One-stage versus two-stage brachiobasilic arteriovenous fistula with superficialization of the basilic vein regarding patency and failure rates

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Background
Safe, reliable, and durable vascular access is essential for successful hemodialysis. Native arteriovenous fistulae have the best long-term patency rates compared with other methods, for example, synthetic grafts and double-lumen catheters. Autogenous arteriovenous fistulae also have the lowest cost and lowest infection rate. If the patient does not have a suitable cephalic vein at the wrist for a Brescia–Cimino–Appel native arteriovenous fistula or at the upper arm for a brachiocephalic arteriovenous fistula, brachiobasilic arteriovenous fistulas (BBAVF) transposition is considered. Currently, there are two usual methods of BBAVF creation: a one-stage or a two-stage operation.
Objectives
The aim of this study is to compare between one-stage and the two-stage techniques in the formation of BBAVF regarding primary patency, secondary patency, and failure rates.
Patients and methods
A total of 56 patients with end-stage renal disease were enrolled in the study. The study is a prospective randomized interventional analytical clinical trial conducted in El-Sahel Teaching and Ain Shams hospitals. All patients were evaluated for full history, upper extremity examination, and measurements of basilic vein and brachial artery diameters using duplex. A total of 56 patients were included from the Vascular Surgery Department of Ain Shams University and El-Sahel Teaching hospitals (and other authorized hospitals under the supervision of thesis supervisors).
Results
On following up the patients over a period of 6 months, there was a primary patency rate of 82.1% for all of the patients who underwent one-stage BBAVF, compared with a 96.4% primary patency rate for those who underwent two-stage BBAVF. There was no statistically significant difference between both groups regarding the primary patency rate over a period of 6 months (P=0.084). There was a 92.9% secondary patency rate for all of the cases in both groups (P=1.000). None of the cases were considered to have primary failure.
Conclusion
There was no statistically significant difference between one-stage and two-stage techniques of BBAVF creation, with comparable complication rates between both groups.

Keywords:
brachiobasilic arteriovenous fistula, end-stage renal disease, one-stage technique, two-stage technique

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Introduction

Superficialization of the basilic vein can be achieved by one of the two methods: the transposition technique, where the entire length of the basilic vein is mobilized and positioned anterolaterally under a subcutaneous flap, and the elevation technique, where the vein is elevated superficially without mobilization to the surgically created flap between the deep fascia and the subcutaneous tissue in the arm [1].

Currently, there are two usual methods of brachiobasilic arteriovenous fistulas (BBAVF) creation: one-stage and two-stage operations. In the one-stage procedure, we first do a transposition of the basilic vein and then we create an anastomosis between the basilic vein and the brachial artery. In contrast, a two-stage procedure allows for the maturation of the basilic vein first [1].

Aim

The study was done to compare between the one-stage and the two-stage techniques in the formation of BBAVF regarding primary patency, secondary patency, and failure rates.

Patients and methods

This study is a prospective randomized interventional analytical clinical trial including patients with end-stage renal disease who underwent BBAVF in one-stage or two-stage techniques who presented to the vascular surgery clinics of Ain Shams University (El Demerdash) and El-Sahel Teaching hospitals.

The study plan was accepted by the ethical committee of Ain shams University Hospital.

The study included 56 patients with end-stage renal disease with the following inclusion and exclusion criteria.

Inclusion criteria:

The following were the inclusion criteria:

(1) All patients with end-stage renal disease who had their BBAVFs created either by the one-stage or two-stage technique.
(2) Patients with brachial artery diameter more than 3 mm by duplex ultrasound (DUS).
(3) Patients with triphasic brachial artery by DUS.
(4) Patients with basilic vein diameter more than 3 mm by DUS.
(5) Patients whose cardiac ejection fraction was more than 55%.
(6) Patients whose echocardiography showed pulmonary pressure less than 60 mmHg.
(7) Patients who were able to give informed consent.
(8) Requirements for intervention agreement between the patient and the surgeon.
(9) Availability of patients for all follow-up visits.

