European Journal of Vascular and Endovascular Surgery 44 (2012) 88–91

Contents lists available at SciVerse ScienceDirect

European Journal of Vascular and Endovascular Surgery

journal homepage: www.ejves.com

A Scoring System (DISTAL) for Predicting Failure of Snuffbox Arteriovenous Fistulas

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WHAT THIS PAPER ADDS

- Even though snuffbox fistulas have high patency rates published from centres familiar with the technique, many are reticent to perform them or have published poor patency data for dialysed populations. While many factors have been associated with fistula failure, this paper is the first to synthesise significant factors into a score which would facilitate clinical decision making; not only for creating a snuffbox fistula but for identifying patients who are more suitable for a more proximal first fistula. If DISTAL can be externally validated it could be an important step towards improving the renal registry data for fistula prevalent populations.

ARTICLE INFO

Article history:
Received 10 January 2012
Accepted 16 March 2012
Available online 17 April 2012

Keywords:
Arteriovenous fistula
Vascular patency
Risk factor
Scoring method

ABSTRACT

Objectives: A first fistula failing will lead to serious morbidity in a proportion of patients. Snuffbox fistulas have the advantage of proximal vessel preservation, and although several factors have been associated with failure, the relative importance of these factors combined and their clinical applicability is unknown. The aim of this study was to determine the relative importance of risk factors for snuffbox fistula failure and create a simple scoring system to aid fistula placement decision making.

Methods: 218 consecutive patients were examined using Cox regression analysis to determine risk factors for failure. Primary patency was used as the endpoint.

Results: Diabetes, IHD, Stroke, Two snuffbox procedures, Age $>$ 70 and Less than 2.0 mm vein (DISTAL, maximum score 6) were significant predictors of primary patency failure. There was a clear decrease in primary patency with increasing DISTAL score (log rank $\chi^2 = 30.3$, DF = 5, $P < 0.001$). Performing snuffbox procedures on patients with a score $\leq$3 would give a 23% reduction in the number of failures within two months for a 12% reduction in the number of patients offered snuffbox procedures.

Conclusion: The DISTAL scoring system could give large improvements in primary patency for the snuffbox fistula if the results can be validated in other datasets.

Introduction

The anatomical snuffbox fistula may be the first considered in any patient requiring haemodialysis access. It was technically possible in around 50% of patients in this unit and failure still leaves several options for a fistula available on that limb.[1] Half of those with failed snuffbox fistulas will even be suitable for an ipsilateral wrist radiocephalic fistula.[1]

Although a one year primary patency of 65% is expected for snuffbox fistulas, 20% fail or fail to mature within six weeks.[1,2] A proportion of patients who require dialysis urgently will experience significant morbidity as a result and subsequent central venous catheter insertion is associated with significant morbidity and mortality, especially with long term use.[3] Central venous stenosis may also result and lead to a subsequent fistula failure.

Patients who require dialysis urgently need a balance to be struck between a high probability of fistula success and the possibility of future fistula creation. For example, if a patient anatomically suitable for a snuffbox fistula was known to have a very high chance of failure, a wrist fistula could be attempted instead. Knowledge of risk factors for fistula failure is required to guide this

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1078-5884/$ – see front matter
doi:10.1016/j.ejvs.2012.03.014

decision. The influence of patient age has been studied extensively.[4,5] Venous and arterial duplex findings are known to be prognostically useful,[6] and diabetes has been associated with fistula failure.[7] However, few studies have attempted to rationalise or combine the relative importance of individual factors associated with fistula failure. Furthermore, very little has been published specifically on risk factors for the snuffbox fistula. The aim of this study was therefore to determine the relative importance of risk factors for primary snuffbox fistula failure. The endpoint was to create a simple scoring system to aid fistula placement decision making.

Methods

Consecutive patients undergoing snuffbox fistula formation at Morriston Hospital, Swansea between 1st July 2007 and 1st July 2011 had details prospectively recorded for the UK Renal Registry which conducts a prospective audit of results by unit performing haemodialysis access procedures. Variables included patient demographics, arterial and venous measurements, comorbidities and operative details. Specialist dialysis access nurses also recorded prospective data into a separate computer programme. Any data missing from these databases were hand searched from patient notes. Operations were performed by, or under the supervision of, three specialist vascular surgeons. The criteria for decision making for access planning and surgical technique has been published previously.[1]

Fistula planning

All patients underwent a full preoperative arterial and venous duplex within 2 weeks of the procedure and careful postoperative follow up by specialist dialysis access nurses. A full decision making protocol was published previously.[1] Each year the unit performs around 280 fistulas, 70–75% of which were radial fistulas. Of these, around a third were snuffbox fistulas (25% of all fistulas).

