ORIGINAL ARTICLE

Elbow fistulas using autogeneous vein: patency rates and results of revision

G J Murphy, R Saunders, M Metcalfe, M L Nicholson

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Background: The provision and maintenance of vascular access remains a major cost to end stage renal failure programmes. There are few reports regarding the surgical revision of the failing native elbow arteriovenous fistula (AVF).

Patients and methods: A retrospective case note review was performed on all patients identified from the hospital vascular access database as having undergone construction of an autogeneous vein elbow AVF. Over a seven year period 282 autogeneous vein AVFs were fashioned in 232 patients using the brachial artery as the in-flow conduit. Of these 208 were brachiocephalic fistulas, or a variant thereof, and 74 were fashioned using the transposed autologous basilic vein (136 male: 96 female; median age 60 years, range 14–94 years).

Results: Of 282 elbow fistulas 197 were successfully used for dialysis (70%). Cumulative primary patency of elbow fistulas using autogeneous vein in this series was 68%, 54%, and 44% at one, two, and three years respectively. A further 34 revision procedures were performed on 28 fistulas to maintain fistula function, and cumulative secondary patency after surgical revision was 75%, 60%, and 46% at one, two, and three years. Overall 21 out of 34 procedures (62%) successfully restored fistula function and cumulative primary patency of the revised fistulas was 56% at one year. Eighteen AVFs (brachiocephalic, n=12; autologous basilic vein, n=6) required revision for access dysfunction secondary to a short stenoses within 4 cm of the arteriovenous anastomoses. Of these 18 AVFs eight were revised by excision of the stenosed segment and either primary anastomoses of the two cut ends of arteriatised vein or reanastomoses of the proximal venous limb proximally on the brachial artery. In another nine fistulas the excised segment was replaced with a short interposition graft (polytetrafluoroethylene, n=7; native basilic vein, n=1; bovine carotid artery, n=1). One fistula with postanastomotic stenoses and a more proximal needle site stenoses was revised using two vein patches. Overall 100% were patent at 24 hours, 13 provided successful dialysis (72%), and cumulative primary patency was 67% and 50% at six months and one year respectively.

Conclusions: Successful surgical revision of failing native elbow fistulas can restore patency and improve cumulative secondary patency with potential benefits in terms of patient morbidity and mortality. These results compare favourably to published patency rates after fistula salvage using interventional radiological techniques.

See end of article for authors' affiliations

Correspondence to:
Mr G J Murphy,
Department of
Cardiothoracic Surgery,
Derriford Hospital,
Derriford Road, Plymouth
PL6 8DH, UK

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The radiocephalic arteriovenous fistula (AVF) remains the first choice vascular access procedure for those patients requiring long term haemodialysis.¹ However vascular access surgeons are being referred an increasing number of patients with either inadequate forearm veins or previous failed radiocephalic AVFs. In this situation the secondary vascular access procedure of choice is the formation of an autogeneous (native) vein AVF at the elbow.² In the absence of suitable superficial vein in the arm the choice lies between the transposed autologous basilic vein AVF^{3,4} or a polytetrafluoroethylene (PTFE) graft AVF. In general elbow fistulas using native vein are felt to have superior patency and lower complication rates than prosthetic grafts.^{2,3} As fistula surveillance programmes are introduced in an attempt to prolong fistula survival and reduce patient morbidity and hospital costs the correct management of the failing access is attracting greater interest. The provision and maintenance of vascular access remains a major cost to end stage renal failure programmes,⁶ and with graft revision rates of over one procedure per graft per year required to maintain patency⁷ many studies have considered the management of the failing prosthetic graft. There are few reports regarding the management of the failing native AVF and reports of surgical or radiological interventions to maintain patency have been largely restricted to wrist fistulas.^{8–12} This study reviews our experience using surgical

intervention to restore or maintain function of elbow fistulas constructed using autogeneous vein.

