One Stage Side to Side Brachio-Basilic Arteriovenous Fistula; a New Technique for Long Term Patency

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Background: Side-to-side anastomosis in one stage brachio-basilic arteriovenous fistula (BBAVF) could provide more puncture sites with preservation of access patency for a longer duration.

Patients and methods: 122 patients in need for BBAVF divided into 2 groups. Group I underwent single stage side to side BBAVF while Group II, subjected to single stage side to end BBAVF. Operative data, technical success, and patency rates were analyzed.

Results: Group I included 64 patients while Group II included 58 patients. The Mean follow-up period was 35.3 ± 7.7 months. Venous hypertension was more in Group I. Better patency rates were reported in Group I as it showed significantly higher 2nd and 3rd year primary patency rates compared to Group II (93.8.% and 82.8% vs. 79.3% and 67.2% respectively, P = 0.03 and 0.05).

Conclusions: Side to side one stage BBAVF had better patency rates than side to end anastomosis with comparable operative and postoperative outcome.

Key words: ESRD, hemodialysis, vascular access, arteriovenous fistula, basilic vein superficialization.

Introduction

The number of patients with End Stage Renal disease (ESRD) requiring hemodialysis access is increasing with a parallel increase in the need for repeated hemodialysis access creation in the same patient over years.[1]

Arteriovenous fistula (AVF) is preferred than both arteriovenous graft and central venous catheter (CVC) in patients requiring hemodialysis,[2] as it is associated with lower rate of complications as regard access thrombosis and infection with a higher overall patency rate.[3]

The selection of the ideal site for AVF creation is a crucial point. Over decades, the classic Brescia-Cimino fistula is still the preferred hemodialysis access and the brachio-cephalic (BC) AVF comes next.[4] With unsuitable cephalic vein in the forearm and arm, brachio-basilic (BB) AVF creation represents a valuable option.[5]

Unfortunately, the results of the ulnar basilic arteriovenous fistula in the forearm are not encouraging due to lower patency rates, longer maturation duration and higher initial failure rates in relation to radio-cephalic (RC) AVF.[6]

Since its first introduction by Dagher et al.[7] BBAVF represented an attractive access. As an autologous vein it has a superior patency rate and a fewer rate of complications in relation to prosthetic grafts.[8] In addition to its deeper location in the arm rendering it less subjected to trauma and puncture, the basilic vein usually has a suitable diameter for fistula creation and maturation.[9]

These data were supported by the recommendations of The National Kidney Foundation that reported the superiority of the BBAVF creation over the use of synthetic grafts in patients with unsuitable forearm veins.[2]

The basilic vein must be dissected and mobilized to a subcutaneous plane to be accessible for puncture during dialysis.[10] Up till now, the argument about one or two stages BBAVF creation is still present as every technique has its benefits and drawbacks. The one stage technique is performed in a single operative session with a shorter period required to use the created access for dialysis and it decreases the rate of insertion of temporary catheter and the burden of catheter related morbidities.[8]

On the other hand, in the two-stage procedure arterialization is definite so, protecting the patient from unnecessary arm incision if primary failure occurred. However, the patient will be subjected to two separate operative sessions and more prolonged use of central venous catheters.[11]

Another area of debate regarding AVF creation is to perform side-to-side or side-to-end anastomosis between the artery and the vein. The classic technique described by Brescia et al.[4] was side-to-side radio cephalic anastomosis. later, Wedgwood et al.[12] reported that no difference in patency rates between the two techniques but in patients with side-to-side anastomosis, a higher rate of venous hypertension was observed. But it was also reported that side-to-side anastomosis at the elbow level; particularly BBAVF is associated with higher fistula flow rate and hence faster maturation especially in distal veins providing more available puncture sites.[13]

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In the present study we assumed that one stage side-to-side brachial artery to basilic vein anastomosis with superficialization of the vein will give the patient more possible cannulation sites with increased patency especially in young patients with exhausted veins in the upper limbs.

The aim of the study is to compare between the side-to-side and the side-to-end BBAVF in one stage procedure as regard patency rates and rate of complications. To our current knowledge, this is the first prospective study comparing both techniques in one stage BBAVF creation.