If the first snuffbox fistula failed, choice of second fistula site was usually the ipsylateral wrist then forearm. Once there were no further ipsilateral forearm options the contralateral snuffbox was used for access if needed.

The focus of this study was on snuffbox fistulas, so wrist fistulas were not examined. Arterial and venous diameter measurements would have been different between the two procedures making combined statistical analysis difficult.

Score derivation

Due to the small size of the cohort and limited subsequent limited statistical power we focussed on factors known to influence primary patency.[1,4,7] This was supplemented by an initial Cox regression model examining all available variables. A history of claudication, lower limb ulceration or ischaemic amputation were considered as peripheral vascular disease (PVD). Ischaemic heart disease (IHD) was defined as any previous myocardial infarction, proven angina and coronary vascular disease on angiography. Cerebrovascular accident/Stroke (CVA) was defined by a previous CT proven infarct or haemorrhage. Diabetes included patients taking insulin or oral hypoglycaemic agents. Smoking included patients admitting to currently smoking. Antiplatelet use could not be examined as all patients are commenced on them after fistula surgery.[8] Covariates requiring stratification were examined by Kaplin Meier log rank analysis at bivariate strata around the median, and the most significant was chosen.

Patients who died before their fistula was used ($n = 2$) had fistula outcome truncated at time of death. The statistical power to perform reliable multivariate modelling was not available in this dataset,[9,10] so variables were chosen for inclusion by being a univariate predictor of primary patency with a significance of $p \leq 0.1$. Each significant bivariate risk factor was allocated integer values of 0 and 1, the overall predictive value being the sum.[11,12]

Statistical analysis appropriate for non-parametric data was used. Cox's proportional hazards logistic regression was used to assess the prognostic value of individual covariates.[13] Log rank analysis from Kaplan Meier estimates were used to compare survival for 5 years of follow up, but 2 year data is reported due to the high attrition rate after this time.[14] Data analysis was carried out with the Statistical Package for Social Sciences (SPSS) version 16 (SPSS, Chicago, Illinois, USA). Ethical approval was sought from the Regional Ethics Committee.

Results

Two hundred and eighteen patients underwent snuffbox fistula formation. The commonest causes of renal failure were diabetes (34 patients, 15.6%), renovascular disease (41, 18.8%), idiopathic (30, 13.8%) and glomerulonephritis (30, 12.8%). The median patient age was 69 (range 18–87). Thirty one (14%) of these failed within 2 months. A further 13 (6%) did not mature adequately for haemodialysis and were therefore considered failed at 6 weeks. Four patients had functioning fistulas but did not require haemodialysis. The remaining 170 (78%) matured without loss of primary patency and were used for haemodialysis within 8 weeks of construction.

Loss of primary patency and use of the fistula for dialysis were both assessed as endpoints by Cox regression. There were no differences in variable outcomes between the two endpoints, with less power in the latter group. Primary patency was therefore chosen as the primary endpoint.

Loss of primary patency and score derivation

The median primary patency was 42 months. Cumulative 6 month 1 and 2 year patency was 69%, 61% and 53% respectively. Table 1 shows the risk of loss of primary patency in relation to potential risk factors. In addition, there was no difference in primary patency by operating surgeon (HR = 1.10 (0.79–1.52), $P = 0.588$). The most significant age strata predicting failure was 70 years old ($P = 0.034$). The most significant venous diameter strata predicting failure was 2.0 mm ($P = 0.032$), and the most

Table 1
Risk of failure of primary patency in relation to potential risk factors.

	No. of patients	HR (95% CI)	*P*
Variables			
Age > 70	98 vs 120	1.58 (1.04–2.42)	0.034
Second snuffbox procedure	12 vs 206	2.16 (0.93–5.00)	0.071
Venous diameter[a] ≤2.0 mm	51 vs 167	1.56 (0.99–2.47)	0.056
IHD	136 vs 82	1.56 (1.00–2.42)	0.048
CVA	18 vs 200	1.76 (0.90–3.42)	0.096
Diabetes	52 vs 166	1.54 (0.97–2.43)	0.068
Non-significant variables			
Laterality L vs R	185 vs 33	1.06 (0.58–1.90)	0.860
Gender M vs F	164 vs 54	0.75 (0.47–1.18)	0.214
Arterial diameter[a] ≥2.5 mm[b]	127 vs 91	0.80 (0.52–1.22)	0.298
Smoking	35 vs 183	0.51 (0.16–1.61)	0.250
PVD	31 vs 187	1.30 (0.57–2.99)	0.535

HR = Hazard ratio from univariate Cox regression, *P* = significance of risk association between the two cohorts, IHD = Ischaemic heart disease, CVA = cerebrovascular disease, PVD = Peripheral vascular disease.
[a] At anatomical snuffbox.
[b] Non-significant at any strata.

