Assessment of patency for the second-stage brachiobasilic arteriovenous fistula: a comparative study between basilic vein transpositioning and superficialization

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Background
Arteriovenous fistula (AVF) is the most frequently used method for hemodialysis in patients with end-stage renal disease. The National Kidney Foundation Dialysis Outcome Quality Initiative recommends autologous radiocephalic or brachiocephalic AVF as a primary method of choice in hemodialysis patients, but for the patients with failed radiocephalic fistula or brachiocephalic fistula or with smaller caliber superficial veins, vascular access becomes difficult. Therefore, the basilic vein AVF as a secondary option is recommended in those patients.
Aim
To compare outcomes for both techniques in the creation of brachiobasilic AVF, namely, in the second-stage basilic vein transposition or the second-stage basilic vein superficialization, as well as to determine the primary, assisted primary, and secondary patency of each technique throughout 18 months of follow-up and to detect any procedure-related complications.
Patients and methods
This is a prospective nonrandomized closed envelope clinical trial. This study was conducted at Ain Shams University Hospitals on 50 patients with end-stage renal disease on regular dialysis subjected to brachiobasilic AVF in the period from March 2020 to November 2020. Follow-up was done for 18 months till May 2022. The patients were divided into two groups according to the type of access procedure as the basilic vein superficialization (BBAVFS) group (*n*=25) and basilic vein transposition (BBAVFTn) group (*n*=25). The primary, assisted primary, and secondary patency rates were evaluated.
Results
During the follow-up, the mean age of the cases in group A was 53.56 years and in group B was 57.16 years, with no statistically significant difference between both groups regarding demographic data. In group A, the primary patency rates at 3, 6, 12, and 18 months were 92, 84, 64, and 56%, respectively; the assisted primary patency rates at 3, 6, 12, and 18 months were 100, 96, 80, and 72%, respectively; and the secondary patency rates at 3, 6, 12, and 18 months were 100, 96, 88, and 80%, respectively. However, in group B, the primary patency rates at 3, 6, 12, and 18 months were 88, 72, 52, and 40%, respectively; the assisted primary patency rates at 3, 6, 12, and 18 months were 96, 88, 64, and 52%, respectively; and the secondary patency rates at 3, 6, 12, and 18 months were 96, 96, 84, and 68%, respectively. There was only one case with hematoma detected in the BBAVFT group. There was no statistically significant difference in the patency rates or postoperative complications between the groups.
Conclusion
Owing to their low complication and high patency rates, both basilic vein superficialization and basilic vein transposition can be safely employed in patients in whom AVF cannot be established with the cephalic vein.

Keywords:
arteriovenous fistula, basilic vein transposition, chronic renal insufficiency, hemodialysis, superficialization

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Introduction

The number of patients requiring hemodialysis (HD) has been increasing globally because of the rise in the prevalence of end-stage renal disease (ESRD) [1]. Therefore, hemodialysis is the primary mode of treatment for patients with renal failure [2].

The arteriovenous fistula (AVF) is the most frequently used method for HD in these patients [3]. The National Kidney Foundation Dialysis Outcome Quality Initiative recommends autologous radiocephalic or brachiocephalic AVF as a primary method of choice in HD patients, but for the patients with failed radiocephalic fistula or brachiocephalic fistula or with smaller caliber superficial veins, vascular access becomes difficult. Therefore, the basilic vein AVF as a secondary option is recommended in those patients [4].

Brachiobasilic AVF offers excellent access in such difficult cases and has many advantages over prosthetic graft. In addition to superior long-term patency, most access-related complications can be treated conservatively without fistula failure [5].

Many surgical techniques have been described to create such fistulas. The brachiobasilic AVF transposition technique was first described by Dagher *et al.* [6] with transposition of the mobilized vein inside an anterolateral subcutaneous tunnel. Other techniques were subsequently developed, including vein elevation with reapproximation of the deep fascia under the vein in a two-stage transposition procedure [7].

The reason to perform the two-stage technique is to allow the maturation of the basilic vein, reducing the risk of the periadventitial fibrosis owing to the dissection and the risk of early thrombosis [8]. Moreover, the basilic vein wall is thin and friable, and thus more susceptible to damage when manipulated in a single-stage procedure. For this reason, a two-stage approach has been proposed and increasingly used over the past 15 years [9]. Arterialization usually leads to a more resistant conduit [10,11].

The mechanism of stenosis after superficialization is unclear, and stenosis might be caused by multiple factors, such as dissection, torsion of the basilic vein, tunneling process, and reanastomosis [12,13]. Almost every step of the superficialization procedure includes some risk of basilic vein stenosis and can be affected by the patency of the fistula [14].

