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Comparison of radiocephalic fistulas placed in the proximal forearm and in the wrist

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Abstract

Background—Non-maturation is a common problem in patients receiving an arteriovenous fistula. The first vascular access choice in hemodialysis patients is a distal radiocephalic fistula (dRCF) placed at the wrist. In patients with a failed dRCF or those with vessels unsuitable for a dRCF, the current recommendation is to place a brachiocephalic fistula in the upper arm. Proximal forearm radiocephalic fistulas (pRCF) are created infrequently, but may permit a second forearm fistula before proceeding to the upper arm. The goal of the present study was to compare the outcomes of pRCF and dRCF placed at a single large dialysis center.

Methods—We retrospectively analyzed a prospective, computerized access database to compare the outcomes of 19 RCF and 39 dRCF placed during an six-month period. Primary failure was defined as inability to cannulate a fistula reproducibly for dialysis. Cumulative survival was defined as the time from fistula creation to its permanent failure.

Results—The baseline characteristics of the two patient groups were similar, except that those with a pRCF were more likely to have had a previous access and less likely to be female. Primary failure (non-maturation) was lower for pRCF than dRCF (32 vs 59%, $P=0.05$). After excluding secondary failures, cumulative fistula survival was similar for pRCF and dRCF (92 vs 86% at 1 yr and 74 vs 76% at 2 yr, $p=0.56$).

Conclusion—A pRCF may be an attractive alternative to a brachiocephalic fistula in patients who cannot receive a dRCF. A pRCF has a lower non-maturation rate than that of a dRCF, and a comparable cumulative survival once it is used successfully for dialysis.

Index words

Proximal radial artery fistula; PRAVF; upper forearm fistula

Introduction

Arteriovenous fistulas are the preferred type of vascular access for hemodialysis [1]. As compared with grafts, they have longer survival and require fewer interventions to maintain

long term patency, once they are cannulated successfully for dialysis [2]. However, a substantial proportion (20 to 60%) of new fistulas fail to mature after their creation [3, 4]. The non-maturation rate is greater for distal radiocephalic fistulas (dRCF) placed at the wrist than for brachiocephalic fistulas placed in the upper arm [5, 6]. The non-maturation rate of dRCF is particularly poor in women and older patients [7]. When a dRCF fails to mature or when preoperative mapping indicates there are no suitable vessels for creation of a wrist fistula, current guidelines recommend placement of an upper arm brachiocephalic fistula [1].

An alternative option, which is used infrequently in such patients, is to create a proximal radiocephalic arteriovenous fistula (pRCF) between the proximal radial artery and the cephalic vein [8]. Creation of a pRCF is an attractive alternative, as it delays the need to proceed to a more proximal location, while still preserving the option for future placement of a brachiocephalic fistula. A recent large series of 105 consecutive patients receiving a pRCF reported a 91% primary patency after a mean follow-up of 11 months, which was comparable to that obtained in a concurrent group of patients receiving a dRCF [9]. In patients who had not yet started dialysis fistula maturity was assessed by clinical evaluation.

The goal of the current study was to compare the outcomes of pRCF and dRCF at a single, large dialysis center. We retrospectively analyzed a prospective, computerized access database to perform this comparison. The primary study outcome was fistula non-maturation, and the secondary outcome was cumulative survival of fistulas that were successfully used for dialysis.

Methods

Patient population

Ten nephrologists at the University of Alabama at Birmingham (UAB) provided care for about 600 dialysis and 300 chronic kidney disease patients. The vast majority (>95%) of access surgeries, subsequent access revisions and interventions, and hospitalizations were provided at UAB Hospital. The patients dialyzed at five outpatient hemodialysis units in the metropolitan Birmingham area.

Access procedures

All patients underwent preoperative ultrasound vascular mapping, which was used by the surgeon to determine the optimal type and location of vascular access [10, 11]. The minimal criteria for creation of a native fistula was an arterial diameter ≥ 2.0 mm, a venous diameter ≥ 2.5 mm, and absence of stenosis or thrombosis in the draining vein. The venous diameters were measured after application of a tourniquet [12]. Patients whose vessels were unsuitable for creation of a radiocephalic fistula at the wrist (dRCF) were considered for a more proximal fistula, either an upper arm brachiocephalic fistula or a proximal radiocephalic fistula (pRCF).