PATIENTS AND METHODS

A retrospective case note review was performed on all patients identified from the hospital vascular access database as having undergone construction of an autogeneous vein elbow AVF. Over a seven year period 282 autogeneous vein AVFs were fashioned in 232 patients using the brachial artery as the in-flow conduit. Of these 208 were brachiocephalic fistulas or a variant thereof and 74 were fashioned using the transposed autologous basilic vein (136 male: 96 female; median age 60 years, range 14–94 years). Descriptions of these surgical procedures have been published previously.^{3,4,13} Formation of a brachiocephalic elbow fistula is the procedure of choice in the absence of adequate wrist vessels. Transposed brachiocephalic AVFs or PTFE grafts are used in the absence of suitable superficial vein. Six hundred and twenty wrist fistulas and 13 upper limb PTFE grafts were performed during the same time period.

Indications for fistula revision are detailed in the text. Access dysfunction was determined by a variety of clinical and

Abbreviations: AVF, arteriovenous fistula; PTFE, polytetrafluoroethylene

Table 1 Life tables demonstrating cumulative primary and secondary patency of elbow fistulas constructed using autogeneous vein

Time (months)	Primary patency		Secondary patency	
	No at risk	Cumulative patency (%)	No at risk	Cumulative patency (%)
0	197	100	197	100
6	154	83	159	88
12	110	68	118	75
18	69	60	77	65
24	52	54	56	60
30	30	48	34	53
36	13	44	16	46

Figure 1 Kaplan-Meier survival curves for elbow fistula using autogeneous vein representing cumulative primary and secondary patency rates.

physiological parameters including physical examination, patient biochemistry, urea kinetic modelling, and raised venous dialysis pressures. No systematic fistula surveillance programme was in place during this time period. Steal was a clinical diagnosis characterised by distal ischaemia presenting as claudication, paraesthesia, muscle wasting, or tissue loss due to shunting of arterial blood away from the extremities. One patient was lost to follow up after transfer to another haemodialysis unit.

Definitions of patency and success

For the purposes of this study fistulas were classified as successful, never used for dialysis, or failures. Technical success was defined as the presence of a thrill on palpation or a bruit on auscultation 24 hours postoperatively. Primary patency refers to fistulas functioning for dialysis up to the time of first failure or intervention performed to maintain patency and excludes those fistulas that were never used for haemodialysis for whatever cause. Intervention for the purpose of this study refers only to surgical procedures. Fistula revision refers to any surgical procedure performed to maintain patency that does not change the nature of the fistula and includes short interposition grafts. Cumulative secondary patency refers to fistulas functioning for dialysis, regardless of the number of interventions required to maintain patency. When no attempt was made to needle a fistula it was designated as never used. Fistula failure was defined as inability to use the fistula for haemodialysis due to a cause other than transplantation or death. Operative ligations were classified as failures. Patients who underwent renal transplantation were considered as lost

Table 2 Cumulative patency (primary) of all revised elbow AVF

Time (months)	No at risk	Cumulative patency (%)
0	21	100%
6	17	76%
12	19	56%
18	6	56%

to follow up and not as technical failures. Deaths being unrelated to fistula failure were also treated as lost to follow up. Life table analysis was used to evaluate cumulative primary and secondary patency.

RESULTS

Patency

Of 282 elbow fistulas 197 were successfully used for dialysis (70%), 48 failed before needling for dialysis (16%), 10 are currently maturing (4%), 10 remain patent in predialysis patients (4%), and 17 (6%) are considered lost to follow up due to death (n=13), transplantation (n=2), recovery of renal function (n=1), and transfer to another dialysis unit (n=1).

Cumulative primary patency of elbow fistulas using autogeneous vein in this series was 68%, 54%, and 44% at one, two, and three years respectively (fig 1). A further 34 revision procedures were performed on 28 fistulas to maintain fistula function and cumulative secondary patency after surgical revision was 75%, 60%, and 46% at one, two, and three years (table 1). Overall 21 out of 34 procedures (62%) successfully restored fistula function (see below) and cumulative primary patency of the revised fistulas was 56% at one year (table 2).

