Brachiobasilic fistulae: an upper limb autologous option for everyone?

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ABSTRACT

Purpose Autologous arteriovenous fistulae (AVF) are the vascular access option of choice. However, Brachiobasilic fistula (BBF) are complex procedures with variable outcomes reported in the literature. Our aim was to evaluate outcomes and morbidity associated with BBF in our population. Methods Retrospective analysis of prospectively collected data was undertaken for all 51 BBF created in our institution between January 2010 and March 2013. These were compared to an age and sex-matched group of brachiocephalic fistula (BCF) created over a similar time period. Demographic, operative and outcome data was collected for all patients. The primary end points were primary functional patency, primary-assisted patency and secondary patency at 3, 6 and 12 months. Continuous data was compared using Student’s t-test and categorical data using chi-squared test (p < 0.05 is significant). Results Mean patient age was 57 years (range: 21–82). About 45% were male. About 73% of patients were already on hemodialysis (HD) at the time of BBF creation. BBF was the secondary or tertiary access procedure in 60.8% of patients (n = 31). BBF were associated with significant operative burden with 82% of patients requiring a general anaesthetic and median hospital admission of 2 days (range: 1–4). About 75% had a single-stage procedure. About 23.5% (n = 12) required operative revision (superficialization or anastomotic revision for stenosis). Patients with BBF spent an additional 3.45 days/year in hospital as a result of access related complications compared to 0.56 days/year in the BCF group. Primary-assisted patency at 3, 6 and 12 months was better in the BCF group than BBF group (86%, 72% and 48% vs. 71%, 59%, 33%, respectively; p < 0.01) Primary functional and secondary patency rates at 3, 6 and 12 months were 74%, 58% and 32% and 78%, 63% and 41%, respectively, with an average of 0.33 procedures per AVF to maintain patency (10 fistuloplasties, 4 IR thrombectomy and 3 surgical thrombectomy). About one-third of BBF created in this series were never used. Given the morbidity associated with this procedure, careful consideration should be given to creation of BBF in pre-dialysis patients particularly those in whom the rate of decline in renal function is slow.

Introduction

Arteriovenous fistulae (AVF) are the dialysis access modality of choice.1,2 They are associated with a 6-fold reduction in risk of systemic sepsis3 and lower all cause and cardiovascular mortality than tunnelled central venous catheters (TCVCs).4,5 For this reason, both the UK Renal Association and the Fistula First Initiative in the US advocate that AVF be used as the first line vascular access whenever possible.5,6 Standard convention when planning access creation is to start with the most distal option initially, so patients will have a radiocephalic fistula (RCF), brachiocephalic fistula (BCF) and then Brachiobasilic fistula (BBF) if all the cephalic option have been exhausted. BBF are therefore often secondary or tertiary access procedures in patients who have few alternative autologous upper limb options.

The basilica vein in the arm lays deep and medial, requiring superficialization or transposition to permit cannulation for hemodialysis (HD). However, given that it is a relatively hidden vein, it often escapes the trauma of repeated venipuncture and intravenous cannulation rendering it a high quality conduit for HD.7

Patency rates for BBF vary from 65% to 70% at 1 year and 49% to 51% at 2 years,8–10 which are favourable to the alternative prosthetic PTFE grafts.9,11 However, the...
associated complication and re-intervention rate for BBF\textsuperscript{12} can cause considerable morbidity in a patient group who are already extensively medialized. The aim of this study therefore was to assess the morbidity and burden of vascular access experienced by patients having BBF created in the real world.

Materials and methods

Retrospective analysis of prospectively collected data was undertaken for all BBF created in our tertiary referral vascular access centre between January 2010 and March 2013. At our institution, all details relating to end stage renal disease including vascular access are maintained prospectively within the Scottish Electronic Patient Record which was then interrogated to obtain necessary information. Demographic details (age, sex, dialysis status and co-morbidities) and operative details (site of AVF, single/two-stage procedure, surgeon, anaesthetic technique and length of hospital stay) were collected for all patients.