The purpose of our work was to compare two surgical brachiobasilic AVF techniques. The first technique implies elevating the basilic vein in a subcutaneous pocket without the need for a new arteriovenous anastomosis (BBAVF), whereas the second technique implies tunneling the basilic vein over the fascia (BBAVFTn) with simultaneous execution of a new brachiobasilic anastomosis above the elbow. Both techniques were carried out 4–6 weeks after the first brachiobasilic fistula.

Aim

The aim of this study was to compare the outcomes of two techniques in the creation of brachiobasilic AVF, namely, the second-stage basilic vein transposition (BVT) or the second-stage basilic vein superficialization, and to determine primary, assisted primary, and secondary patency of each technique throughout 18 months of follow-up and detect any procedure-related complications.

Patients and methods

This is a prospective nonrandomized closed envelope clinical trial. This study was conducted at Ain Shams University Hospitals on 50 patients with ESRD on regular dialysis subjected to brachiobasilic AVF in the period from March to November 2020. Follow-up was done for 18 months till May 2022. The patients were divided into two groups according to the type of access procedure: group A (n=25), which underwent basilic vein superficialization (BBAVFS), and group B (n=25), which underwent BVT (BBAVFTn). The primary, assisted primary, and secondary patency rates were evaluated.

Inclusion criteria were patients between 18 and 70 years of age of both sexes, and patients with ESRD with mature first-stage brachiobasilic AVF.

Exclusion criteria were patients with evidence of steal syndrome, one-stage brachiobasilic AVF (fistula creation and superficialization in one operation), failed maturation of AVF, or clinical evidence of central venous stenosis or occlusion.

All patients who met those criteria and accepted to sign a written informed consent for this study were included. The whole study design was approved by the Ethical Scientific Committee of University, Faculty of Medicine, Ain Shams University.

Preoperative preparation

Careful history taking, clinical examination, and duplex ultrasound were done for all patients after 6 weeks of fistula creation (vein maturation) [15]. The duplex volume flow measurement was routinely used as a criterion for the evaluation of access maturation before second-stage surgery. Access flow rate must be more than equal to 600 ml/min and vein diameter more than equal to 6 mm as indicator of mature AVF [16].

Operative technique

The second stage was performed under general or regional anesthesia (brachial plexus block) along with 0.5–1.0% lidocaine for infiltrate the line of incision.

Longitudinal incision was made in the medial aspect of the arm extending from the elbow (the medial epicondyle of the humerus) to the axilla. Exposure of basilic vein up to axilla was done, and crossing vein branches were divided and ligated (Fig. 1).

Identification of the medial antebrachial cutaneous nerve of the forearm was done to avoid its injury (dividing this nerve can lead to medial forearm anaesthesia), which is a sensory nerve originating directly from the medial cord of the brachial plexus and crosses directly in front of the basilic vein at or just central to the entry of the median cubital vein (Fig. 2).

Technique of the second-stage basilic vein superficialization

The entire length of the basilic vein was mobilized, the vein was superficialized, a subcutaneous flap was created by approximating the subcutaneous tissue below the vein, and the vein was positioned anterolaterally (Fig. 3).

Technique of the second-stage basilic vein transpositioning

The basilic vein was exposed to the axilla. A tunnel was created about 2–3 cm anterior to the basilic vein with a tunneler. The basilic vein was marked along its anterior surface, transected distally, gently flushed with heparinized saline, and drawn through the tunnel, with care taken to avoid rotation (twist) or kinking. The transposed basilic vein was reanastomosed to the distal vein (Fig. 4).

Subcutaneous tissue was reapproximated, skin closed, and a sterile adhesive dressing was applied positioned anterolaterally.

Follow-up

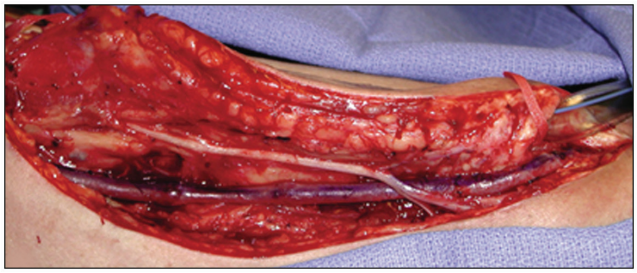
All patients were informed to do wound dressing with betadine every other day, and adequate broad-spectrum antibiotics were prescribed for all patients. Patients were advised to come for follow-up visits including physical examination and duplex scan if required to evaluate the anatomy and hemodynamic status of the fistula in the outpatient clinic at 3, 6, 12, and 18 months. The follow-up was done by regular visits for those who were living nearby or with phone calls for those who were away by asking about the progress of dialysis. Data obtained regarding the patients and his AVF were collected, presented, and statically analyzed.

