Arteriovenous Fistula Formation using Transposed Basilic Vein: Extensive Single Centre Experience


Transplantation Division, Department of Infection, Immunity and Inflammation, University of Leicester, Leicester, UK

Submitted 16 November 2007; accepted 23 February 2008
Available online 18 April 2008

Abstract
Objectives: The expanding haemodialysis population has lead to increased requirement for more complex vascular access. The aim of this study is to present the results of an extensive series of brachiobasilic arteriovenous fistulae.

Methods: BBAVF were performed using single-stage vein transposition. A retrospective review of case notes was performed.

Results: One hundred and sixty eight BBAVF were created in 144 patients. This was the first access procedure in only 30 cases and the fourth or fifth in 30. At 24 h, 165 fistulas (98%) were patent. One hundred and eleven fistulas (66%) were used for haemodialysis and 57 (34%) were never used, of which 39 (23%) were due to fistula failure. The cumulative secondary patency at 1, 2 and 3 years was 66%, 50% and 41% respectively. There were 201 complications in 119 patients (71%), including thrombosis (29%), arm oedema (17%), infection (13%) and arterial steal syndrome (11%). Ten angioplasties and 48 operative procedures were performed for complications. Pre-operative ipsilateral subclavian catheter had been placed in 62 cases (37%) and was associated with poor patency.

Conclusions: BBAVF represents an important option for vascular access with acceptable patency rates, although complication rates remain significant.

ª 2008 European Society for Vascular Surgery. Published by Elsevier Ltd. All rights reserved.

Introduction

The population of end stage renal failure patients dependent on haemodialysis continues to expand as a result of improved survival of patients on dialysis, the inclusion of older patients onto dialysis programmes and the falling availability of renal transplants. In addition, individual patients may require patent vascular access for many years requiring multiple access procedures. The Brescia-Cimino wrist fistula remains the procedure of choice, followed by the brachioccephalic arteriovenous fistula (BCAVF) formed at the elbow. However, increasing numbers of patients require alternative access procedures due to damaged, previously used or poor calibre superficial veins. In most cases the next option lies with the transposed brachiobasilic fistula (BBAVF) or a brachioaxillary polytetrafluoroethylene (PTFE) graft.

* Corresponding author. S. J. F. Harper, Transplant Department, Leicester General Hospital, Gwendolen Road, Leicester LE5 4PW, UK. Tel.: +116 2584604; fax: +116 2490064.
E-mail address: sjfharper@hotmail.com (S.J.F. Harper).

1078-5884/$34 © 2008 European Society for Vascular Surgery. Published by Elsevier Ltd. All rights reserved.
The BBAVF was first described in 1976 and has been increasingly accepted as a viable option for secondary or tertiary vascular access. The basilic vein in the upper arm has the advantage that as a deep vein it is rarely damaged by previous venepuncture and it is often of good calibre. This means however, that the basilic vein must be mobilised and superficialised during fistula formation thus increasing the complexity of the procedure. It is therefore accepted that the BBAVF has a higher complication rate than, for example, the BCAVF. The brachioaxillary graft remains a recognised alternative to the BBAVF and there have been several comparative studies, the majority reporting similar patency rates for the two techniques. However, lower complication rates are observed in the BBAVF and this is generally thought to outweigh the advantage that the PTFE graft can be used immediately without requiring a period of maturation.

In currently published studies there remain several contentious issues surrounding BBAVF formation and maintenance itself and significant variation in reported outcomes. The aim of this paper is to present the results of a large series of BBAVF in terms of outcome, patency and complication rates.

Materials and Methods

Brachial artery to transposed basilic vein arteriovenous fistulas (BBAVF) were performed using a previously described technique. One hundred and sixty eight BBAVFs were performed in 144 patients over a 10 year period. Patient demographics are shown in Table 1. All patients underwent surgical review 6–8 weeks post-operatively and further review and imaging was instigated at this time if necessary. Patients were then monitored at haemodialysis for changes in fistula function and referred for further investigation as required.

