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Two-stage brachial-basilic transposition fistula provides superior patency rates for dialysis access in a safety-net population

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Abstract

Background—Guidelines of the National Kidney Foundation recommending aggressive pursuit of autogenous fistulae for dialysis access in lieu of prosthetic arteriovenous grafts have stimulated a renewed interest in transposed brachial-basilic fistulae as an alternative technique for upper arm access in patients who may not be candidates for a lower arm radial-cephalic or forearm brachial-cephalic fistula. We hypothesized that in our safety-net population, where radial-cephalic and brachial-cephalic often are not possible, brachial-basilic would provide patency rates superior to arteriovenous grafts and equivalent to radial-cephalic and brachial-cephalic fistulae.

Methods—We analyzed retrospectively our most recent 2.5-year experience with dialysis access procedures at our metropolitan safety-net hospital. Procedures were grouped as follows: radial-cephalic, brachial-cephalic, brachial-basilic, and arteriovenous grafts. The access outcomes measured were primary failure, time to use, need for intervention, and primary as well as secondary patency. Differences in age, sex, race, renal function (Modification of Diet in Renal Disease), baseline diagnoses (diabetes mellitus, hypertension, coronary artery disease, and peripheral vascular disease), as well as the number of previous accesses, were adjusted in the analysis. Logistic regression was used to identify independent predictors of primary failure, and Kaplan-Meier plots assessed differences in primary patency rates. A log of the time variables was used to approximate normal distribution.

Results—In all, 193 patients were included in this study as follows: radial-cephalic, 75 (39%) patients; brachial-cephalic, 35 (18%) patients; brachial-basilic, 33 (17%) patients; and

arteriovenous grafts, 50 (26%) patients. Primary patency means differed marginally between groups ($P = .08$), and when grafts were excluded from the analysis, no difference was found between primary patency in all autogenous fistula techniques ($P = .88$). Kaplan-Meier plots showed that when analyzing the first 35 weeks, a significantly lower primary patency among graft recipients early after the procedure was noted, and a higher performance of BB after 20 weeks was noted (log-rank $P = .05$, Wilcoxon $P = .004$). Furthermore, secondary patency did not vary significantly between groups ($P = .62$). Radial-cephalic were more likely to fail primarily when compared with the other access groups ($P = .03$), and in a univariate analysis, underlying hypertension was associated with a lower risk of primary failure ($P = .01$) compared with other diagnoses. A logistic regression stepwise selection showed that the underlying diagnoses of peripheral vascular disease, diabetes mellitus, or coronary artery disease were associated with a greater risk of primary failure compared with those with HTN ($P = .001$; odds ratio, 4.05; 95% confidence interval, 1.71–9.59), as well as the presence of a previously failed access ($P = .04$; odds ratio, 2.39; 95% confidence interval, 1.08–5.67).

Conclusion—In a safety-net population, our results suggest that 2-stage brachial-basilic transposition fistulae provide patency rates equivalent to brachial-cephalic and radial-cephalic fistulae and superior to grafts. Although 2 procedures are required, brachial-basilic fistulae provide a reliable access and should be considered the next choice when radial-cephalic and/or brachial-cephalic are not possible.

The establishment and maintenance of hemodialysis vascular access for the end-stage renal disease (ESRD) patient is a costly enterprise with significant associated morbidity and mortality.¹ Furthermore, the use of a carefully planned autogenous, arteriovenous fistula has shown to decrease complications consistently when compared with prosthetic arteriovenous grafts (AVG) or catheters,^{2,3} as reflected by the Center for Medicare and Medicaid Services' "fistula first" initiative, which has increased autogenous access placement in the United States from 26% to 35% during the 5-year period 1998–2003.⁴ Interestingly, such rates remain inferior to reports from Europe and other countries, where >80% autogenous access rates have been achieved.⁵

According to the National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (KDOQI),⁶ radial-cephalic (RC) and brachial-cephalic (BC) fistulae should be the first and second choices for vascular access, respectively, and in the absence of adequate veins or after failed RC/BC access, a brachial-basilic (BB) fistula or AVG should be considered. Given the established thrombotic risks associated with an artificial membrane, autogenous fistula creation has resulted consistently in superior long-term patency with a decrease in thrombotic complications when compared with AVG.^{3,7,8} Furthermore, an increased risk of access infection with AVG has also been reported.⁹ KDOQI guidelines recommend that the choices for tertiary access should be dictated by local expertise.⁶ Accordingly, practice pattern variations may influence the particular choice of access significantly, beyond those attributed to patient-related issues.

