The Snuffbox Arteriovenous Fistula for Vascular Access

L. Wolowczyk[1], A. J. Williams[2], K. L. Donovan[2] and C. P. Gibbons[1]

Departments of [1]Vascular Surgery and [2]Nephrology, Morriston Hospital, Swansea, U.K.

Objectives: *to determine the applicability, patency rates and factors influencing patency of snuffbox arteriovenous fistulae for haemodialysis access.*

Design: *retrospective non-randomised study.*

Materials and methods: *patency was determined by reference to an ongoing database and dialysis records of 645 vascular access procedures between 1985 and 1997, including 210 snuffbox fistulae in 201 patients.*

Results: *snuffbox fistulae comprised 189/376 (50%) primary procedures. Records of 208 snuffbox fistulae were available for patency analysis by the life-table method. Twenty-two (11%) thrombosed within 24 hours of operation. After six weeks 80% were used for dialysis. Cumulative patency was 65% at 1 year and 45% at 5 years. After thrombosis of snuffbox fistulae, ipsilateral wrist fistulae could be constructed in 45%. Fistula patency was significantly better in men than women (p<0.001) and for left- than right-sided fistulae (p<0.001). Diabetes, age >70 years, and the prior commencement of haemodialysis did not significantly affect fistula survival.*

Conclusions: *the snuffbox AV fistula gives a long segment of arterialised vein for needling and preserves proximal vessels. It is feasible in 50% of patients requiring primary access and has good long-term patency, especially in men. A more proximal fistula may be preferable in women with smaller vessels.*

Key Words: Vascular access; AV fistula; Anatomical snuffbox.

Introduction

All patients with chronic renal failure undergoing regular haemodialysis depend on reliable vascular access, which is best achieved by creation of an arteriovenous (AV) fistula. The originally described Brescia–Cimino fistula[1] between the radial artery and cephalic vein just proximal to the wrist, with end-to-side and end-to-end modifications, is still widely used, with good patency and low complication rates. Alternative sites for an AV fistula in the upper limb include: (a) a radiocephalic fistula in the anatomical snuffbox, (b) a branchiocephalic fistula in the antecubital fossa, (c) between the ulnar artery and basilic vein at the wrist.[2] For many patients with renal failure, haemodialysis is a lifelong necessity and loss of vascular access has grave implications. Hence, it is good practice to establish the first AV fistula as distally as possible, giving a long segment of arterialised vein for repeated venepuncture and allowing creation of a further fistula proximally in the case of occlusion.

A radiocephalic AV fistula in the anatomical snuffbox was first described in 1969 by Rassat *et al.*[3] It is the most distal site for AV fistula in the upper limb but, although recommended by several authors,[4–13] it is uncommonly used in the United Kingdom. The aim of this retrospective study is to report our experience with this type of AV fistula in a large series of patients and to identify factors affecting fistula patency.

Methods

Patients

Between September 1985 and December 1997, 210 snuffbox AV fistulae were created in 201 patients with end-stage renal failure (89 female and 112 male) with a mean age of 63 (range 16 to 89) years. All fistulae were constructed using the same surgical technique by or under supervision of one vascular surgeon (CPG). The hospital records of two patients were untraceable, leaving 208 fistulae in 199 patients (89 female and 110 male) available for survival analysis. All patients undergoing vascular access surgery were entered prospectively on a computerised database from which immediate complications could be assessed.

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* Please address all correspondence to: C. P. Gibbons, Department of Vascular Surgery, Morriston Hospital, Swansea SA6 6NL, U.K.
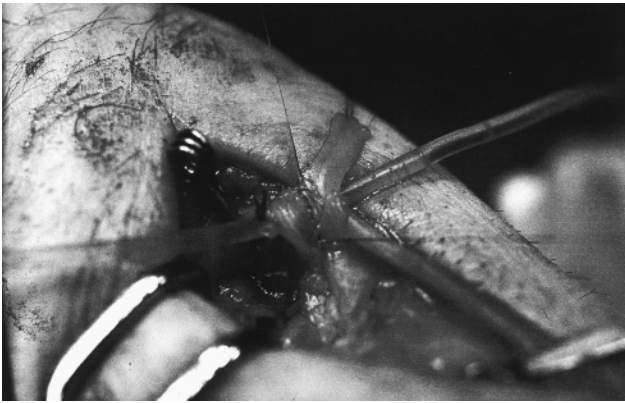
Fig. 1. A snuffbox AV fistula under construction.

