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Original Article

Comparative Analysis of One-Stage versus Two-Stage Brachio-Basilic Arteriovenous Fistulas

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Abstract

Brachio-basilic arteriovenous fistulas (BBAVFs) are a preferred vascular access option for hemodialysis in patients with end-stage renal disease (ESRD) when the cephalic vein is unsuitable. Both the one-stage and two-stage BBAVF techniques offer distinct advantages and are widely practiced, but their comparative outcomes remain under debate. This study aims to compare the clinical outcomes of one-stage versus two-stage BBAVF creation in patients with ESRD. This prospective, randomized interventional study was conducted at the Vascular Surgery Department of Ibrahim Cardiac Hospital & Research Institute, Dhaka, from January 2021 and June 2024. A total of 64 ESRD patients who met the inclusion criteria were randomly assigned into two equal groups (n = 32 each) to undergo either one-stage or two-stage BBAVF creation. Preoperative evaluations included clinical assessment, laboratory tests, and duplex ultrasonography. The outcomes assessed included primary and secondary patency, complication rates, early postoperative discomfort, and vascular parameters, with consideration of baseline characteristics. Baseline characteristics were comparable between the two groups. The two-stage group demonstrated significantly higher primary patency (96.9% vs. 81.3%; p = 0.045), while secondary patency rates were identical (90.6%) in both groups. However, the two-stage technique was associated with significantly higher rates of venous hypertension (p = 0.020) and steal syndrome (p = 0.039). Early postoperative pain was significantly lower in the one-stage group (p = 0.001). No significant differences were found between the groups regarding postoperative vein diameter, depth, or volume flow. Although the two-stage BBAVF technique offers superior primary patency, it carries a higher risk of complications. In contrast, the one-stage approach provides comparable long-term outcomes with less early postoperative pain. These findings highlight the need to individualize the choice of technique based on patient anatomy, comorbidities, and surgical expertise.

Keywords: *One-stage, two-stage, brachio-basilic arteriovenous fistula, end-stage renal disease*

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INTRODUCTION

An arteriovenous fistula (AVF) is a surgically created connection between an artery and a vein, commonly used for vascular access in hemodialysis patients. The concept of AVFs dates back to the early 20th century,[1,2,3] with their clinical use for dialysis first introduced in 1960 by Belding Scribner and Wayne Quinton. [2,3] Since then, AVFs have become the preferred method of vascular access due to their superior long-term patency and lower complication rates compared to other options such as grafts or central venous catheters.[4]

Over recent decades, advances in AVF techniques and surgical strategies have significantly improved the safety, effectiveness, and durability of hemodialysis access.[1-7] These developments have contributed not only to better patient outcomes in nephrology but have also influenced broader applications in vascular surgery and revascularization procedures.[1,5]

AVFs can be created at either distal or proximal sites of the body.[5,6] Proximal AVFs, such as the brachio-basilic arteriovenous fistula (BBAVF), are often used when superficial veins are unsuitable or have been exhausted. BBAVF creation can be performed via two main approaches: the one-stage and the two-stage technique. However, the optimal method remains a subject of ongoing debate. [3,4,7]

The brachiobasilic arteriovenous fistula (BB-AVF) is currently a primary method for establishing AVFs in dialysis patients.[8] The BB-AVF procedure can be performed using either a one-stage or two-stage technique.[9] However, the choice between these techniques remains debated.

The one-stage method is criticized for its long incision and extended operation time, which may increase the risk of wound-related complications.[11,12] Conversely, the two-stage technique is considered less complex, offering higher vascular patency rates and fewer complications around the wound.[9,12,13] The debate over brachiobasilic arteriovenous fistulas (BB-AVF) often centers on the choice between one-stage and two-stage techniques.

