Outcomes of basilic vein transposition versus polytetrafluoroethylene forearm loop graft as tertiary vascular access

Drouven, Johannes W.; de Bruin, Cor; van Roon, Arie M.; Oldenziel, Job; Zeebregts, Clark J.

Published in:
Journal of Vascular Surgery

DOI:
10.1016/j.jvs.2018.06.220

Outcomes of basilic vein transposition versus polytetrafluoroethylene forearm loop graft as tertiary vascular access

Johannes W. Drouven, MD,[a] Cor de Bruin,[a] Arie M. van Roon,[b] Job Oldenziel, MD,[c] *and* Clark J. Zeebregts, MD, PhD,[a] *Groningen, The Netherlands*

ABSTRACT

Background: Radial-cephalic arteriovenous fistula and brachial-cephalic arteriovenous fistula are the first and second choices for creating vascular access in dialysis patients as recommended by the National Kidney Foundation Kidney Disease Outcomes Quality Initiative. Basilic vein transposition or use of a forearm (polytetrafluoroethylene [PTFE]) loop graft is recommended thereafter. The aim of this study was twofold: first, to compare the outcomes and patency rates of patients treated with a basilic vein transposition with those of patients treated with a PTFE loop; and second, to identify patient-related factors of influence on patency rates.

Methods: Data collected in our prospectively maintained database of patients with chronic renal dysfunction requiring hemodialysis were analyzed. From April 2006 to August 2017, there were 55 patients with a basilic vein transposition and 75 patients with a PTFE loop included. Primary, primary assisted, and secondary patency rates were calculated. Multivariate analysis was used to identify factors of influence on survival. Incidence rates of complications and reinterventions were calculated and compared.

Results: Mean follow-up time was 29 months. A significantly higher 2-year primary assisted patency rate was found for the basilic vein transposition group (72.7% ± 6.5% vs 47.6% ± 6.2%; $P < .01$). The 2-year primary patency rates and secondary patency rates were comparable between basilic vein transposition and PTFE loop (25.1% ± 6.6% vs 13.7% ± 4.4% [$P = .11$] and 75.5% ± 6.5% vs 73.9% ± 5.3% [$P = .17$], respectively). Cox regression identified body mass index (hazard ratio [HR], 1.77; 95% confidence interval [CI], 1.05-2.98; $P = .03$) and age (HR, 0.54; 95% CI, 0.32-0.91; $P = .02$) as predictors for failure regarding primary patency in PTFE loop patients. Previous catheter use (HR, 0.29; 95% CI, 0.12-0.70; $P = .006$) and the presence of diabetes (HR, 3.32; 95% CI, 1.50-7.39; $P = .003$) were independent predictors for failure regarding primary patency in basilic vein transposition patients. The incidence rate of total complications was significantly higher in the PTFE loop group with 0.70 per patient-year (PY^{-1}) compared with 0.28 PY^{-1} in the basilic vein transposition group ($P = .001$). In terms of intervention rate, a significantly higher percutaneous transluminal angioplasty rate and surgical revision rate were found in the PTFE loop group than in the basilic vein transposition group (1.77 PY^{-1} vs 1.05 PY^{-1} [$P = .022$] and 0.20 PY^{-1} vs 0.07 PY^{-1} [$P = .002$], respectively).

Conclusions: In this nonrandomized study, basilic vein transposition has better primary assisted patency, fewer complications, and fewer reinterventions compared with PTFE loop. (J Vasc Surg 2019;69:1180-6.)