Fig. 2. The completed snuffbox AV fistula.

Long-term patency was determined by referring to the detailed and accurate dialysis unit notes.

All patients were assessed preoperatively and, wherever possible, a fistula was constructed in the anatomical snuffbox of the non-dominant arm. Patients were considered unsuitable for a snuffbox fistula if: (a) the cephalic vein overlying the anatomical snuffbox was thrombosed, absent anatomically, or appeared to be smaller than 3 mm in diameter during proximal venous occlusion, or (b) a radial pulse was not palpable at the wrist. Such patients had an AV fistula created at a more proximal site. Occasionally the snuffbox was explored speculatively in obese patients when a suitable vein was not apparent preoperatively. In some of these patients suitable veins were found. The absence of the ulnar pulse and presence of diabetes and smoking were not viewed as contraindications. Access surgery was almost exclusively performed on a dedicated weekly local anaesthetic list.

Surgical technique

The procedure was performed under local anaesthesia (0.5% bupivacaine) and sedation (diazepam 5–10 mg i.v.) following a single dose of prophylactic antibiotic (cefuroxime 750 mg i.v.). A longitudinal 3–4 cm skin incision over the anatomical snuffbox was used, as this was found to give good access to both vein and artery. An end-to-side fistula was created between the cephalic vein and the radial artery, using continuous polypropylene sutures (6/0 Prolene, Ethicon) with the aid of magnifying loupes (Figs 1 and 2). A palpable thrill was taken as an indicator of good function. In some cases of immediate failure, patency was restored using a No. 2 or 3 embolectomy catheter. Patients whose fistulae failed after leaving the operating theatre were, in general, not re-explored immediately and a

Fig. 3. A mature snuffbox AV fistula to demonstrate the length of vein available for dialysis.

Fig. 4. A snuffbox AV fistula during dialysis to demonstrate the distal needle placement.

more proximal fistula was created electively at a later date.

Whenever possible, the fistula was allowed to mature for 6 weeks, by which time the cephalic vein had usually developed sufficiently for needling (Figs 3 and 4). In the meantime, haemodialysis was accomplished using a temporary double-lumen central venous line.

Table 1. Distribution of access procedures among 645 fistulae.

	Procedure no.*			
	1st	2nd	3rd	4th and 5th
Total	376	161	69	39
Snuffbox fistula	189	15	6	0

* Procedure no. = No. of previous vascular access procedures + 1.

Most patients were given aspirin 75 mg daily and dipyridamole 100 mg three times a day post-operatively.

Outcome

The outcome was classified as follows:

(1) Patients whose fistulae failed, usually as a result of thrombosis. Two subgroups were distinguished:
(a) Early failure within 6 weeks, before the fistula could be used for haemodialysis, including immediate thrombosis within 24 h, and
(b) late failure. Fistulae that were patent but never developed adequately to be used for dialysis were regarded as failures at 6 weeks.
(2) Patients who died with a functioning fistula.
(3) Patients who underwent successful renal transplantation with a functioning fistula.
(4) Patients whose fistulae continued to function at the time of data analysis.

The patients in groups 2–4 above were considered to be lost to follow-up and the data were treated as right-censored at the time of death, transplantation or at the time of data analysis, respectively.

Primary patency rates were subjected to survival analysis according to the method of Kaplan and Meier.[15] Comparisons of survival curves were made by the method of Cox proportional hazards for diabetics vs. non-diabetics, males vs. females, left vs. right fistulae and patients in whom dialysis was commenced before the formation of a fistula vs. those in whom a fistula was constructed first. Analyses were performed assuming right-censored data, using a commercial statistical software package (SYSTAT 7.0, SPSS Inc., Chicago, U.S.A.)

