REVIEW


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Aims. To review the available literature regarding patency rates and complications of the brachial-basilic arterio-venous fistula (BBAVF) and to discuss this with relation to the current dialysis outcomes quality initiative guidelines.

Methods. An internet based literature search was performed using Pubmed, Medline and Medscape databases to identify all published reports of the BBAVF in the English language from which the full articles were retrieved and cross-referenced.

Results. Of 136 papers identified, 28 were directly relevant to this review including four prospective studies (one randomised trial, three non-randomised trials) and 24 retrospective studies. First described by Dagher in 1976, the BBAVF has since been modified to a two-stage procedure with initial fistula formation followed by superficialisation of the basilic vein 6 weeks later. It can be formed successfully in 95% of cases. Mean 1-year primary and secondary patency rates were 72 and 74.6%, respectively. Complications included haematoma (3.8%), stenosis (2.3%), thrombosis (9.7%), transient arm oedema (3.7%), steal syndrome (2.9%) and aneurysm/pseudoaneurysm formation (1.9%). The BBAVF had a lower rate of infection than prosthetic fistulas (3.6 vs. 16%).

Conclusions. The BBAVF has good primary and secondary patency rates with lower rates of infection than prosthetic fistulas making it a preferred secondary access procedure.

Keywords: Brachial-basilic fistula; Basilic vein transposition; Haemodialysis vascular access.

Introduction

Haemodialysis was developed in 1944 as a successful temporary treatment for patients with end stage renal disease (ESRD) awaiting transplantation and in the USA and Europe in 1999 there were 400,000 patients maintained on haemodialysis.1,2 The success rate and increased availability has considerably improved patient long-term survival: more than 4000 patients with ESRD required vascular access procedures in the UK in 1989 and this number has now more than doubled.3 The small number of available kidney donors and the increased survival of patients means that most will require a prolonged period of artificial renal support necessitating the formation of an arterio-venous fistula (AVF).

The most commonly performed primary access fistula is the radial-cephalic fistula first introduced in 1966 by Brescia with its relative ease of formation and reliable patency rates.4 However, in a recent meta-analysis there was a pooled primary failure rate of 15.3%, primary patency rate of only 62.5% and a secondary patency rate of 66.0% at 1 year.5 Controversy also exists regarding the best type of fistula to be formed in secondary and tertiary access procedures when primary fistulas have failed.

The brachial-basilic arterio-venous fistula (BBAVF) was first described by Cascardo in 1970 and Dagher in 1976. With this technique, the basilic vein is anastomosed to the brachial artery in the antecubital fossa and later superficialised to make it amenable to needle puncture. Advantages are that it produces a long length of straight, superficial fistula with a high flow rate. It involves the formation of only one vascular anastomosis, maintains anatomic continuity with the axillary vein, obviates the need for autologous, prosthetic or heterografts and can be used when
other techniques have been exhausted. Unlike other veins in the arm, the basilic vein is naturally deep and protected from damage caused by previous venepuncture making it an ideal haemodialysis conduit but necessitating superficialisation.

The use of an autogenous arterio-venous access for chronic haemodialysis is recommended by the national kidney foundation dialysis outcomes quality initiative practice guidelines (NKF-DOQI). These guidelines recommend the use wherever possible of native autogenous fistulas over synthetic grafts to improve patency and contain costs, providing adequate flow rates, low rates of complications and fistula longevity. These guidelines are exceptionally conservative in recommending that only 50% of patients should have formation of autogenous AVFs and many centres now achieve rates of 90% or more. These guidelines also recommend that the order of preference for AVF placement is the radial-cephalic primary AVF followed by the secondary brachial-cephalic AVF and, if either of these is not viable then a secondary/tertiary fistula should be fashioned using a synthetic material before proceeding if necessary to a BBAVF.

The purpose of this paper was to review the available literature relating to the formation of the BBAVF in terms of surgical technique, patency rates and complications with particular reference to its use as advocated by the DOQI guidelines.