The one-stage procedure involves creating a fistula between the basilic vein and the brachial artery in a single operation.[9,11,13,14] This requires a long incision to access and mobilize the basilic vein, ensuring the anastomosis is not under tension and that no significant proximal stenosis is present. The main advantage of the one-stage technique is the shorter wait time for cannulation and the cost-effectiveness, as it involves only one hospital visit.[14-18] However, the technique's drawbacks include a lengthy incision that takes longer to heal and a higher risk of wound-related complications, as well as a more complex procedure. Additionally, a study by Anaya-Ayala et al. found that only 66% of patients have a "normal" basilic vein, with the remaining 34% having an "abnormal" variant that could negatively affect the fistula's maturation.[14,17,19]

The two-stage procedure allows the basilic vein to undergo arterialization, making it more resistant to torque and easier to mobilize in the subsequent operation as it becomes a larger, stronger structure. This approach aims to reduce operative difficulty and complications while improving patency rates.[20,21]

Previous studies have produced conflicting results regarding the comparative efficacy and safety of these two techniques. Some suggest higher primary patency and fewer wound complications with the two-stage approach, while others highlight the cost-effectiveness and faster usability of the one-stage method. Additionally, anatomical variations in the basilic vein may impact fistula maturation, as noted by Anaya-Ayala et al., who found that approximately one-third of patients may have aberrant vein anatomy, complicating the outcome.[17]

Given the ongoing uncertainty, this prospective study was designed to compare the one-stage and two-stage BBAVF techniques with respect to primary patency, secondary patency, complication rates, and early postoperative outcomes, aiming to provide clearer evidence to guide surgical decision-making in patients requiring durable hemodialysis access.

MATERIALS AND METHODS

This prospective, randomized, interventional analytical study included patients with end-stage renal disease (ESRD) who underwent brachio-basilic arteriovenous fistula (BBAVF) creation using either a one-stage or two-stage technique. The study was conducted in the Department of Vascular Surgery at Ibrahim Cardiac Hospital & Research Institute, Dhaka, from January 2021 to June 2024. Inclusion criteria consisted of all ESRD patients undergoing BBAVF creation by either the one-stage or two-stage technique. Exclusion criteria were: (i) presence of a suitable cephalic vein for arteriovenous fistula creation, (ii) brachial artery diameter <3 mm as assessed by duplex ultrasonography (DUS), (iii) evidence of brachial artery disease on DUS, and (iv) basilic vein diameter <3 mm on DUS. All patients underwent a comprehensive preoperative assessment, including medical history (age, sex, comorbidities such as diabetes, hypertension, and cardiovascular disease), smoking status, chronic kidney disease (CKD) stage, and previous dialysis access.

A detailed clinical examination was performed, including assessment of both upper limbs for visible basilic veins and chest wall veins (suggestive of central venous stenosis or occlusion), and evaluation for signs of arterial insufficiency. Neurological status (motor and sensory) was also assessed. The examination further included evaluation for upper limb edema, dermatological lesions, surgical scars, aneurysms or pseudoaneurysms, and musculoskeletal abnormalities. Laboratory investigations included complete blood count, international normalized ratio (INR), serum sodium and potassium, urea and creatinine levels, and viral serology. Preoperative duplex ultraso- nography (DUS) was used to assess: (i) Patency, diameter, depth, and length of the basilic vein (ii) Presence of basilic vein confluence with brachial vena comitans or axillary vein (iii) Distance between the basilic vein and brachial artery (iv) Patency and diameter of the brachial artery (v) Arterial flow velocity and waveform characteristics and (vi) Patency of the ipsilateral internal jugular and subclavian veins.

Patients were randomized into two groups using computer-generated random numbers. **Group I** –

One-Stage BBAVF (n = 32): Patients received local anesthesia, supraclavicular nerve block, or general anesthesia. A longitudinal incision was made from the antecubital fossa to the axilla. The basilic vein was dissected, and all tributaries were ligated using 3-0 or 4-0 Vicryl ties. After adequate mobilization, the distal end of the basilic vein was ligated and transected at the antecubital fossa. A subcutaneous tunnel was created laterally, and the vein was transposed without sharp angulation or torsion. After systemic heparinization, the brachial artery and basilic vein were clamped. End-to-side anastomosis was performed, and a suction drain was placed before layered wound closure. **Group II –** Two-Stage BBAVF (n = 32): This group underwent two-stage BBAVF, performed in two distinct surgical phases. In the **first stage**, under local anesthesia, a longitudinal or transverse incision was made at the antecubital fossa. The basilic vein and brachial artery were dissected and mobilized. Tributaries were ligated, the basilic vein was transected distally, and an end-to-side anastomosis with the brachial artery was performed after heparinization. The the skin incision was then closed. After six weeks, the **second stage** involved superficialization of the basilic vein. A longitudinal incision was made from the antecubital fossa to the axilla, and the basilic vein was dissected along its entire course. Tributaries were ligated with 3-0 or 4-0 Vicryl. The medial cutaneous nerve of the forearm was sacrificed if it crossed the vein. The vein was elevated into a surgically created flap between the deep fascia and subcutaneous tissue. A suction drain was inserted, and layered closure was performed.