Access dysfunction/thrombosis

A total of 18 AVFs (brachiocephalic, n=12; autologous basilic vein, n=6) required revision for access dysfunction and included four AVFs that thrombosed before planned revision. Sixteen had prior fistulography, demonstrating a narrowing of the venous limb within 4 cm of the arteriovenous anastomoses (n=15, including poststenotic aneurysmal dilatation, n=2 and needle site stenoses, n=1), and proximal needle site stenoses (n=1). Two further patients who presented with thrombosis without fistulography were seen at operation to have thrombosed due to a narrowing of the venous limb adjacent to the arteriovenous anastomoses. Of these 18 AVFs eight were revised by excision of the stenosed segment and either primary anastomoses of the two cut ends of arteriolised vein or reanastomoses of the proximal venous limb several centimetres proximally on the brachial artery. In another nine fistulas the excised segment was replaced with a short interposition graft (PTFE, n=7; native basilic vein, n=1; bovine carotid artery, n=1). One fistula with postanastomotic stenoses and a more proximal needle site stenoses was revised using two vein patches. Overall 100% were patent at 24 hours, 13 provided successful dialysis (72%) and cumulative primary patency was 67% and 50% at six months and one year respectively (table 3).

A further four AVFs, which presented with acute thrombosis and without prior fistulography, underwent attempted thrombectomy of which one remained patent at 24 hours but failed to remain patent for dialysis.

Two other fistulas underwent revision of the juxta-anastomotic venous limb. One fistula had an aneurysmal dilatation of the venous segment immediately adjacent to the anastomoses excised and the cephalic vein reanastomosed to the brachial artery more proximally. One perforating vein elbow fistula that was draining preferentially into the basilic

Table 3 Cumulative patency (primary) for AVF after revision of vein stenoses within 4 cm of the arteriovenous anastomoses

Time (months)	No at risk	Primary patency (%)
0	13	100
6	8	67
12	5	50

rather than the cephalic vein had a segment of the basilic vein transposed to a more superficial position. Both provided successful dialysis.

Steal

Six fistulas were revised for steal (brachiocephalic, $n=4$; autologous basilic vein, $n=2$). This included diameter reduction of the draining limb by placing a crescent shaped plication suture in the draining vein with Doppler monitoring of fistula flow ($n=2$),¹⁴ ligation of draining venous tributaries ($n=2$), patch angioplasty of the brachial artery immediately adjacent to the arteriovenous anastomoses ($n=1$), and ligation of the artery distal to the fistula anastomoses with subsequent saphenous vein bypass from the proximal brachial artery to the brachial artery beyond the ligature ($n=1$).¹⁵ Three fistulas (diabetic, $n=2$; lupus, $n=1$) required early post-operative ligation (persistent steal, $n=2$; graft infection, $n=1$) and three were used subsequently for dialysis of which two required subsequent ligation (arm oedema and venous hypertension, $n=1$; progressive ischaemia, $n=1$).

Bleeding

Three fistulas required revision for needle site bleeding (brachiocephalic, $n=2$, autologous basilic vein, $n=1$). All provided access for dialysis, however, two later failed because of previously undiagnosed venous outflow obstruction. One fistula (autologous basilic vein) had a vein patch angioplasty for a bleeding false aneurysm and provided immediate postoperative access for haemodialysis.

DISCUSSION

These results demonstrate that surgical revision is an excellent treatment option in the management of the failing elbow fistula particularly in fistulas that have developed stenoses of the draining vein within 4 cm of the anastomoses.

The cumulative secondary fistula patency rates of native elbow fistula reported in this series are comparable to others with reported secondary patency rates of 69%–85% and 57%–63% at one and two years respectively.^{16–18} Cumulative primary patency of elbow fistulas in this series was 44% at three years. This is an important value as it represents access function without further surgical intervention in contrast to similar secondary patency of PTFE grafts reported in several large series (40%–50%)^{2–5, 19} with over one revision per graft per year required to maintain graft patency.