BBAVF was the procedure of choice in the absence of a suitable cephalic vein. This was the first vascular access procedure in 30 cases, the second in 56, the third in 52 and the forth or fifth in 30. The left arm was selected in 102 cases. In 34 patients, a range of procedures were performed simultaneously to BBAVF formation. These included permanent central venous catheter insertion (n = 19), ligation of pre-existing fistula (n = 8), parathyroidectomy (n = 3), removal of permanent central venous catheter (n = 2) and removal of peritoneal dialysis catheter (n = 2).

Previous placement of an ipsilateral subclavian permanent central venous catheter had been performed in 62 patients (37 per cent). Patients with no identifiable risk factors for venous stenosis underwent clinical evaluation only. Pre-operative imaging of central and arm veins was undertaken using contrast venography in 89 patients (53 per cent) and identified a total of 19 ipsilateral stenoses. Five patients underwent angioplasty and 3 endoluminal stent insertion prior to fistula formation. The remaining 11 patients had mild stenoses (≤50%) deemed not to require intervention prior to fistula formation.

Data was collected from patient case notes retrospectively with a mean follow up of 15.9 months. Technical success was defined as the presence of an audible bruit in the fistula at 24 h post-operatively. Primary, assisted primary and secondary patency rates (per cent ± s.e.m.) were recorded as defined by the recommended standards for reporting haemodialysis access and calculated using Kaplan-Meier survival curves (GraphPad Instat Version 3; GraphPad Software Inc., San Diego, USA). Patient deaths unrelated to fistula failure and patients who underwent transplantation were considered lost to follow up. Complication rates include those that were indications for surgical or radiological intervention and those leading to fistula failure.

Results

Of the 168 fistulas 165 were patent at 24 h. A further 8 patients (not included in the 168) were found to have basilic veins unsuitable for fistula formation intra-operatively, thus the procedure abandoned, giving a technical success rate of 94 per cent.

One hundred and eleven fistulas (66%) were used for haemodialysis and 57 (34%) were never used. Of those never used for haemodialysis, 39 (23%) failed prior to needling, 3 patients received a renal transplant, 7 patients died and 8 fistulas are currently maturing or remain patent in pre-dialysis patients. True fistula failures were secondary to thrombosis (n = 14), failure to mature (n = 14) and poor flows (n = 2). In addition, 9 maturing fistulas required ligation for infection (n = 3), arm oedema (n = 3), aneurysm (n = 2) and steal syndrome (n = 1). The 30 day secondary patency was 95 per cent with five fistulas failing secondary to thrombosis (2 cases related to wound infection) and four requiring early ligation for steal, arm oedema, secondary haemorrhage and peri-anastomotic infection. The primary and assisted primary patency rates at 1, 2 and 3 years were 59 ± 4.0% and 66 ± 4.1%, 38 ± 3.8% and 49 ± 4.8%, 30 ± 5.0% and 39 ± 5.7% respectively. The cumulative secondary patency at 1, 2 and 3 years was 66 ± 4.1%, 50 ± 4.8% and 41 ± 5.6% respectively (Fig. 1).

The median hospital stay was 5 days (range 2–27). There were 4 patient deaths within 30 days of surgery all of which were unrelated to fistula formation. Eighty-three patients required 120 re-admissions due to complications relating to their fistula. In total one hundred and nineteen patients (71 per cent) developed two hundred and one complications (Table 2). Ten post operative upper limb and central vein angioplasties were performed, five with endoluminal stent insertion. Thrombolysis was used in one patient, resulting in the successful declotting of a subclavian vein stent. A total of 48 further operative procedures were performed on the brachiobasilic fistulas of 42 patients (Table 3).
Of the 19 fistulas formed in patients with ipsilateral venous stenosis diagnosed pre-operatively, three are currently patent following pre-operative angioplasty and stent insertion \( (n = 1) \), pre-operative angioplasty alone \( (n = 1) \) and post-operative angioplasty \( (n = 1) \). The remaining 16 fistulas failed secondary to poor maturation \( (n = 3) \), thrombosis during maturation \( (n = 3) \), poor flows \( (n = 5) \), thrombosis while in use for haemodialysis \( (n = 4) \) and death during maturation \( (n = 1) \).