Patients and methods

Study design and selection criteria

This prospective comparative nonrandomized study included 122 patients with ESRD in need for AVF creation for hemodialysis. All patients were admitted in Vascular and Endovascular Surgery Department, Faculty of Medicine, Tanta University, during the period from June 2018 to June 2022. A written informed consent was obtained from all patients before enrollment in the study.

Patients included in the study if they were suffering from ESRD in need for AVF creation with inability to perform either RC fistula in the forearm or BC fistula in the arm with good quality of the arm basilic vein and suitable vein diameter ≥ 3 mm.

Patients with unsuitable arm basilic vein (With diameter < 3 mm, thrombosed or sclerosed vein) were excluded from the study. Also, patients with signs of central vein occlusion as dilated chest wall collaterals and upper limb edema and patients with arteriopathy were also excluded from the study.

This is a comparative non-randomized study, patients who met the selection criteria were assigned to Group I if the basilic vein in the arm is connected with a palpable vein segment in the forearm (Forearm basilic vein or a segment of cephalic vein through the antecubital vein) as this connection may serve as possible future puncture sites. While patients who had only patent basilic vein in the arm with no forearm palpable veins were assigned to Group II.

Preoperative workup

All patients underwent thorough history taking and clinical examination (To detect associated comorbidities, previous CVC insertion, previous AVF created, and dialysis time). Routine preoperative laboratory investigations, and duplex ultrasound scanning were also performed.

Operative technique

Patients assigned for Group I, underwent single stage side-to-side basilic vein superficialization. While patients in Group II, subjected to single stage side-to-end basilic vein transposition.

Surgical technique: Local infiltration anesthesia was used in all cases in both groups. The standard operation consisted of making a skin incision 1 cm distal to the antecubital crease and parallel and medial to the brachial artery extending proximally along the medial aspect of the arm about 10 cm long to expose the basilic vein. Care was taken to avoid damage to the medial cutaneous nerve of the arm. The vein was dissected out and its tributaries tied using 3-0 polyglactin.

In Group I, the basilic vein in the arm was dissected and if crossing branches of the medial cutaneous nerve of the arm imbedding the vein free mobilization, careful dissection of the entire length of the nerve was done till the vein becomes completely free **(Figure 1).** Then, exposure of appropriate length of the brachial artery at the level of antecubital fossa was performed. A 6 mm longitudinal incision was made in the artery and the neighboring vein. The side-to-side anastomosis was constructed using continuous 6-0 polypropylene sutures **(Figure 2)**. No attempts were made to disrupt venous valves distal to the anastomosis. After performing the anastomosis, the vein is mobilized from its subfascial location and a flap of the brachial fascia with subcutaneous tissue is created and then closed below the vein rendering it superficialized **(Figure 3).** Then the subcutaneous tissue is closed in layers and skin is closed with suture.

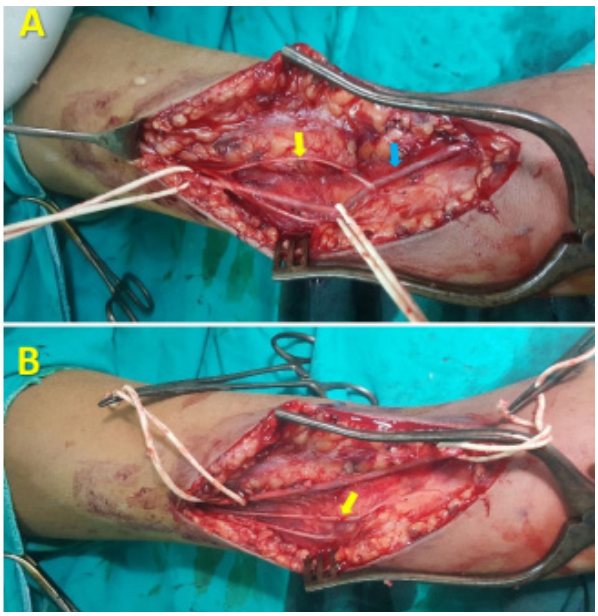

Fig 1: Intraoperative photo showing: A) Basilic vein (Blue arrow) crossed by branches of medial cutaneous nerve of arm (Yellow arrow), B) Dissection of the nerve to get freely mobilized vein.