Methods

Data sources

An internet based literature search was performed using the words ‘basilic vein transposition’, ‘basilic vein fistula’, ‘brachial-basilic fistula’ ‘brachial-basilic arterio-venous fistula’ and ‘basilic vein elevation’. The search included Pubmed, Medline and Medscape databases to identify all published reports in the English language. Manual cross-referencing from the reference lists of all relevant articles identified further papers included in this review.

Outcome measures

The primary outcome measures were primary patency and secondary patency rates. Primary patency rate refers to the successful functioning of the fistula after the initial procedure without further intervention. Secondary patency rate refers to patency regardless of the number of interventions.

Results

One hundred and thirty six papers were identified with reference to the BBAVF. Twelve were written in languages other than English and were, therefore, excluded and of the remainder only 28 were regarded as directly relevant to this review. Of these 28 studies, four were prospective (one randomised, three non-randomised) and 24 were retrospective from which reliable data regarding primary and/or secondary patency rates and complications could be retrieved.

Surgical technique of formation of the BBAVF

The original description by Dagher in 1976 described surgery on an out-patient basis under local anaesthesia. Through three incisions the basilic vein was mobilised, relocated through a subcutaneous tunnel and anastomosed end-to-side with the brachial artery. Two weeks was allowed for the fistula to mature before instigating haemodialysis. LoGerfo et al. used a similar but modified technique using two incisions also adopted later by Dagher. Davis described a similar technique using one long incision in which the fistula was laid subcutaneously rather than being tunneled. More recently there have been reports of minimally invasive techniques including video assisted transposition. These techniques may avoid a long wound incision in the arm and may reduce pain but have yet to gain popularity.

One stage vs. two-stage procedure

Many surgeons now perform the technique as a two-stage procedure. El Mallah randomised 40 patients to a one-stage or a two-stage procedure: Primary patency rates were 50 and 80%, respectively, at a median follow-up of 15 months. A retrospective study of 40 patients by Hossny showed no significant difference in 12 months secondary patency rates between one and two-stage procedures at 90 and 84%, respectively. The former study would indicate a benefit for the two-stage procedure although larger randomised trials may answer this question more reliably. The staged procedure may give the vein time to arterialise and strengthen in order to withstand superficialisation.

Statistical analysis

Data was retrieved from each relevant paper and entered into a purpose-designed database using SPSS 11.0 for Windows. Data was aggregated and is presented as means with ranges.
and may be less prone to thrombosis. The higher occlusion rates in the one-stage procedure may reflect the damage that can be caused by extensive dissection of this thin walled vein. Most authors now agree that the fistula should be left for 4–6 weeks to mature before use so as to prevent complications such as thrombosis.

**Superficialisation—transposition vs. elevation**
Different surgical techniques and their relation to fistula patency have been investigated in only one retrospective study. Seventy BBAVF s were constructed, transposed in 30 patients and elevated in 40 patients (20 in one-stage and 20 in two-stages). Cumulative secondary patency rates at 1 year were 87, 90 and 84% in the transposed, elevated in one-stage and elevated in two-stage groups, respectively. At 2 years, these figures were 83, 70 and 68%, respectively. The total complication rate was significantly higher in the elevated group (71.4% vs. 28.6%) and the transposed vein was also more favoured by dialysis staff. These results would indicate that transposition may be better but again larger randomised trials would allow more reliable conclusions to be drawn. Figs. 1–3 show the techniques of elevation and transposition.

**Primary patency rates of the BBAVF compared with other fistulas**

The general patency rates of radial-cephalic, brachial-cephalic and prosthetic fistulas are shown in Table 1. When the primary patency rate of the BBAVF is compared with other fistulas it appears to be a reliable fistula. The radial-cephalic fistula which is routinely used as a primary fistula because of its good long-term results has reported 1 year primary patency rates of 70–91% although a recent meta-analysis suggests that the rate may actually be as low as 62.5%.