The unit’s protocol for vascular access was non-dominant RCF, BCF, then dominant RCF, BCF followed by non-dominant BBF. The decision whether or not to perform one- or two-stage procedure was made based on surgeon preference and individual basis taking into account the combination of comorbidities, urgency of access need and likelihood of success. The one-stage procedure was always performed under general anaesthetic (GA). The vein was mobilized fully to the axilla using a single incision in the inner aspect of the arm, rather than multiple relieving incisions. The vein was then tunnelled using a standard vascular tunneller within the subcutaneous tissue of the anterior upper arm. The basilica vein was then anastomosed to the brachial artery in the antecubital fossa using 6.0 Prolene sutures (Somerville, NJ). The initial stage of the two-stage procedure was performed either under local anaesthetic (LA) or supraclavicular block. The second stage of the procedure was performed under general anaesthetic. The first-stage involved a simple anastomosis between basilic vein and brachial artery via a skin incision in the antecubital fossa with the anastomosis lying latterly either at or just above the antecubital fossa medial in the arm. Once the fistula had matured, the second-stage was performed. The anastomosis was taken down and the basilic vein mobilized to the axilla using a single incision in the inner arm. The vein was then tunnelled within the subcutaneous tissue of the anterior upper arm. The anastomosis was then refashioned using 6.0 Prolene sutures.

An age and sex-matched group of 50 BCFs created over similar time period was also obtained for comparison. The primary end points were primary functional patency, primary-assisted patency and secondary patency at 3, 6 and 12 months. Additional data was also collected on complications (including infection and thrombosis), additional procedures required to achieve functional patency and the need for hospital re-admission. Primary patency was defined as the time from access creation to first intervention or loss of access. Primary-assisted patency was defined as the time interval from access creation to access thrombosis, including any interventions (surgical or endovascular) aimed at maintaining functionality of a patent access. A fistula was deemed to be functionally patent once it was used successfully for six consecutive HD sessions. Primary functional patency was therefore the time from date of such functional patency to any intervention or access failure. Secondary patency was defined as the time from access creation to access loss (including any salvage procedures). The date of patency loss was considered to be the date of last HD through the access if the patient was using the fistula, or the date which the patient presented with access complications if the fistula was not used.

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 19.0 (SPSS, Chicago, IL). Patients were stratified according to site of AVF. Results are presented as a mean±SEM or percentage of the total population. Continuous data were compared using a Student’s t-test and categorical data compared using chi-squared test. Kaplan–Meier survival curves were used to assess long-term patency. These were compared using a log-rank method. \( p<0.05 \) is considered significant.

Results

Patient demographics

Fifty-one BBF were created in 49 patients (22 male and 27 female). Mean patient age was 57 years (range: 21–82 years). The comparative cohort of age and sex-matched BCF contained 50 fistulas created over the same period. The two groups were similar in terms of age, sex, dialysis status at the time of fistula creation and co-morbidities (Table 1). Notably, over 70% of patients were already on HD by the time their BBF was created. Mean number of previous failed access sites in the BBF group was 1 (range: 0–4). BBF was the secondary or tertiary access procedure in 31 patients (60.8%).

Operative details

Table 2 outlines operative details. There were no peri-operative deaths. However, nine patients with
Brachiobasilic and six patients with BCF died during the mean follow-up period of 11.7 months (range: 1–38.8). Only 5.9% of BBF were created as day case procedures versus 50% of BCF (p < 0.001). The average length of initial hospital stay after creation of a BBF was significantly longer than BCF (2.0 days vs. 0.5 days; p < 0.01). Nine patients with BBF required subsequent superficialization procedure. Mean time to superficialization was 4 months. Four BBF required anastomotic revision for stenosis or a secondary re-superficialization procedure. Thirty-eight percent of BBF were created by a single surgeon while BCF were shared equally in number between eight surgeons.

**Patency**

Ninety percent of BBF and 96% of BCF were patent upon discharge from hospital. Primary functional and secondary patency rates at 12 months were comparable for BCF and BBF (BCF: 39% and 46%, respectively, BBF: 32% and 41%, respectively), however the primary-assisted patency of BBF at 12 months was less than BCF (33% for BBF vs. 46% for BCF; p < 0.01) (Table 3). On long-term follow-up (1200 days) there was no difference in primary or secondary patency (Figures 1 and 2); however functional primary patency and primary-assisted patency were better in the BCF group (Figure 3).

Fewer interventions were performed on BBF in an attempt to keep them patent. The mean number of interventions per patient in the BBF group was 0.33 versus 0.5 in the BCF group (p < 0.05). This difference primarily reflected a higher angioplasty rate in BCF than BBF (p < 0.001). Four radiological and three surgical thrombectomies were performed on the BBF cohort during the follow-up period (Table 4).