Results

Out of 645 vascular access procedures performed during a 12-year period, 210 fistulae (33%) were created in the anatomical snuffbox. There were 376 primary vascular access procedures, of which 189 (50%) were snuffbox fistulae (Table 1). Over the same period only
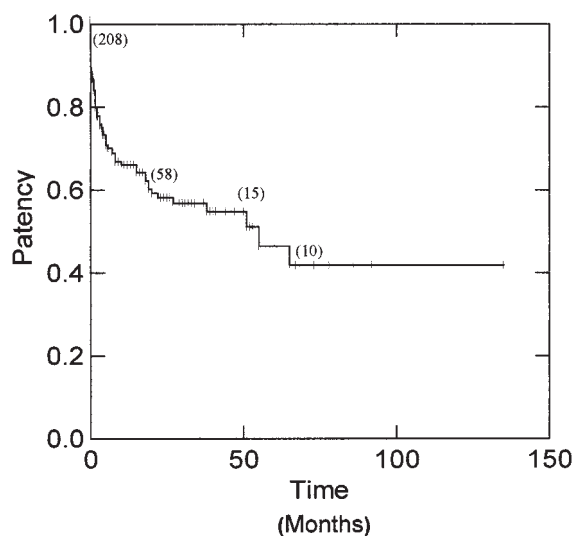
Fig. 5. Survival analysis (Kaplan–Meier) for patency of 208 snuffbox AV fistulae. (Number of fistulae at risk in parenthesis.)

18 prosthetic AV grafts were inserted, all in patients with failed AV fistulae. Two patients, whose records were unretrievable, were excluded from the study, leaving 208 for analysis.

Patency rates (Fig. 5)

Twenty-two (11%) of the 208 fistulae failed within 24 h. A further 8 fistulae failed within 6 weeks. Eleven fistulae were patent but did not develop adequately for haemodialysis access and were therefore classified as failures at 6 weeks. The remaining 167 fistulae (80%) matured and could be used for haemodialysis within 6 weeks of construction. Among those, there were 35 (17%) late failures between 2 and 55 months. One patient underwent successful fistula thrombectomy following occlusion after 4 years and was able to continue haemodialysis, using the same snuffbox fistula for a further 19 months (this case was classified as failure at the time of first occlusion).

A further 73 patients (35%) died and 29 patients (14%) underwent successful renal transplantation with functioning fistulae. One patient recovered renal function spontaneously at one month and one was converted to continuous ambulatory peritoneal dialysis at two months. The remaining 27 patients were alive and maintained on haemodialysis using snuffbox fistulae at the time of analysis in January 1998. The longest patency was recorded in a patient who had been dialysed using the snuffbox fistula for 11 years and 3 months until death at the age of 74. The cumulative primary patency rates were 65% at 1 year, 58%
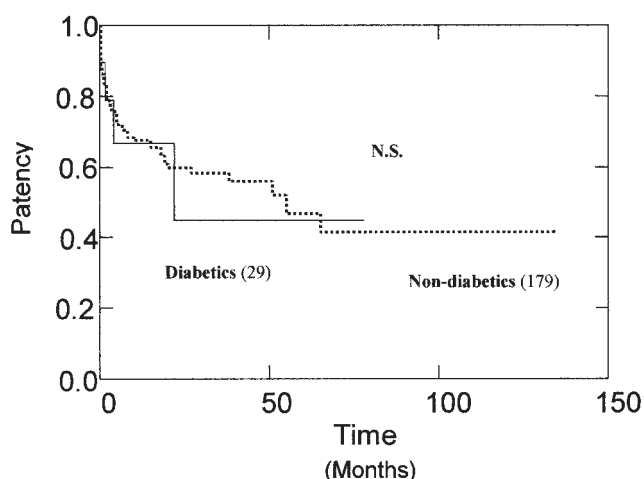
Fig. 6. Comparison of patency of snuffbox AV fistulae for diabetics and non-diabetics. (Initial numbers of fistulae at risk in each group shown in parenthesis.)
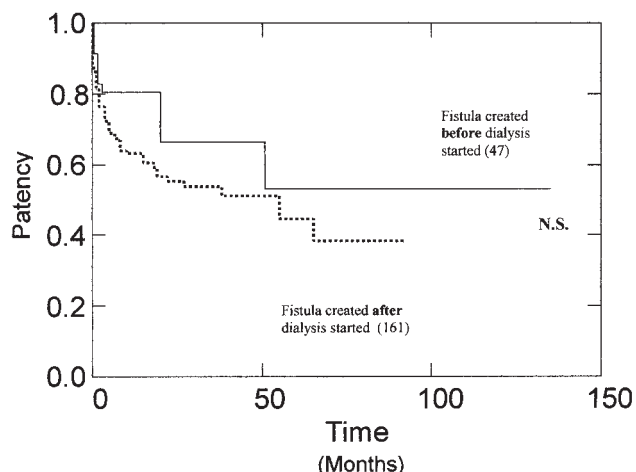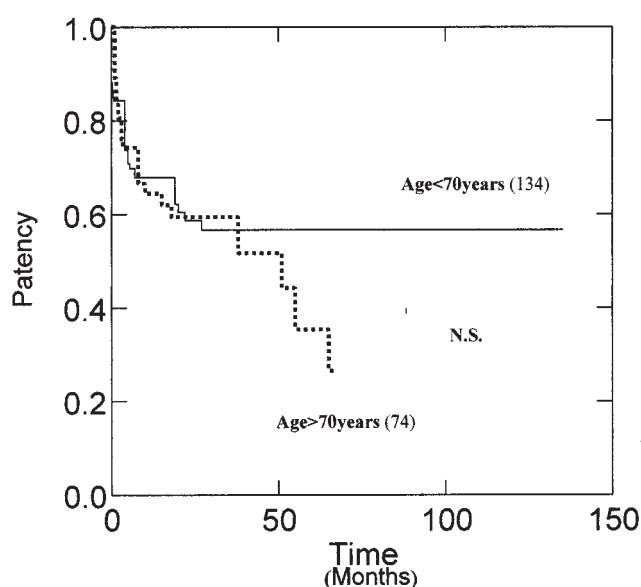