Postoperative Protocol: All patients were advised to perform handgrip exercises using a rubber ball to enhance fistula maturation. Patients were instructed to avoid blood pressure measurement, intravenous cannulation, and central venous catheter placement in the ipsilateral limb. Weekly clinical follow-ups and a duplex scan at 6 weeks postoperatively were scheduled to assess fistula maturation.

Study Endpoints: *Primary endpoints* included (i) Maturation of the basilic vein at 6 weeks postoperatively (in one-stage group) assessed by DUS (ii) Suitability of the vein for hemodialysis (iii) Maturation after the first stage in the two-stage group (iv) Primary failure rate and (v) Primary and secondary patency rates over a 6-month period. *Secondary endpoints* included complications such as bleeding, infection, thrombosis, aneurysm formation, distal limb ischemia, and venous hypertension.

Statistical Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 25.0 (SPSS Inc., Chicago, IL, USA). Results were expressed as mean ± standard deviation (SD). A **P-value ≤ 0.05** was considered statistically significant; **P ≤ 0.001** was considered highly significant; **P > 0.05** was considered not significant.

Operational Definitions

Primary fistula failure: Failure within 72 hours of surgery
Primary patency: Time from access creation to first thrombosis or intervention to restore flow
Assisted primary patency: Time from access creation to thrombosis with or without intervention
Secondary patency: Time from access creation to access abandonment, including all interventions

RESULTS

Table I presents the baseline demographic and clinical characteristics of patients in the one-stage (n = 32) and two-stage (n = 32) BBAVF groups. No statistically significant differences were found between the groups in terms of age, sex distribution, presence of diabetes mellitus, hypertension, smoking status, cardiac disease, limb side, or vascular measurements (basilic vein diameter, brachial artery diameter, and blood flow velocity). This indicates that the groups were comparable at baseline.

Table- I: Baseline demographic and clinical characteristics of patients (n = 64)

Variables		One Stage (n=32)	Two Stages (n=32)	P value
Age in years (Mean±SD)		49.31±14.62	50.62±17.11	0.743
Sex	Male	18(56.2%)	17(53.1%)	
	Female	14(43.8%)	15(46.9%)	0.802
DM		10(31.3%)	8(28.1%)	0.784
HTN		14(43.8%)	16(50%)	0.616
Smoking		6(18.8%)	2(6.3%)	0.131
Cardiac Disease		10(31.3%)	13(40.6%)	0.434
Side of the upper limb				
Right		18(56.3%)	15(46.9%)	0.211
Left		14(43.8%)	17(53.1%)	
Diameter of Basilic Vein (mm)		3.56±0.25	3.45±0.23	0.058
Diameter of Brachial Artery (mm)		4.28±0.31	4.19±0.27	0.238
Velocity of Blood in Brachial Artery (cm/s)		54.84±3.13	54.56±2.79	0.706

Table II summarizes the postoperative vascular parameters of the basilic vein. While the one-stage group showed slightly higher mean vein diameter and lower depth from the skin, these differences were not statistically significant. Similarly, there was no significant difference in the volume flow of blood through the basilic vein between the two groups.

Table- II: Postoperative Characteristics of the Basilic Vein (n = 64)

Variables	One Stage (n=32)	Two Stages (n=32)	P value
Diameter of Basilic Vein (mm)	7.13±0.51	6.90±0.46	0.058
Depth of the basilic vein from the skin(mm)	4.12±0.33	4.38±0.32	0.297
Volume flow of blood within basilic vein (ml/min)	757.78±55.49	737.78±56.84	0.173

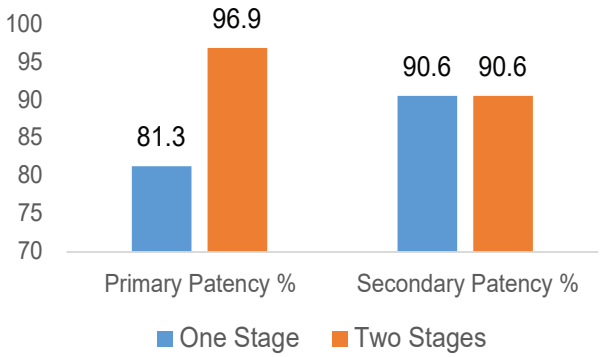

Figure- 1: Primary and secondary patency among both groups (n=64)

Figure 1 illustrates a comparison of primary and secondary patency rates between the one-stage and two-stage groups. The two-stage group demonstrated higher primary patency, whereas secondary patency rates were identical in both groups. The visual presentation supports the quantitative findings detailed in the results section.

