A comparison of the outcomes of one-stage and two-stage brachiobasilic arteriovenous fistulas

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Objective: The brachiobasilic arteriovenous fistula (BBAVF) can be formed in one or two stages. This study examined the failure rates and functional patencies of one-stage vs two-stage brachiobasilic transposition fistulas to compare the two surgical techniques.

Methods: We retrospectively identified all the patients who underwent BBAVF access surgery at King’s College Hospital between January 1, 2009, and December 31, 2011 (3 years). Patients were divided into two groups according to one-stage or two-stage procedure. All patients were seen in the access clinic 4 to 6 weeks postoperatively, and their fistulas were scanned (duplex). The surveillance of fistulas consists of duplex scans every 6 months to assess volume flow.

Results: During the study interval, 149 brachiobasilic transpositions (65 one-stage and 84 two-stage) were performed in 141 patients. Patients undergoing the two-stage procedure had a smaller mean preoperative vein diameter (4.0 ± 1.1 vs 3.6 ± 1.3 mm; P = .041) and tended to be older (58 ± 15 vs 63 ± 15 years; P = .062). Mean overall follow-up was 559 ± 333 days. There was no difference in primary failure between the two groups (45% vs 42%; P = .718). At 1 year, the two-stage BBAVFs had significantly better primary (71% vs 87%; P = .034), assisted primary (77% vs 95%; P = .017), and secondary functional (79% vs 95%; P = .026) patencies. The same applied to 2-year primary (53% vs 75%; P = .034), assisted primary (57% vs 77%; P = .017), and secondary functional (57% vs 77%; P = .026) patencies. Multivariate Cox regression showed that the one-stage procedure was 3.2 times more likely to fail (P = .026). Men were 2.7 times more likely to lose their access (P = .054).

Conclusions: This study describes a large series of BBAVFs and makes an extensive comparison between the one-stage and two-stage operations. Significantly improved overall functional patency is demonstrated for the two-stage operation. (J Vasc Surg 2013;58:1300-4.)

The use of the basilic vein for an autogenous fistula creation is often considered a complex vascular access procedure, usually involving a general anesthetic and significant surgical dissection. However, when other simple fistula options are exhausted, the basilic vein, lying deep and protected from damage by venipuncture, makes an excellent hemodialysis conduit.

The brachiobasilic arteriovenous fistula (BBAVF) was first described by Dagher1 in 1976. Several modifications of the initial operation have been developed in the years since then.2,3 However, the basic principle is to superficialize the basilic vein and make it amenable to needle puncture.

The BBAVF can be formed in one stage or two stages. To date, limited and conflicting data exist regarding primary failure and the patency rates of one-stage and two-stage procedures.4-12 Each procedure has advantages and disadvantages. The one-stage procedure offers the benefits of a single operation with earlier functional patency and possible shorter duration with a central venous catheter. The advantage of a two-stage procedure is the ease of mobilization of a larger “arterialized” vein, rendering it less susceptible to torque and devascularization during mobilization.13 If surgical revision for postanastomotic stenosis is required, this is easily performed at the second stage. In case of early failure, the patient is spared a general anesthetic and significant surgical dissection. However, the two-stage procedure necessitates two operations, which may affect operating theater capacity and delay acquisition of permanent access.

In this study, we examined primary failure rates and the primary, primary assisted, and secondary functional patencies of one-stage vs two-stage brachiobasilic transposition fistulas to compare the two surgical techniques. The hypothesis is that two-stage BBAVFs provide longer patency. In addition, we examined the effect of patient variables on the final outcome.

METHODS

Design and patients. We retrospectively identified all patients who underwent BBAVF at King’s College Hospital between January 1, 2009, and December 31, 2011 (3 years). Patients who underwent creation of a brachiobasilic transposition fistula were divided into groups according to one-stage or two-stage procedures. During this 3-year period, 149 BBAVFs were formed in 141 patients. The patients were consecutive, and two experienced surgeons performed the operations. One of the
the surgeons usually performs the one-stage operation, whereas the other usually performs the two-stage one. In patients with small-sized veins, both surgeons would mostly perform the procedure in two stages. Minimum vein threshold for AVF is 2 mm, as determined by preoperative vein mapping, which was performed without the use of tourniquet on all patients.