Bleeding requiring hospital admission occurred in 21 patients \( (13\% \text{ per cent}) \). Early post operative haemorrhage was seen in 11 patients and was managed successfully with surgical exploration in 6 patients and conservative treatment with local pressure in 4 cases. One patient required fistula ligation for haemorrhage secondary to wound infection and dehiscence. Late bleeding from needle puncture sites occurred in 10 patients, 2 developing a false aneurysm requiring ligation and 3 developing a significant haematoma leading to fistula loss.

Thrombosis (including thrombosis secondary to other complications e.g. infection) was the most common complication occurring in 48 patients \( (29\% \text{ per cent}) \). Exploratory surgery with thrombectomy +/- fistula revision or angioplasty was performed in eight patients and successfully re-established patency in 4 cases. Three fistulas were managed successfully with conservative measures by resting them from needling for 6 weeks.

Wound infection in the early post operative period was seen in 21 patients \( (13\% \text{ per cent}) \), 2 following early revision surgery. Late wound infection occurred in 12 patients, 11 cases associated with needling sites and one wound infection following late fistula revision. Fifteen patients with early infection and 7 patients with late infection were successfully treated with antibiotics alone. Three fistulas thrombosed as a result of early infection (two within 30 days post-op) and a further 3 were ligated (two within 30 days post-op), one following secondary haemorrhage and two at high risk of anastomotic breakdown. Early wound infection was associated with ultrasound proven collection in 6 patients and was associated with fistula loss in 2 cases. Thrombosis occurred in 3 cases of late infection and two fistulas required ligation following bleeding from a needle site mycotic false aneurysm.

Arterial steal syndrome was diagnosed in 18 patients \( (11\% \text{ per cent}) \) and was an early complication in 8 patients, requiring early ligation in one case. In regard to late steal syndrome, fistula revision using proximal fistula plication was performed in 3 cases proving successful in 2 and requiring subsequent ligation for continued ischaemia in one case. Successful revision using a distal revascularisation — interval

![Figure 1](image_url)
ligation procedure was performed in 2 patients. A further four fistulas with severe distal ischaemia involving active or impending tissue loss were ligated without previous revision and 1 with mild steal syndrome was managed conservatively. One case of high output cardiac failure was recorded. Arm oedema occurred in a total of 28 patients (17 per cent) and was an early post operative complication in 17 cases. Conservative management was successful in 14 such cases but three patients required fistula ligation (one within 30 days post-op). In late onset arm oedema a central vein stenosis was identified in four patients, three undergoing successful angioplasty and stent insertion and one undergoing unsuccessful angioplasty alone, eventually requiring ligation. One patient was found to have basilic vein stenosis which subsequently occluded and another subclavian stent thrombosis which was successfully thrombolysed. Of the five patients with late onset oedema of unidentified cause 3 were treated conservatively and a further 2 required ligation.

Flow rates inadequate for dialysis were identified in 13 patients (8 per cent), 3 patients undergoing angioplasty +/- stenting and five undergoing surgical revision. Poor fistula maturation occurred in 19 patients (11 per cent) and post-operative angioplasty +/- stenting was performed in three cases and surgical revision in four cases.

Discussion

The brachiobasilic AVF is increasingly the access procedure of choice when a superficial arm vein is unavailable. Reported long term cumulative patency rates are in the range of 54–90, 38–82 and 43–57 per cent at 1, 2 and 3 years respectively.1,6,12–15 In this large series the secondary patency rates were comparable at 66, 50 and 41 per cent at 1, 2 and 3 years, remaining similar to patency rates reported after five years experience with BBAVF formation. In addition, the significantly high number of BBAVF never used for dialysis remains unchanged despite a consistent 30 day secondary patency of 95%. The early fistula failure rate of 23 per cent in this study is similar to other reports (range 8–28%). Asif et al. found that despite an early failure rate of 28% all but 2 of 86 AVFs, including BBAVF and PTFE grafts, could be salvaged using a structured close surveillance program allowing timely intervention.12,16 In a recent series of 75 BBAVFs only 8 per cent were never used for dialysis as a result of the effective use of salvage angioplasty.12 Interestingly however, this group found thrombectomy unsuccessful which is contrary to this present series in which half of thrombectomies performed re-established patency. In contrast, catheter derived thrombolysis was only used once in this series, although significant success with this approach has been reported.17 These findings support the increasing interest in close fistula surveillance programs.18 In the context of the high rates of stenosis and thrombosis seen in this study introducing such an approach may be beneficial.