Table III outlines postoperative complications observed in both groups. Although the overall complication rate was higher in the two-stage group, the difference was not statistically significant. Notably, the incidence of steal syndrome (p = 0.039) and venous hypertension (p = 0.020) was significantly higher in the two-stage group. Other complications such as bleeding, infection, thrombosis, and pseudoaneurysm formation did not differ significantly between groups.

Table- III: Complications among both groups (n=64)

Variables	One Stage (n=32)	Two Stages (n=32)	P value
Complication overall	13(40.6%)	17(53.1%)	0.316
Bleeding	3(9.4%)	7(21.9%)	0.391
Infection	2(6.3%)	4(12.5%)	0.391
Thrombosis	5(15.6%)	2(6.3%)	0.230
Pseudoaneurysm formation	3(9.4%)	5(15.6%)	0.450
Steal Syndrome	0(00)	4(12.5%)	0.039
Venous Hypertension	0(00)	5(15.6%)	0.020

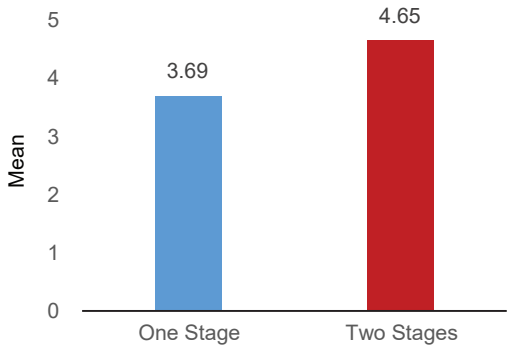

Figure- 2: Comparison between both groups according to early post-operative pain (n=64)

Figure 2 displays the comparative levels of early postoperative pain between the one-stage and two-stage groups, as assessed using a visual analog scale. The one-stage group reported significantly lower pain scores (p = 0.001), suggesting a clinical advantage in terms of early postoperative comfort.

DISCUSSION

Brachiobasilic AVF (BBAVF) can be established using two primary techniques: the transposition technique, where the entire length of the basilic vein is mobilized and repositioned anterolaterally under a subcutaneous flap, or the elevation technique, where the vein is elevated superficially without full mobilization into the surgically recreated deep fascia and subcutaneous tissue on the medial arm. BBAVF creation typically follows one of two approaches: a one-stage or a two-stage operation. The

one-stage procedure involves creating an anastomosis between the basilic vein and brachial artery, followed by vein elevation or transposition within a single surgery, which may reduce infection and anesthetic risks but involves extensive dissection, potentially posing higher risks for patients with immature fistulas. The two-stage procedure, on the other hand, allows for vein maturation before further intervention, resulting in a more palpable and less vulnerable vein that is easier to superficialize, though it increases costs and may elevate the risks of infection and anesthesia due to requiring two surgeries. Additionally, the assumption that the fistula has matured before the second stage is uncertain, as maturity can only be confirmed through cannulation.[23]

This study shows the average age was 49.31±14.62 years in one stage and 50.62±17.11 years in two stage. Maximum 35 patients were male and 29 were female. This findings consistent with previous studies Lebda et al.[18] Similar study Ozcan et al.[24] conducted a nonrandomized retrospective study involving 96 patients with end-stage renal disease, with an average age of 43.6 ± 14 years. The study included 54 male and 42 female patients, who underwent either a one-stage or two-stage technique for BBAVF creation.

This study found no statistically significant difference between both groups regarding age, sex, smoking, diabetes, hypertension, and cardiac condition (P>0.05). These findings are well agreement with other study.[18] Another study Ozcan et al.[24] reported no statistically significant differences between the two groups in terms of age, sex, and the number of previously performed fistulae. Additionally, there were no significant differences between the groups concerning risk factors such as smoking, diabetes, hypertension, cardiac diseases, and peripheral vascular diseases.