To create a pRCF, the surgeon created a 3 to 4 cm longitudinal proximal forearm skin incision over the raphe separating the brachioradialis and the flexor carpi radialis. A self-retaining skin retractor was placed and the proximal radial artery mobilized anteriorly into the wound. The cephalic vein (or a large cephalic tributary) was mobilized. Next, a 0.6 to

1.0 cm venotomy was made, and serial sequential coronary dilators passed distally to lyse venous valves in order to increase the possibility of distal (i.e. retrograde) outflow. Clamps were then applied proximally and distally to the artery and vein. A 0.6 to 1.0 longitudinal arteriotomy was made and a side-to-side anastomosis performed between the artery and the vein using CV-8 suture (W. L. Gore & Associates, Inc.). After releasing the clamps, a bidirectional thrill was palpable in the outflow cephalic vein, both proximally and distally.

Postoperative ultrasounds were obtained liberally in patients whose fistulas were not unequivocally mature by clinical examination at 4 to 6 weeks after their creation [13]. Fistulas were considered sonographically mature if their diameter was ≥ 4 mm, access blood flow ≥ 500 ml/min, and their depth from the skin ≤ 5 mm. If the ultrasound revealed an immature fistula with potentially correctable anatomic problem (stenosis, accessory veins, or excessive depth), the patients were referred for an appropriate surgical or angiographic intervention [14]. Fistulas were usually cannulated 6 to 8 wk following their placement if they were deemed clinically mature. New fistulas were initially cannulated with 17 gauge needles at a dialysis blood flow of 250 ml/min. The needle size and dialysis blood flow were gradually increased at the dialysis nurse's discretion.

Fistulas were monitored by the nephrologists and dialysis nurses for clinical evidence of dysfunction [15]. Patients with clinical suspicion of access stenosis were referred to an interventional radiologist or nephrologist for a diagnostic fistulogram (Figure 1). Angioplasty was done in fistulas with $\geq 50\%$ stenosis. An elective surgical revision was performed if the angioplasty was unsuccessful. Thrombectomy and angioplasty of the underlying stenotic lesion was attempted in thrombosed fistulas [16]. The access was abandoned, if thrombectomy was not feasible or was unsuccessful.

Data analysis

Two full-time access coordinators scheduled all access procedures; communicated regularly with the nephrologists, access surgeons, radiologists, and dialysis staff; and maintained a prospective, computerized database of all access-related procedures and complications [17]. Permission was obtained from the UAB Institutional Review Board to retrospectively review the access database and the patients' electronic medical records for research purposes. We retrospectively queried the access database to identify 77 patients receiving a radiocephalic fistula, including 30 pRCF and 47 dRCF, during the 6-month-period from 08/01/06 to 01/31/07. A single surgeon (AMH) placed all the pRCF. The vascular access outcome was considered indeterminate if the access had not failed at the time of analysis but the patient died, received a kidney transplant, transferred to an outside dialysis unit before the access could be cannulated, or had not yet started dialysis. After excluding 19 patients with indeterminate fistula outcomes, the remaining 58 patients were the focus of the current analysis. These included 19 patients with a pRCF and 39 patients with a dRCF. Baseline demographic and clinical characteristics of the study patients were obtained from the UAB Hospital electronic medical records.

The access was considered to be clinically mature if it could be cannulated reproducibly for dialysis with two needles with a blood flow ≥ 300 ml/min for at least 1 month within 6 months of its creation. In patients who had not yet initiated dialysis, fistula maturity was

assessed during the first month after starting dialysis. A primary fistula failure was defined as inability to use the fistula for dialysis, due to either early thrombosis or failure to mature. Cumulative fistula survival was calculated as the time from placement to permanent failure, regardless of the number of interventions required to maintain patency. Because fistulas with a primary failure had no useful life expectancy, their cumulative survival was considered “0 d” for the purpose of this analysis.