In addition, patient-related factors, particularly in a safety-net population (older patients, women, African Americans, and those with diabetes, peripheral vascular disease, or previous access failures) are important to consider and likely contribute to inferior

outcomes.^{2,10,11} We hypothesized that in our safety-net population, where RC and BC fistulae are often not possible, BB would provide patency rates superior to traditionally placed AVG and equivalent to RC and BC.

MATERIALS AND METHODS

Consecutive patients who required vascular access from January 2007 to May 2009 were identified via query of our prospective dialysis access database. Demographic and clinical data of interest included age, sex, race, presence or absence of hypertension (HTN), diabetes mellitus (DM), coronary artery disease (CAD), peripheral vascular disease (PVD), and renal function (calculated from the Modification of Diet in Renal Disease glomerular filtration rate formula, MDRD-GFR). Complications and subsequent need for additional operative or invasive radiologic intervention was ascertained by a review of operative and radiology reports, as well as clinic and dialysis unit notes.

At our institution, all patients who undergo operative placement of a vascular access are screened routinely by preoperative ultrasonographic vascular mapping. A minimum vein diameter of 2.5–3.0 mm was considered acceptable, although when there was doubt about the consistency of venous size or patency, we performed selective venography as well. The operative cases were performed by either of the coauthors (J.L.K. and E.E.M.) under general anesthesia in most cases and with rare selective use of axillary block. Patients who required access were discussed routinely at our weekly multidisciplinary conference, and the decision for access placement followed current KDOQI guidelines, considering preoperative vascular mapping, presence of thrombosis or stenosis of the draining vein, and history of previously failed access attempts. A more distal access was placed if vessels were adequate, and a primary upper arm access was considered when distal vessels were judged unsatisfactory. Our general policy was always to attempt an autogenous BB when there was a satisfactory basilic vein in lieu of an AVG. These decisions were made in our conference jointly with the nephrology service based on the degree of renal failure, anticipated time frame for required dialysis, infection risks with tunneled catheter placement, and the required time for maturation and use of a 2-stage BB fistula.

At our institution, general anesthesia is preferred for all vascular access procedures, whereas a brachial plexus block is used selectively. Systematic intraoperative anticoagulation was not administered routinely. In patients considered at an increased risk for thrombosis, however, intra-operative intravenous heparin bolus (50 units/kg) was given. Perioperative intravascular heparin flush irrigation was used liberally. Postoperative anticoagulation (heparin or antiplatelet therapy) was not prescribed routinely unless the patient was on a specific therapy previously.

An RC fistula was created via a longitudinal incision just proximal to the skin crease at the wrist. After identification and careful dissection, an end-to-side cephalic vein to radial artery anastomosis was created. A BC fistula was constructed through a curvilinear incision following the course of the cephalic vein over the antecubital crease. Approximately 5 cm of the cephalic vein was dissected free and rotated medially toward the brachial artery to create an end-to-side, vein-to-artery anastomosis. All BB fistulae were created using a 2-staged

procedure. In the first stage, identification of the basilic vein was accomplished through an incision just proximal to the antecubital fossa, with division of the vein as distally as possible. A spatulated, end-to-side, vein-to-artery anastomosis was then created between the basilic vein and brachial artery. After maturation with dilatation over approximately 6–8 weeks, transposition was performed. The second stage required sequential incisions along the medial upper arm, with ligation of side branches of the arterialized vein and division of the vein just proximal to the brachial anastomosis. The vein was then tunneled through the anterior aspect of the upper arm and venous reconstruction was performed at the brachial junction. After access placement, all patients were evaluated routinely at 2 weeks, followed by every 4 weeks until maturation was verified.

Prosthetic AVG were constructed either as a BC forearm loop graft or as a brachial-axillary straight graft using standard polytetrafluoroethylene material. AVGs were cannulated for hemodialysis if the surgical wound was considered to be appropriately healing after a 2-week postoperative time frame.