Keywords: Vascular access; Graft; Dialysis; Outcomes; Patency

Radial-cephalic arteriovenous fistula (AVF) and brachial-cephalic AVF are the first and second choices for creating vascular access in dialysis patients as recommended by the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (KDOQI) vascular access guidelines and European guidelines.[1,2] Tertiary access is indicated when these options have failed or are not possible. Basilic vein transposition or the use of a forearm (polytetrafluoroethylene [PTFE]) loop graft is then recommended.[2] The latest guidelines indicate that basilic vein transposition should first be considered and not a PTFE forearm loop graft, but the evidence supporting this guideline is moderate.[2-4] Reasons for preferring basilic vein transposition seem to be based on lower infection and reintervention rates compared with a PTFE loop.[5-8] In addition, the decision seems to become patient specific and might depend on life expectancy, comorbidity, and age.[9] Studies that directly compare the outcomes of basilic vein transposition with the placement of a PTFE loop remain scarce. Noncomparative studies are often used in reviews and consist of a wide variety of patient subgroups. As a consequence, varying outcomes in terms of patency and complication rates have been reported.[5-8,10]

The aim of this study was twofold: first, to compare the outcomes and patency rates of patients treated with a basilic vein transposition with those of patients treated with a PTFE loop in our prospectively maintained

From the Division of Vascular Surgery, Department of Surgery,[a] Division of Vascular Medicine, Department of Internal Medicine,[b] and Department of Radiology,[c] University Medical Center Groningen, University of Groningen.

Author conflict of interest: none.

Correspondence: Johannes W. Drouven, MD, Division of Vascular Surgery, Department of Surgery, University Medical Center Groningen, University of Groningen, Hanzeplein 1, PO Box 30 001, 9700 RB Groningen, The Netherlands (e-mail: w.j.w.drouven@umcg.nl).

The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

0741-5214

https://doi.org/10.1016/j.jvs.2018.06.220

database; and second, to identify patient-related factors of influence on the patency of tertiary vascular access.

METHODS

Study design. We analyzed the data collected in our prospectively maintained database of patients with chronic renal dysfunction requiring hemodialysis. From April 2006 to August 2017, a total of 130 patients who underwent either a basilic vein transposition or placement of a PTFE forearm loop in our center were included in this study. Retrospective research of patients' files does not fall under the scope of the Dutch Act on Medical Scientific Research involving Human Beings, and therefore patients' informed consent was not required and thus not obtained. Patient-related data were analyzed anonymously.

Preoperative assessment. Following the KDOQI and national guidelines, basilic vein transposition or a PTFE loop was considered when radial-cephalic AVF or brachial-cephalic AVF in either arm was not possible or had failed. Physical examination of both arms including assessment of possible central venous obstructions was routinely performed. Duplex ultrasound examination was carried out in all patients to measure the course, depth, and diameter of arteries and suitable veins.[11] Vein diameter measurements were performed with an inflated cuff to 50 mm Hg at the level of the proximal upper arm. Doppler spectral analysis combined with pressure measurements of arm and hand were performed. Basilic vein transposition was considered eligible when the basilic vein had a minimal diameter of 3 mm and was nonstenotic and nondiseased with a minimal length of 15 cm. For creation of a PTFE loop, a suitable elbow vein with a minimal diameter of 4 mm was considered necessary. For patients in predialysis, basilic vein transposition was scheduled for creation approximately 3 months before the expected start of hemodialysis; in the PTFE loop patients, patients were scheduled for creation 4 to 6 weeks before the expected start of hemodialysis. The nondominant arm was preferred for the vascular access. Patient-specific factors were taken into account in deciding between a basilic vein transposition and PTFE loop procedure. Basilic vein transposition was preferred when possible, especially in cases of expected long-term dialysis. In case of elderly patients, patients with previous maturation problems, or patients with a subacute indication for dialysis, a PTFE loop was considered.[9,12] In eight PTFE loop patients, basilic vein transposition was also technically feasible on the basis of vessel diameters only. However, a PTFE loop was created in two elderly patients because of the urgent need for dialysis in three patients and the extensive upper arm size in three patients.

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective analysis of prospectively collected single-center data
- **Key Findings:** Basilic vein transposition had better 2-year primary assisted patency and fewer revisions than a forearm prosthetic loop graft; however, each access option has subgroups that perform better.
- **Take Home Message:** The authors suggest using basilic vein transposition if possible over polytetrafluoroethylene loop grafts when only these options are available for dialysis.