Exclusion criteria:

The following were the exclusion criteria:

(1) Patients who already had a suitable cephalic vein for arteriovenous fistula creation.
(2) Patients whose brachial artery diameter was less than 3 mm by DUS.
(3) Patients with brachial artery disease proved by DUS.
(4) Patients whose basilic vein diameter was less than 3 mm by DUS.
(5) Patients with ischemic cardiomyopathy.
(6) Patients with pulmonary hypertension more than 60 mmHg evidenced by echocardiography.
(7) Patients with central venous stenosis or occlusion evidenced by duplex scanning.
(8) Patients with flexion deformity or skin lesions at the site of the fistula or over the course of the vein.
(9) Patients who were unfit for general anesthesia.

Methods

Patients' evaluation

All patients were subjected to the following: full history taking, including age, sex, history of comorbidities (diabetes, hypertension, and heart diseases), smoking, chronic kidney disease staging, previous dialysis access, and all other relevant information.

Clinical examination including full examination on both upper limbs for any visible appropriate basilic vein and chest walls for the presence of any visible chest veins which denote central venous stenosis or occlusion and exclusion of any signs of arterial insufficiency was done. Sensation and motor power were examined as well. Examination was also done to reveal the presence of upper limb edema, any skin dermatological lesions, any previous scars which may include scars of previous dialysis access operations, any true or pseudoaneurysms, and any orthopedic, rheumatological, and neurological pathologies. Laboratory investigations including complete blood count, international normalized ratio, serum sodium and K levels, serum urea and creatinine levels, and virology markers were done. Preoperative DUS was done commenting on patency and length of the basilic vein, joining of the basilic vein with brachial vena comitans or axillary vein, diameter and depth of the basilic vein, distance between the basilic vein and the brachial artery, patency and diameter of the brachial artery, velocity of blood in the brachial artery, type of arterial waves in the brachial artery, and patency of ipsilateral internal jugular vein and subclavian vein.

By using computer-generated random numbers, selected patients were divided into two groups according to the intended procedure. Patients who underwent one-stage BBAVF creation were given local anesthesia, supraclavicular nerve block, or general anesthesia. However, patients who underwent the two-stage technique were given local anesthesia in the first stage and were given local anesthesia, supraclavicular nerve block, or general anesthesia in the second stage of the operation.

The first group included 28 patients who underwent one-stage BBAVF by the following technique: a longitudinal incision is made over the basilic vein from the antecubital fossa up to the axilla, and then dissection of the basilic vein was done along its entire length followed by ligation of all of the venous tributaries with 3/0 or 4/0 vicryl ties to free up the basilic vein. Thereafter, dissection of a good length of the brachial artery was done. Then, ligation and transection of the distal end of the basilic vein at the antecubital fossa were done. After that, a tunnel in the lateral aspect of the arm was created, followed by subcutaneous tunneling of the basilic vein in a good curvature without acute angels or twisting of the vein. Clamping of the brachial artery and the basilic vein was then done after heparinization of the patient. Anastomosis was then performed between the end of the basilic vein and the side of the brachial artery, and the operation was ended by closure of the skin incision in layers after inserting a suction drain.

The second group included 28 patients who underwent two-stage BBAVF, which was done in two stages. The first stage was done by the following technique: a longitudinal or transverse incision was made at the antecubital fossa followed by dissection of a good length of the basilic vein and then ligation of any apparent venous tributaries with 3/0 or 4/0 vicryl ties was done. After that, dissection of a good length of the brachial artery was done, followed by ligation and transection of the distal end of the basilic vein. Clamping of the brachial artery and the basilic vein was then done after heparinization of the patient. This was followed by anastomosis between the end of the basilic vein and the side of the brachial artery. Finally, closure of the skin incision was done.