The endpoints of this study included primary failure, time to functional access use for hemodialysis, frequency of additional interventions required for confirming or maintaining patency, and primary as well as secondary patency. Patency rates were documented according to the guidelines of the Society for Vascular Surgery.¹² A fistula was deemed to have had a primary failure when judged to have failed adequate maturation for initiation of dialysis. Primary patency was defined as the interval from the time of access placement until any intervention designed to maintain or reestablish patency, access thrombosis, or the time of measurement of patency. Secondary patency was defined as the interval from the time of access placement until access abandonment, thrombosis, or the time of patency measurement including interventions (operative or endovascular) designed to reestablish functionality. For BB, calculation of patency was established from the second stage time frame. Primary and secondary patency was calculated via exclusion of primary access failures.

Statistical analyses were performed using SAS for Windows version 9.0 (SAS Institute, Cary, NC). Continuous data were represented as mean $\pm$ standard error of the mean (SEM) or, when not normally distributed, as median and range. For crude association with continuous variables, in normally distributed variables, the Student *t* test was used, whereas the Wilcoxon nonparametric test was employed when the distribution was unlikely to be normal. For categoric variables, the Chi-square test or the Fisher exact test (when expected cell value <5) were used. The primary outcomes were primary failure (yes or no) and primary patency time (in weeks), whereas the type of vascular access (divided into 4 main groups: RC, BC, BB, and AVG) was the effect variable. Logistic regression with stepwise selection procedure was used to identify independent predictors of primary failure including the variable of interest (vascular access type), as well as age, sex, race, renal function (MDRD-GFR), baseline diagnoses (HTN, DM, CAD, PVD), previous accesses, previous dialysis, and placement of vascular access on the left versus right arm. The performance of the logistic regression models was assessed through the c-statistic. Kaplan-Meier plots were created to assess differences in primary patency, using the log-rank test (which privileges

differences in later survival) and the Wilcoxon test (which privileges differences in early survival).

This study was approved by the Colorado Multi-Institutional Review Board.

RESULTS

General demographics

General demographic data were collected on 193 operative vascular access procedures performed over 30 months (Table I). The distribution of the procedures was: 75 (39%) RC patients, 35 (18%) BC patients, 33 (17%) BB patients, and 50 (26%) AVG patients. In all, 68% of AVGs were performed via BC forearm loop, whereas 32% required a brachial artery–axillary vein straight graft configuration.

Age, sex, race, MDRD-GFR at time of access placement, and prevalence of HTN and PVD were similar among all groups. BB and AVG, however, were more likely to be placed in patients who were diabetic, had CAD, and had previously failed accesses when compared with RC (Table I). These differences were not significant between BB and AVG.

Hemodialysis access outcomes

The outcome results for the various access procedures are noted in Table II. The primary failure rates were RC (39%), BC (17%), BB (18%), and AVG (12%). The RC primary failure rate was significantly higher when compared with the rest of the groups ($P = .03$). Primary failure rates between BB and AVG groups were not different (18% vs 12%; $P = .44$). AVG required more frequent access interventions (including endovascular and operative angioplasty and/or thrombectomy, and operative revisions) when compared with other access groups, and were associated with the poorest primary patency rates (186 ± 29 , days). Although BB and AVG allowed for earlier functional cannulation for dialysis when compared with RC and BC, these differences were not significant between BB and AVG (116 ± 19 and 95 ± 36 days, respectively). The figure depicts the Kaplan-Meier plot for primary patency by type of procedure performed in this study. No differences were found in primary patency among the 4 access groups (log-rank: $P = .59$, Wilcoxon: $P = .14$) when the entire observation period was included (120 weeks); however, when we analyzed the first 35 weeks, a difference was found between the curves because of lesser patency rates among graft recipients early after the procedure, and greater performance of the BB 2-staged access after 20 weeks (log-rank: $P = .05$, Wilcoxon: $P = .004$). When other access groups were excluded from the analysis, and BB and AVG were compared directly, BB primary patency was significantly greater than that of AVG throughout the entire observation period (Wilcoxon: $P = .049$). The number of patients at risk during the time intervals analyzed for primary patency is presented in Table III.

Univariate analysis

Table IV outlines the results of a univariate analysis evaluating multiple factors for association with primary failure. Of note, associations were noted with a DM, CAD, or PVD

diagnosis (versus HTN, $P = .01$), a history of failed previous access ($P = .01$), as well as the type of vascular access placed ($P = .04$).