Overall primary patency of revised AVF was 56% at one year with cumulative one year primary patency of 50% for fistulas revised for venous stenoses within 4 cm of the arteriovenous anastomoses. These figures compare favourably to published patency goals² of surgical revision for access stenoses without thrombosis of 50% at one year and are similar to the results of surgical revision of Brescia fistulas (19% to 57% primary patency at one year).^{9–12} Stenoses of the venous limb within 4 cm of the arteriovenous anastomoses due to intimal hyperplasia is a common finding and is readily amenable to surgical correction preserving a long segment of the arterialised vein suitable

for continued cannulation. This can be achieved in a large proportion of cases by excising the affected segment and re-anastomosing the arterialised vein more proximally to the brachial artery. Such procedures involve minimal intimal trauma, are relatively non-invasive, and can be performed under local anaesthetic. In the case of insufficient length of vein a short interposition graft can be inserted however this carries the added risk of severe intimal hyperplasia in autogeneous vein grafts or stenoses at the graft/vein anastomoses in the case of PTFE grafts.

The results from our present study compare favourably with those achieved by interventional radiologists, particularly with regard to primary patency. Reports of primary patency after percutaneous angioplasty of stenoses in native AVFs vary widely (16%–60% one year primary patency)^{10–12} with the best reports of 62% one year primary patency after percutaneous angioplasty of juxta-anastomotic venous stenoses in Brescia fistulas.¹⁰ Percutaneous angioplasty is less invasive than surgery, can be performed under local anaesthetic as a day case procedure, and allows continued use of the fistula for haemodialysis. There is, however, a high restenoses rate (50% at six months)¹⁰ necessitating repeated angioplasty to maintain patency, although in such cases surgery or stenting²⁰ remains a possibility. Such results in combination with the need to improve access patency has led to the proliferation of fistula surveillance programmes with percutaneous intervention widely used to treat stenoses.^{10–21–23} These and other reports would appear to suggest a significant benefit with endovascular intervention in prolonging fistula patency while preserving venous capital for future access. However many of these studies, like the results presented here, suffer from their retrospective design and lack of suitable control group. Two randomised controlled trials of percutaneous angioplasty in the management of thrombosed and failing prosthetic graft AVFs demonstrated no overall benefit of percutaneous angioplasty compared with no percutaneous angioplasty for significant luminal stenoses and improved primary patency after surgery compared with percutaneous angioplasty after graft thrombosis.^{24–25} It is probable that the results of percutaneous angioplasty and surgery are largely institution dependent and that they are complementary rather than in competition. Their precise roles in prolonging access patency in autogeneous vein AVF remain undefined and these issues need to be addressed in a randomised controlled trial.

The results of attempted surgical revision after thrombosis were disappointing, as were the results for the surgical management of steal. Although the data presented here would suggest that thrombectomy of thrombosed native vein fistula must be accompanied by revision of the stenosed segment, surgical thrombectomy and subsequent imaging of the stenosed segment can prove technically challenging and overall success rates in native fistulas are generally low.² In such cases preoperative detection of critical stenoses by active investigation of access dysfunction and fistula surveillance carries the best chance of salvage. Arteriovenous steal also presents a formidable surgical problem in that it usually represents diversion of arterial blood from extremities that already have a significant degree of vascular impairment as is commonly found for example in diabetics or those with lupus. In this case the small numbers of each procedure make interpretation difficult, although 50% of fistulas revised for steal did provide further vascular access in this study.

In conclusion successful surgical revision of failing native elbow fistulas can restore patency and improve cumulative secondary patency with potential benefits in terms of patient morbidity. These results compare favourably to published patency rates following fistula salvage using interventional radiological techniques. A randomised controlled trial of the two techniques is required to establish the most cost effective way to maintain fistula patency. Our experience shows that

surgical salvage is particularly successful in the case of juxta-anastomotic venous stenoses and we recommend surgical revision in such cases.

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Authors' affiliations

G J Murphy, R Saunders, M Metcalfe, M L Nicholson, University Department of Surgery, Leicester General Hospital, Leicester, UK

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