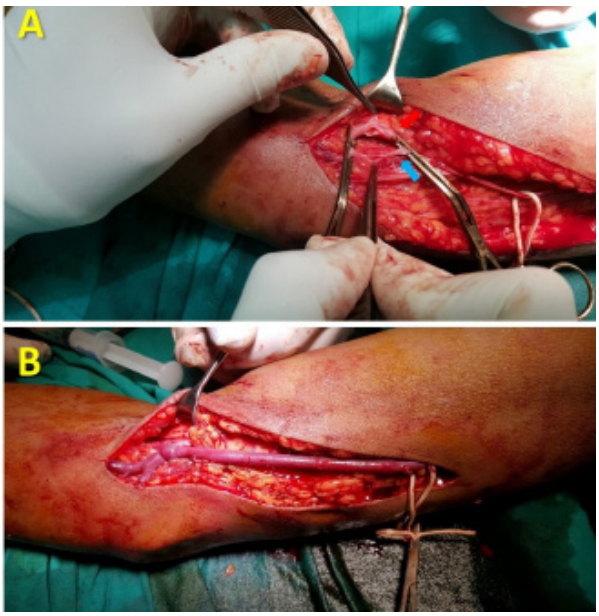

Fig 2: Intraoperative photo showing (A) venotomy and arteriotomy to make side-to-side anastomosis, (B) engorged vein after anastomosis creation.

Fig 3: Fascial flap created and positioned deep to the vein.

In Group II patients, there was no need to free mobilization of the nerve as the vein can be withdrawn between the nerve branches after ligation of its end, the vein was then tied and divided distally at the level of the elbow and dilated with heparinized solution **(Figure 4A).** The free end of the vein was then tunneled in a subcutaneous position along the anterior aspect of the arm. In the antecubital fossa it was anastomosed side-to-end with the brachial artery using 6-0 polypropylene **(Figure 4B).**

Technical success was defined by presence of palpable thrill or audible bruit by the end of procedure.

Fig 4: Intraoperative photo of side-to-end fistula creation showing (A) Distal division of the vein and its freeing from the nerve (Yellow arrow), (B) Subcutaneous tunneling of the vein (Blue dashes).

Outcome measure

Operative data, technical success, postoperative complications, and their management were analyzed for each patient.

Patient deaths unrelated to fistula failure and patients who underwent transplantation were considered lost during the follow up period.

Follow up

The follow up visits were done every week during the first month then every month in the 1st 3 months and then every 3 months for 2 years, and biannually thereafter. Early follow up (Less than 30 day) to detect any complications as presence of infection, steal syndrome, aneurysm, seroma/hematoma, non-maturation, stenosis, and thrombosis were predefined and recorded at the time. Late follow up to detect the maturation, functionality (Successful cannulation of the access), and the Patency (Defined as primary and secondary patency), of the created AVF.

Definitions

They were recorded following ESVS Guidelines definitions 3.

Primary patency: The interval between AVF creation and the first re-intervention (Intervention free AVF survival).

Secondary patency: The interval between AVF creation and the abandonment of this fistula (i.e., thrombosis) after one or more interventions or the time of measurement of patency.

Primary and secondary patency rates were calculated by Kaplan Meier life-table analysis

Statistical analysis

Data were analyzed using "IBM SPSS" version 24.0 (SPSS Inc., Chicago, IL, USA). Categorical data were represented as numbers and percentages and were tested for association using Chi-square test or Fisher's exact test. Numeric variables were presented as mean and standard deviation and Student t test was used to compare its means. Kaplan-Meier Survival curve was used for evaluation the patency rates and freedom from reintervention over the period of the study. P-value ≤ 0.05 was considered significant.

Results

The study included (122) patients divided into (64) patients in Group I and (58) patients in Group II.

The mean age in Group I was 46.25 ± 11.81 years and in Group II was 51.83 ± 15.69 years and the age was significantly lower in Group I (P = 0.03). The duration of hemodialysis was long in both groups (33.38 ± 30.01 months in Group I and 32.17 ± 30.51 months in Group II) as most patients had previous access and the BBAVF was the only option due to exhausted forearm and upper arm veins.