All patients were seen in the access clinic 4 to 6 weeks postoperatively, and their AVFs underwent duplex scanning to assess maturation. Once in use, the fistulas entered the surveillance program of 6-month duplex scanning of volume flow. Prolonged bleeding, raised static venous pressure (>170 mm Hg), inability to achieve blood pump speed of 300 mL/min, urea reduction ratio <65%, and dialyzer clearance of urea (K) dialysis time (t)/volume of distribution of urea (V) <1.2 prompted referral for fistuloplasty. Stenotic areas on duplex imaging were considered for fistuloplasty if they affected the quality of hemodialysis.

**Definition of variables.** *Primary patency* (intervention-free access survival) was defined as the interval from time of access placement to any intervention designed to maintain or re-establish patency.14 *Assisted primary patency* (thrombosis-free access survival) was defined as the interval from time of access placement to access thrombosis.14 *Secondary patency* (access survival until abandonment) was defined as the interval from time of access placement to access abandonment. A functional AVF is an access that is able to deliver a flow rate of 350 to 400 mL/min without recirculation for the total duration of dialysis. A nonfunctional AVF is an access that is not being successfully used for hemodialysis, regardless of whether it is patent.14

*Primary failure* was defined as an AVF that was never used for dialysis. This definition includes (1) inadequate maturation, (2) early thrombosis, (3) failure of first cannulation, and (4) other complications, such as ischemia or infection, which made it unusable.

This study refers to primary functional, assisted primary functional, and secondary functional patency. Therefore AVFs that were not used for dialysis were not included in the survival models.

All complications were extracted from the electronic patient records. Early complications are defined as occurring ≤30 days from the operation date.

**Description of surgical technique.** The one-stage operation is performed under general anesthesia. A 5-cm incision at the antecubital fossa identifies the basilic vein. Brachial vein fistulas were not included in this series. Intraoperative ultrasound imaging was not used. The incision is extended proximally, and the underlying deep fascia is opened. The basilic vein is mobilized up to its junction with the brachial vein. The median cutaneous nerve of the forearm is carefully dissected and preserved. After side branches are ligated, the basilic vein is tunneled subcutaneously, with a Roberts’ forceps maintaining its axial orientation. An end-to-side arteriovenous anastomosis to the brachial artery is performed.

The first stage of the two-stage operation is performed under local anesthesia by formation of the arteriovenous anastomosis with minimal disturbance of the basilic vein. After 4 to 6 weeks, a flow assessment of the AVF by duplex scanning is made to determine if revision of the anastomosis is necessary at the second stage. The second stage is performed under general anesthesia. The entire length of the basilic vein is mobilized, a “subcutaneous flap” is created, and the vein is positioned anterolaterally. Usually, a further 4 weeks is required before the AVF can be used.

**Statistical analysis.** Analyses were conducted using SPSS 20.0 software (SPSS Inc, Chicago, Ill). Descriptive statistics were calculated for all variables. Results are shown as means ± standard deviation, unless otherwise described. Categoric variables were compared using Pearson χ² and Fisher exact tests. The Kolmogorov-Smirnov test was used to test continuous variables for normal distribution. Normally distributed data were compared with the t-test and are expressed as mean ± standard deviation; otherwise, the Mann-Whitney test was used and they are expressed as median and interquartile range. Primary, assisted primary, and secondary functional patencies were estimated with the use of the Kaplan-Meier method and were compared with the log-rank test.

Multivariate Cox proportional hazard models were used to assess the independent effects of one-stage or two-stage procedure and other factors on patency and failure rates, including age >65 years, sex, ethnic origin (white, black, other), diabetes, body mass index (BMI) >30 kg/m², and size of vein <3 mm on preoperative vein mapping. The selection of the factors was based on previously published studies. Data from patients who had patent fistulas at the last follow-up (August 31, 2012) were censored on that date. Patient deaths unrelated to fistula failure, patients who had successful kidney transplantation, or those who were transferred to other dialysis units were censored.

All reported P values are two-sided, and a P value of <.05 was considered statistically significant.

**RESULTS**

From January 1, 2009, to December 31, 2011, 149 brachiobasilic transpositions (65 one-stage and 84 two-stage) were performed in 141 patients (1.06 operations/patient). The left arm was used in 99 and the right in 50. Mean follow up was 559 ± 33 days (range, 1-1261 days). Median interval between the first and second operation for the two-stage BBAVFs was 90 days (interquartile range, 68-129 days).