One of the most commonly performed alternative fistulas is the prosthetic PTFE graft with 1 year primary patency rates ranging from 62 to 87%. Coburn and Carney reported results of a comparison between PTFE and the BBAVF. The primary patency rate of the BBAVF (90%) was superior to that of PTFE (70%) at 1 year and at 2 years (86 vs. 49%). Complications were two and a half times more frequent in the PTFE group (17 vs. 43%). They concluded that the PTFE graft does have some advantages over the BBAVF in that it is technically easier to perform, has high dialysis flow rates and can be punctured sooner, but wherever possible the BBAVF is to be preferred based on patency and lower rates of complications. In a retrospective paper

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**Fig. 1.** Basilic vein mobilisation (the second stage of a two-stage procedure). The medial cutaneous nerve of the forearm is seen traversing the vein.

**Fig. 2.** Basilic vein elevation—the vein has been elevated from its anatomically deep position to lie directly beneath the incision.

**Fig. 3.** Basilic vein transposition—the vein has been superficialised and tunnelled to lie away from the incision.
by Matsuura et al., 30 BBAVF were compared with 68 PTFE fistulas. PTFE grafts had a significantly higher thrombosis rate (51 vs. 30%) and a higher infection rate (10 vs. 0%). Dialysis related complications (haemorrhage and haematoma) were higher in the BBAVF group (20 vs. 5%). Two year primary patency rates for the BBAVF were 70 vs. 46% for PTFE.

Gormus et al. reported slightly better short term primary patency rates in radial-basilic fistulas created in the forearm when compared with BBAVFs created at the elbow (90 vs. 80%, respectively, at 10 months) but with more complications. Primary patency rates of the brachial-cephalic fistula have been reported at 70–84%. This fistula is also not without problems. In a study by Dunlop et al. 81 fistulas were performed in 77 patients. Overall patency was 70% at 1 year, 57% at 2 years and 50% at 3 years. Cardiac failure and steal syndrome were significant problems with the side to side anastomosis and two patients died from fistula complications (haemorrhage and high output cardiac failure).

Certain patient characteristics are associated with poorer outcome. Many are diabetic although several studies have failed to show that this group have a worse fistula outcome. The same authors have reported primary access failure to be higher in females than in males. Several studies have shown older age to be a significant factor in access failure, as well as obesity, previous vascular access and ipsilateral central venous catheterisation. Many patients have numerous comorbidities including diabetes and cardiovascular disease making access difficult and making them prone to complications including death.

Table 1 reports the studies that have assessed the BBAVF from 1976 to the present day. Many of the early studies failed to distinguish between primary and secondary patency rates and failed to provide data regarding patient demographics. Overall, the mean (range) primary patency rate of the BBAVF at 12 months follow-up from the studies listed in Table 2 that specifically report a primary patency rate, is 60.4% (28–86) out of 580 fistulas.

Secondary patency rates of the BBAVF

From most of the papers cited in this review, secondary patency rates are only quoted in papers from 1993 onwards. Overall, the mean (range) secondary patency rate of the BBAVF at 12 months follow-up from the studies listed in Table 2 that specifically report a secondary patency rate, is 74.6% (55–96) out of 807 fistulas. The mean (range) secondary patency rate of the BBAVF at 24 months follow-up from the studies listed in Table 2 that specifically report a secondary patency rate, is 67.5% (52–86) out of 686 fistulas.

Complications of the BBAVF

Fistula surgery is complex surgery and this group of patients often have other co-morbidities in particular diabetes, hypertension and coronary artery disease. All fistula techniques have recognised complications and the BBAVF is no exception.

Inability to create the fistula
An inability to perform the procedure at the time of exploration due to an inadequate basilic vein (too small, too short, already thrombosed or absent) is reported to occur in 5–7% of cases.

Failure of the fistula to develop
Failure to mature is an inability to use the fistula for haemodialysis at 6 weeks. In a recent study by Rao et al., failure of maturation was reported to be as high as 38% although most other authors have not reported rates as high as this. Logistic regression analysis showed that age over 60 years was associated with failure to mature and lower patency rates.