The reported complication rate for BBAVF remains high at 47–71 per cent and this study concurs with other studies.12–14,19 However the complication rate for PTFE grafts is even higher, in the range of 60–100 per cent. This difference remains the central argument supporting BBAVF over PTFE grafts as long-term patency rates are similar.6,9,20 In addition, the overall re-operation rate for PTFE grafts ranges from 45 to 67 per cent,9,9,21 much higher than the 29 per cent for BBAVF in this study. A more recent comparative study by Oliver et al. highlighted in particular the higher risk of infection (BBAVF 2% vs. PTFE 13%) and seroma (BBAVF 0% vs PTFE 6%). Furthermore, although both types of fistula had similar secondary patency rates, PTFE grafts had a significantly lower 1 year primary patency of 50 per cent compared to 77% in BBAVF.8

The reasons for the high early failure and complication rates associated with BBAVF are multi-factorial. Patient age and co-morbidity have been shown to have a significant effect on AVF patency.22 The median patient age in this series was 61, with 39 per cent of patients aged 65 or over, reflecting the ageing dialysis population. Interestingly, Kawecka et al. report significantly better patency rates in PTFE grafts compared to BBAVF in the over 65 age group, a difference not seen in younger patients.6 This may relate to poorer quality autologous veins in older patients. Diabetes is associated with impaired AVF maturation, increased complications and lower patency rates.19 The high incidence of diabetes (34 per cent) in this study, may significantly affect BBAVF outcome. BBAVF formation was the first access procedure in only 18 per cent of patients highlighting that this was commonly more complex surgery performed on patients at higher risk of AVF failure. Careful vascular access planning, selective venous imaging and vein preservation in terms of central catheter avoidance and judicious primary fistula formation are vital. The rate of ipsilateral subclavian catheter placement has been reduced from 57 to 37 per cent when compared to previously published results, although the incidence of

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Indications and interventions for fistula complications. Values in parentheses are procedures performed within 30 days following fistula formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-exploration</td>
<td>Revision</td>
</tr>
<tr>
<td>Arm oedema</td>
<td>6 (1)</td>
</tr>
<tr>
<td>Steal</td>
<td>5</td>
</tr>
<tr>
<td>Infection</td>
<td>3 (2)</td>
</tr>
<tr>
<td>Bleeding</td>
<td>6 (6)</td>
</tr>
<tr>
<td>Aneurysm</td>
<td>3</td>
</tr>
<tr>
<td>Poor flow</td>
<td>5</td>
</tr>
<tr>
<td>Thrombosis</td>
<td>4 (2)</td>
</tr>
<tr>
<td>Poor maturation</td>
<td>4 (2)</td>
</tr>
</tbody>
</table>

---

pre-operative stenosis remains similar at 10 vs. 11 per cent. In this series pre-operatively diagnosed ipsilateral stenosis was associated with a patency rate of only 16 per cent highlighting the significance this has on fistula outcome. In a study of 99 patients undergoing BBAVF formation risk factors associated with poor patency were obesity, increased age, previous fistula formation and previous subclavian venous catheter insertion. Pre-operative assessment of basilic vein quality and calibre using Duplex ultrasound has been increasingly advocated as a way of improving fistula outcome, particularly in terms of technical success rate. In the light of high complication rates for BBAVF the impact of technique of forming BBAVF on outcome remains a contentious issue. In this study the vast majority of BBAVF were formed with the same single-stage, vein transposition technique. Hossny et al. found that basilic vein elevation was associated with a higher rate of complications, in particular haematoma formation, when compared to vein transposition but there was no significant difference in patency. It has been proposed that BBAVF should be performed as a two-stage procedure with delayed superficialisation. A small comparative study reported a significantly higher patency rate following a two-stage procedure although other studies found no significant difference. This study demonstrates that BBAVF remains an important option for permanent vascular access. Medium-term patency rates remain acceptable within this large series although complication rates are high and require a significant number of secondary interventions. Overall results do not appear to improve significantly with greater experience and this reflects the ongoing difficulty in managing complex vascular access in an increasingly high risk cohort of patients. In this context, careful access planning, close surveillance and timely intervention are likely to be of particular importance.

References