Primary patency (intervention-free access survival) was defined as the interval from time of superficialization to any intervention designed to maintain or reestablish

Figure 1

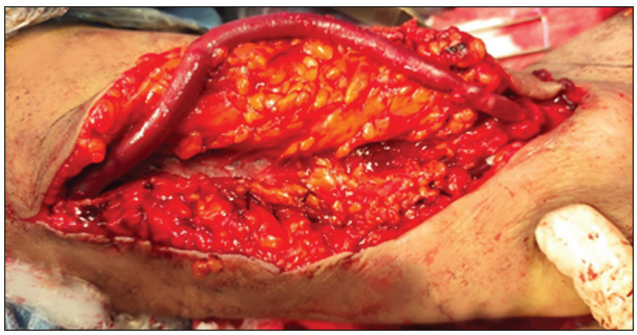
The left basilic vein is exposed from the elbow to the axilla and the medial antebrachial cutaneous nerve of the forearm.

Figure 2



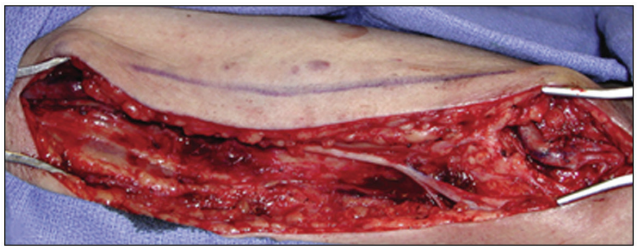
The left basilic vein is exposed from the elbow to the axilla and the medial antebrachial cutaneous nerve of the forearm, which crosses the basilic vein in the distal arm.

Figure 3



The left basilic vein has been superficialized, and a subcutaneous flap was created by approximating the subcutaneous tissue below the vein.

Figure 4



The basilic vein has been tunneled anteriorly and anastomosed to the distal vein.

patency, access thrombosis, or the time of measurement of patency [17].

Assisted primary patency (thrombosis-free access survival) was defined as the interval from time of superficialization to access thrombosis or time of measurement of patency, including intervening manipulations (surgical or endovascular interventions), designed to maintain the functionality of a patent access [17].

Secondary patency (access survival until abandonment) was defined as the interval from time of superficialization to access abandonment or time of measurement of patency, including intervening manipulations (surgical or endovascular interventions) designed to reestablish the functionality of thrombosed access [17].

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 22.0 software (IBM Corp., Armonk, New York, USA). Continuous variables were expressed in mean±SD and categorical variables were expressed in number and frequency. Comparisons were performed using the *t* test, contingency χ^2 test, and log-rank tests to determine whether any statistically significant differences existed between tunnelling and elevation groups in primary patency, primary-assisted patency, and secondary patency. A *P* value less than 0.05 was considered statistically significant for all data.

Results

There was no statistically significant difference between the two groups in age and sex, as shown in Table 1. The mean age of the cases in group A was 53.56 years and in group B was 57.16 years. There were 14 (56%) males and 11 (44%) females in group A and 12 (48%) males and 13 (52%) females in group B (Fig. 5).

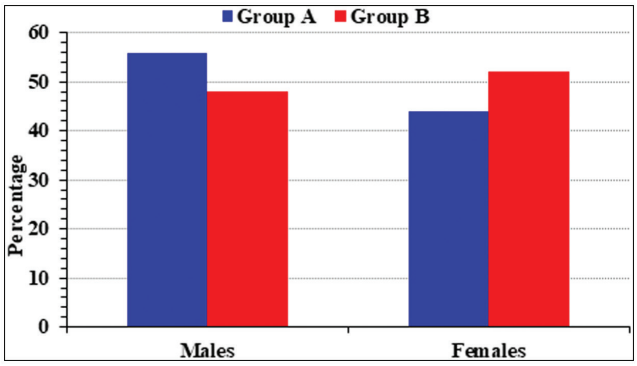
Regarding the analysis of the associated chronic diseases and other risk of the cases included in the study, DM was the most common associated chronic disease that was found in 48% of the cases in group A and in 40% of the cases in group B followed by HTN, which was found in 36% of the cases in group A and in 48% of the cases in group B. The mean duration of dialysis in group A was 2.9 years with range between 1 and 8 as compared with mean duration of 3.82 years with range between 1 and 11 years in group B (Fig. 6). These data and the most common associated chronic diseases are shown in Table 2.