In a study by Hakaim et al. in 1998, the outcome of radial-cephalic, brachial-cephalic and BBAVFs were compared in patients with diabetes. Although not randomised, the maturation rate of radial-cephalic fistulas was only 30% compared with 100% for BBAVFs and primary patency rates at 18 months were 33 and 79%, respectively. They concluded that in patients with renal failure and diabetes, a BBAVF (or a brachial-cephalic fistula) are optimal fistulas for primary access, not just as secondary access procedures.
Pain
The incision for this procedure is longer than for many other access procedures. Post-operative analgesia can be facilitated by the introduction of long acting local anaesthetic at the time of surgery. An epidural catheter can be placed in the axillary sheath at the time of surgery and boluses of local anaesthesia introduced over several days. However, this necessitates an in hospital stay of several days whereas most patients are now treated and discharged within 24 h. Most authors do not specifically report pain indicating that it is probably not a significant problem.

Table 2. Patency rates and complications of the brachial-basilic arterio-venous fistula

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Type of study</th>
<th>N</th>
<th>Age (years)</th>
<th>Male</th>
<th>Follow-up (months)</th>
<th>Primary patency</th>
<th>Secondary patency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dagher (1976)</td>
<td>Retrospective</td>
<td>24</td>
<td>44 (18–73)</td>
<td>13/23</td>
<td>8 (2–15)</td>
<td>92%</td>
<td>–</td>
</tr>
<tr>
<td>LoGerfo (1978)</td>
<td>Retrospective</td>
<td>25</td>
<td>–</td>
<td>–</td>
<td>12 (0–19)</td>
<td>85%</td>
<td>–</td>
</tr>
<tr>
<td>Barnett (1979)</td>
<td>Prospective</td>
<td>16</td>
<td>24–83</td>
<td>–</td>
<td>(0–9)</td>
<td>94%</td>
<td>–</td>
</tr>
<tr>
<td>Dagher (1980)</td>
<td>Retrospective</td>
<td>90</td>
<td>16–73</td>
<td>36/81</td>
<td>12 (0–60)</td>
<td>78%</td>
<td>–</td>
</tr>
<tr>
<td>Cantelmo (1982)</td>
<td>Retrospective</td>
<td>68</td>
<td>–</td>
<td>–</td>
<td>12</td>
<td>70%</td>
<td>–</td>
</tr>
<tr>
<td>Koontz (1983)</td>
<td>Retrospective</td>
<td>12</td>
<td>–</td>
<td>–</td>
<td>12 (1–34)</td>
<td>75%</td>
<td>–</td>
</tr>
<tr>
<td>Dagher (1986)</td>
<td>Retrospective</td>
<td>96</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>70%</td>
<td>–</td>
</tr>
<tr>
<td>Davis (1986)</td>
<td>Retrospective</td>
<td>66</td>
<td>–</td>