Patients' demographics and characteristics, including the use of anticoagulant medication, catheter use (tunneled or nontunneled), comorbidity, intraoperative details, and postoperative complications, were recorded. Primary, primary assisted, and secondary patencies were calculated. According to the KDOQI clinical practice guidelines, cannulation was allowed after a 6-week maturation period in patients with basilic vein transposition. In patients with a PTFE loop, cannulation was allowed within 3 to 4 weeks after surgery.[2]

Surgical procedure. All procedures were performed under regional or general anesthesia. In case of the creation of a PTFE loop, patients received prophylactic antibiotic therapy according to our hospital standard.

For basilic vein transposition, a one-stage procedure was performed.[13] A continuous or interrupted longitudinal incision was placed at the medial side of the upper arm. The basilic vein was then dissected. Exploration of the brachial artery was performed through a transverse incision 2 cm proximal to the elbow. After mobilization of the basilic vein and ligation of side branches, the vein was transected as distally as possible and a bulldog clamp was placed at the proximal end. Special attention was given to spare the medial brachial cutaneous nerve. An anterolateral subdermal tunnel was created by using a tunneling device with a minimum diameter of 6 mm. The basilic vein was then marked to prevent twisting and was pulled through the tunnel. Next, an end-to-side anastomosis was then performed with a running polypropylene 6-0 suture (Prolene; Ethicon Inc, Somerville, NJ).

To create a PTFE loop, a standard wall PTFE graft (Gore-Tex; W. L. Gore & Associates, Flagstaff, Ariz) with 6-mm diameter and 0.5-mm wall thickness was used. A subcutaneous loop was created with a curved tunneling device in the forearm between the brachial artery and a suitable elbow vein. End-to-side arterial and venous anastomoses were created with a running polypropylene 6-0 suture (Prolene).

Definitions. Primary patency was defined as the interval from the time of access placement until any intervention designed to maintain or to re-establish patency, access thrombosis, or time of measurement of patency. Primary assisted patency was defined as the interval from the time of access placement until access thrombosis or the time of measurement of patency, including intervening manipulations designed to maintain the functionality of a patent access. Secondary patency was defined as the interval from the time after creation until access abandonment, thrombosis, or time of patency measurement including intervening manipulations designed to re-establish functionality in thrombosed access. Stenosis was defined as the presence of a peak systolic velocity >375 cm/s with a vessel diameter <2.0 mm.[14] Adequate fistula maturation was defined as a fistula with a vein diameter >4 mm, a flow >500 mL/min, and a puncture track length >10 cm.[15,16]

Follow-up. All patients were intensively monitored in the postoperative period until discharge. After discharge, routine physical examination, duplex ultrasound examination, and ultrasound dilution flow measurements with either a Transonic HD01 Plus Hemodialysis Monitor (Transonic Systems Inc, Ithaca, NY) or Fresenius 5008S CorDiax dialysis machine (Fresenius Medical Care, Bad Homburg, Germany) were performed. Indications for interventions were standardized. In the basilic vein transposition group, patients with repeatedly measured flow rates of <1000 mL/min or a consistent monthly decrease of 25% or more underwent angiography with additional percutaneous transluminal angioplasty (PTA) in case of stenosis. In the PTFE loop group, patients with repeatedly measured flow rates of <600 mL/min underwent angiography with additional PTA in case of stenosis.[1] In case of remaining stenosis after balloon angioplasty, a self-expanding nitinol stent was placed. No drug-coated balloons were used. In case of occlusion, surgical or endovascular thrombectomy was performed if eligible. Complications and interventions were recorded.

Statistical analysis. Data are presented as means including standard error of the mean or medians including range. Differences in incidence rates between groups were calculated with the Pearson χ^2 test or Fisher exact test. Assessment of normality was tested with the Kolmogorov-Smirnov test. Differences between the groups were calculated with the Mann-Whitney *U* test because data were not normally distributed. Kaplan-Meier survival analysis and the life-table method were used to calculate patency rates. The log-rank test was used to compare patencies between the different procedures and to determine significant factors influential to survival. Following univariate analysis, all significant factors with a *P* value <.10 were then entered into a multivariate Cox regression model with backward elimination.