In the study population, in group A, there were 12 (48%) patients on antiplatelet, eight (32%) patients were on insulin, six (24%) patients were on statins, four

Table 1 Demographic data in the two study groups

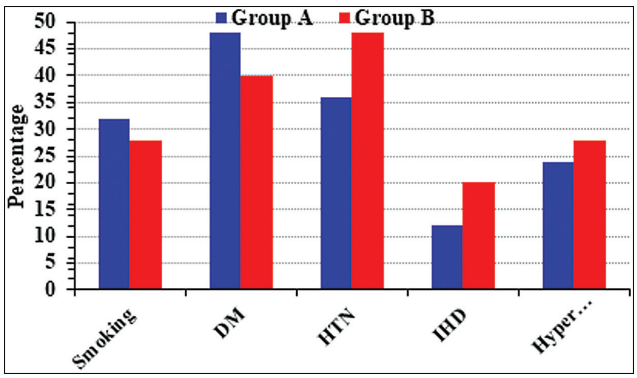
Item	Group A (BBAVF)	Group B (BBAVFTn)
Age (years)		
Number	25	25
Mean	53.56	57.16
SD	12.13	12.51
t test	1.012	
P value	0.317	
Males [*n* (%)]	14 (56)	12 (48)
Females [*n* (%)]	11 (44)	13 (52)
BMI (kg/m^2)	28.35±3.89	27.83±4.46

Figure 5



Percentages of sex distribution in the two study groups.

Figure 6



Other comorbidities in the two study groups.

Table 2 Other comorbidities in the two study groups

Risk factors and comorbidities	Group A (BBAVF) [*n* (%)]	Group B (BBAVFTn)
Risk factors and comorbidities		
Smoking	8 (32)	7 (28)
DM	12 (48)	10 (40)
HTN	9 (36)	12 (48)
IHD	3 (12)	5 (20)
Hyperlipidemia	6 (24)	7 (28)
Duration of dialysis (years)		
Range	1–8	1–11
Mean	2.9	3.82
SD	1.88	2.36
Median	2	3
Mode	2	2

(16%) patients on metformin, three (12%) patients were on beta-blockers, and six (24%) patients were on calcium channel blockers.

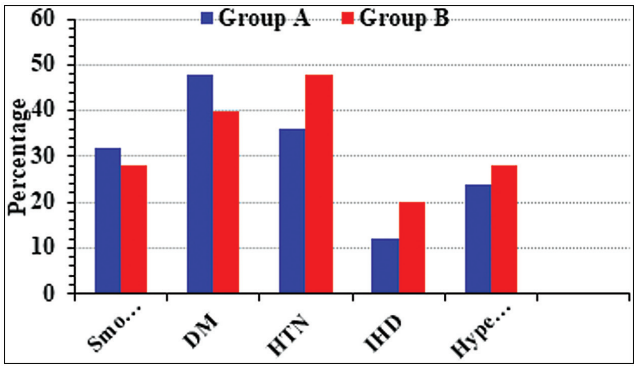
However, in group B, 14 (56%) patients were on antiplatelet, six (24%) patients were on insulin, four (16%) patients were on statins, four (16%) patients on metformin, two (8%) patients were on beta-blockers, and 10 (40%) patients were on calcium channel blockers (Fig. 7).

As shown in Table 3, in group A, the procedure was conducted in the right arm in eight (32%) cases and in the left arm in 17 (68%) cases, whereas in group B, the procedure was conducted in the right arm in 10 (40%) cases and in the left arm in 15 (60%) cases (Fig. 8).

Regarding the primary outcomes in the two study groups, no patient was lost during the 18-month follow-up. In group A, the primary patency rates at 3, 6, 12, and 18 months were 92, 84, 64, and 56%, respectively; the assisted primary patency rates at 3, 6, 12, and 18 months were 100, 96, 80, and 72%, respectively; and the secondary patency rates at 3, 6, 12, and 18 months were 100, 96, 88, and 80%, respectively.

However, in group B, the primary patency rates at 3, 6, 12, and 18 months were 88, 72, 52, and 40%, respectively; the assisted primary patency rates at 3, 6, 12, and 18 months were 96, 88, 64, and 52, respectively; and the secondary patency rates at 3, 6, 12, and 18 months were 96, 96, 84, and 68%, respectively (Fig. 9). There was no statistically significant difference between the two groups for primary, assisted primary, or secondary patency rates and also by using log-rank test statistics, as shown in Tables 4 and 5.

Figure 7



Drugs taken by the study population.