Other patients` co morbidities and demographic data are summarized in **(Table 1).**

Operative data

Preoperative duplex scanning was routinely performed for all patients. Mean brachial artery and basilic vein diameters in Group I patients were 4.2 ± 0.5 mm and 4.1 ± 0.5 mm, respectively, while in Group II patients were and 4.0 ± 0.7 mm and 4.0 ± 0.4 mm, respectively, with no significant statistical difference between both groups. It was noted that the mean intraoperative time was insignificantly longer in Group I compared to Group II (96.19 ± 8.67 minutes vs. 93.71 ± 7.05 minutes,

P=0.09). Technical success was defined by presence of palpable thrill or audible bruit by the end of procedure. It was achieved in all patients except 6 cases, 2 in Group I and 4 in Group II and the lower failure rate in Group I may be due to less incidence of vein twisting and even if there is a problem in the proximal outflow vein the distal limb is still draining it rendering a thrill over the fistula. **(Table 2).**

Early postoperative data

During early postoperative period (30 days), a few complications has been reported **(Table 3)**. Maturation of basilic vein was evaluated by the end of that period. In this study, 9 patients only were reported to have failed maturation, 4 In Group I (6.3%) and 5 in Group II (8.6%). The 4 patients in Group I had dialysis from the distally matured vein while patients in Group II abandon this access.

Follow-up data

Following surgery, patients were scheduled for regular follow-up visits to evaluate patency of the AVF and record any adverse events encountered. Mean follow-up period was 35.3 ± 7.7 months. Follow-up index (FUI) has been calculated as the ratio between the investigated follow-up period and the theoretically possible follow-up period based on pre-specified study end date. Mean FUI was 0.98 ± 0.1.

The interval between creation of the AVF and beginning of its cannulation for hemodialysis has been calculated. It was found that Group I patients had significantly longer maturation time compared to Group II (42.5 ± 6.9 days vs. 36.8 ± 6.1 days, P <0.001). It was also observed that in Group I, maturation of the distal venous limb occurred in 49 cases (76.6%) **(Figure 5)** and it was suitable for cannulation during hemodialysis sessions thus providing more cannulation sites in the same fistula proximal and distal to the anastomosis, which was not possible in Group II. Venous hypertension was reported in 21 patients (32.8%) of Group I and 8 patients (13.8%) of Group II. In Group I, 18 patients had venous hypertension due to maturation of the distal venous limb (13 patients were managed by ligation of the distal limb and 5 patients conservatively) **(Figure 6)**, while the remaining 3 patients had central venous stenosis due to repeated ipsilateral CVC insertion (All of them underwent angioplasty that was successful in 1 patient only). However, all the 8 Group II venous hypertension cases were due to central venous stenosis, 6 of them underwent angioplasty and the remaining 2 were managed conservatively.

Fig 5: Maturation of the fistula with distal and proximal venous limbs for cannulation.

Fig 6: Management of peripheral venous hypertension after side-to-side brachio-basilic AVF (A) Peripheral edema and ulceration of the hand, (B) Maturation of distal venous limb, (C) Ligation of the distal venous limb, (D) Resolution of peripheral edema.

Two cases (3.1%) in Group I and 3 cases (5.2%) in Group II developed Dialysis associated steal syndrome (DASS). Surgical correction (RUDI) was required in 3 cases while the remaining 2 cases had mild symptoms and responded well to conservative medical treatment. Other adverse events and re-interventions are illustrated in **(Table 4).**

Survival Kaplan Meier analysis has been used to compare patency rates between both groups **(Figsures 7,8)**. It revealed that at 1 year follow up, Group I showed a higher 1ry and 2ry patency in comparison to Group II, yet without statistical significance (96.9% and 98.4% vs. 93.1% and 94.8%, P = 0.42 and 0.19, respectively). However, in the 2nd year, 3rd year Group I showed significantly higher primary and secondary patency rates compared to Group II as illustrated in **(Table 5).**

Primary patency in Group I was achieved in 93.8%, and 82.8% of cases at 2nd and 3rd year respectively. While 2ry patency in Group I was achieved in 96.9%, and 89.1% of cases at 2nd and 3rd year respectively. While for Group II, the primary patency was achieved in 79.3% and 67.2% of cases at 2nd and 3rd year respectively. While 2ry patency in Group II was achieved in 86.2% and 77.6% of cases at 2nd and 3rd year respectively.

