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The Basilic Vein and the Cephalic Vein Perform Equally in Upper Arm Arteriovenous Fistulae

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WHAT THIS PAPER ADDS

- In the existing literature, it remains controversial which upper arm arteriovenous fistula (AVF) has the best performance, and the number of comparative studies is limited. Our results provide nformation to make a decision in clinical practice.

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ABSTRACT

Objective: To compare the brachiocephalic (BC) and basilic vein transposition (BVT) arteriovenous fistula (AVF) with regard to maturation, patency, blood flow and complication rates.
Design: A retrospective chart review.
Materials and method: Between January 2000 and December 2010, consecutive patients undergoing BC or BVT AVF were included. Patient characteristics were collected retrospectively from digital patient files and a prospective database of haemodialysis patients.
Results: A total of 173 autologous upper arm AVFs (87 BC and 86 BVT) were created in 151 patients. Mean (±SEM) follow-up was 19 ± 1.4 months (range 0–100). There were no differences between the groups in respect to brachial artery and cubital fossa vein diameters, time to first use, flow and the number of secondary interventions.
Operative time was significantly longer ($P < 0.001$) and the mid upper arm vein diameter before bifurcation greater ($P = 0.038$) in BVT patients. The 1- and 2-year primary patency rates for the whole cohort was 40.8% and 30.2% with secondary patency rates of 78.0% and 72.4%. There was no difference between the groups for these outcomes ($P = 0.951$, $P = 0.516$, respectively).
Conclusion: With the exception of the efferent vein diameter in the mid upper arm and operative time, there was no difference between a BC and BVT AVF.

The National Kidney Foundation Dialysis Outcome and Quality Initiative (NKF-DOQI) and the European Best Practice Guidelines on Vascular Access recommend the use of an autologous upper extremity arteriovenous fistula (AVF) instead of a prosthetic arteriovenous graft, and this should be constructed as distal as possible.[1–3] Due to a small diameter of either the radial artery or the cephalic vein, not all patients are candidates for a radiocephalic AVF. In these patients, the DOQI guidelines recommend a brachiocephalic (BC) AVF. If the cephalic vein in the upper arm is not available, a basilic vein transposition (BVT) or an arteriovenous prosthetic graft should be attempted. However, prosthetic arteriovenous grafts are associated with decreased patency rates and higher complication rates in addition to higher yearly costs compared to autologous AVFs.[4–6] For this reason, many centres aim at a high BVT AVF use in patients without other autologous AVF options in the arm.

In contrast to the cephalic vein, the basilic vein runs deep on the medial side of the upper arm. The vein has to be transposed to a superficial and lateral position to be accessible for cannulation. Therefore, constructing a BVT AVF is a more complex procedure

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compared to a BC AVF. On the other hand, the basilic vein may offer some advantages over the cephalic vein. It is a large vein which is available and suitable in almost every patient. The number of comparative studies is limited and it is therefore unclear which upper arm AVF performs best.[7,8] The aim of this study was to compare the BC and BVT AVF in our institution with regard to maturation, patency, flow and complication rates.

Patients and Methods

Between January 2000 and December 2010, all consecutive patients who underwent construction of a BC[9] or BVT[10] AVF were included. Patient characteristics were collected retrospectively from digital patient files and a prospectively recorded database on haemodialysis patients (Diamant, Diasoft B.V. Leusden, The Netherlands). The database contains data on age, gender, co-morbidity, primary kidney disease, fistula history, preoperative and postoperative duplex data, type of surgery, date of first use, flow measurements, complications and secondary interventions.

Preoperative assessment

Preoperative work-up included physical examination and duplex ultrasound (DUS). Arterial patency was assessed by arterial pulse examination and performance of the Allen test. Venous evaluation consisted of examination of the veins of the upper arm, cubital fossa and lower arm with a tourniquet in place. Preferably the non-dominant arm was evaluated with DUS. The diameter and peak systolic velocity (PSV) of the radial, ulnar and brachial artery were measured. The vein diameter and depth of the vein in the arm were assessed. In our series, patients with central venous stenosis would be excluded for an ipsilateral upper arm fistula. Either this stenosis would be treated by angioplasty or an AVF would be constructed on the contralateral arm. Patients were eligible for surgery if both the artery and vein contained no stenosis and the diameter was larger than 2 mm. This protocol has been published previously.[11] If the cephalic vein was not suitable for a radiocephalic or BC AVF, a BVT AVF was performed.