Table 3 Side of fistula in the two study groups

Side of fistula	Group A (BBAVF) [*n* (%)]	Group B (BBAVFTn) [*n* (%)]
Right arm	8 (32)	10 (40)
Left arm	17 (68)	15 (60)

The operation time was 121 ± 23.2 min for group A (BBAVFS) and 88 ± 15.4 min for group B (BBAVFTn), with *P* value 0.263, but there was no statistically significant difference between the two groups.

During the follow-up, in group A, there were six cases of stenoses that were successfully treated with endovascular angioplasty, and later on, two of them thrombosed and a trial of thrombectomy failed to regain its functioning. A total of seven cases of thrombosis were identified in the follow-up, with a trial of thrombectomy done for all cases; two successfully regain functioning, and the other five failed.

However, in group B, there were six cases of stenoses that were successfully treated with endovascular angioplasty, and later on, three of them thrombosed, and a trial of thrombectomy was failed for two cases and succeeded for one, but later on, it was thrombosed again after 3 months and failed thrombectomy.

A total number of 12 cases thrombosed were identified in the follow-up, with a trial of thrombectomy done for all cases; four successfully regain functioning and the other eight failed.

On performing log-rank test statistical analysis on drugs against three cases of patency during the four times (comparison between groups A and B), we found that there was no statistically significant difference between the two groups, as shown in Table 6.

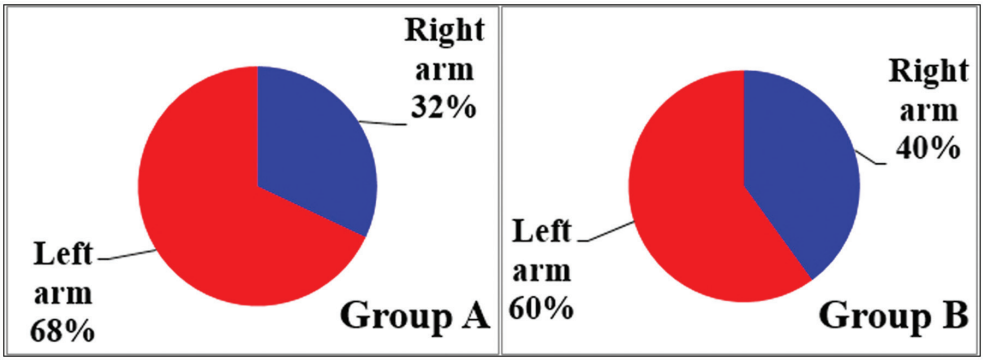
Hypertension was associated with decreased primary patency at 18 months, with *P* value of 0.0163, and ischemic heart disease was associated with decreased primary patency at 6 and 12 months, with *P* values of 0.0204 and 0.0168, respectively, as shown in Table 7.

Complication related to surgical procedure

In the perioperative period, there was only one case with hematoma detected in the BBAVFT group (group B) that appeared 24 h after the surgical procedure, whereas this complication was observed 30 days after the intervention and passed without the need for intervention.

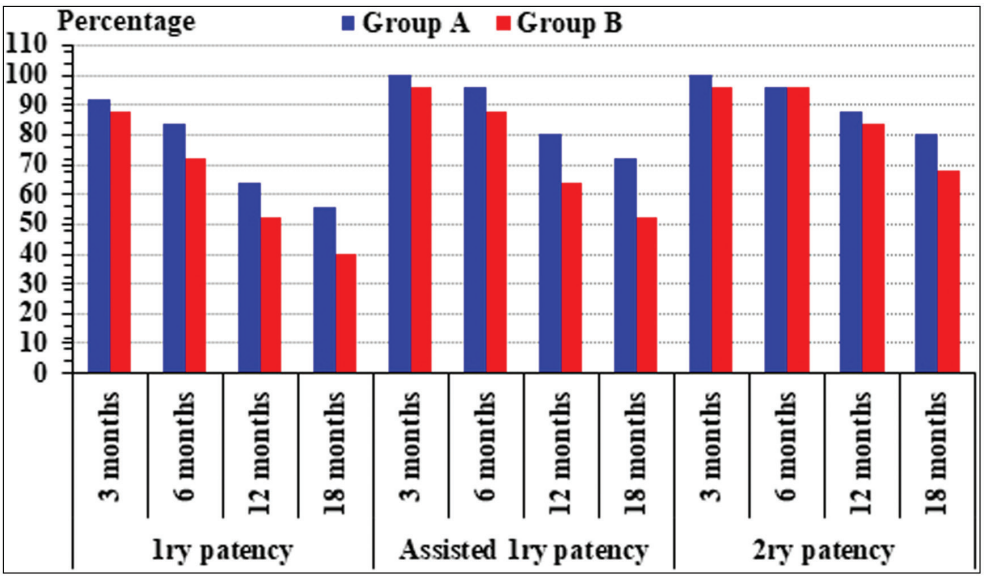
In addition, upper extremity edema was seen in 14 (56%) patients in group A (BBAVFS) and 11 (44%) patients in group B (BBAVFTn). All the upper extremity edema cases resolved entirely with elevation. There were no patients who had surgical site infection or nerve injury complications during the perioperative period.