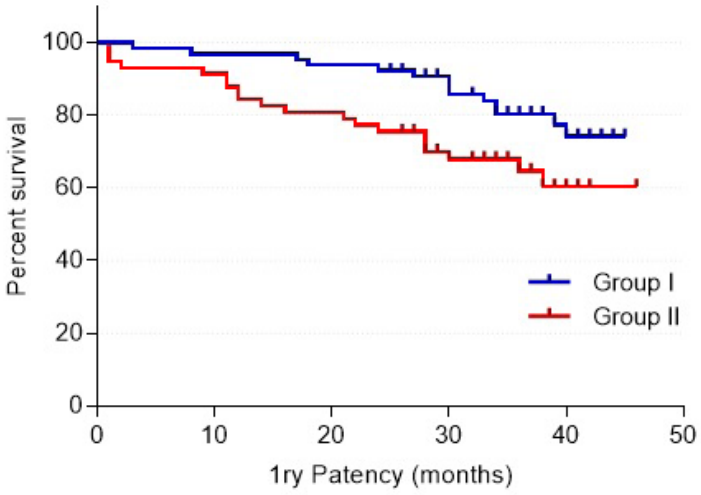

Fig 7: Kaplan Meier survival curve of primary patency of both groups.

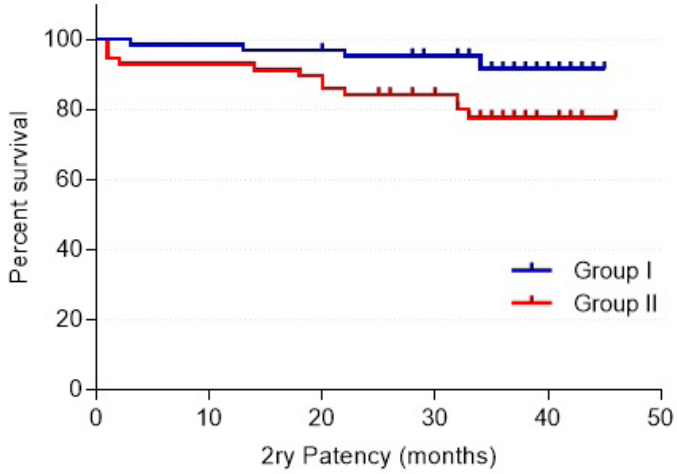

Fig 8: Kaplan Meier survival curve of secondary patency of both groups.

Table 1: Demographic data and co-morbidities of the studied patients

Variable	Group I (N: 64)	Group II (N: 58)	P-value
Age (Years)	46.25 ± 11.81	51.83 ± 15.69	0.03*
Gender (Male)	25 (39.1%)	21 (36.2%)	0.85
Diabetes mellitus	26 (40.6%)	23 (39.7%)	1.00
Hypertension	37 (57.8%)	35 (60.3%)	0.85
IHD	23 (35.9%)	18 (31%)	0.70
Dyslipidemia	30 (46.9%)	22 (37.9%)	0.36
Antiplatelet therapy	23 (35.9%)	25 (43.1%)	0.46
HD duration (Months)	33.38 ± 30.01	32.17 ± 30.51	0.83
Prior ipsilateral AVF	37 (57.8%)	32 (55.2%)	0.86
Prior ipsilateral CVC	32 (50%)	23 (39.7%)	0.28

AVF: Arterio-venous fistula, CVC: Central venous catheter, HD: Hemodialysis, IHD: Ischemic heart disease.

Table 2: Preoperative and intraoperative data of the studied patients

Variable	Group I (N: 64)	Group II (N: 58)	P-value
Brachial a. Diameter (mm)	4.22 ± 0.47	4.01 ± 0.70	0.16
Basilic v. Diameter (mm)	4.08 ± 0.51	4.01 ± 0.37	0.38
Side (Left)	46 (71.9%)	39 (67.2%)	0.69
Operative time (Min.)	96.19 ± 8.67	93.71 ± 7.05	0.09
Technical success	62 (96.9%)	54 (93.1%)	0.42

Table 3: Early postoperative complications

Variable	Group I (N: 64)	Group II (N: 58)	P-value
Hematoma	3 (4.7%)	5 (8.6%)	0.48
Seroma	3 (4.7%)	3 (5.2%)	1.00
Infection	4 (6.3%)	2 (3.4%)	0.68
Failure to maturate	4 (6.3 %)	5 (8.6 %)	0.62

