.971
Steal syndrome		1(3.57%)	2(6.90%)	0.574
Venous hypertension		**0(0%)**	**6(20.69%)**	**0.024**
Seroma		2(7.14%)	2(6.90%)	0.971
Maturation time (WEEKS)		5.67±0.48	5.66±0.48	0.855

Discussion

AVF is preferred over synthetic grafts and double lumen cuffed central catheters due to less complication and superior patency rates. Despite low rate of complications of native AVF, primary failure within 1 month may be as high as 29%[9] .Primary failure occurs when a fistula either thromboses before its use or never becomes suitable for dialysis. The probable causes of primary failure include the use of inappropriate vessels and failure of dilatation due to perivascular fibrosis, improper surgical technique

causing intraoperative vessel intimal injury or torsion/tension of vessel, low blood pressure, or thick subcutaneous fat tissue[10]. primary failure rate in our study is much lower than reported (25% to 60%) in other series[11].

Technical consideration[9]

During creation of STS anastomosis- if artery and vein lies side by side, then arterial and venous incision should be made exactly on the lateral aspect of the vessels & if artery and vein cross each other, then incisions should be located on the top and the bottom of the respective vessels for creation of a properly aligned tension/torsion free AVF. Creation of ETS anastomosis is technically more demanding than STS AVF. ETS anastomosis requires three-dimensional visualization of the final result. Kinking of vein must be prevented during ETS AVF creation. After creation of AVF if thrill can be palpated-torsion or kinking is unlikely, but if a water hammer pulse is palpated - stenosis, kinking or torsion should be suspected. Perforation of posterior wall should be prevented during arteriotomy or venotomy- should they occur, they must be repaired immediately to prevent later bleeding/ hematoma/pseudoaneurysm formation. if the artery is stiff, some tissue at arteriotomy site should be excised to prevent turbulences. emptying the vein by gentle compression and watching the filling should be done to assess The lumen and the distensibility of vein. Fogarty catheter should never be used lest it may geoardise the intima. venous run-off should be tested because optimal venous drainage is an essential prerequisite for optimal function of the anastomosis.

Aneurysm and pseudoaneurysms are classified in - type 1a: dilatation along the length of the vein; type 1b: postanastomotic aneurysm; type 2a: classic "camel hump"; type 2b: combination of type 2a and 1b; type 3: complex aneurysm ; and type 4: pseudoaneurysm[12]. Their management varies from observation in stable aneurysm upto emergency surgical ligation in pseudoaneurysm with impending rupture[13] .

Four stages of AVF-related steal syndrome can be seen[14]. In stage I, retrograde inflow of blood into the access during diastole occur – it is usually without complaints & is a frequent finding in AVF/grafts and needs no intervention. In stage II - Patients experience pain on exercise or during dialysis, in stage III - rest pain occurs & in stage IV Ulceration / necrosis / gangrene supervenes. Incidence of steal syndrome varies between 1–2% in distal radio-cephalic AVF to 5–15% in brachio-cephalic/basilic fistulae and grafts[15]. Various treatment options are available for management of steal syndrome like ligation of fistula, banding, distal revascularization-interval ligation (DRIL procedure), distal radial artery ligation (DRAL procedure), more proximal arteriovenous anastomosis (PAVA procedure), revision using distal inflow (RUDI procedure), Minimally invasive limited ligation endoluminal-assisted revision (MILLER procedure) [15].

Seroma formation following AVF creation is a rare complication, it is managed by vaccuum drainage/ exploration of wound and drainage of seroma or ligation of fistula[16]. Venous hypertension following AVF creation can be distressing and may necessitate closure of fistula if endovascular procedures fail[17]. The symptoms of venous hypertension ranges from edema / pain / ulceration / pigmentation / dermatosclerosis / Superficial venous dilatation over the chest and shoulder upto digital gangrene[18] .

A matured[19] Fistula (assessed 4-6 weeks after creation) has blood flow>600ml/min, has length >10 cm of arterialised vein, depth from skin <6 mm, and diameter of arterialised vein >6 mm & is able to deliver a flow rate of 350 to 400 ml/min and maintain dialysis for 4 hours or more after successful cannulation.

Conclusion

From this study, it is seen that occurrence of venous hypertension is significantly higher in side to side AV fistula than end to side AV fistula. Fistula maturation rate & operating time and other complication rates like steal syndrome did not

differ significantly between side to side AV fistula and end to side AV fistula.

Limitation of the study

This study was retrospective in nature and the cohort size was small. Only early outcome/ complication was assessed to compare between ETS and STS AVF, while long term follow up could have enabled better analysis of outcome. Prospective long term studies / RCTs are needed to compare between these two techniques.

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Conflict of interest: None declared

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