After 6 weeks, the second stage was done by the following technique: a longitudinal incision over the basilic vein was made from the antecubital fossa up to the axilla followed by dissection of the basilic vein along its entire length. Then, ligation of all of the venous tributaries was done with 3/0 or 4/0 vicryl ties to free up the basilic vein. The medial cutaneous nerve of the forearm maybe sacrificed if it crosses the basilic vein. The basilic vein is then elevated superficially to a surgically created flap between the deep fascia and the subcutaneous tissues followed by suturing of the deep fascia and the subcutaneous tissues after insertion of a suction drain. Finally, closure of the skin incision is made.

Postoperatively, all the patients were advised to use a rubber ball to improve the maturation of the basilic vein. They were advised as well not to insert intravenous lines, not to measure the blood pressure in the limb for which they underwent the fistula procedure and not to insert dialysis catheters in the subclavian vein of the same side of the procedure. Additionally, they were asked to come for weekly regular follow-up visits to assess the fistulas clinically and for a duplex scan 6 weeks postoperatively to assess the maturation of the vein.

The primary end points were maturation of the basilic vein in the one-stage technique 6 weeks after intervention and its suitability to be used for hemodialysis evidenced by DUS, maturation of the basilic vein after the first stage of the two-stage technique to be superficialized to be used for hemodialysis, assessment of primary failure rate, and assessment of both primary and secondary patency rates during a period of 6 months. However, the secondary end points were complications of the fistula, including bleeding, infection, thrombosis, aneurysm formation, distal limb ischemia, and venous hypertension.

Primary fistula failure is defined as an immediate failure of the BBAVF within 72 h of surgery [2].

Primary patency is defined as the interval from the time of access creation to the first thrombosis occurring at the access site or any intervention to restore the blood flow [2].

Assisted primary patency is defined as the interval from the time of the access placement to access thrombosis [2].

Secondary patency is defined as the time from access creation until access abandonment and includes any interventional procedures to restore patency [2].

Statistical analysis

Recorded data were analyzed using the statistical package for social sciences, version 25.0 (SPSS Inc., Chicago, Illinois, USA). Values were expressed as means±SD. *P* value assessment was done as follows: *P* value less than or equal to 0.05 was considered significant, *P* value less than or equal to 0.001 was considered as highly significant, and *P* value more than 0.05 was considered insignificant.

Results

The study included 56 patients with end-stage renal disease. Their mean±SD age was 51.45 ± 15.91 years

Table 1 Comparison between both groups according to comorbidities

Variables	One stage	Two stages	*P* value	Significance
DM %	14.2	14.2	1.00	NS
HTN %	50	67.8%	0.174	NS
Smoking %	17.8	3.5	0.084	NS
Cardiac disease %	10.7	32.1	0.051	NS

Table 2 Comparison between both groups according to preoperative brachial artery and basilic vein characteristics

Variables	One stage	Two stages	*P* value	Significance
Side of the limb				
Right : left	15 : 13	11 : 17	0.284	NS
Diameter of the basilic vein (mm)	3.60 ± 0.390	3.45 ± 0.276	0.102	NS
Diameter of the brachial artery (mm)	4.34 ± 0.526	4.18 ± 0.379	0.205	NS
Velocity of blood in the brachial artery (cm/s)	55.82 ± 5.27	55.86 ± 5.19	0.980	NS

Table 3 Comparison between both groups according to the postoperative characteristics of the basilic vein

Variables	One stage	Two stages	*P* value	Significance
Diameter of the basilic vein (mm)	7.22 ± 0.612	7.08 ± 0.519	0.375	NS
Depth of the basilic vein from the skin (mm)	4.15 ± 0.525	4.49 ± 0.473	0.34	NS
Volume flow of blood with the basilic vein (ml/min)	779.64 ± 108.712	789.29 ± 112.412	0.74	NS

(range, 19–85 years). A total of 29 (51.8%) patients were males, whereas 27 (48.2%) patients were females.

Comorbidity distributions are shown in Table 1.

