Distal-to-Snuffbox Arteriovenous Fistula

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Int J Angiol 2018;27:227–231.

Abstract

The dogma for optimal arteriovenous fistula (AVF) creation is based on starting as distally as possible on the upper limb and progressing proximally. We herein present our findings of an AVF that is as distal as possible on the hand. To document primary patency rates of the distal-to-snuffbox AVF. A 10-year prospective study (2006–2016) involving 31 patients whose distal cephalic vein diameter was ≥ 3 mm with a normal Allen's test was conducted. Patients were excluded if the radial artery in the wrist was highly calcified, the cephalic vein did not dilate more than 3 mm with proximal compression, and there was previously failed AVF of the limb or previous trauma to the limb. The procedure was performed under local anesthetic, and the anastomosis performed with a 6.0 polypropylene suture in an end-to-side fashion. Thirty-one patients with end-stage renal disease underwent distal vascular access using the distal-to-snuffbox (Hitchhiker's) AVF (HAVF). During follow-up, eight patients died with an adequately functioning HAVF. The primary patency rates at 12, 24, 48, and 60 months were 90, 87, 85, and 82%, respectively. Failure occurred in six (19%) cases over the follow-up period, two in the first 2 weeks and four over a span of 60 months.

Conclusion The creation of radiocephalic AVFs in the first web space, distal to the tendon of the extensor pollicis longus, serves as a viable option with acceptable success rates. This allows the surgeon more options with proper patient selection for this procedure.

Keywords

- vascular access
- kidney
- hemodialysis
- fistula
- distal

The history of vascular access for hemodialysis was first highlighted in the 1960s with the description of the Scribner shunt.¹ Brescia et al described the first surgically created AVF for chronic hemodialysis.² The use of the anatomical snuffbox for the creation of an AVF was later described,³ with further studies highlighting its success rate.^{4–6} This study documents a decade of experience by two vascular units performing AVF in the first web space distal to the anatomical snuffbox and the tendon of the extensor pollicis longus (EPL).

Methods

Over a decade (2006–2016), 31 patients had a distal-to-snuffbox AVF or Hitchhiker's AVF (HAVF) for hemodialysis secondary to end-stage renal disease (ESRD). Venous Duplex scans were

performed according to the standard protocol.⁷ Inclusion criteria included the following: distal cephalic vein diameter ≥ 3 mm as evidenced on preoperative duplex scanning, a normal Allen's test, and a palpable radial pulse at the distal-to-snuffbox site. Patients were excluded from our procedure and considered for a proximal procedure if: (1) the radial artery in the wrist was highly calcified, (2) the cephalic vein did not dilate more than 3 mm with proximal compression, (3) there was a previously failed AVF surgery on ipsilateral upper limb, (4) there was previous trauma to the upper limb, and (5) there was any neurologic deficit in the upper limb. Consent was obtained from all patients prior to the surgical procedure once they met the inclusion criteria. Patients were followed up at 2 weeks, 2 months, and biannually thereafter. Fistula adequacy was defined as the ability to use it for hemodialysis with two

needles and a blood flow of at least 350 mL/minute on at least six dialysis sessions in 1 month.⁸

Age, sex, ethnicity, diabetes mellitus, hypertension, hand used, and vein diameter was compared with patency. A 5-year follow-up of the fistulas was projected to show the patency rates. The variables that affected patency rates were also analyzed, and a 95% confidence interval (CI) was used. Data were analyzed using Statistical Package for the Social Sciences (SPSS v.22; IBM Corp.), and a *p*-value of <0.05 was considered statistically significant.

Of note, the patients in the Trinidad and Tobago region are commonly referred quite late for vascular access, resulting in many patients being not suitable for distal AVFs due to injudicious cannulation and thrombosis of the distal veins by emergency physicians. Additionally, many patients are poorly controlled diabetics and consequently have poor quality radial and ulnar arteries. Many patients did not fit the criteria that we have set and therefore explains the low patient numbers in this particular series.

No comparison was conducted in relation to other types of fistulas in this study.