 Patients undergoing the two-stage procedure had a smaller mean preoperative vein diameter (4.0 ± 1.1 vs 3.6 ± 1.3 mm; P = .041). There was also a trend to use the two-stage procedure on older patients (58 ± 15 vs 63 ± 15 years; P = .062; Table 1).

The BBAVF was the first access in 64 patients (43%), second in 50 (34%), third in 23 (15%), fourth in six (4%), fifth in three (2%), and sixth in two (1%). The number of previous fistulas is not mentioned in two patients (1%).
Table I. Patient demographics

<table>
<thead>
<tr>
<th>Variables</th>
<th>One-stage (n = 65)</th>
<th>Two-stage (n = 84)</th>
<th>P</th>
</tr>
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<tbody>
<tr>
<td>Age, mean ± SD, years</td>
<td>58 ± 15</td>
<td>63 ± 15</td>
<td>.062</td>
</tr>
<tr>
<td>Female sex, %</td>
<td>49</td>
<td>52</td>
<td>.703</td>
</tr>
<tr>
<td>Diabetes, %</td>
<td>58</td>
<td>39</td>
<td>.825</td>
</tr>
<tr>
<td>Hypertension, %</td>
<td>81</td>
<td>80</td>
<td>.821</td>
</tr>
<tr>
<td>BMI, mean ± SD, kg/m²</td>
<td>29 ± 6</td>
<td>27 ± 7</td>
<td>.221</td>
</tr>
<tr>
<td>Black race, %</td>
<td>45</td>
<td>46</td>
<td>.958</td>
</tr>
<tr>
<td>Vein size, mean ± SD, mm</td>
<td>4.0 ± 1.1</td>
<td>3.6 ± 1.3</td>
<td>.041</td>
</tr>
</tbody>
</table>

BMI, Body mass index; SD, standard deviation.

Table II. Primary failure

<table>
<thead>
<tr>
<th>One-stage (n = 65)</th>
<th>Two-stage (n = 84)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>45%</td>
<td>42%</td>
<td>.718</td>
</tr>
</tbody>
</table>

Of the fistulas created, 93 (62%) were used for hemodialysis (66% one-stage vs 60% two-stage; P = .407), and 56 (38%) were not used, of which 19 (34%) failed before needling, two patients (4%) received a renal transplant, seven (13%) died, and 28 (50%) BBAVFs remain patent in predialysis patients (equally distributed between the two groups).

Primary failure was similar between the two groups (45% vs 42%; P = .718; Table II). Intervention before first dialysis was similar in the two groups (21% vs 11%; P = .201). Most preemptive interventions were endovascular, whereas open surgery was reserved for two one-stage patients. The mean flows at 6 weeks postoperatively were 1256 ± 471 mL/min for the one-stage group and 1167 ± 439 mL/min for the two-stage group (P = .313).

Primary functional patency, assisted primary functional patency, and secondary functional patency for both groups are depicted in Kaplan-Meier graphs seen in Figs 1, 2, and 3, respectively. In the one-stage vs two-stage groups, the mean primary functional patency was 753 ± 88 days and 853 ± 59 days (P = .045), mean assisted primary functional patency was 795 ± 79 and 987 ± 54 days (P = .026), and mean secondary functional patency was 803 ± 77 and 992 ± 52 days (P = .027), respectively.

At 1 and 2 years, the primary, assisted primary, and secondary functional patency rates were significantly better for the two-stage BBAVFs (Table III).

Risk factors associated with the BBAVF outcome, such as age >65 years, sex, diabetes, BMI >30 kg/m², ethnic origin, and size of the vein (<3 mm) preoperatively were analyzed in a multivariate Cox proportional hazard model (Table IV). The overall model was statistically significant (P = .040) and showed that the one-stage procedure was 3.2 times more likely to fail (P = .028) and that men were 2.7 times more likely to lose their access (P = .054).

There were 27 deaths during the 3-year study period: 10 one-stage patients and 17 two-stage patients (χ² P = .446)

DISCUSSION

This is the largest single-center study to compare the functional patencies of one-stage vs two-stage brachiobasilic transposition fistula. Several previous studies have compared the two operations. However, which technique is superior in long-term patency and complications remains unclear.