Figure 8



Side of fistula in the two study groups.

Figure 9



Patency during the follow-up period.

Table 4 Patency during follow-up period

Item	Period	Group A (BBAVFS) *N*=25 [*n* (%)]	Group B (BBAVFTn) *N*=25 [*n* (%)]	*P* value
Primary patency	3 months	23 (92)	22 (88)	0.8815
	6 months	21 (84)	18 (72)	0.6309
	12 months	16 (64)	13 (52)	0.5775
	18 months	14 (56)	10 (40)	0.4142
Assisted primary patency	3 months	25 (100)	24 (96)	0.8864
	6 months	24 (96)	22 (88)	0.7681
	12 months	20 (80)	16 (64)	0.505
	18 months	18 (72)	13 (52)	0.3692
Secondary patency	3 months	25 (100)	24 (96)	0.8864
	6 months	24 (96)	24 (96)	1.0000
	12 months	22 (88)	21 (84)	0.8788
	18 months	20 (80)	17 (68)	0.6219

Discussion

Easy access to the vascular system is vital in patients with end-stage renal failure who need long-term intermittent haemodialysis [18]. In accordance with the National Kidney Foundation/Kidney Foundation Dialysis Outcome Quality Initiative (KDOQI) recommendation, basilic vein AVF is the first-choice approach when the autologous superficial veins are not suitable for radio-cephalic or brachiocephalic AVF construction [4].

Table 5 Three cases of patency during the four times using log-rank test statistic (comparison between groups A and B)

Time (months)	Primary		Assisted		Secondary	
	Value	*P* value	Value	*P* value	Value	*P* value
3	0.022	0.8815	0.020	0.8864	0.020	0.8864
6	0.231	0.6309	0.087	0.7681	0.000	1.0000
12	0.310	0.5775	0.444	0.505	0.023	0.8788
18	0.667	0.4142	0.806	0.3692	0.243	0.6219

Table 6 Drugs against three cases of patency during the four times using log-rank test statistic (comparison between groups A and B)

Patency	Time (months)	Antiplatelets		Insulin		Statins	
		Value	*P* value	Value	*P* value	Value	*P* value
Primary	3	1.062	0.3028	0.790	0.3742	0.271	0.6024
	6	1.785	0.1815	0.243	0.6218	0.271	0.6024
	12	0.723	0.3857	0.287	0.5919	0.088	0.7674
	18	1.274	0.2591	0.080	0.7769	0.002	0.9622
Assisted	3	0.778	0.3778	0.840	0.3593	0.832	0.3616
	6	1.344	0.2463	0.012	0.9131	0.852	0.3616
	12	1.287	0.2567	0.896	0.3438	0.568	0.4509
	18	1.287	0.2567	0.013	0.9089	0.568	0.4509
Secondary	3	0.778	0.3778	0.840	0.3593	0.832	0.3616
	6	0.778	0.3778	0.840	0.3593	0.832	0.3616
	12	0.465	0.4952	2.070	0.1503	0.568	0.4509
	18	1.418	0.2840	1.309	0.2525	0.568	0.4509

Table 7 Diseases against three cases of patency during the four times using log-rank test statistic (comparison between groups A and B)

Patency	Time (month)	Diabetes mellitus		Hypertension		Ischemic heart disease		Hyperlipidemia	
		Value	*P* value	Value	*P* value	Value	*P* value	Value	*P* value
Primary	3	1.011	0.3147	1.947	0.1629	2.679	0.1017	0.691	0.4060
	6	0.054	0.8162	3.700	0.0544	**5.381**	**0.0204**	1.291	0.2559
	12	0.011	0.9165	2.703	0.1002	**5.720**	**0.0168**	0.176	0.6750
	18	0.016	0.8993	**5.767**	**0.0163**	3.821	0.0506	0.171	0.6791
Assisted	3	0.802	0.3705	1.947	0.1629	1.400	0.2367	0.296	0.5867
	6	0.178	0.6731	3.700	0.0544	2.879	0.0897	0.674	0.4116
	12	0.109	0.7413	3.649	0.0561	3.046	0.0809	0.184	0.6678
	18	0.186	0.6663	3.649	0.0561	3.046	0.0809	0.002	0.9623
Secondary	3	0.802	0.3705	1.947	0.1629	1.400	0.2367	0.296	0.5867
	6	0.802	0.3705	1.947	0.1629	1.400	0.2367	0.296	0.5867
	12	0.529	0.4670	1.747	0.1862	1.477	0.2242	0.226	0.6347
	18	0.228	0.6330	1.747	0.1862	1.477	0.2242	0.019	0.8902

Bold values are significant.