Table 2
Primary patency failure associated with DISTAL score.

DISTAL	No. of patients (%)	Primary patency (%)			
		2 months	6 months	1 years	2 years
0	45 (20.6)	93	93	93	85
1	79 (36.2)	90	73	69	62
2	60 (27.5)	80	60	58	44
3	25 (11.5)	75	68	63	39
4	6 (2.8)	73	50	20	20
5	3 (1.4)	0	0	0	0
6	0	–	–	–	–

significant arterial diameter was 2.5 mm ($P = 0.029$). The variables most significantly predicting loss of primary patency were: a second, contralateral snuffbox fistula after a first snuffbox fistula and ipsilateral access had failed; venous diameter of ≤2.0 mm; presence of IHD; previous CVA and diabetes. The resulting risk score was therefore: Age > 70 years old = 1; Second, contralateral procedure = 1; venous diameter ≤2.0 mm = 1; IHD = 1; CVA = 1; Diabetes = 1. The score was termed DISTAL (Diabetes, IHD, Stroke, Two snuffbox procedures (second, contralateral procedure), Age > 70, Less than 2.0 mm vein). The maximum cumulative score was 6.

Table 2 shows loss of patency associated with DISTAL score. The three strata analysed were 0–2, 3 and 4–6. No patients scored 6. There was a clear trend for decreasing primary patency by increasing DISTAL score (log rank $\chi^2 = 30.3$, DF = 5, $P < 0.001$). Although the number of patients with DISTAL 4–6 were low ($n = 9$, 4.2%), primary patency between 2 and 6 months was far below the 65% suggested for commencement of haemodialysis.[15] DISTAL 2 and 3 appear broadly comparable, however the number of patients with a score of 3 was very low ($n = 25$), and attrition above 6 months was high. DISTAL 3 was therefore considered separately when grouping by score (Fig. 1). The three DISTAL strata were examined using Cox regression to determine the risk of loss of primary patency (Table 3).

Secondary patency and likelihood of fistula salvage by DISTAL score

There was no significant overall difference between primary and secondary patency results. Sixteen (10%) of the 170 mature fistulas underwent intervention to maintain patency. Of those: two

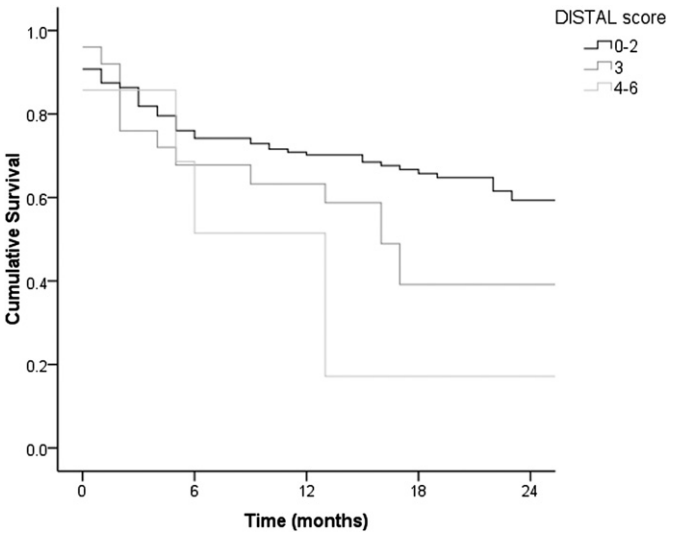

Figure 1. Primary patency by grouped DISTAL score. Log rank χ^2 7.734, DF = 2, $P = 0.021$.

Table 3
Risk of failure of primary patency in relation to DISTAL score.

DISTAL	No. of patients (%)	HR (95% CI)	*P*
0–2	184 (84.4)	0.52 (0.31–0.86)	0.011
3	25 (11.4)	1.31 (0.99–1.73)	0.061
4–6	9 (4.2)	1.35 (0.98–1.78)	0.073

underwent open fistulaplasty; three were proximalised to the radial artery at the wrist; seven required fistula outflow angioplasty (six at the proximal forearm, one mid forearm) and four central venous angioplasty. The DISTAL score in these patients was 1 (4 patients), 2 (6 patients) and 3 (6 patients). There was no relationship between increasing DISTAL score and need for intervention ($P = 0.546$).