Table I. Causes of renal failure

Chronic renal failure, etiology unknown	17 (13.1)
Cortical or tubular necrosis	1 (0.8)
Cystic kidney diseases	9 (6.9)
Diabetes mellitus	27 (20.8)
Interstitial nephritis, pyelonephritis, drug induced, nephrolithiasis	9 (6.9)
Not specified	2 (1.5)
Other congenital diseases or hereditary kidney diseases	2 (1.5)
Other multisystem diseases	8 (6.2)
Primary glomerular diseases	11 (8.5)
Renal vascular disease, excluding vasculitis	23 (17.7)
Transplant failure	21 (16.2)

Data are presented as number (%).

The incidence of complications and reinterventions was defined per patient-year (PY); the total number of complications and reinterventions was divided by the cumulative follow-up time of all patients in years.[6] Differences were calculated with the Mann-Whitney *U* test. *P* values of <.05 were considered statistically significant. SPSS 24 (IBM Corp, Armonk, NY) was used for analysis.

RESULTS

Characteristics. A total of 130 patients were included in this study, 55 patients with a basilic vein transposition and 75 patients with a PTFE loop. The causes of renal failure are listed in Table I. Diabetes mellitus, renal vascular disease, and transplant failure were the major underlying causes of renal failure. No significant differences were seen in underlying diseases between the groups ($P = .07$). Patients' characteristics are listed in Table II. No significant differences were found in primary vascular access and previous catheter use between the groups, 54.5% and 69.1% in the basilic vein transposition group vs 46.7% and 73.3% in the PTFE loop group, respectively. Age and body mass index (BMI) were significantly different between groups. Mean follow-up time was 29 months in both groups. Total follow-up time was 134.6 PY in the basilic vein transposition group and 184.8 PY in the PTFE loop group. Time to cannulation was significantly different between the groups, 66.9 days for basilic vein transposition vs 41.1 days for PTFE loop ($P < .001$).

Patency. Primary, primary assisted, and secondary patency rates are shown in Figs 1 to 3. Primary patency rates were comparable between both groups, with a 2-year patency rate of 25.1% ± 6.6% for the basilic vein transposition group and 13.7% ± 4.4% for the PTFE loop group ($P = .11$). A significantly higher 2-year primary assisted patency rate was found for the basilic vein transposition group compared with the PTFE loop group, 72.7% ± 6.5% vs 47.6% ± 6.2% ($P < .002$). Secondary

Table II. Patients' characteristics

	Basilic vein transposition	PTFE forearm loop	*P* value
No. of patients	55	75	
Sex			
Male	30 (54.5)	39 (52)	.774
Female	25 (45.5)	36 (48)	
Age at surgery, years	58.3 (13.9)	62.6 (14.9)	.046
Diabetes mellitus	15 (27.3)	35 (46.7)	.025
Hypertension	44 (80)	66 (88)	.212
BMI, kg m^{-2}	27.3 (7)	28.4 (8)	.575
Died within 30 days	0 (0)	2 (2.7)	.328
Primary vascular access	30 (54.5)	35 (46.7)	.443
No. of previous accesses	0.9 (1.1)	0.6 (0.8)	.219
Previous catheter use	38 (69.1)	55 (73.3)	.695
Time to cannulation, days	66.9 (36.4)	41.1 (40.5)	.001
Follow-up time, months	29.4 (27.2)	29.6 (28.7)	.830

BMI, Body mass index; *PTFE,* polytetrafluorethylene.
Data are presented as number (%) or mean (standard deviation).