The clinical characteristics were compared between the two patient groups with an unpaired t-test for continuous variables and a χ^2 analysis for categorical variables. Cumulative fistula patency was plotted as Kaplan-Meier survival curves. The difference between survival curves was calculated using the log rank test. A p value < 0.05 was considered statistically significant.

Results

Patient characteristics

The two patient groups were similar in terms of age, race, hypertension, diabetes, and vascular disease (Table 1). As expected, patients receiving a pRCF were more likely to have had a previous vascular access than those receiving a dRCF (47 vs 18%, $P=0.04$). In addition, patients receiving a pRCF were less likely to be female than those with a dRCF (5 vs 36%, $P=0.03$).

Primary access failure (fistula non-maturation)

Primary fistula failure was defined as the inability to use the fistula reproducibly for dialysis for at least one month, either due to early thrombosis or failure to mature. Primary access failure was significantly lower in patients with pRCF, as compared to those with dRCF (32 vs 59%, $P=0.05$).

Cumulative access survival

When primary access failures were excluded, cumulative fistula survival of pRCF and dRCF was similar (92% vs 86% at 1 yr, and 74 vs 76% at 2 years, $P = 0.56$ between groups) (Figure 2).

Discussion

When a distal radiocephalic fistula (dRCF) fails or is not feasible, most access surgeons place an upper arm brachiocephalic fistula. This sequence sacrifices potential access sites in the forearm. The proximal radiocephalic fistula (pRCF) is an infrequently used option, which provides an opportunity to place a second fistula in the forearm before proceeding to the upper arm. There has been little published literature comparing the short- and long-term outcomes of pRCF and dRCF. The current investigation observed a lower rate of primary access failures in pRCF than in dRCF. This difference in non-maturation rates is potentially attributable to the use of larger vessels to create a pRCF, and is consistent with prior reports of a lower primary failure with brachiocephalic fistulas, as compared with dRCF [5–7].

However, once fistula maturation was achieved, the cumulative access survival (until permanent failure) was similar for pRCF and dRCF.

Conclusion

Proximal radiocephalic fistulas (pRCF) are an attractive alternative to brachiocephalic fistulas in patients who cannot receive a distal radiocephalic fistula (dRCF). As compared with dRCF, pRCF have a substantially lower primary failure rate, and a similar cumulative survival (excluding primary failures). In selected patients, creation of a pRCF may delay the need to proceed to the upper arm.