**Complications**

Patients with BBF were readmitted with vascular access complications more often compared to those with BCF. The average additional hospital stay as a result of vascular access complications in patients with BBF was 3.45 days (range: 0–7) compared to only 0.56 days (range: 0–5) in the BCF cohort. Access related complications included ruptured fistulas requiring ligation, venous stenosis, clotted fistulas, steal and poor post-operative wound healing. It was also found that pain on cannulation and chronic pain was significantly higher amongst patients with BBF (mean visual analog pain score (VAS) 13.9 and 2.2, respectively, for BBF versus 2.2 and 1.5 in the BCF group; p < 0.05).

**Utilization of AVF**

Seventeen patients (32%) had BBF made which were never used. About five were in patients who remained pre-dialysis and two in patients who received a preemptive transplant. Nine BBF failed to mature adequately to permit dialysis and one patient declined the second-part of a two-stage procedure to permit use of her BBF. Comparatively, only 11 patients (22%) in the BCF group did not go on to use their AVF.

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**Table 1. Basic demographic details of patients with BCF and BBF. Results are presented as a mean ± SEM or percentage of the total population.**

|                | Brachiobasilic fistula | Brachiocephalic fistula | p values |
|----------------|------------------------|-------------------------|----------|
| Number of fistulas | 51                    | 50                      |          |
| Age (years) | 57.4 ± 15              | 61.0 ± 15               | 0.24     |
| Sex, N (%) | Male 23 (45)            | Female 28 (55)         |          |
| BMI at AVF creation | 27.9 ± 5.7         | 26.4 ± 5.2              | 0.09     |
| Morbidly obese (≥35), N | 5                     | 4                       |          |

**Table 2. Operative details for creation of BBF and BCF. Results are presented as a percentage of the total population.**

|                | Brachiobasilic fistula | Brachiocephalic fistula | p values |
|----------------|------------------------|-------------------------|----------|
| Number of surgeons | 8                     | 8                       |          |
| Anesthetic technique, N (%) |                |                        |          |
| GA 42 (82) | 7 (14)                  |                         |          |
| LA 1 (2) | 12 (24)                  |                         |          |
| Block 8 (16) | 31 (62)                 |                         |          |
| Procedure type, N (%) |                |                        |          |
| 1 stage 38 (75%) |                          |                         |          |
| 2 stage 13 (25%) |                          |                         |          |
| Patency on discharge (%) | 96%                      | 96%                     |          |

**Table 3. A comparison of primary-assisted patency, primary functional patency and secondary patency between the BBF and BCF cohort.**

|                | Brachiobasilic fistula | Brachiocephalic fistula | p values |
|----------------|------------------------|-------------------------|----------|
| Primary-assisted patency |                       |                         | <0.01    |
| 3 month 71% | 86%                      |                         |          |
| 6 month 59% | 72%                      |                         |          |
| 12 month 33% | 46%                      |                         |          |
| Primary functional patency |                       |                         | 0.04     |
| 3 month 74% | 81%                      |                         |          |
| 6 month 58% | 64%                      |                         |          |
| 12 month 32% | 39%                      |                         |          |
| Secondary patency |                       |                         | 0.1      |
| 3 month 76% | 88%                      |                         |          |
| 6 month 63% | 72%                      |                         |          |
| 12 month 41% | 46%                      |                         |          |
Discussion

Early access failure of BBF (prior to discharge from hospital) was 10% in this series. Despite the complexities of the operative procedure to create basilica fistulae, this was comparable to the immediate patency rates of BCF (96%) and the results of BBF in other published series. This supports the assertion that BBF are a viable autologous option for patients who have no suitable cephalic vein. Primary functional and secondary patency rates at 12 months were comparable for BCF.