In terms of the side of the limb, our study found no statistically significant difference between the two groups (P=0.211), which aligns with the findings of Tan et al.[25] who reported similar results (P=0.915). Another study[18] also concluded that there was no statistically significant difference between the groups regarding the limb side (P=0.284).

This study found no statistically significant difference in overall complication rates between the two groups (40.6% vs. 50%, P=0.316), a finding consistent with other research. Hossny[26] reported a significantly higher complication rate in the two-stage elevation group compared to the one-stage transposition group (71.4% vs. 28.6%, P<0.001), while Kakkos et al.[27] observed the opposite, with a higher complication rate in the one-stage group compared to the two-stage group (43% vs. 11%, P<0.001). Vrakas et al. [28] also found no statistically significant difference in complication rates between the two groups (P=0.715).

Ozcan et al.[18] identified a statistically significant difference between the two groups concerning bleeding. However, in this study, no statistically significant difference was observed between the groups regarding postoperative bleeding (P=1.000).

Dilege et al.[29] reported an infection rate of 7%, which is consistent with the findings of this study, where the postoperative infection rate was 7.1% in both groups.

Ozcan et al.[24] found that the aneurysm formation rate was 4% in the one-stage group and 5% in the two-stage group, with no significant difference between them. In contrast, this study reported a pseudoaneurysm formation rate of 9.4% in the first group and 15.6% in the second group, also with no statistically significant difference between the two groups.

Ozcan et al.[24] reported that the rate of steal syndrome was 8% in the one-stage group and 11% in the two-stage group, with no statistically significant difference. In contrast, this study found no cases of steal syndrome in the first group, while the rate was 12.5% in the second group, which was also statistically insignificant.

In this study, the thrombosis rate was 15.6% in the first group and 6.3% in the second group, with no statistically significant difference found. These results align with previous findings. Ozcan et al.[24] reported a thrombosis rate of 34% in the one-stage group and 23% in the two-stage group, which was statistically significant. Vrakas et al.[28] found that the two-stage technique had a significantly higher primary patency rate compared to the one-stage technique at both 1 year (71% vs. 87%, P=0.034) and 2 years (53% vs. 75%, P=0.034). They also observed that the two-stage technique had 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 found that the two-stage group had a higher primary patency rate (96.9%) compared to the one-stage group (82.6%) at the 6-month mark, though this difference was not statistically significant (P=0.084). However, both groups had identical secondary patency rates of 92.9% after 6 months (P=1.00).

This study observed that the average time to first use was 45.7 ± 1.24 days for the one-stage technique and 57.16 ± 1.76 days for the two-stage technique, with no statistically significant difference found (P=0.0648). In contrast, Kakkos et al.[27]reported a significantly shorter mean time to first cannulation for the one-stage technique (68 days) compared to the two-stage technique (132 days) (P=0.001).

Kakkos et al.[27] found that only one patient in the two-stage group developed ischemic monomelic neuropathy, which necessitated fistula ligation prior to the completion of the second stage.

In this study, the mean visual analog score for early postoperative pain was 3.69 ± 1.09 in the one-stage group and 4.65 ± 1.07 in the two-stage group, with no statistically significant difference (P=0.001). Similarly, Lebda et al.[18] reported a mean visual analog score of 3.6 ± 1.4 for the one-stage group and 4.75 ± 1.2 for the two-stage group, also finding no statistically significant difference (P=0.428).

Limitations of the study

One strength of this study is its prospective, randomized design; however, the relatively modest sample size may limit the generalizability of the findings. Additionally, while the short-term follow-up provides valuable early outcome data, a longer follow-up period would be beneficial to more comprehensively assess long-term patency and complication rates. Future studies with larger cohorts and extended observation periods are recommended to validate and expand upon these findings.

CONCLUSION

This study reveals that the two-stage BBAVF technique demonstrated superior primary patency; however, it also exhibits a higher occurrence of certain complications and delayed usability. In contrast, the one-stage technique, despite slightly lower patency rates, leads to reduced early postoperative pain and a quicker time to initial use.. Both techniques yielded similar results regarding secondary patency and overall complication rates suggesting that the choice of approach should be customized according to patient risk factors, surgical expertise, and institutional preferences.

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