<td>–</td>
<td>? (0–24)</td>
<td>83.3%</td>
<td>–</td>
</tr>
<tr>
<td>Hibberd (1991)</td>
<td>Non-randomised</td>
<td>15</td>
<td>54 (43–67)</td>
<td>1/15</td>
<td>12</td>
<td>70%</td>
<td>–</td>
</tr>
<tr>
<td>Elcheroth (1994)</td>
<td>Retrospective</td>
<td>80</td>
<td>(17–87)</td>
<td>–</td>
<td>12</td>
<td>76.7%</td>
<td>–</td>
</tr>
<tr>
<td>Coburn (1994)</td>
<td>Retrospective</td>
<td>59</td>
<td>64</td>
<td>30/59</td>
<td>12</td>
<td>90%</td>
<td>90%</td>
</tr>
<tr>
<td>Stonebridge (1995)</td>
<td>Retrospective</td>
<td>19</td>
<td>54 (28–73)</td>
<td>–</td>
<td>16 (4–41)</td>
<td>79%</td>
<td>–</td>
</tr>
<tr>
<td>El Mallah (1998)</td>
<td>Prospective</td>
<td>40</td>
<td>35</td>
<td>23/40</td>
<td>15 (6–24)</td>
<td>50%</td>
<td>1S</td>
</tr>
<tr>
<td>Butterworth (1998)</td>
<td>Randomised</td>
<td>23</td>
<td>60 (32–77)</td>
<td>10/30</td>
<td>8 (2–18)</td>
<td>78.3%</td>
<td>–</td>
</tr>
<tr>
<td>Hakaim (1998)</td>
<td>Retrospective</td>
<td>26</td>
<td>59 (35–85)</td>
<td>16/26</td>
<td>18</td>
<td>79%</td>
<td>–</td>
</tr>
<tr>
<td>Matsuura (1998)</td>
<td>Retrospective</td>
<td>30</td>
<td>59</td>
<td>14/30</td>
<td>24</td>
<td>70%</td>
<td>70%</td>
</tr>
<tr>
<td>Humphries (1999)</td>
<td>Retrospective</td>
<td>67</td>
<td>(11–73)</td>
<td>33/66</td>
<td>12</td>
<td>84%</td>
<td>–</td>
</tr>
<tr>
<td>Murphy (2000)</td>
<td>Retrospective</td>
<td>74</td>
<td>61 (24–94)</td>
<td>29/65</td>
<td>12</td>
<td>–</td>
<td>73%</td>
</tr>
<tr>
<td>Gibson (2001)</td>
<td>Retrospective</td>
<td>181</td>
<td>66</td>
<td>96/181</td>
<td>12</td>
<td>44%</td>
<td>60%</td>
</tr>
<tr>
<td>Dahduli (2002)</td>
<td>Retrospective</td>
<td>16</td>
<td>(25–85)</td>
<td>6</td>
<td>85%</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Murphy (2002)</td>
<td>Retrospective</td>
<td>74</td>
<td>60 (14–94)</td>
<td>12</td>
<td>68%</td>
<td>75%</td>
<td>–</td>
</tr>
<tr>
<td>Tsai (2002)</td>
<td>Prospective</td>
<td>54</td>
<td>61 (31–80)</td>
<td>23/54</td>
<td>12</td>
<td>90%</td>
<td>1S</td>
</tr>
<tr>
<td>Segal (2003)</td>
<td>Retrospective</td>
<td>99</td>
<td>55</td>
<td>46/99</td>
<td>12</td>
<td>47%</td>
<td>64%</td>
</tr>
<tr>
<td>Taghizadeh (2003)</td>
<td>Retrospective</td>
<td>75</td>
<td>49 (6–77)</td>
<td>–</td>
<td>12</td>
<td>92%</td>
<td>66%</td>
</tr>
<tr>
<td>Rao (2004)</td>
<td>Retrospective</td>
<td>56</td>
<td>56</td>
<td>30/56</td>
<td>12</td>
<td>35%</td>
<td>47%</td>
</tr>
</tbody>
</table>