Of 56 (46.4%) patients, 26 had their BBAVF created in their right upper limb, whereas 30 (53.6%) patients had the fistula created in their left upper limb.

The mean±SD preoperative diameter of the basilic vein was 3.6 ± 0.39 mm in the first group, whereas in the second group, the mean±SD preoperative diameter of the basilic vein was 3.45 ± 0.27 mm.

The mean±SD preoperative diameter of the brachial artery was 4.34 ± 0.52 mm, whereas in the second group, the mean±SD preoperative diameter of the brachial artery was 4.18 ± 0.37 mm before intervention of the first stage.

The mean±SD preoperative velocity of blood in the brachial artery was 55.82 ± 5.27 cm/s in the first group, whereas in the second group, the mean preoperative velocity of blood in the brachial artery was 55.86 ± 5.19 cm/s.

The results of side of limb and preoperative diameters of the basilic vein and the brachial artery are shown in Table 2.

In the first group, the mean±SD preoperative diameter of the basilic vein increased from 3.6 ± 0.39 to 7.22 ± 0.61 mm 6 weeks postoperatively, whereas in the second group, the mean preoperative diameter of the basilic vein increased from 3.45 ± 0.27 to 7.08 ± 0.51 mm 6 weeks postoperatively.

Regarding the depth of the basilic vein from the skin, the mean±SD depth of the basilic vein 6 weeks postoperatively in the first group was 4.15 ± 0.52 mm, whereas in the second group, it was 4.49 ± 0.47 mm after 6 weeks from the first stage of the procedure.

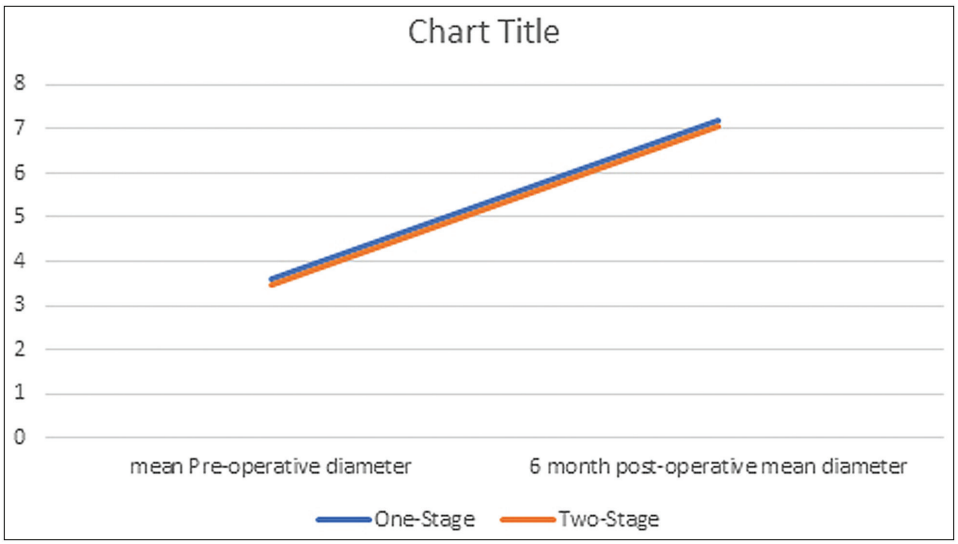
When it comes to the volume flow of blood inside the basilic vein, the mean volume flow 6 weeks postoperatively in the first group was 779.64 ± 108.71 ml/min whereas in the second group, it was 789.29 ± 112.41 ml/min after 6 weeks from the first stage of the procedure (Table 3).

Comparison between both groups according to preoperative and 6-week postoperative mean diameter of the basilic vein is shown in Fig. 1.

Regarding primary failure rate, none of the cases were considered to have primary failure as there was no immediate failure to any of the cases and none of the cases failed to mature.