Surgical procedure

Five surgeons performed both operations with standardised technique. The preferred type of anaesthesia was locoregional. General anaesthesia was performed if locoregional anaesthesia was not sufficient or on the patients' request. The BC AVF is created following a transverse incision in the cubital fossa. The brachial artery and cephalic vein are identified. After an arteriotomy of 7 mm, an end-to-side anastomosis is made. Creating a BVT AVF requires complete mobilisation of the basilic vein in the upper arm. In addition to the transverse incision in cubital fossa, two longitudinal incisions are made in line over the basilic vein. The brachial fascia is opened and the basilic vein is identified. After mobilisation, the basilic vein is tunnelled subcutaneously anterior to the biceps brachii muscle. In the cubital fossa an end-to-side anastomosis is made after an arteriotomy of 7 mm.

Surveillance

Four weeks after surgery, DUS was performed. If an early stenosis was assessed, patients were scheduled for percutaneous transluminal angioplasty (PTA) to improve maturation. A significant stenosis was defined as a PSV of more than 400 cm s^{-1} on DUS or a luminal diameter reduction of 50% on angiography.[12,13] When flow decline was measured during dialysis, patients were referred for DUS and in case of a stenosis, a PTA was performed. If a stenosis could not be treated endovascularly, a surgical intervention was performed. This protocol has been published previously.[11]

Definitions

Patency rates were defined and calculated in accordance with reported standards as described by Sidawy.[14] Fistula failure was defined as any event that required an intervention to maintain or re-establish patency, including stenosis, thrombosis, pseudo-aneurysm, infection, haemorrhage, ischaemia of the hand and patient dissatisfaction leading to another type of access. Flow was defined as the mean flow measured in the first 4 months after starting dialysis. In AVFs that were not cannulated prior to a secondary intervention, blood flow was measured after the intervention.

Statistics

Measured values are reported as mean ± standard error of the mean (SEM). Differences between groups were investigated using the Student *t*-test. The χ^2 test was used for categorical variables. Correlations were assessed using Pearson's correlation. Patency rates were estimated using Kaplan–Meier curve. Patency rates were based on a per fistula analysis. Comparison between survival curves was made by the log-rank test. A statistical software package (Statistical Package for the Social Sciences (SPSS) version 15.0, Chicago, IL, USA) was used for statistical analysis, where $P \leq 0.05$ was considered statistically significant.

Results

Demographics

A total of 173 autologous upper arm AVFs (out of a total of >900 AVFs in the same time period) were created in 151 patients, of which 87 were BC and 86 BVT AVFs. The mean age was 62.6 ± 1.07 years. A small majority of the patients was male (52%). The BVT AVF was constructed significantly more frequent among females. The mean body mass index (BMI) was 26.0 ± 0.8 and was not significantly different between the patients in the BC and BVT group (Table 1). In the BC AVF group, 19 patients have had one previous fistula and one patient had two previous fistulae in the ipsilateral arm. In the BVT AVF group, 27 patients have had one previous fistula and nine patients had two previous fistulae in the ipsilateral arm. Significantly, more patients had previous fistulae in the BVT AVF group ($P = 0.006$).

Artery and vein diameters

The preoperative mean diameter of the brachial artery in the cubital fossa was not significantly different between BC and BVT AVF (4.2 ± 1.4 mm and 4.1 ± 1.3 mm, respectively, $P = 0.550$). In patients with a BC AVF, the mean preoperative diameter of the cephalic vein in the cubital fossa was 3.5 ± 1.4 mm and for patients with a BVT AVF, the preoperative diameter of the basilic vein was 3.3 ± 1.8 mm ($P = 0.509$). In the mid upper arm, the mean diameter of the efferent vein, proximal to the confluence with the median cubital vein, was significantly different in the BC and the BVT AVF group (3.3 ± 1.5 mm vs. 3.8 ± 1.8 mm, respectively, $P = 0.038$) (Table 2).