TD, transposed; 1SE, one-stage elevation; 2SE, two-stage elevation; –, not stated.
Bleeding
Bleeding may present as a haematoma requiring no intervention, haematoma requiring wound exploration and evacuation, or fistula rupture. Of the studies listed in Table 2 that reported their complication rates, there are 45 cases of haematoma out of 1180 giving a rate of 3.8%. In the same patients there were three (0.25%) fistula ruptures. Early haematoma causing the fistula to fail can be due to premature venepuncture and most surgeons now give the fistula a period of maturation of 6 weeks prior to its use. In the study by Hossny, haematoma formation was the major predisposing factor for fistula failure. Fistula rupture is a serious complication that can lead to death if not quickly corrected. Nicholson and Polo advise the use of suction drains in these wounds but there is no randomised trial of their use to show a benefit.

Infection
Infection of the wound or fistula was initially reported as common. With improved aseptic precautions this is now much less but has still been reported in many studies. Infection can be associated with vein rupture and loss of the fistula. Of the studies in Table 2 that have reported complication rates, the rate of infection in the wound or the fistula is reported at 3.6% (42/1180). There is no randomised trial that has assessed rates of wound and fistula infection in patients randomised to peri-operative antibiotic vs. no antibiotic. In the study by Taghizadeh et al., local infection rate was reported in 8% (6/75) requiring fistula ligation in two patients. In a retrospective comparison of PTFE and BBAVF, there was a much higher infection rate in the PTFE group at 16.1% vs. 3.4% and overall complications were two and a half times more frequent in the PTFE group.

Stenosis
Stenosis is another commonly described complication which can lead to subsequent thrombosis. Previously this required re-operation and reformation of the fistula, interposition grafting or vein patch angioplasty but with the advent of endovascular techniques, many stenoses can now be treated by percutaneous transluminal balloon angioplasty (PTA). Although endovascular treatment may be preferable for several reasons there is no conclusive evidence that it results in better patency than surgical treatment and indeed there is some evidence to the contrary. Angioplasty can be cumbersome and result in vein rupture. In a study by Marston et al. in which 115 patients with thrombosed dialysis shunts were randomised to either surgical or endovascular treatment, neither resulted in long-term function for the majority of shunts but surgical management resulted in significantly longer primary patency.

Thrombosis
Early thrombosis suggests a technical error with the formation of the fistula and should lead to re-exploration with angiography to identify anastomotic and venous stenoses, kinking or twisting of the vein. Thrombus can sometimes be recovered by catheter thrombectomy. This may be prevented by exact surgical technique and the intra-operative administration of intravenous heparin but to date there is no randomised trial comparing the rates of early thrombosis with the use of heparin. Late thrombosis appears to be common in fistulas after several years particularly in those that are not used for dialysis and nearly all studies report episodes of fistula thrombosis. In the study by Hossny, the rate of thrombosis was reported to be 16.7%. Taghizadeh et al. reported a thrombosis rate as high as 33% and Murphy et al. reported a rate of 22%. Of the studies listed in Table 2 that reported their complication rates, there are 114 cases of thrombosis out of 1180 giving a rate of 9.7%.

Distal embolisation
Embolisation is an uncommonly-reported event. Dagher described one case in which embolisation to the fingers occurred although the patient died of unrelated causes prior to revision of the fistula.
and the paper does not indicate at what time point this occurred.11

**High output cardiac failure**

High output cardiac failure is uncommon but associated with a high mortality and many papers specifically comment on the absence of this complication which appears to be more common with the side-to-side brachial-cephalic fistula.9,10,31,35,39 The diagnosis often remains unrecognised for long periods. Murphy et al. reported one late case out of 74 fistulas and this resolved after spontaneous thrombosis of the fistula.42 Engelberts et al. described one case causing life-threatening heart failure caused by excessive shunting of blood through the fistula demonstrated by invasive measurement of cardiac output, systemic arterial blood pressure, systemic vascular resistance and oxygen consumption before and after temporary occlusion of the fistula.52 The patient recovered after surgical closure of the fistula. None of the papers in Table 2 report a case of high output cardiac failure although there was one case of cardiac arrest and one myocardial infarction in the study by Rao et al.47 In a recent study by Nakhoul et al., a high prevalence of pulmonary hypertension was found in patients with ESRD on chronic haemodialysis via an AVF.53 They measured endothelin-1 and nitric oxide levels and pulmonary artery Doppler pressures in 42 patients before and after haemodialysis. Patients with pulmonary hypertension had higher cardiac outputs, higher endothelin-1 levels and greater rises in nitric oxide metabolites. Pulmonary artery pressure and cardiac output appeared to transiently decrease after temporary occlusion of the fistula and permanently decrease after successful transplantation. They concluded that haemodialysis-induced nitric oxide production in patients with pulmonary hypertension contributes to increased pulmonary vascular tone. Temporary or permanent shunt closure was associated with restoration of pressure and cardiac output indicating that excessive pulmonary blood flow is involved in pulmonary hypertension in these patients. The incidence of high output cardiac failure is probably less than 0.2% (2/1180) based on the available figures in Table 2.