During a period of 6 months, there was a 82.1% primary patency rate for all of the cases in the first group, compared with a 96.4% primary patency rate for the fistulae in the second group. Statistically, there was no significant difference between both groups in

Figure 1



Comparison between both groups according to preoperative and 6 months postoperative mean diameter of the basilic vein.

Table 4 Comparison between both groups according to primary and secondary patency

Variables	One stage	Two stages	*P* value	Significance
1ry Patency (%)	82.1	96.4	0.084	NS
2ry Patency (%)	92.9	92.9	1.00	NS

terms of primary patency (*P*=0.084). Five cases in the first group had thrombosis, whereas only one case in the second group had thrombosis.

When it comes to the secondary patency, there was a 92.9% secondary patency rate for all of the cases in both groups during a period of 6 months (*P*=1.000). Two thrombosed cases ended up with loss of the access in the first group, whereas two cases were abandoned in the second group, one of them had thrombosis, whereas the second case had venous hypertension and ended up with ligation of the fistula after failure of venoplasty (Table 4).

Regarding postoperative bleeding complication, it occurred in seven (12.5%) of 56 patients. Those seven patients can be detailed as follows: three (10.7%) of 28 patients experienced bleeding in the first group, and in the second group, four (14.3%) of the 28 patients experienced bleeding complication. By comparing bleeding between both groups, there was no statistically significant difference between both groups regarding postoperative bleeding (*P*=1.000).

Regarding postoperative infection, four (7.1%) of the 56 patients experienced infection of the fistula. All of them had early postoperative wound infection that was treated by empirical antibiotics for 6 weeks. This can be detailed as occurrence of infection in two (7.1%) patients of each group. Statistically, there was no significant difference when comparing between both groups regarding postoperative infection (*P*=1.000).

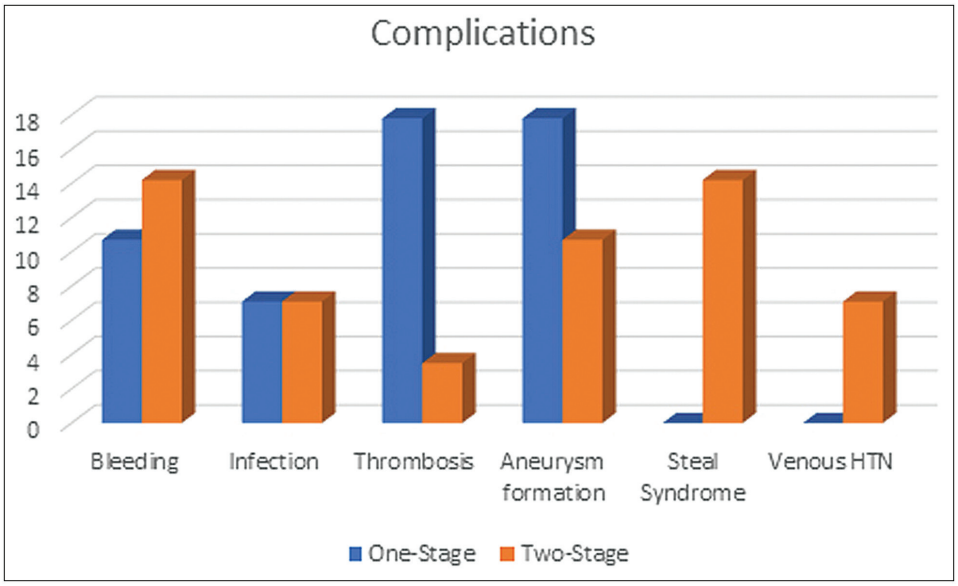
Regarding postoperative thrombosis, it occurred in six (10.7%) of 56 patients, all of whom had venous thrombosis in the basilic vein. This can be detailed as the presence of thrombosis in five (17.9%) patients in the first group. Only one of the five cases had no intervention due to the delayed presentation and ended by loss of the access, whereas the other four cases underwent thrombectomies that were successful in three of them and ended up with loss of access in only one case. However, in the second group, only one patient experienced thrombosis (3.6%). This case in the second group had no intervention owing to the delayed presentation and ended up with loss of access. By comparing both groups regarding thrombosis, it was found that there was no statistically significant difference between both groups (*P*=0.193).