Surgical Technique

The artery and vein within the first web space, just distal to the tendon of the EPL, are marked (► **Figs. 1** and **2**) and the procedure is performed using surgical loupes with a magnification of $3.5 \times$. Local anesthetic without adrenalin is infiltrated in the area, and an incision of about 2 cm is made approximately parallel to the EPL tendon. Anatomically, the radial artery is deep and in close proximity to the cephalic vein at this site. The radial artery is dissected and mobilized, and an approximately 1 cm arteriotomy is made. The vein is then mobilized, transected, and spatulated with care taken to remove any valve leaflets at the proposed point of anastomosis. The distal segment of the vein is ligated. After standard irrigation and preparation, the cephalic vein is anastomosed to the radial artery in an end-to-side fashion using a continuous 6.0 polypropylene suture (► **Fig. 3**). The presence of a thrill and bruit is then used to determine immediate patency.

Fig. 2 Photo of the hand demonstrating the location of the fistula distal to the anatomical snuffbox.

Fig. 3 Photo showing the small incision and close proximity of the radial artery to the cephalic vein distal to the extensor pollicis tendon with anastomosis in progress.

Fig. 1 Diagram showing the anatomical relations to the distal-to-snuffbox site.

Results

Over a period of 4 years, 31 patients with ESRD underwent distal vascular access using HAVF. During follow-up, eight patients died with a functional HAVF. There were 21 (68%) males and 10 (32%) females with a mean age of 57 years. Twenty-five (81%) patients were diabetic and 21 (68%) were hypertensive. Two patients had polycystic kidney disease and one had glomerulonephritis. Age, gender, ethnicity, diabetes mellitus, hypertension, hand used, and vein diameter were compared with patency (►Table 1). No statistical difference was found between gender ($p = 0.95$), ethnicity ($p = 0.69$), diabetes mellitus ($p = 0.85$), hypertension ($p = 0.36$), hand used ($p = 0.41$), and vein diameter ($p = 0.86$) compared with patency using Students' t -test (►Table 1) and Cox proportional hazards regression analysis (►Table 2).

Access failure occurred in six cases (2 in the first 2 weeks and 4 over 60 months), with primary patency rates at 12, 24, 48, and 60 months being 90, 87, 84, and 81%, respectively,

Table 1 Analysis of factors and associated patency rates in 31 consecutive patients

Variable	Distal-to-snuffbox fistula		p-Value
	Patent, n = 25 (%)	Occluded, n = 6 (%)	
Gender			
Male	17 (55)	4 (13)	0.95
Female	8 (26)	2 (6)	
Age (SD) in years	52 (7.27)	54.52 (8.74)	<0.001
Diabetes mellitus			
Yes	20 (65)	5 (16)	0.85
No	5 (16)	1 (3)	
Ethnicity			
Afro-Trinidadian	10 (32)	2 (6)	0.69
Indo-Trinidadian	13 (42)	4 (13)	
Mixed Trinidadian	2 (6)	0 (0)	
HTN			
Yes	16 (52)	5 (16)	0.36
No	9 (29)	1 (3)	
Hand used			
Right	8 (26)	3 (10)	0.41
Left	17 (55)	3 (10)	
Vein diameter			
3	19 (61)	4 (13)	0.86
3.1	2 (6)	1 (3)	
3.2	3 (10)	1 (3)	
3.3	1 (3)	0 (0)	

Abbreviation: HTN, hypertension.

Note: Student's t -test was used to compare age with patency. Chi-square tests were used to compare gender, ethnicity, diabetes mellitus, HTN, hand used, and vein diameter with patency.

Table 2 Cox proportional hazards regression analysis was used to determine which variables affected patency rates and presented as HR and 95% CI

Variable	SE	HR	95% CI	p-Value
Sex				
Male	1.02	0.52	0.07–3.80	0.52
Female		1		
Age	0.05	0.97	0.87–1.07	0.52
Diabetes mellitus				
Yes	1.34	0.40	0.03–5.52	0.50
No		1		
HTN				
Yes	1.26	0.34	0.03–4.07	0.40
No		1		
Hand used				
Right	0.98	2.33	0.34–15.85	0.39
Left		1		

Abbreviations: CI, confidence interval; HR, hazard ratio; HTN, hypertension; SE, standard error.

and is demonstrated by the Kaplan–Meier survival curve shown in ►Fig. 4 (standard error: 3.472).

One fistula thrombosed 2 weeks postoperatively during hospitalization for septic shock in a poorly controlled diabetic. The second fistula thrombosed at 2 weeks due to poor flow rates secondary to atherosclerotic disease. In one diabetic patient, failure occurred at 4 months, thrombectomy was unsuccessful, and a Brescia–Cimino AVF was performed, which remained patent for 5 years. The other three patients thrombosed at 12, 24, and 48 months. Patients with diabetes mellitus are 0.4 times more likely to have a failure than nondiabetics, and patients with hypertension are 0.34 more likely to have a failure (►Table 2). However, none of these variables were statistically significant.