Table 4: Follow-up data of the studied patients

Variable	Group I (N: 64)	Group II (N: 58)	P-value
Maturation time (Days)	42.48 ± 6.85	36.84 ± 6.08	< 0.001*
Venous HTN	21 (32.8%)	8 (13.8%)	0.02*
Peripheral venous stenosis	2 (3.1%)	3 (5.2%)	0.69
DASS	2 (3.1%)	3 (5.2%)	0.69
Thrombosis	4 (6.3%)	7 (12.1%)	0.38
Infection/rupture	6 (9.4%)	5 (8.6%)	1.00
Reintervention	26 (40.6%)	21 (36.2%)	0.71
• **Ligation of distal vein**	13 (20.3%)	0	
• **PTA**	3 (4.7%)	6 (10.3%)	
• **RUDI**	1 (1.6%)	2 (3.5%)	
• **Thrombectomy**	3 (4.7%)	6 (10.3%)	
• **Repair**	4 (6.3%)	3 (5.2%)	
• **Termination**	2 (3.1%)	2 (3.5%)	

DASS: Dialysis associated steal syndrome, HTN: Hypertension, PTA: Percutaneous transluminal angioplasty, RUDI: Revascularization using distal inflow.

Table 5: Patency data of both groups

Variable		Group I (N: 64)	Group II (N: 58)	P-value
1ry Patency	1 Year	62 (96.9%)	54 (93.1%)	0.42
	2 Years	60 (93.8%)	46 (79.3%)	0.03*
	3 Years	53 (82.8%)	39 (67.2%)	0.05*
2ry Patency	1 Year	63 (98.4%)	55 (94.8%)	0.19
	2 Years	62 (96.9%)	50 (86.2%)	0.05*
	3 Years	57 (89.1%)	45 (77.6%)	0.05*

Discussion

Recent guidelines recommend having a tailored treatment protocol for each patient with progressive chronic kidney disease to ensure that the available dialysis options meet the patient`s requirements.[14] The patient`s lifestyle can largely affect the decision making. For example, a young active patient will need a more durable access than an older patient with limited life expectancy. In our practice, it is preferred to create the AVF using native veins over synthetic grafts as the observational studies show a lower incidence of postoperative complications with autogenous AVF.[15] The ideal strategy is to start with a distal AVF in the non-dominant upper limb and if failed a more proximally located AVF can be performed.[16]

Brachio-basilic fistula in the upper arm is a good choice when Radio-cephalic or brachio-cephalic AVF have failed or are not feasible. Even if the basilic vein in the forearm is patent, there is preference to perform upper arm BBAVF over ulno-basilic AVF creation due to small vessel diameter and delayed maturation.[5]

BBAVF can be performed in either one or two stage procedure. However, there are no national guidelines on performing the procedure in a single or two stages as both procedures have its pros and cons. Also, there is no agreement on the preferred type of anastomosis as every type has its own advantages and disadvantages. The standard practice for BBAVF in our institution is to be performed in a single stage procedure with side-to-end anastomosis.

Some patients who are allocated for BBAVF may have a patent basilic vein in the forearm. Moreover, some of those patients may have a patent segment of cephalic vein in the arm (Which is not suitable to perform RC fistula) which is connected to the basilic vein through the antecubital vein. In this study we assumed that if there is a distal patent vein below the elbow, the patient could get benefit of it for puncture if we performed side-to-side anastomosis. As the use of a technique to create AVF with more available cannulation sites seems to be logical.

Side-to-side anastomosis can provide higher flow and expected better patency, compared to side-to-end anastomosis but there are no clear published data regarding differences in patency. However, with side-to-side anastomosis there is a higher risk of AVF-induced ischemia, vein approximation, and mobilization is more difficult, and there is a higher risk of distal venous hypertension.[3,12]

Actually, only few studies have compared the anastomosis type and, there is a paucity of evidence to recommend either anastomosis type, and most guidelines do not mention it. Only European Society for Vascular Surgery (ESVS) guidelines recommend a side-to-end anastomosis but based on weak and old evidence.[3,12]

The one-stage procedure requires only one operation, with a shorter time for maturation. The two-stage procedure ensures the ease of mobilization of arterialized vein, with a lower risk for rotation and devascularization.[11]

Cooper et al.[17] performed a Meta-analysis comparing one-stage with two-stage BBAVF and no difference was observed in failure rates and patency rates between both groups, despite the two-stage procedure's being used in patients with smaller diameter of basilic veins. Also, Bashar et al.[18] published a meta-analysis reviewing eight published studies comparing the outcomes of one-stage and two-stage BBAVF and no significant difference between the two techniques in terms of the rates of maturation, patency, and complications.