When it comes to pseudoaneurysm formation, eight (14.3%) of 56 patients experienced pseudoaneurysm formation; all of those aneurysms were false venous aneurysms that can be defined as presence of a venous wall defect. None of them had complications. No surgical interventions were done in those patients. Pseudoaneurysm formation occurred in five (17.9%) of the 28 patients in the first group, whereas in the second group, only three (10.7%) patients experienced pseudoaneurysm formation. By comparing both groups, it was found out that there was no statistically significant difference between both groups (*P*=0.705).

Table 5 Comparison between both groups according to complications

Variables	One stage (28) [*n* (%)]	Two stages (28) [*n* (%)]	*P* value	Significance
Complications overall	13 (46.4)	14 (50)	0.55	NS
Bleeding	3 (10.7)	4 (14.2)	1.00	NS
Infection	2 (7.1)	2 (7.1)	1.00	NS
Thrombosis	5 (17.8)	1 (3.5)	0.193	NS
Aneurysm formation	5 (17.8)	3 (10.7)	0.705	NS
Steal syndrome	0	4 (14.2)	0.111	NS
Venous hypertension	0	2 (7.1)	0.491	NS

Figure 2



Comparison between both groups according to different complications.

Regarding distal limb ischemia or steal syndrome after BBAVF creation, it was found that only four patients had distal limb ischemia, and all of them existed in the second group. They all experienced coldness of hand (grade 1 steal syndrome) and had no intervention. They represented 14.3% out of 28 patients in the group. By comparing both groups regarding distal limb ischemia, there was no statistically significant difference between both groups (*P*=0.111).

Concerning venous hypertension, only two patients experienced it owing to the presence of significant subclavian stenosis. Those two patients existed in the second group as well. The first patient had significant improvement regarding upper limb edema after venoplasty, whereas the second patient had ligation of his fistula after failure of venoplasty. They represent 7.1% of the 28 patients in the group. Statistically, there was no significant difference between both groups (*P*=0.491).

Comparison between both groups according to complications is shown in Table 5, Fig. 2.

Table 6 Comparison between both groups according to early postoperative pain

Variable	One stage	Two stage	*P* value	Significance
Early postoperative pain	3.6 ± 1.4	4.75 ± 1.2	0.428	NS

When it comes to early postoperative pain, the mean visual analog score of the one-stage group was 3.6 ± 1.4, whereas the mean visual analog score of the two-stage group was 4.75 ± 1.2, and this was shown to be statistically insignificant (*P*=0.428) (Table 6).

Regarding perioperative hospital stay, it was found that the mean perioperative hospital stay was 1.1 ± 0.31 days in the one-stage group, whereas it was 2.2 ± 0.35 days in the two-stage group. By comparing both groups, there was no statistically significant difference (*P*=0.533).

Concerning the time needed for the first use after creating the BBAVF, the mean time needed for the first use was 45.9 ± 1.21 in the one-stage group, whereas it was 57.18 ± 1.74 in the two-stage group, which was

found to be statistically insignificant when comparing both groups (*P*=0.0643).

Discussion

Ozcan *et al.* [3] performed a nonrandomized retrospective study on 96 patients with end-stage renal disease. Their mean age was 43.6 ± 14 years. A total of 54 cases were male, whereas 42 cases were female. They underwent either a one-stage or a two-stage technique for BBAVF creation.

Ozcan *et al.* [3] found no statistically significant difference between both groups in terms of age, sex, and number of fistulae previously performed. They also found no statistically significant difference between both groups regarding risk factors such as smoking, diabetes, hypertension, cardiac diseases, and peripheral vascular diseases.

However, in this study, we found no statistically significant difference between both groups regarding age, sex, smoking, diabetes, hypertension, and cardiac condition (*P*>0.05).