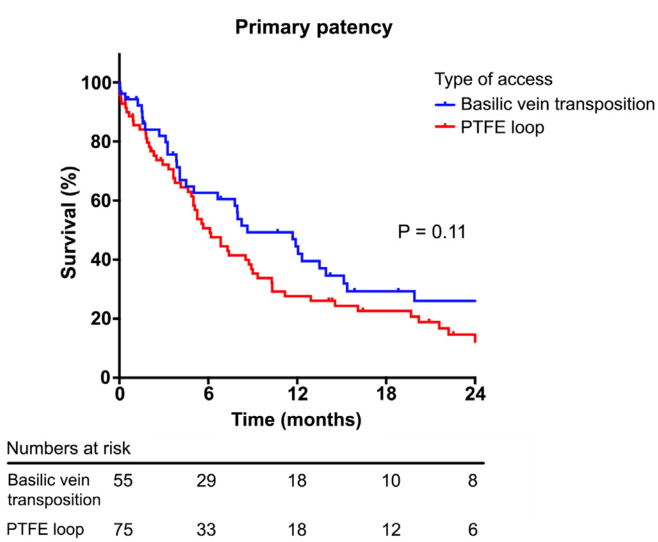


Fig 1. Primary patency. *PTFE,* Polytetrafluoroethylene.

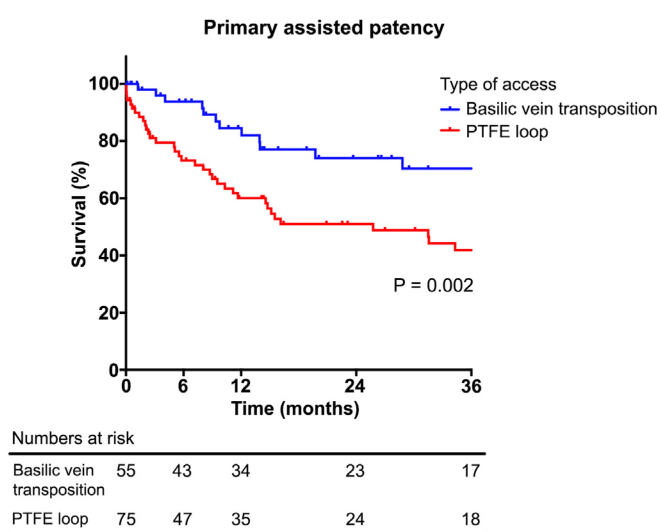
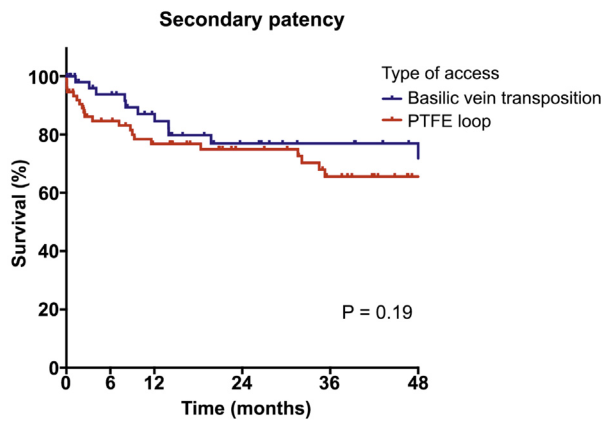


Fig 2. Primary assisted patency. *PTFE,* Polytetrafluoroethylene.

patency rates were also comparable between the two groups, with a 2-year patency rate of 75.5% ± 6.5% for the basilic vein transposition group and 73.9% ± 5.3% for the PTFE loop group ($P = .19$).

The results of the univariate survival analysis are shown in Table III. Diabetes mellitus and previous catheter use were significantly associated with the primary patency of basilic vein transposition, and sex was significantly associated with the secondary patency of basilic vein transposition. BMI was significantly associated with the primary patency of PTFE loop, and previous catheter use was significantly associated with the secondary patency of PTFE loop. Following univariate analysis, univariate factors with a P value <.10 were entered in a multivariate Cox regression model. A higher BMI (hazard ratio [HR], 1.77; 95% confidence interval [CI], 1.05-2.98; $P = .031$) and a younger age (HR, 0.54; 95% CI, 0.32-0.91; $P = .021$) were independent predictors for failure regarding primary patency in PTFE loop patients. Previous catheter use (HR, 0.29; 95% CI, 0.12-0.70; $P = .006$) and the presence of diabetes (HR, 3.32; 95% CI, 1.50-7.39; $P = .003$) were independent predictors for failure regarding primary patency in basilic vein transposition patients.