Fig. 8. Comparison of snuffbox AV fistula patency for patients less than or greater than 70 years of age. (Initial numbers of fistulae at risk in each group shown in parenthesis.)
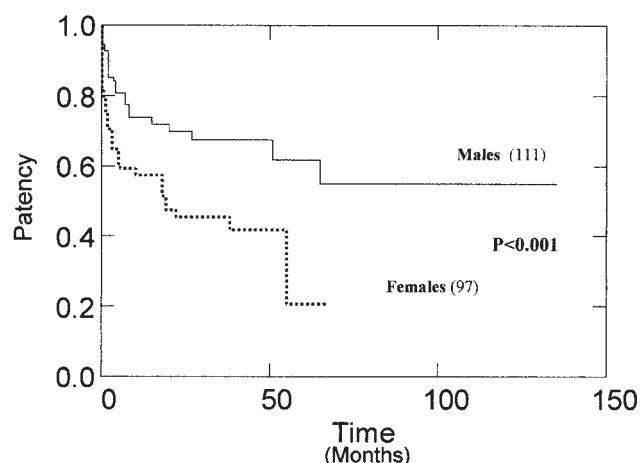

Fig. 7. Comparison of patency of snuffbox AV fistulae for patients in whom a fistula was created before dialysis with those created after the commencement of dialysis. (Initial numbers of fistulae at risk in each group shown in parenthesis.)

Fig. 9. Comparison of patency of snuffbox AV fistulae for males and females. (Initial numbers of fistulae at risk in each group shown in parenthesis.)

at 2 years, 55% at 3 years, and 45% at 5 years (Fig. 5). Mean fistula patency was 38 months.

Fistula thrombosis often occurred unexpectedly and spontaneously, although in some cases this was preceded by a rise in dialysis venous pressure and low dialysis flow rates. In two patients subclavian vein thrombosis, confirmed by venography, contributed to fistula failure.

Factors affecting fistula failure

The fistula survival curves (Fig. 6) for diabetics vs. non-diabetics were not significantly different ($\chi^2 =$

0.643; $p = 0.423$). For those in whom an AV fistula was constructed prior to the start of dialysis (Fig. 7) there was a tendency towards more prolonged patency, but this did not reach statistical significance ($\chi^2 = 1.879$; $p = 0.170$). Age of greater than 70 years failed to affect fistula survival ($\chi^2 = 0.002$; $p = 0.969$) (Fig. 8).