**Steal syndrome**

Steal syndrome is an important and recognised complication of fistula formation although it is uncommon.11,21,32,34–36,38,39,41,46 If the anastomosis is too large, arterial blood is ‘stolen’ from the distal arteries to the hand as blood preferentially flows from the brachial artery to the basilic vein. It is imperative, therefore, to create an anastomosis that is not too small so as to cause thrombosis and not too large so as to cause steal—most authors recommend an anastomosis of only 5–7 mm in length. The arteriotomy for anastomosis in this procedure is smaller than that used for a PTFE anastomosis (less flow is required in autogenous material to maintain patency). As a result steal syndrome is less common and high output cardiac failure is less likely to occur.54

Steal syndrome usually presents with coldness of the fingers, occasionally with true ischaemia and sometimes only occurs on exertion of the limb. Although in most cases it presents in the immediate post-operative period, in some papers it has been reported late even after 10 years presumably due to expansion of the fistula over time. Occasionally the steal may resolve spontaneously within a few days.36 In some cases steal requires ligation of the fistula.34,39,41 Berman et al. reported success in limb salvage whilst maintaining a functioning fistula using a distal revascularisation-interval ligation technique.55 They claim that the technique restores antegrade flow, eliminates the pathway for the steal physiologic mechanism and maintains continuous dialysis. Papa-savas et al. reported the rate of symptomatic steal (not all were brachial-basilic fistulas) to be 17% with a half of these needing revision of the fistula.56 They recommend that by measuring the digital-brachial pressure index (DBI, a DBI <0.6 on the day of surgery can predict which patients are at risk of symptomatic steal. Odland et al. reported a rate of 6.4% and also recommended the use of DBI using intraoperative photoplethysmography.57 Rao et al. reported a rate of 5.4% (3/56), two requiring distal revascularisation or interval ligation and one requiring partial finger amputation.47 Levine described three cases in which hand amputation was required for severe ischemia following access surgery.58 Risk factors for this included peripheral vascular disease, diabetes, multiple interventions and the use of a synthetic graft. Of the studies listed in Table 2 that reported their complication rates, there are 34 cases of steal out of 1180 giving a rate of 2.9%.

**Ischaemic neuropathy**

This is a rare complication of brachial artery fistula thought to be due to nerve ischaemia or infarction.59 Often predisposed by diabetes, the patient complains of profound weakness and severe pain and paraesthesiae postoperatively in the distribution of the median, ulnar or radial nerves.50 Although there is no evidence of distal arterial insufficiency, the treatment is prompt ligation of the fistula.
Pseudoaneurysm and aneurysm formation

Pseudoaneurysm formation is reported in several studies and usually occurs at a site of repeated venepuncture hence most dialysis technicians and patients are taught to alter the site of access on each occasion. True aneurysm formation can also occur at the arterio-venous anastomosis. The rate of aneurysm formation is, however, much less than that reported with PTFE grafts. Of the studies listed in Table 2 that reported their complication rates, there are 22 cases of pseudoaneurysm out of 1180 giving a rate of 1.9%.

Oedema of the forearm and hand

Transient oedema of the hand and forearm is common but under-reported. In most cases it resolves with arm elevation in a sling without any long term consequences. Murphy et al. reported the incidence to be approximately 24% and Hossny reported a rate of 21% but others have reported the rate to be zero. In some cases it is associated with wound infection. Occasionally the oedema has been severe enough to warrant ligation of the fistula. Severe arm oedema should raise the possibility of an unrecognised subclavian vein stenosis. Of the studies listed in Table 2 that reported their complication rates, there are 44 cases of arm oedema out of 1180 giving a rate of 3.7% but this may be under-reported.

Other complications

Peripheral nerve compression has been reported by Reinstein et al. They presented three cases: one radial nerve compression by a basilic vein haematoma, one median nerve compression secondary to a graft associated abscess and one median nerve compression secondary to a basilic vein aneurysm. Surgical decompression led to full nerve recovery in all. The authors do not however indicate how many patients had undergone this fistula formation, so we are unable to draw conclusions as to the incidence of this complication although it would seem to be rare.