Complications and reinterventions. Total complications and reinterventions including incidence rates are shown in Tables IV and V. A significantly larger amount of occlusions was seen in the PTFE loop group than in the basilic vein transposition group ($P < .001$). The



Numbers at risk

Basilic vein transposition	55	44	36	25	20	15
PTFE loop	75	56	47	35	26	16

Fig 3. Secondary patency. *PTFE,* Polytetrafluoroethylene.

incidence rate of total complications was significantly higher in the PTFE loop group with 0.70 PY^{-1} compared with 0.28 PY^{-1} in the basilic vein transposition group ($P = .001$). For intervention rate, significantly higher PTA rate and stent use were found in the PTFE loop group than in the basilic vein transposition group, 1.77 PY^{-1} vs 1.05 PY^{-1} ($P = .022$) and 0.30 PY^{-1} vs 0.08 PY^{-1} ($P = .002$), respectively. In case of occlusion, endovascular thrombectomy and surgical revisions were most frequently seen in the PTFE loop group compared with the basilic vein transposition group, 0.25 PY^{-1} vs 0.03 PY^{-1} ($P < .001$) and 0.20 PY^{-1} vs 0.07 PY^{-1} ($P = .002$), respectively. The venous anastomosis site was most frequently the origin of the occlusion, which required additional treatment.

DISCUSSION

In this single-center retrospective cohort study, we compared the survival outcomes, complication rates, and intervention rates of patients with a basilic vein transposition with those of patients who received a PTFE loop during a follow-up period of 29 months. Significantly higher primary assisted patency was found in the basilic vein transposition group than in the PTFE loop group. Tendencies toward higher primary and secondary patencies were also seen in the basilic vein transposition group, although the differences were not statistically significant. Significantly fewer complications and reinterventions were seen in the basilic vein transposition group than in the PTFE loop group. The PTFE loop, on the other hand, could be cannulated earlier.

Regarding the multivariate regression model, BMI and age were significant predictors for primary patency in patients with a PTFE loop. In addition, previous catheter use and diabetes were significant predictors for primary patency in patients with a basilic vein transposition. In interpreting the results of the multivariate analysis, older patients with a lower BMI have better primary patency rates in case of a PTFE loop, and patients without catheters and without diabetes have better primary patency in case of basilic vein transposition. Other studies indicate that older individuals have lower primary patency rates and higher primary failure rates in AVF.[7,8,17] No data on the effect of age on arteriovenous graft (AVG) can be found. However, in a recent study conducted to establish patient-specific criteria for upper extremity vascular access, panelists associated older age with appropriateness of AVG creation, whereas larger BMI was associated with appropriateness of AVF creation. Diabetes and catheter use were not associated with appropriateness in this study.[9] However, the use of catheters might damage outflow vessels and therefore hamper the primary patency in basilic vein transposition patients.

Basilic vein transposition was first described by Dagher et al[18] in 1976. Whereas basilic vein transposition is a more complex and time-consuming procedure than the creation of a PTFE loop, the basilic vein is often spared of iatrogenic injury thanks to its proximal and deep anatomic location. In addition, the diameter is frequently suitable for vascular access because of its proximal anatomic position. The main disadvantages are a longer period of maturation and the risk of primary failure. PTFE loop, on the other hand, has no need for maturation, has a low primary failure rate, and is easy to cannulate. However, studies report a higher incidence of complications, such as infection and thrombosis, and a higher intervention rate compared with basilic vein transposition.

Studies comparing outcomes of basilic vein transposition with PTFE loop in patients in need of vascular access are scarce. Most frequently, reviews are based on noncomparative, descriptive studies.[7,8] To date, only one randomized controlled trial comparing basilic vein transposition directly with PTFE forearm loop has been conducted. Keuter et al[6] compared 52 basilic vein transposition patients with 53 PTFE forearm loop patients in 2008. The total follow-up period was 1 year. Significantly higher patency rates were found with regard to 1-year primary patency (46% vs 22%; $P = .005$) and 1-year primary assisted patency (87% vs 71%; $P = .045$) for the basilic vein transposition group; no significant differences were found with regard to 1-year secondary patency rates (89% for the basilic vein transposition group vs 85% for the PTFE loop group).