Operation time

The operation time was significantly shorter in patients who received a BC AVF compared to patients with a BVT AVF (77 ± 2.4 min and 133 ± 2.9, respectively, $P < 0.001$) (Table 2).

Table 1
Patient characteristics.

	BC AVF $n = 87$	BVT AVF $n = 86$	*P*-value
Sex			0.018
Male	53 (61%)	37 (43%)	
Female	34 (39%)	49 (57%)	
Mean age (years)	64.1	61.1	0.155
BMI	26.5	25.4	0.491
Male	27.6	26.8	
Female	25.0	24.3	
Co-morbidity			
Hypertension	71 (82)	66 (77)	0.431
Cardiac disease	51 (59)	48 (56)	0.709
Hyperlipidaemia	51 (59)	41 (48)	0.149
Diabetes mellitus	38 (44)	42 (49)	0.496
Pulmonary disease	21 (24)	17 (20)	0.488
Carotid disease	5 (6)	1 (1)	0.099
Primary renal disease			0.826
Hypertensive nephropathy	29	29	
Diabetic nephropathy	26	23	
Glomerulonephritis	9	12	
Polycystic kidney disease	2	4	
Other[a]	21	18	
Previous vascular access in ipsilateral arm	20	36	0.006

BMI: Body mass index; BC AVF: Brachiocephalic arteriovenous fistula; BVT AVF: Basilic vein transposition arteriovenous fistula.
[a] Other: Atherosclerosis, cardial, laxatives abuses, drugs abuses, eci, M. Kahler, postrenal obstruction, relapsing urinary tract infection, SLE.

Maturation and flow

Two patients were considered early technical failures, in which both were bleeding of the fistula. A total of 12 fistulae did not mature (7%) and were considered early failures. Of these, seven were BC and five were BVT AVFs. In these fistulae, non-maturation was the result of stenosis or thrombosis.

Twenty-three fistulae matured, but were not used. In total, 138 fistulae were eventually used for dialysis, of which 70 were BC and 68 BVT AVFs. The mean time between surgery and first use for all BC and BVT AVFs was 12 ± 1.8 weeks and 12 ± 2.2 weeks, respectively ($P = 0.948$). For BC and BVT AVFs that were used in the first 6 months, this was 7 ± 0.5 weeks and 8 ± 0.5 weeks, respectively ($P = 0.550$).

The mean flow in the first 4 months after cannulation of the BC and BVT AVF was 1205 ± 91 ml min^{-1} and 1276 ± 101 ml min^{-1}, respectively ($P = 0.603$). In BC AVFs, no correlation between flow and preoperative diameters of the cephalic vein measured in the cubital fossa and at the mid upper arm was observed ($P = 0.694$ and $P = 0.271$, respectively). Also, in BVT AVFs, no correlation was observed between flow and the diameters of the basilica vein measured in the antecubital fossa and at the mid upper arm ($P = 0.906$ and $P = 0.775$, respectively).

Table 2
Characteristics of the upper arm arteriovenous fistulas.

	BC AVF mean ± SEM	BVT AVF mean ± SEM	*P*-value
Diameters (millimetre)			
Art. Brachialis in the antecubital fossa	4.2 ± 1.4	4.1 ± 1.3	0.550
Efferent vein in cubital fossa	3.5 ± 1.4	3.3 ± 1.8	0.509
Efferent vein in the mid upper arm	3.3 ± 1.5	3.8 ± 1.8	0.038
Surgery Time (minutes)	77 ± 2.4	133 ± 2.9	<0.001
Time to first use all fistulas (weeks)	12 ± 1.8	12 ± 2.2	0.948
Fistulas used in the first 6 months	7 ± 0.5	8 ± 0.5	0.550
Flow (milliliter/minute)	1205 ± 91	1276 ± 101	0.603
Subsequent Interventions (number)	1.24 ± 0.23	0.93 ± 0.13	0.237

BC AVF: Brachiocephalic arteriovenous fistula; BVT AVF: Basilic vein transposition arteriovenous fistula.

Table 3
Reason for first intervention.