Logistic regression analysis

The results of LR analysis for independent predictors of primary failure demonstrate that patients with DM, CAD, or PVD were 4.1 times (95% CI, 1.71–9.59) (C-statistic = 0.71) more likely than patients with HTN to develop primary failure, whereas a previously failed access increased the risk of primary failure by 2.4 times (95% CI, 1.08–5.67; C-statistic = 0.65). After excluding patients who required grafts, patients who received vascular access through an RC were 3.7 more likely to develop primary failure than those that received BB, whereas no differences in primary failure rates were detected between BB and BC.

DISCUSSION

Because dialysis access-related issues represent the leading cause for hospitalization during the first year after initiation of hemodialysis,^{13,14} establishing and maintaining a reliable access, with minimal interventions, carries substantial potential for a decrease in of morbidity and mortality in this group. Furthermore, an aging ESRD population,⁴ with clinically important associated comorbidities, highlights the challenges inherent in treating this group. Accordingly, evidence suggests that the need for initial and subsequent access is growing.¹⁵ Although KDOQI guidelines have popularized the “fistula first” principle, no overall consensus exists as to which type of access should be preferred, particularly after initial failures, because well-powered randomized trials are lacking.

Although recent meta-analyses^{16–18} suggest primary failure rates of BB to be in the 21–36% range, our results using a 2-staged approach demonstrated that BB had a lesser primary failure rate that was not significantly different than AVG (18% vs 12%, respectively). We also noted that primary patency rates of BB during the first 35 weeks were superior to RC, BC, and AVG (Fig). We also noted that despite a greater time period to maturation, secondary patency rates of BB were comparable with other approaches, although our mean follow-up time (320 days) was relatively short.

Despite these findings, some have suggested that AVG should be the preferred technique for access after initial failure because of reports of low primary failure and a decreased interval to maturation.⁸ We noted that the time to first functional cannulation for hemodialysis did not differ between the 2 groups, whereas AVG required more frequent intervention when compared with other autogenous access groups. Others have reported results similar to our findings.^{9,19}

AVG have been noted consistently to have inferior primary and secondary patency rates^{17,20}; accordingly, recent reports,^{21,22} including one with a median follow-up of 6 years,²¹ have suggested that BB should be used in preference to AVG. Furthermore, Choi et al¹⁹ reviewed their institution’s experience comparing transposed fistulae (consisting of autogenous forearm and basilic) versus AVG and direct fistulae, concluding that the transposed had improved long-term patency significantly at 2 years. Another group⁹

compared transposed BB with BC and upper arm AVG, reporting equivalent patency but decreased reintervention and infection rates in the BB group.

We noted that a previously failed access increased the risk of primary failure by 2.4 times (95% confidence interval [CI], 1.01–5.67). In our study, 42% of patients who underwent an access procedure had already failed an initial attempt at access, most commonly RC and BC. Furthermore, as reported previously by other studies,^{10,11} we found that patients with comorbidities other than HTN, such as DM, PVD, or CAD, to be 4.1 times (95% CI, 1.71–9.59) more likely to develop primary failure. In our practice, BB and AVG were equally likely to be placed in patients with diabetes or a previously failed access (Table I), likely because of advanced radial artery atherosclerosis in this subgroup of patients.

Previous studies have reported increased access failure rates among older patients, women, and individuals of black race.^{2,10,11} Of note, whereas 1 series demonstrated decreased patency rates of BC fistulae in patients aged >60 years,²² data from the U.S. Renal Data System did not support these findings.⁹ In contrast, we believe our safety-net population is at a substantially increased risk for access failure, yet unfortunately, a preemptive approach for establishment of access is often not feasible in this group. This observation is evidenced by the fact that National Kidney Foundation Kidney Disease Outcomes Quality Initiative guidelines encourage access planning as soon as a GFR of 25 is reached; yet, in our population, the mean MDRD-GFR at time of access placement was 14.5 ± 0.6 , and these findings did not differ significantly among groups.

Limitations of this study include all common issues related to retrospective design, as well as a relatively short follow-up time, which particularly relevant for data regarding secondary patency. Because this is a retrospective analysis, we did not accumulate specific color-flow duplex data on either arterial or venous status on all patients and correlate these results with outcomes. Furthermore, although it was not our usual policy to administer postoperative anticoagulation, we did not note any specific data on patients who may have received such therapy.