This study adds significant data on the functional patencies, complications, and risk factors associated with one-stage and two-stage BBAVFs. The primary functional patency of BBAVFs in this study at 1 year is comparable to reports published within the last 10 years. Our data suggest that at 1 year, the two-stage BBAVFs have significantly better primary (71% vs 87%; P = .034), assisted primary (77% vs 95%; P = .017), and secondary (79% vs 95%; P = .026) functional patencies. A similar trend is seen for 2-year primary (53% vs 75%; P = .034), assisted primary (57% vs 77%; P = .017), and secondary functional (57% vs 77%; P = .026) patencies. These data are in accord with work by El Mallah, who randomized 40 patients to
a one-stage or a two-stage procedure, with primary patency rates 50% and 80%, respectively, at a median follow-up of 15 months, indicating a benefit for the two-stage procedure. However, the retrospective study of 70 patients (30 transposed/20 elevated in one-stage and 20 elevated in two-stages) by Hossny showed no significant difference in secondary patency rates at 12 and 24 months between one-stage and two-stage procedures, at 90% and 84.2% vs 70% and 68.4%, respectively.

Several studies have shown older age is a significant factor in access failure, as well as obesity. Our study did not show that BMI >30 kg/m² (P = .139) or older age (P = .748) had a clear link with access failure. In addition, our study did not show that diabetic individuals have a worse fistula outcome, as seen in another study. Why men would be at a higher risk for losing their access is unclear.

The reported complication rate for BBAVF remains high, between 43% and 71%. The 53.7% overall complication rate in this study is in agreement with such findings. Hossny showed the complication rate was significantly higher in the two-stage elevation group compared with the one-stage transposition group (71.4% vs 28.6%; P > .001). Kakko et al. however, found the complication rate was significantly higher in the one-stage operation (43% vs 11%; P < .001). Our study did not show any significant difference in the complication rates between the two procedures (P = .715). However, there was a trend toward more thrombosis in the one-stage operation (4% vs 1%);...
**Table V. Complications**

<table>
<thead>
<tr>
<th>Variable</th>
<th>One-stage (n = 65), %</th>
<th>Two-stage (n = 84), %</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>24</td>
<td>30</td>
<td>.715</td>
</tr>
<tr>
<td>Infection</td>
<td>3</td>
<td>2</td>
<td>.297</td>
</tr>
<tr>
<td>Hematoma</td>
<td>3</td>
<td>3</td>
<td>.504</td>
</tr>
<tr>
<td>Thrombosis</td>
<td>4</td>
<td>1</td>
<td>.079</td>
</tr>
<tr>
<td>Steal syndrome</td>
<td>2</td>
<td>3</td>
<td>.1</td>
</tr>
<tr>
<td>Venous hypertension</td>
<td>2</td>
<td>1</td>
<td>.318</td>
</tr>
<tr>
<td>Stenosis</td>
<td>9</td>
<td>20</td>
<td>.06</td>
</tr>
</tbody>
</table>

a possible explanation could relate to the smaller vein diameter (4.0 ± 1.1 vs 3.6 ± 1.3 mm; P = .041).

This study has several limitations. It is a retrospective, nonrandomized study, therefore allowing for selection bias. Personal preference of the two operating surgeons affected the type of the operation, and patients with smaller veins would mostly be allocated to the two-stage group. Another limitation is that our survival analysis is based only on functional BBAVFs (43 one-stage and 50 two-stage cases).

**CONCLUSIONS**

This study demonstrates significantly improved primary, assisted primary and secondary functional patency for the two-stage operation, with a similar complication rate to the one-stage procedure. The superior functional patency of the two-stage procedure noted in this study suggests that the two-stage approach should be the operation of choice for BBAVFs. However, our results should be confirmed by a prospective, randomized multicenter trial.

**AUTHOR CONTRIBUTIONS**

Conception and design: GV, ST
Analysis and interpretation: GV
Data collection: GV, ST, FD
Writing the article: GV, FC
Critical revision of the article: CJ, JT, FC
Final approval of the article: FC
Statistical analysis: GV, CJ
Obtained funding: Not applicable
Overall responsibility: GV

**REFERENCES**


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