According to these data we preferred the one stage procedure in all our patients with side-to-side technique to add more puncture sites in forearm as this study aims to help young patients with long-life expectancy and limited options to have more durable vascular access.

And this was reflected on the results of this nonrandomized study as more young patients were included in Group I as the mean age in Group I was 46.25 ± 11.81 years and in Group II was 51.83 ± 15.69 years and the age was significantly lower in Group I (P = 0.03).

In this study, maturation of the distal venous limb occurred in 49 cases (76.6%) as they had matured

distal venous limb ready for cannulation allowing more prolonged use of the same access. Valenti et al.[19] reported similar data and added that the repeated cannulation of the same venous segment in case of single out flow vein will cause an aneurysm and eventually, rupture of the vein.

In Group I, there was a longer operative time in relation to Group II (96.19 ± 8.67 minutes vs. 93.71 ± 7.05 minutes, P = 0.09, respectively), but it had no impact on operative, early postoperative outcome and rate of maturation as no significant difference was reported between the two groups. The longer time can be explained by the time needed for complete mobilization of the vein and the nerve and the time for creation of the fascial flap as in the other group only a tunnel is performed which takes less time.

The needed time for maturation was also found to be prolonged in Group I in comparison to Group II (42.5 ± 6.9 days vs. 36.8 ± 6.1 days, respectively. P value <0.001). As the presence of a single outflow vein in side-to-end group receiving the whole flow of the AVF promotes earlier maturation. On the other hand, there is distribution of the arterial flow to both the distal and proximal veins in side-to-side group.

This study demonstrated that both techniques had high technical success rates and low rates of complications, the rates were more or less similar with no statistically significant difference between both groups. This agrees with Mestres et al.[20] who investigated the effect of anastomosis type in elbow level AVF and it was not found significantly related to different outcomes. They observed better patency rate at 6 months interval for side-to-end anastomosis but similar assisted primary and secondary patency, maturation, and functionality rates have been reported.

Despite the higher incidence of venous hypertension that was reported in Group I (21 cases, 32.8%), only 13 cases required surgical ligation of the distal venous limb under local anesthesia for preservation of the access. Also, Mestres et al.[20] reported very low rate of arm edema in side-to-side group.

An important clinical observation in our practice that some patients with elbow side-to-side AV fistula have very high patency rates and they are still using their access for more than 15 years. However, there is a lack of published evidence to support this observation.

The increased patency rate in the side-to-side group can be explained also by the regular anastomosis configuration beside presence of proximal and distal outflow veins, if proximal vein segment is thrombosed the distal draining vein could preserve the functionality of the fistula.

Our study matches this fact regarding patency, Group I showed significantly better primary and secondary patency rates in comparison to Group II. Despite no significant statistical difference was found between both groups in 1st year, but on longer follow up period, Group I showed significantly higher 2nd and 3rd year primary patency rates compared to Group II (93.8% vs. 79.3% respectively, P = 0.03 in 2nd year and 82.8% vs. 67.2% respectively, P = 0.05 in 3rd year) and also significantly higher 2nd and 3rd year secondary patency rates compared to Group II (96.9% vs 86.2% respectively, P = 0.05 in 2nd year and 89.1% vs. 77.6% respectively, P = 0.05 in 3rd year).

Mestres et al. 20 showed better early patency rate for side-to-end group but it was confirmed as an independent predictor and the study had a very short follow up period (six months). Mestres et al.[20] also reported that patients with side-to-side anastomosis more often required vein superficialization (2.1–16.2%; P = 0.002) and presented more frequent puncture hematomas (4.9–30.0%; P = 0.015). This may be explained because they didn't perform superficialization of basilic vein which make it difficult for puncture in contrast to our study.

Conclusion

Side-to-side one stage BBAVF could be a valuable access option - especially in younger patients. It is performed in one operation with comparable technical, operative outcome and even better patency rates than side-to-end anastomosis. Venous hypertension after side-to-side anastomosis could be managed conservatively or by surgical ligation of distal venous limb without affection of the access patency.

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