References

1. KDOQI clinical practice guidelines and clinical practice recommendations for vascular access 2006. *Am J Kidney Dis.* 2006; 48 (suppl 1):S176–S322. [PubMed: 16813989]
2. Lee T, Barker J, Allon M. Comparison of survival of upper arm arteriovenous fistulas and grafts after failed forearm fistulas. *J Am Soc Nephrol.* 2007; 18:1936–1941. [PubMed: 17475812]
3. Allon M, Robbin ML. Increasing arteriovenous fistulas in hemodialysis patients: problems and solutions. *Kidney Int.* 2002; 62:1109–1124. [PubMed: 12234281]
4. Dember LM, Beck GJ, Allon M, Delmez JA, Dixon BS, Greenberg A, Himmelfarb J, Vazquez MA, Gassman JJ, Greene T, Radeva MK, Braden GL, Ikizler TA, Rocco MV, Davidson IJ, Kaufman JS, Meyers CM, Kusek JW, Feldman HI. Effect of clopidogrel on early failure of arteriovenous fistulas for hemodialysis. *JAMA.* 2008; 299:2164–2171. [PubMed: 18477783]
5. Miller PE, Tolwani A, Luscly CP, Deierhoi MH, Bailey R, Redden DT, Allon M. Predictors of adequacy of arteriovenous fistulas in hemodialysis patients. *Kidney Int.* 1999; 56:275–280. [PubMed: 10411703]
6. Miller CD, Robbin ML, Allon M. Gender differences in outcomes of arteriovenous fistulas in hemodialysis patients. *Kidney Int.* 2003; 63:346–352. [PubMed: 12472802]
7. Peterson WJ, Barker J, Allon M. Disparities in fistula maturation persist despite preoperative vascular mapping. *Clin J Am Soc Nephrol.* 2008; 3:437–441. [PubMed: 18235150]
8. Gracz KC, Ing TS, Soung LS, Armbruster KFW, Seim SK, Merkel FK. Proximal forearm fistula for maintenance hemodialysis. *Kidney Int.* 1977; 11:71–74. [PubMed: 839655]
9. Jennings WC. Creating arteriovenous fistulas in 132 consecutive patients: exploiting the proximal radial artery arteriovenous fistula: reliable, safe, and simple forearm and upper arm hemodialysis access. *Arch Surg.* 2006; 141:27–32. [PubMed: 16415408]
10. Allon M, Lockhart ME, Lilly RZ, Gallichio MH, Young CJ, Barker J, Deierhoi MH, Robbin ML. Effect of preoperative sonographic mapping on vascular access outcomes in hemodialysis patients. *Kidney Int.* 2001; 60:2013–2020. [PubMed: 11703621]
11. Robbin ML, Gallichio ML, Deierhoi MH, Young CJ, Weber TM, Allon M. US vascular mapping before hemodialysis access placement. *Radiology.* 2000; 217:83–88. [PubMed: 11012427]
12. Lockhart M, Robbin ML, Fineberg NS, Wells CG, Allon M. Cephalic vein measurement prior to forearm fistula creation: Does use of a tourniquet to meet venous diameter threshold increase the number of usable fistulas? *J Ultrasound Med.* 2006; 25:1541–1545. [PubMed: 17121948]
13. Robbin ML, Chamberlain NE, Lockhart ME, Gallichio MH, Young CJ, Deierhoi MH, Allon M. Hemodialysis arteriovenous fistula maturity: US evaluation. *Radiology.* 2002; 225:59–64. [PubMed: 12354984]
14. Singh P, Robbin ML, Lockhart ME, Allon M. Clinically immature arteriovenous hemodialysis fistulas: effect of US on salvage. *Radiology.* 2008; 246:299–305. [PubMed: 17991787]
15. Maya ID, Oser R, Saddekni S, Barker J, Allon M. Vascular access stenosis: Comparison of arteriovenous grafts and fistulas. *Am J Kidney Dis.* 2004; 44:859–865. [PubMed: 15492952]
16. Jain G, Maya ID, Allon M. Outcomes of percutaneous mechanical thrombectomy of arteriovenous fistulas in hemodialysis patients. *Semin Dial.* 2008; 21:581–583. [PubMed: 19000116]

17. Allon M, Bailey R, Ballard R, Deierhoi MH, Hamrick K, Oser R, Rhynes VK, Robbin ML, Saddekni S, Zeigler ST. A multidisciplinary approach to hemodialysis access: prospective evaluation. *Kidney Int.* 1998; 53:473–479. [PubMed: 9461109]

Figure 1.

Digitally subtracted angiogram showing a proximal radiocephalic fistula (pRCF). Note that the blood flow is bidirectional (toward the upper arm and to the forearm). There is a side-to-side anastomosis (radial artery and cephalic vein).

Figure 2. Cumulative survival of proximal radiocephalic fistulas (pRCF) and distal radiocephalic fistulas (dRCF), after exclusion of primary failures. $p = 0.56$ between groups.

Table 1

Baseline characteristics of the study patients

	pRCF	dRCF	P value
N Patients	19	39	
Age, years(mean)	61	58	0.251
Sex, N (%) Female	1(5%)	14(36%)	0.03
Race, N (%) Black	15(80%)	29(74%)	0.93
Hypertension, N (%)	19(100%)	38(98%)	1.00
Diabetes, N (%)	12(63%)	21(54%)	0.72
CAD, N (%)	3(16%)	6(15%)	0.75
PVD, N (%)	2(11%)	2(5%)	0.80
CVD, N (%)	3(16%)	3(7%)	0.55
Previous access, N (%)	9(47%)	7(18%)	0.04

CAD, coronary artery disease; PVD, peripheral vascular disease; CVD, cerebrovascular disease.

pRCF, proximal radiocephalic fistula

dRCF, distal radiocephalic fistula