As shown in Fig. 9, females had significantly worse fistula survival than males ($\chi^2 = 11.30$; $p<0.001$). Right-sided fistulae also had poorer patency than left-sided fistulae ($\chi^2 = 10.79$; $p<0.001$) (Fig. 10). Right-sided fistulae were more likely to be secondary or tertiary procedures than left-sided procedures (right: 19/35;
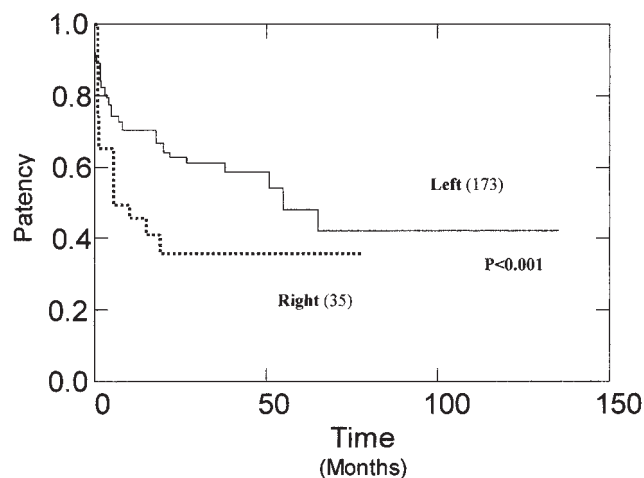
Fig. 10. Comparison of patency of left and right-sided snuffbox AV fistulae. (Initial numbers of fistulae at risk in each group shown in parenthesis.)

left: 2/173: $\chi^2 = 84.8$; $p < 0.001$) and had a greater proportion of females (right: 23/35; left: 74/173: $\chi^2 = 5.27$; $p < 0.02$).

Complications

Except for thrombosis, which was by far the commonest factor limiting the duration of fistula function, other complications were rare. Superficial skin infections at the site of incision always responded to antibiotics and no fistula was jeopardised. In one patient, who suffered uncontrollable bleeding from the puncture site four weeks after fistula creation, the bleeding site was under-run, but the fistula subsequently thrombosed. Recurrent problems with persistent bleeding from puncture sites due to thrombocytopenia prevented continued use of the fistula in a patient who changed to peritoneal dialysis (CAPD), although the fistula remained patent until he died three years later. Significant digital ischaemia developed in another patient, requiring ligation of the fistula after functioning well for ten months. There was one case of aneurysmal dilatation of the arterialised vein which thrombosed three years after renal transplantation and was excised for cosmetic reasons.

There were no deaths related to the procedure, although one patient died within one week from an unrelated cause. There were no cases of high-output cardiac failure, arm-swelling due to venous hypertension or of false aneurysms.

Further procedures

After failure of a snuffbox fistula, further vascular access was attempted in 69 patients. Of these, a standard radiocephalic AV fistula was constructed on the same side and functioned for at least three months in 31 (45%). Eighteen (26%) required brachiocephalic AV fistulae on the same side and vascular access was established in the contralateral arm in 15 (22%). Only two patients required a prosthetic graft. The remaining patients had an ulnobasilic fistula (one patient), re-fashioning of the snuffbox AV fistula (one patient) or were thrombectomised successfully (one patient).

Discussion

The present study shows that construction of a snuffbox AV fistula was feasible in 50% of patients undergoing their first vascular access procedure and in a few patients as a secondary access procedure on the opposite side to the primary fistula.

The snuffbox AV fistula has the following advantages:

- It is the most distal site for AV fistula and therefore gives a long segment of vein for needling.
- The close proximity between the radial artery and the cephalic vein in the anatomical snuffbox allows easy anastomosis without mobilisation and transposition of the vein.
- It preserves proximal vessels for creation of a further AV fistula in the case of failure, and this is often facilitated by the presence of an already arterialised vein.
- Due to the smaller calibre of the artery the risk of developing a steal phenomenon or cardiac failure is minimised.

Whilst this was a retrospective study, the data are accurate, having been retrieved from an ongoing database personally kept up-to-date by one of the authors (CPG). The timing of fistula failure could be determined from the dialysis records to within one week with confidence.

The immediate failure rate in the present series was relatively low (11%), but nevertheless only 80% of fistulae were usable after 6 weeks. These patients in whom early fistula failure occurred were usually submitted to further attempts at securing vascular access. In most cases a second or third procedure was successful but in occasional patients other options, such as CAPD or a permanent indwelling jugular venous catheter, were used. Of those that were patent

Table 2. Comparison of patency rates of snuffbox fistula (%) with other reports.