Carpal tunnel syndrome is reported to be common in the forearm AVF making the upper arm a more suitable place for fistula formation as long as care is taken to identify and preserve the relevant nerves. Median nerve compression has also been reported by Barnett et al. Cutaneous nerve dysfunction has also been reported.

Other uncommon complications include lymphatic leak. Of the studies listed in Table 2 that reported their complication rates, there are six cases of lymphatic leak out of 1180 giving a rate of 0.5%. Subclavian vein occlusion has been reported in one case in Table 2. Segal et al. reported one case of flap necrosis and three cases of wound dehiscence in the same series of patients.

Discussion

We have seen from the available literature reviewed here, that the BBAVF has primary patency rates and secondary patency rates of 72 and 60%, respectively, at 1 year. These patency rates are comparable to those of the brachial-cephalic fistula but better than a recent meta-analysis of radial-cephalic patency and better than patency for prosthetic grafts. Also, infection rates are much lower for the BBAVF than for the prosthetic loop graft. Prosthetic graft infection is reportedly high at 19% necessitating removal of the graft. These grafts are also associated with more steal symptoms, high output cardiac failure, aneurysm formation, thrombosis, deterioration in function over time and pseudoluminal cannulation.

The current DOQI guidelines suggest that the order of preference for the formation of AVFs should be a radial-cephalic AVF, followed by a brachial-cephalic AVF, followed by a prosthetic loop graft, followed by a BBAVF. In the light of the data reviewed here, this order would seem illogical for the reasons listed above. On the basis of the data it would seem more prudent to attempt a BBAVF before attempting a prosthetic loop graft in the majority of patients needing secondary access procedures.

As a secondary access procedure there are several advantages of the BBAVF over other forms of fistula. Advantages for the patient and the dialysis technician are that it provides a large, long, straight conduit for dialysis. When elevated or transposed to a superficial position it is easy to puncture (particularly useful for patients on home dialysis), resilient to repeated puncture, there is low risk of nerve injury caused by puncture and the position of the fistula is obvious by the position of the arm incision. Post-dialysis bleeding is reportedly easy to stop by direct pressure, which is not always the case with prosthetic grafts. The available evidence suggests that a two-stage procedure and transposition rather than elevation may be associated with better outcomes although more studies are required. There do not appear to be many disadvantages in using the BBAVF over other forms of fistula except perhaps that it requires two separate operations although both can be done under local anaesthetic.

The limitations of the present review are that there are few randomised trials from which to draw conclusions and for this reason, this paper is presented as a review rather than a meta-analysis. It is clear that...
in order to answer some of the questions raised by access surgery, there is a need for well conducted randomised trials although many of the procedures used are likely to remain in use by personal preference rather than based on scientific evidence.

Conclusions

No one form of fistula access surgery is without problems and surgery should, therefore, be tailored to the needs of the patient, the availability of suitable veins for access and the ability of the operating surgeon (most access surgery is in some way centralised to surgeons with an interest in this field). From the available evidence and despite the current DOQI guidelines, for secondary access procedures, the majority of patients will be best treated by a transposed basilic vein fistula which has good long-term patency rates and relatively few complications when compared with other types of fistula.

References

8 Dagher F, Gelber R, Ramos E, Sadler J. The use of basilic vein and brachial artery as an A–V fistula for long term haemodias-
18 Kinnaird P, Vereerstraeten P, Toussaint C, van Geertruiden J. Nine years’ experience with internal arteriove-
22 Matsuura JH, Rosenthal D, Clark M, Shuler WB, Kirby L, Shotwell M et al. Transposedbasilic vein versus polytetrafluoro-
26 Bender MH, Bruyninckx CM, Gerlag FG. The Graczi arter-
32 Kozatz FG, Helling TS. Subcutaneous brachial vein arteriove-