Regarding the side of the limb, our study concluded no statistically significant difference between both groups (*P*=0.284), and this comes in accordance with a study published by Tan *et al.* [4], who showed the same results (*P*=0.915).

Hossny [5] concluded that the complications rate was statistically highly significant in the two-stage elevation group in comparison with the one-stage transposition group (71.4 vs. 28.6%) (*P*<0.001), whereas Kakkos *et al.* [6] found the opposite, as they concluded that the complications rate was statistically significant higher in the one-stage group when compared with the two-stage group (43 vs. 11%) (*P*<0.001).

Vrakas *et al.* [7] stated that there was no statistically significant difference between both groups when it comes to complications (*P*=0.715). This comes in accordance with this study, which showed no statistically significant difference between both groups in terms of overall complications (46.4 vs. 50%) (*P*=0.55).

Ozcan *et al.* [3] figured out that there was a statistically significant difference between both groups in terms of bleeding, whereas in this study, there was no statistically significant difference between both groups regarding postoperative bleeding (*P*=1.000).

Dilege *et al.* [8] stated that the infection rate was 7%, and this comes in accordance with this study, which found that the postoperative infection rate was 7.1% in both groups.

Ozcan *et al.* [3] concluded that the aneurysm formation rate was 4% for the one-stage group and 5% for the two-stage group with no significant difference between both groups.

However, in this study, the rate of pseudoaneurysm formation was 17.8% in the first group, compared with 10.7% in the second group, with no statistically significant difference between both groups.

Ozcan *et al.* [3] mentioned that the rate of steal syndrome was 8% in the one-stage group and 11% in the two-stage group, which was considered to be statistically insignificant. However, this study did not show any steal syndrome events in the first group, whereas the rate was 14.2% in the second group, and this was proven to be statistically insignificant.

Ozcan *et al.* [3] stated that the rate of thrombosis was 34% in the one-stage group, whereas it was 23% in the two-stage group, which was considered to be statistically significant. In this study, it was found that the rate of thrombosis was 17.8% in the first group, and 3.5% in the second group, which was proven to be statistically insignificant. Vrakas *et al.* [7] concluded that the two-stage technique has a significantly higher primary patency rate compared with the one-stage technique at 1 year (71 vs. 87%) (*P*=0.034) and 2 years (53 vs. 75%) (*P*=0.034). They also concluded that the two-stage technique has a notably better secondary patency rate at 1 year (79 vs. 95%) (*P*=0.026) and 2 years (57 vs. 77%) (*P*=0.026).

This study concluded that there was a higher primary patency rate for the two-stage group (96.4%), compared with the one-stage group (82.1%) at a 6-month period, but it was not statistically significant (*P*=0.084). However, both groups had the same secondary patency (92.9%) after a period of 6 month (*P*=1.00).

Kakkos *et al.* [6] concluded that the mean time for the first cannulation after creating the BBAVF was significantly decreased in the one-stage technique (68 days) compared with the two-stage technique (132 days) (*P*=0.001), whereas this study found that the mean time for the first use was 45.9 ± 1.21 days in the one-stage technique compared with 57.18 ± 1.74 days in the two-stage technique, which was proven to be statistically insignificant (*P*=0.0643).

Kakkos *et al.* [6] concluded that only one patient in the two-stage group experienced ischemic monomelic

neuropathy that required fistula ligation before the performance of the second stage.

In this study, the mean visual analog score of the early postoperative pain was 3.6 ± 1.4 for the one-stage group, whereas it was 4.75 ± 1.2 for the two-stage group and this was shown to be statistically insignificant (*P*=0.428).

Limitations

One of the limitations of our study was the relatively small number of the sample size. Furthermore, the follow-up duration was relatively short, and a longer period is needed for gathering more accurate results regarding patency and complication rates.

Conclusion

This study has not shown any statistically significant difference between one-stage and two-stage techniques of BBAVF creation, with comparable complication rate between both groups.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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