The natural position of the basilic vein in the deep, medial part of the arm protects it from vascular intervention damage and not used routinely for venipuncture. However, its large diameter allows rapid maturation and easy cannulation [19]. Its high flow rate and smooth fistula tract make basilic vein AVF creation a viable option. The BBAVF involves a longer and more complex surgical procedure than other AVF procedures [20].

The reason to perform two-stage techniques is to allow the maturation of the basilic vein, reducing the risk of the periadventitial fibrosis due to the dissection and the risk of early thrombosis [8]. Moreover, the basilic vein wall is thin and friable, and thus more susceptible to damage when manipulated in a single-stage procedure. For this reason, a two-stage approach has been proposed and increasingly used over the past 15 years [9].

Basilic vein stenosis may occur after superficialization; however, the causes are unclear, but they may be related to the surgery. Possible surgical causes include electric burns, dissection injury, torsion, and external tissue compression following tunnel transposition [21,22]. In the transposition method, reanastomosis, and tunnel

creation can increase the risk of vessel injury and vein stenosis [23,24]. However, superficialization of the basilic vein using the elevation method is a simple procedure, and it has been associated with lower rates of vascular injury as reanastomosis and tunneling are not required [23,25].

The choice between one-stage and two-stage approaches has been a subject of focus in creating BBAVF. Many studies were compered between them with advantage toward the two-stage approaches. Sheta *et al.* [9] compared outcomes in two groups randomly allocated to receive either one-stage BVT or two-stage BVT. The difference in early patency rates was significant and favored the two-stage approach (60% of one stage vs. 90% of two stage), as well as overall patency rates at the end of follow-up (50% of one stage vs. 80% of two stage). Postoperative wound infection rate also favored the two-stage approach, with one case, compared with three in the one-stage group.

Vrakas *et al.* [26] evaluated the difference in outcomes between one-stage (65 fistulas) and two-stage (84 fistulas) BBAVFs performed in 141 patients. They showed that the one-stage procedure was 3.2 times more likely to fail. They demonstrated significantly improved primary, assisted primary, and secondary functional patency rates for the two-stage operation, with a similar complication rate to the one-stage procedure. The superior functional patency of the two-stage procedure suggested that the two-stage approach should be the operation of choice for BBAVFs.

Ozcan *et al.* [7] compared one-stage and two-stage BVT to create AVF access in HD patients. They retrospectively divided their patients to those with a basilic vein greater than 3 mm and who had a one-stage BVT procedure and those with a basilic vein less than 3 mm who had a two-stage procedure. Early interventions for fistula thrombosis occurred more frequently in the first group (21 vs. 12%), although there was no significant difference in terms of late interventions required to deal with access thrombosis (20% in the first group vs. 22% in the second). Moreover, they observed that two-stage BVT was superior to one-stage BVT owing to its lower rate of postoperative complications and higher fistula maturation, despite its disadvantage of late fistula use. Although the diameter of the basilic vein was larger in patients who underwent one-stage BVT, one-stage BVT was disadvantageous in terms of postoperative complications and fistula maturation.

Kakkos *et al*. [11] have compared one-stage and two-stage procedures, showing higher maturation and better 1-year patency in the two-stage procedure. They found that the incidence of venous hypertension, wound infection, and all complications were significantly higher in patients who had one-stage BVT when compared with those who had a two-stage BVT. Time to fistula use in HD was shorter in the one-stage group compared with the two-stage group. This difference was significant. They showed that the rate of fistula maturation was higher, but the time to cannulation was longer in the two-stage procedure.

Our study adopted the two-stage superficialization technique for both patient groups (BBAVFS and BBAVFTn) because superficialization of the basilic vein before its arterialization may be difficult owing to the risk of vein thrombosis [17,27].

In our study, the mean age of patients in group A was 53.56 years (14 males and 11 females) and in group B was 57.16 years (12 males and 13 females). However, in the study by Ergene *et al.* [28], the BBAVFS group consisted of 42 patients (18 males and 24 females; mean age of 57.6 years), and the BBAVFTn group consisted of 29 patients (14 males and 15 females; mean age of 55.5 years). No significant differences were found between the two patient groups in terms of age and sex.