![Survival comparison of primary patency with brachio-basilic and brachio-cephalic fistulas](image)

**Figure 1.** Primary patency.

|          | 0 days | 200 days | 400 days | 600 days |
|----------|--------|----------|----------|----------|
| BBF      |        |          |          |          |
| Number at risk | 51     | 23       | 10       | 4        |
| Number of events | 0      | 28       | 41       | 47       |
| BCF      |        |          |          |          |
| Number at risk | 50     | 28       | 11       | 4        |
| Number of events | 0      | 22       | 39       | 46       |

![Survival comparison of primary-assisted patency with brachio-basilic and brachio-cephalic fistulas](image)

**Figure 2.** Primary-assisted patency.
and BBF in our cohort. The secondary patency rate is lower than in other published series and may reflect the co-morbid population with a high prevalence of diabetes and peripheral vascular disease (known factors associated with AVF failure). Nearly one-third of all BBF created were not used for HD. Many of these were because the functioning AVF was created in a patient who was predialysis and whose renal function has recovered or stabilized (median follow up 11 months) or who received preemptive renal transplant. Patency rates of BBF have been shown to be better if the AVF is created when the patient is predialysis. However, given the morbidity associated with the complex, complicated BBF procedure, this calls into question whether preemptive BBF creation in every patient is appropriate. In particular, more than half of the patients who did not use their AVF due to stabilization of renal function were over the age of 70 years. It is well recognized that the rate of decline of renal function in elderly patients is more gradual. A 70-year-old man with an eGFR > 15 ml/min is more likely to die than need to commence HD. This coupled with poorer outcomes from BBF in the patients over 60 years old may favour a watchful waiting approach to these patients access creation. Perhaps early cannulation grafts have a role in this subgroup of patients to permit avoidance of TCVCs but also minimize the morbidity associated with unnecessary access procedures. Such strategies would, however, need to be further evaluated given the high re-intervention rate required to maintain long-term patency of arteriovenous grafts.

This study highlights the burden of access related complications and morbidity associated with BBF. The overwhelming majority of patients required an inpatient hospital stay with mean length of hospital admission for BBF creation 2 days compared to 0.5 days for BCF creation. Three-quarters of patients had a more extensive one-stage initial operative procedure and 12 patients (23.5%) required a second procedure to allow use of the fistula. A recent Scottish study has demonstrated comparable functional patency rates from one and two-stage procedures. As with other series the complication rate and morbidity associated with

Table 4. Comparison of the number of interventional procedures performed in an attempt to maintain access patency between BCF and BBF.

|         | Brachiobasilic fistula | Brachiocephalic fistula | p values |
|---------|------------------------|------------------------|----------|
| Mean number of total access interventions | 0.33 (range, 0–3) | 0.5 (range, 0–3) | <0.05 | 0.05 |
| Interventions needed, N (%) | 0 (76%) | 34 (68%) | 1 (16%) | 10 (20%) | 2 (6%) | 3 (6%) | 3 (2%) | 3 (6%) |
| Fistuloplasty | 10 | 22 | 0.001 |
| Thrombectomy | 4 | 2 | 0.14 |
| Surgical declotting | 3 | 1 | 0.24 |

Figure 3. Secondary patency.

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dialysing via a BBF was higher. This translated into a higher re-admission rate and in-patient bed usage as a result of access related complications. Given that vascular access complications are responsible for 20% of all hospital admissions and one-third of all bed usage in patients with end-stage renal disease (ESRD), it is possible that a slightly more aggressive approach to salvage procedures of BBF could improve outcomes; however this has not been our experience locally.

This study does have a number of limitations. It is single centre and the number of BBF is relatively small, however this reflects current practice and highlights the fact that BBF are secondary and tertiary procedures for most patients. Superficialisation procedures made it difficult to directly compare primary functional patency of BBF and BCF. Strict terminology was used regarding ability to sustain two-needle dialysis. Therefore some patient who had a two-stage BBF did not achieve primary functional patency until after the second procedure. Finally, it maybe that outcome of access procedures (complex BBF in particular) related to the experience of operator with the respective procedure. Considering the study was experience of a centre, some surgeons were responsible for the more complex access procedures e.g. BBF which is reflected in the fact that 38% of the BBFs were created by a single surgeon unlike BCF which were more evenly distributed amongst the operating team.

In summary, we have demonstrated that BBF are a viable secondary or tertiary native AVF option with acceptable patency rates in patients with no cephalic option. However, they can be associated with significant morbidity and complications. A large number of functioning BBF were never used. Careful consideration should be given prior to creating a BBF in pre-dialysis patients, especially the elderly in whom early cannulation grafts at the time of commencing dialysis may provide a valid alternative.

Disclosure statement

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

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