	BC AVF Nr. of patients (%)	BVT AVF Nr. of patients (%)	*P*-value	Mean time to intervention in days (SEM)
Stenosis	27 (31)	33 (38)	0.286	289 (36)
Thrombosis	9 (10)	16 (19)	0.115	201 (76)
Steal	10 (11)	2 (2)	0.019	166 (38)
Bleeding	3 (3)	5 (6)	0.494	304 (149)
Pseudo aneurysm	3 (3)	1 (1)	0.621	364 (180)
Unknown	1 (1)	0	0.497	–
Total	53 (61)	57 (66)		245 (29)

BC AVF: Brachiocephalic arteriovenous fistula, BVT AVF: Basilic vein transposition arteriovenous fistula.

Fistula failure and secondary interventions

Fistula failure occurred in 110 (64%) AVFs (Table 3). In these fistulae, 88 secondary interventions were performed of which 58 were endovascular. Fifty-seven fistulae developed a second failure and 46 of these fistulae underwent an intervention, of which 36 were endovascular. A total of 12 patients developed steal. Four patients had mild symptoms and could be treated conservatively. Seven patients were treated by banding or revision using distal inflow. One fistula was ligated. More BC AVFs developed steal compared to BVT AVF ($P = 0.019$). There was no difference between the number of interventions performed in BC and BVT AVFs ($P = 0.237$).

Patency

Mean follow-up of all 173 fistulae was 19 ± 1.4 months (range 0–100). In total, 55 patients died during follow-up. The 1- and 2-year primary patency rates of all AVFs were 40.8% and 30.2%, respectively (Table 4, Fig. 1). No significant difference between the different types of AVFs was observed (log-rank, $P = 0.951$). The overall primary assisted patency rates were 73.4% at 1 year and 66.8% at 2 years. The overall secondary patency rates were 78.0% at 1 year and 72.4% at 2 years. Again, no significant differences between the different types of AVFs were observed for primary assisted and secondary patency rates (log-rank, $P = 0.628$ and $P = 0.516$, respectively).

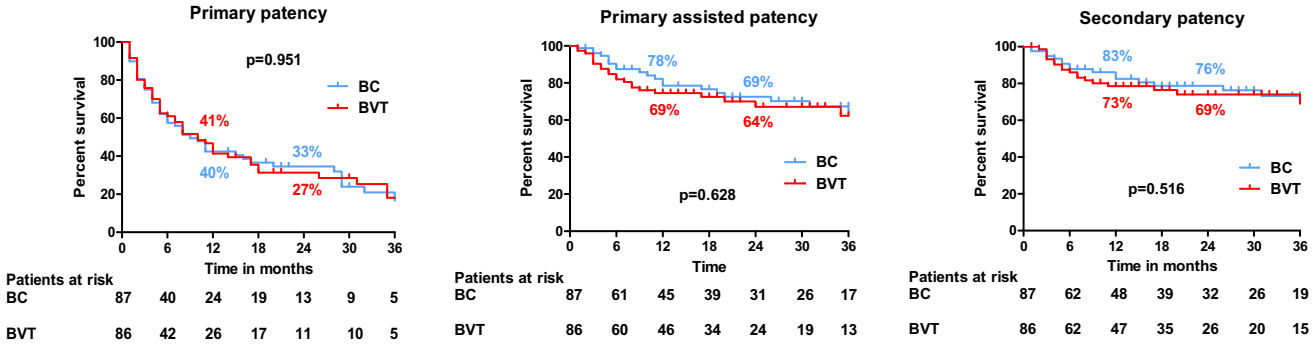
Discussion

In our series of 173 autologous upper arm AVFs, no difference in flow dynamics, maturation, patency and complication rates was observed between BC and BVT AVFs. The only differences were the operation time, the number of patients with previous fistulae and

Table 4
Patency rates by fistula type.

	All patients $n = 173$	BC AVF $n = 87$	BVT AVF $n = 86$	*P*-value
Primary patency (%)				0.951
1-year	40.8	40.0	41.3	
2-year	30.2	32.6	27.2	
Primary assisted patency (%)				0.628
1-year	73.4	78.4	68.5	
2-year	66.8	69.2	64.3	
Secondary patency (%)				0.516
1-year	78.0	83.1	73.1	
2-year	72.4	76.0	68.9	

BC AVF: Brachiocephalic arteriovenous fistula; BVT AVF: Basilic vein transposition arteriovenous fistula.