Singh *et al.* [27] reported that the primary patency rates for the superficialization group were 89, 79, 63, and 57.9% at 3, 6, 12, and 18 months, respectively, whereas for transposition group, they were 74, 62, 49, and 41% at 3, 6, 12, and 18 months, respectively.

Furthermore, Ergene *et al.* [28] reported that the primary and secondary patency rates at 18 months were 86 and 90%, respectively, in the superficialization group and 76 and 90%, respectively, in the transposition group. There was no statistically significant difference in the patency rates between the groups.

A study by Mauro *et al.* [29] showed that the primary and assisted primary patency rates were not statistically different in BBAVFS versus BBAVFTn at 12 months (80 ± 5 vs. 91 ± 5%, P=0.42 and 85 ± 6 vs. 93 ± 6%, P=0.41, respectively) or at 24 months (71 ± 7 vs. 91 ± 5%, P=0.21, and 78 ± 8 vs. 93 ± 6%, P=0.33, respectively). The secondary patency rates did not differ between BBAVFS and BBAVFTn at 12 months (90 ± 6 vs. 95 ± 5%, P=0.53) or at 24 months (87 ± 6 vs. 95 ± 5%, P=0.43). As the same as our study, there were no statistically significant differences in the patency rates between the groups.

In contrast, Li *et al.* [30] reported that the elevation transposition group had a significantly higher primary patency rate than the tunneled transposition group

(*P*=0.033); however, primary-assisted patency was achieved in all patients (100%) in both groups.

Wang *et al.* [14] have reported that the primary patency rate is significantly lower in the group of basilic tunnel transposition than that in the group of basilic elevation transposition (26 vs. 61% at 1 year; 21 vs. 55% at 2 years; *P*=0.006). They reported that surgical procedure (tunneling vs. elevation) was the single factor that significantly affected the primary patency rate of the basilic vein.

In our study, hypertension was associated with decreased primary patency at 18 months, with *P* value of 0.0163, and ischemic heart disease was associated with decreased primary patency at 6 and 12 months, with *P* values of 0.0204 and 0.0168, respectively. However, in Li *et al*. [30], the coronary artery disease was the only variable that was significantly different between the tunnel transposition and elevation transposition groups (31.1 vs. 4.8%, *P*=0.035).

A significantly lower rate of postoperative complications was detected in both groups, which probably depends on the different surgical technique. The BBAVFTn group had only one hematoma; this complication was observed 30 days after the intervention and passed without the need for intervention.

The number of studies comparing BBAVF procedures among themselves in terms of patency rates and complications is extremely limited [14].

In a retrospective study, Hossny [25] evaluated 20 patients undergoing single-stage superficialization, 20 undergoing two-stage superficialization, and 30 undergoing single-stage transposition. Although no significant difference was observed in the patency rates among the groups, as the cumulative secondary patency rate at 12 months was 86.7% for the transposition group and 87.1% for the superficialization group, and the cumulative secondary patency rate at 24 months was 82.8% for the transposition group and 69.2% for the elevation group. The overall complication rates were significantly higher in patients undergoing superficialization than in those undergoing transposition (71.4 vs. 28.6%, respectively; *P*<0.001).

The study by Mauro *et al*. [29] founded among patients in the BBAVFS group that 15/40 patients presented with hematoma at a mean time of 30(5) days after the intervention, because of interdialytic and postdialytic bleeding related to the difficult venipuncture. Only three of these patients required a surgical revision, whereas spontaneous healing occurred in 12 patients; five of them required Central Venous Catheter (CVC) placement before fistula reuse, whereas the BBAVFTn group had only one hematoma due to a tributary bleeding of the basilic vein, which required revision surgery 24 h after the earlier procedure.

We had some limitations in this study that should be acknowledged. The most important limitation is the relatively small number of the patients, and the absence of data for longer-term follow-up periods, so some factors that could affect the success of our procedure could not be fully analyzed. Thus, more research is still needed in the future to elicit clinically useful results.

Conclusion

Both the BBAVFS and BBAVFTn procedures can be safely applied in patients in whom AVF cannot be created using the cephalic vein, owing to their low complication and high patency rates. The use of ultrasonography at both preoperative evaluation and postoperative follow-up can make a significant contribution to the improved patency rates. Our results suggest that there is no statistically significant difference between the two methods in terms of complication and patency rates. We recommend further, larger-scale, prospective studies to confirm these findings.

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Conflicts of interest

There are no conflicts of interest.

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