Reference	Patency (%)							
	Immediate failure	1 month	1 year	2 years	3 years	5 years	6.5 years	10 years
Bonalumi et al.[7]	10.2		83.1				46.3	
Harder, Landmann[5]			75		72			
Bartova et al.[9]		84	70					
Marx, Landmann[10]			74	67	64			
Sekar, Mnams[13]		94.8						
Simoni et al.[14]				77.3	60.1		36.3	18.9
Current study	11	82	65	58	58	45		

at 6 weeks, 20% were lost in the first year. Similarly, a further 10% were lost in the second year. The subsequent rate of fistula loss slowed to 7% per year (Fig. 5).

When a snuffbox fistula thrombosed, a standard ipsilateral wrist fistula could be constructed in almost half of the cases with ipsilateral brachiocephalic fistulae or contralateral access being established in most of the remainder. A prosthetic graft was only required in 3%.

The patency rates in the present series were slightly lower than in some other reports (Table 2). This may reflect a more liberal use of vessels of borderline suitability. However, the creation of a high proportion of snuffbox fistulae may reduce the need for more complicated secondary access procedures such as AV prosthetic grafts (only 18 out of 645 access procedures in the present series over 12 years). In some subjects, particularly the obese, preoperative assessment can be difficult. In this situation it may be worth exploring the anatomical snuffbox to visualise the vessels, as in some patients they are found to be adequate for fistula construction. Selection criteria may vary between authors: e.g. one series excluded diabetics and patients with low blood pressure.[14] Horimi et al.[16] suggested that the long-term patency of snuffbox fistulae in diabetics is significantly lower by comparison with non-diabetics, but this has not been confirmed in the present study. Another possible reason for lower patency rates could be a higher mean age by comparison with other reports,[7,14] but no effect of increasing age has been demonstrated here.

In this series and others[9,13] an end-to-side (vein-to-artery) anastomosis has been used exclusively to minimise the risk of digital ischaemia, venous hypertension or oedema, which can occur with end-to-end and side-to-side fistulae.[8,10] However, both end-to-end[7,12,14] and side-to-side[6,11] anastomoses have been used by others.

Early thrombosis of an AV fistula is attributable to technical error,[7,8] small vessels,[7,8] or proximal venous obstruction.[17] It has also been suggested that fistula formation in patients who have started haemodialysis using temporary access is associated with a higher incidence of early fistula failure.[17] The present study would tend to confirm this, although statistical significance was not reached.

In this series, female gender and a right-sided fistula were significant factors adversely affecting fistula patency both in the short and long term. It would seem likely that this can be attributed to smaller vessels in women and poorer veins in those patients in whom the dominant hand was used following failure of a non-dominant fistula. In support of the latter, there was a greater proportion of secondary or tertiary procedures in the right-sided fistula group. The relatively poorer patency in females suggests that a more proximal fistula may be wise in women with smaller veins. However, a similar trend has been recently found in standard wrist fistulae.[18]

After maturation of the snuffbox fistula, blood flow and ease of needling are similar to that of the classical Brescia–Cimino fistula, except that a longer length of vein is usually available in the forearm. However, in eleven cases the cephalic vein never dilated adequately to be used for haemodialysis, despite an audible bruit or a palpable thrill.

Subclavian vein occlusion, confirmed by venography, contributed to fistula failure in two patients. Subclavian vein stenosis or occlusion can occur in up to 50% of patients who have had an indwelling subclavian catheter.[17] Routine preoperative subclavian duplex scanning could detect this but has not been used here. Temporary haemodialysis access via the internal jugular vein on the side contralateral to the proposed permanent access site may be preferable,[17,19] but this is not always feasible.

In this hospital there is a weekly half-day operating list, which is reserved for local-anaesthetic vascular access surgery. This provides a regular service and easy planning with a reduced risk of cancellation, and allows for the adequate attention that these patients require.

Despite its infrequent use in the United Kingdom, the snuffbox AV fistula is safe and easy to perform, has good function, and can be used for primary vascular access in about half the dialysis population. However, a more proximal fistula may be wise in women with small vessels.

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