BC: Brachiocephalic AVF; **BVT**: Basilic vein Transposition

Figure 1. Kaplan-Meyer curve of the primary, primary assisted and secondary patency of both BC and BVT AVF.

the preoperative efferent vein diameter in the mid upper arm, which were significantly higher in the BVT AVF group.

When constructing a radiocephalic AVF is not possible or has failed, other options are usually possible such as a more proximal radiocephalic AVF, an ulnar AVF or various transposition or looped forearm AVFs. In case there are no possibilities in the forearm, two alternative efferent veins in the upper arm are available. In our institution, less and less looped forearm AVFs are performed. This might contribute to a high number of BVT AVFs. The European and North-American guidelines recommend the construction of a BC AVF prior to a BVT AVF.[1,2] Nonetheless, some clinicians may prefer the basilic vein for its larger diameter and the fact that the vein runs deep and is thus protected from damage caused by previous venapuncture.[8,15,16] Several studies have reported on the results of the BVT, with a 1- and 2-year primary patency rate of 72% (35–92) and 60.4% (28–86), respectively.[16] The primary patency rate of BC AVF in the literature varies. A study from the Netherlands reported a 1- and 2-year primary patency rate of 55% and 40%, respectively, and a secondary patency rate of 79% and 68%.[17] Woo et al. reported a 1- and 2-year primary patency rate of 56% and ±51%, and a 1- and 2-year secondary patency of 66% and ±59%, respectively.[15] The 1- and 2-year secondary patency rates of the BC and BVT AVF in our series were similar to the results reported in other publications.[18–20] The disappointing primary patency rate in our series may be explained by the intensive surveillance strategy and high early secondary intervention rate in our hospital to facilitate maturation. Comparative studies were done between BC AVF and BVT AVF and, as in our series, they did not find differences between patency rates.[8,21]

Some studies imply that the BVT AVF is more prone to develop steal syndrome and forearm oedema.[1,21,22] The prevalence of steal is described around 5–15% and oedema around 21–24%.[22–24] In a more recent study, however, the frequency of steal and oedema was 4% and 4%, respectively.[21] Koksoy et al. even reported that there was no clinically significant steal syndrome in their study.[8] Ascher et al. reported steal to be more prevalent with BVT AVF compared to BC AVF and that this was probably caused by the larger diameter of the basilica vein.[25] In our series, more fistulae were complicated by steal in the BC AVF group than in the BVT AVF group. Despite the greater basilic vein diameter, steal was more common in the BC group.

In selected patients, the BVT AVF may perform better than a BC AVF. Gonzalez et al. demonstrated in a safety-net population (i.e., older patients, women, African Americans, diabetes, peripheral vascular disease or previous access failure) that in a two-stage BVT AVF primary patency is marginally improved ($P = 0.08$) compared to other AVF.[26] Furthermore, in a study with 2422 patients, it was demonstrated that if the BVT AVF only is performed as a third choice for vascular access it has superior primary patency rates compared to that of a BC AVF.[27]

In our series, more females were present in the BVT AVF group compared to BC AVF. Stoikes et al. described a series in which superficialisation of the efferent vein was performed more often in obese patients compared to non-obese patients. The majority of these patients were female.[28] We did not observe a difference in BMI between males or females. However, the body fat in men is differently distributed compared to women and it may be that more pronounced subcutaneous fat in the arms of women influenced the selection of the AV fistula. However, other studies demonstrated that obesity did not influence maturation, AVF revision or patency.[29,30] In obese patients, AVF cannulation might be difficult. In these patients, a BVT AVF has the advantage of tunnelling the basilic vein superficially in the subcutis.

The most important limitation of this study is the retrospective data collection and the non-randomised comparison. Consequently, the results are subject to selection bias. Nevertheless, with the exception of sex, all patient characteristics are comparable for both groups.

In conclusion, with the exception of surgery time and mid upper arm vein diameters, we found no differences between the BC and BVT AVF, although more females had a BVT AVF compared to men and more patients with BVT AV fistulae had more previous fistulae. Since the construction of a BC AVF requires a smaller operation, this should be the preferred upper arm AVF when both the cephalic and basilica vein are available.

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Conflict of Interest

None.

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