Discussion

The most significant factors associated with snuffbox fistula failure were grouped as the DISTAL score (Diabetes, IHD, Stroke, Two snuffbox procedures, Age > 70, Venous diameter less than 2.0 mm). In this, the largest dataset published on snuffbox fistulas, a score of three or more was highly predictive of fistula failure in a patient in whom a snuffbox fistula would technically be expected to function.

Data was collected rigorously for national audit and is broadly comparable to outcomes from the same unit 10 years previously.[1] The fact that the risk factors in the DISTAL score have been previously independently reported to predict fistula failure indicates that the score is likely to have good external validity.[4,7,16–20] Performing snuffbox fistulas in patients with a DISTAL score under 3 would result in 88% of these patients still being offered a primary snuffbox fistula with a 1 year patency of 71%. Additionally, for this 12% reduction in the number of snuffbox fistulas performed, there would be a 23% reduction in the number of early failures within 2 months. This implies that if the score could be validated in external datasets it would have an important clinical impact on a fistula service.

From this data it is impossible to predict the fate of a wrist or even brachiocephalic fistula performed on a patient with a high DISTAL score. It may be that these would also fail, and that these patients are simply at high risk of fistula loss. The predicted patency savings may therefore be false, and this would have to be carefully examined before the score was used clinically. If this proved to be the case, the score could still be useful for predicting the 'at risk' snuffbox fistula which would merit more aggressive follow up. This is the first ever attempt to rationalise fistula placement by a clinically predictive score, and as such needs validating in large independent external datasets before useful recommendations can be made.

The difference in primary patency between patients scoring DISTAL 2 and 3 is currently unclear. Patency was similar to 18 months, which may represent type II error in a small cohort of patients. This could be examined more closely in a larger dataset, as could the difference in primary patency under 6 months between patients with a score of 3 and 4–6 (Fig. 1). The size of the dataset meant that there was inadequate power for conditional Cox analysis to determine whether the factors composing DISTAL were truly independent. Univariate Cox regression is more accurate in this situation, and was successfully shown to be when deriving the original ABCD score for stroke risk after transient ischaemic attack from a similar sample size.[11] The score did not accurately predict patients requiring intervention for maintenance of patency. However, venous stenosis at sites of previous venous cannulation was the underlying reason for intervention in the majority of

patients and this would not be expected to be caused by any of the factors in DISTAL.

In the previous study from this unit 10 years ago, female sex was associated with a much poorer patency of snuffbox fistulas whereas here it was not found to be an independent variable.[21] This might suggest that the poorer patency in women found previously was related to vessel size which was not accurately assessed in the previous study where most patients were selected on clinical examination alone rather than on clinical and duplex information together. This difference could also be attributed to bias from a change in practice after the first study was published, although this was not perceived to be the case. Fistula laterality was also found previously to influence outcome[1] but was not an independent variable here. This probably represents an increased failure risk in second procedures (right sided) as was previously suggested. There is evidence that diabetes and age[4,22] may be associated with fistula failure. These formed part of the DISTAL score but were also non-significant 10 years ago.[1] Both associations may be attributed to error due to small sample size in either study or may reflect changing patterns of disease. It was also surprising that smoking and PVD were not associated with failure in this study.[7,17] While not all studies find smoking and PVD to be significant, of all risk factors smoking is the most likely to be under reported and PVD under diagnosed.

Whilst there are no comparable data for snuffbox fistulas, the overall patency rates in this study are higher than some of those quoted in the literature for wrist fistulas.[4,23–25] Since the introduction of both the US[6] and UK[15] guidelines there has been controversy as to whether a high primary patency is achievable for snuffbox or wrist fistulas. Although there is the possibility that these results are falsely high due to the retrospective collection of a minority of the data, the patency rates from this unit were remarkably consistent over the 10 years between studies.[1] Additionally, some meta-analysed primary patency rates are in agreement with these findings.[2]

The latest UK renal registry report shows that some UK units are struggling to reach an AV fistula prevalent population of greater than 85%, implying a difference between patency rates published in the literature and UK clinical practice.[26] This continuing debate serves to reinforce the need for further improvements in fistula practice, which a scoring system like DISTAL could be a step towards.

The increasing prevalence of haemodialysis[27] makes it ever important that the first fistula received by a patient functions primarily and for a significant period of time. The snuffbox fistula provides acceptable primary patency rates with the advantage of preservation of proximal vessels for future access. Successful primary patency of a snuffbox fistula could be predicted by a score based on the presence of Diabetes, IHD, Stroke, Two snuffbox procedures, Age $>$ 70 and Less than 2.0 mm vein (DISTAL). If DISTAL can be externally validated it would be an important first step towards improving fistula outcomes by rationalising placement.

Conflict of Interest

None.

Sources of Funding

None.

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