There were no major complications from the procedure, such as hematoma, infection, false aneurysm, steal syndrome, and high-output cardiac failure.

Discussion

After the observation that in some people the vein distal to the snuffbox is quite large, in the same area, there is an easily palpated radial artery pulse. We decided to explore this site beyond the tendon of the EPL in the first web space of the hand, which we referred to as the “distal-to-snuffbox arteriovenous fistula or Hitchhiker's fistula” (HAVF). We referred to it in this way since extension of the thumb to locate “the distal-to-snuffbox” site is like putting up one's thumb as though one is hitchhiking, hence the genesis of the name. The patency rate at 1 month was 94%, representing early technical success. The patency rate at 4 months, however, was 90% and at 1 year was 87%. This was done in only clinically

Fig. 4 Kaplan-Meier survival curve. The 5-year follow-up of the fistulas was analyzed with the Kaplan-Meier survival analysis (standard error: 3.472).

suitable cases, as described in the inclusion criteria earlier. No comparison was done to the snuffbox AVF.

In a review of the factors that may contribute to failure, Suttie et al in 2012 found that the type of upper limb fistula did not impact on failure rates. In particular, they compared radiocephalic, brachiocephalic, and brachio basilic grafts.⁹ We also noted that in our population, there is a different ethnic background compared with populations where most of the research has taken place. Of note, we had 10 Afro-Trinidadians, 13 Indo-Trinidadians, and 2 mixed Trinidadians. It is noteworthy that in a study conducted by Ishaque et al in 2012, it was highlighted that Afro-American men have smaller diameter veins in the upper limb and therefore had a higher risk of failure.¹⁰

When compared with the data on snuffbox AVF, our short-term patency rates are similar, whereas long-term patency rates are superior for HAVF.^{11–15} In the study by Simoni et al in 1994,¹³ the primary patency rate at 1 year was 77%. In the study by Wolowczyk et al in 2000,¹⁴ the failure rate at 24 hours, was 11% with a primary patency rate of 65% at 1 year and 45% at 5 years. The study by Lee and Sara in 2000¹⁵ showed a patency rate of 83% at 4 to 6 weeks. These results are in keeping with ours where we had two failures (6%) within 1 month, with better long-term primary patency rates at 12, 24, and 48 to 60 months being 87, 84, and 81%, respectively.

It is also noteworthy that the more distally one goes in the hand, the artery and vein are in closer proximity, requiring less dissection, less local anesthesia, and smaller incisions. This decreases the likelihood of infection and less chance of tension at the anastomotic site by our observation. Additionally, distal AVFs are associated with a very small chance of steal syndrome and cardiac embarrassment. As a result, we had no major

complications from the procedure. The predictors of primary snuffbox failure include diabetes, ischemic heart disease, stroke, two snuffbox procedures, age > 70 years, and vein diameter < 2 mm, which has been shown in the study by Twine et al in 2012.¹⁶ In our series, though most patients were diabetic, the other criteria were virtually absent and may account for our superior patency rates. We were also very careful in our selection criteria with exclusion of patients with the following: (1) the radial artery in the wrist was highly calcified, (2) the cephalic vein did not dilate more than 3 mm with proximal compression, (3) there was a previously failed AVF surgery on ipsilateral upper limb, (4) there was previous trauma to the upper limb, and (5) there was any neurologic deficit in the upper limb.

Similar studies show a direct link between diabetic nephropathy and AVF failure.^{17–19} Some studies also report a higher failure rate in women due to the small caliber of the veins of the upper limb.²⁰ Our relatively low failure rate in females may, in part, be due to the inclusion of patients with a vein diameter greater than 3 mm.

With regard to distal ligation to the cephalic vein in the hand, it does not appear to affect patency of the AVF in our study, as demonstrated in the study by Beigi et al in 2009.²¹ In conclusion, the first web space or distal-to-snuffbox HAVF has proven to be a simple and safe option while performing an AVF from this analysis. While the series is small, it was carefully done with well-defined selection criteria. This technique offers the vascular access surgeon more options with no added risk. This technique, while appearing durable, requires further research to properly define the inclusion criteria and possibly develop a scoring system to give credibility to the procedure.

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