In conclusion, our results support the use of BB in a safety-net population based on low primary failure rates, prolonged primary patency, and secondary patency rates equivalent to those of other autogenous techniques. Based on our findings, we believe that AVG should be reserved for patients with a failed BB or for patients who lack a usable basilic vein. These data suggest that BB may permit implementation of current KDOQI guidelines which advocate >50% use of autogenous routes of access, particularly in challenging patient groups such as our safety-net population.

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Figure.

Kaplan-Meier plot of primary patency. When analyzing the first 35 weeks, a significant difference was found between the curves because of lesser patency rates among graft recipients early after the procedure and greater performance of the BB 2-staged access after 20 weeks (log-rank: $P = .05$, Wilcoxon: $P = .004$). Direct comparison between BB and AVG (excluding other access groups) shows superior patency for BB (Wilcoxon: $P = .049$).

Table 1

Patient demographic and clinical characteristics

	RC	BC	BB	AVG	P value
N (%)	75 (39%)	35 (18%)	33 (17%)	50 (26%)	.15
Age, years, mean ($\pm$ SE)	54.3 ($\pm$ 1.5)	50.2 ($\pm$ 2.5)	54.5 ($\pm$ 1.5)	49.8 ($\pm$ 3.4)	.59
Sex, N (%) female	36 (48%)	17 (49%)	18 (54%)	25 (50%)	.35
Race, N (%) black	21 (28%)	9 (25%)	10 (30%)	15 (30%)	.61
HTN, N (%)	59 (79%)	29 (82%)	28 (85%)	42 (83%)	.50
DM, N (%)	42 (56%)	24 (68%)	27 (81%)*	39 (78%)*	.04
CAD, N (%)	5 (7%)	4 (11%)	9 (27%)*	15 (30%)*, [†]	.03
PVD, N (%)	3 (4%)	1 (3%)	2 (6%)	2 (4%)	.79
GFR-MDRD, mean ($\pm$ SE)	13.4 ($\pm$ 1.2)	14.6 ($\pm$ 1.0)	15.0 ($\pm$ 1.4)	14.9 ($\pm$ 1.0)	.73
Previous access, N (%)	5 (7%)	15 (43%)*	17 (51%)*	26 (52%)*	.01

* $P < .05$ compared with RC.[†] $P < .05$ compared with BC.

Table II

Access outcomes by group

	RC	BC	BB	AVG	P value
N (%)	75 (39%)	35 (18%)	33 (17%)	50 (26%)	
Primary failure, N (%)	29 (39%) ^{†,‡,§}	6 (17%)	6 (18%)	6 (12%)	.03
Time to use, * days, mean (± SE)	218.5 (± 38.7)	277.2 (± 45.1)	115.5 (± 19.4) ^{†,‡}	95 (± 35.7) ^{†,‡}	.04
Reinterventions needed, mean (± SE)	0.9 (± 0.1)	0.5 (± 0.2)	0.6 (± 0.2)	1.6 (± 0.4) ^{†,‡,§}	.04
Primary patency, days, mean (± SE)	204.2 (± 21.6)	215.8 (± 35.4)	243.0 (± 38.0)	186 (± 29.4)	.08
Secondary patency, days, mean (± SE)	242.2 (± 24.7)	288.5 (± 39.8)	319.5 (± 39.5)	300.5 (± 39.8)	.62

* Measured from the time of access placement to the first *functional* dialysis cannulation.[†] $P < .05$ compared with RC.[‡] $P < .05$ compared with BC.[§] $P < .05$ compared with BC.

Table III

Patients at risk during time intervals for primary patency analysis

Number of patients at risk at the beginning of interval	Days after procedure					
	0	10	20	30	40	50
BB	33	24	18	16	12	10
BC	35	30	16	10	7	7
RC	75	57	40	26	18	14
Graft	50	29	23	16	13	9
Total	193	140	97	68	50	40

Table IV

Univariate analysis of multiple factors evaluated for association with primary failure

Risk factor	Primary failure		P value
	No N (%)	Yes N (%)	
Male sex	79 (81)	18 (19)	.15
Black race	38 (76)	12 (24)	.83
HTN	127 (81)	30 (19)	.01
DM	96 (80)	24 (20)	.23
CAD	25 (89)	3 (11)	.09
PVD	5 (71)	2 (29)	.71
Previously on dialysis	67 (80)	14 (20)	.33
Previous access	55 (83)	11 (17)	.01
Arm used (left versus right)	108 (74)	37 (26)	.11