Our patency rates were comparable with their findings. Their complication and intervention rate was relatively high compared with our results. However, flow decrease was not scored as a complication in our study because of the standardized indications for reinterventions.

Fitzgerald et al[19] retrospectively compared the outcomes of 60 patients with a PTFE loop and 86 patients with an upper arm AVF in 2005. Data from all upper arm AVFs were pooled and compared with PTFE loops; 32 (37%) of the patients with an AVF underwent a basilic

Table III. Factors influencing patency at univariate analysis

	Basilic vein transposition patency			PTFE loop patency		
Factor	Primary	Primary assisted	Secondary	Primary	Primary assisted	Secondary
Median age	.345	.234	.385	.011[a]	.120	.133
Median BMI	.918	.635	.998	.017[a]	.720	.700
Preoperative anticoagulant therapy	.584	.317	.448	.721	.197	.128
Median operation time	.481	.093[a]	.182	.900	.898	.077[a]
Sex	.073[a]	.069[a]	.032[a]	.095[a]	.423	.895
No previous catheter use	.032[a]	.441	.356	.308	.776	.039[a]
Primary vascular access	.452	.209	.141	.564	.691	.090[a]
No. of previous accesses	.785	.353	.514	.454	.737	.298
Diabetes mellitus	.043[a]	.435	.642	.159	.718	.686
Hypertension	.936	.126	.274	.556	.789	.452

BMI, Body mass index; *PTFE,* polytetrafluorethylene.
P values are presented.
[a] *P* value <.10.

Table IV. Complications

Complication	PTFE	Incidence rate (PY^{-1})	Basilic vein transposition	Incidence rate (PY^{-1})	*P* value
Infection	4	0.02	0	0.00	.084
Nonmaturation	0	0.00	5	0.04	.008[a]
Stenosis	21	0.11	10	0.07	.073
Occlusion	100	0.54	15	0.11	<.001[a]
Aneurysm	3	0.02	1	0.01	.486
Hematoma	0	0.00	2	0.01	.097
Venous hypertension	0	0.00	4	0.03	.242
Steal and distal ischemia	1	0.01	1	0.01	.831
Total complications	129	0.70	38	0.28	.001[a]

PTFE, Polytetrafluorethylene.
Data are presented as numbers and incidence rates per patient-year (PY^{-1}).
[a] *P* value of <.05.

Table V. Interventions

	PTFE	Incidence rate (PY^{-1})	Basilic vein transposition	Incidence rate (PY^{-1})	*P* value
All interventions					
PTA	327	1.77	142	1.05	.022[a]
Stent use	56	0.30	11	0.08	.002[a]
In case of occlusion					
Endovascular thrombectomy	46	0.25	4	0.03	<.001[a]
Surgical revisions	37	0.20	10	0.07	.002[a]
Surgical thrombectomy	4	0.02	1	0.007	.305
Anatomic location of thrombosis					
Venous	40	0.22	3	0.02	<.001[a]
Arterial	7	0.04	0	0	.032[a]
Both	36	0.19	4	0.03	.005[a]

PTA, Percutaneous transluminal angioplasty; *PTFE,* polytetrafluorethylene.
Data are presented as numbers and incidence rates per patient-year (PY^{-1}).
[a] *P* value of <.05.

vein transposition procedure. No subgroup analysis was performed in this group. A significantly higher complication rate and intervention rate were found in the PTFE loop group compared with upper arm AVF. No significant differences were found in patency rates. The PTFE loop could be cannulated after 1.8 months vs 3.8 months for the upper arm AVF group ($P < .018$).

Oliver et al[5] retrospectively compared the outcomes of 89 patients with a basilic vein transposition with those of 82 patients with an upper arm AVG and 56 patients with a brachiocephalic AVF in 2001. Follow-up was 1 to 2 years. PTFE loops were more likely to thrombose than basilic vein transpositions (relative risk of 1.6), required more interventions (0.7 vs 2.4) per access-year ($P < .01$), and were more likely to become infected (0% vs 13%; $P < .05$). No significant differences were found in thrombosis-free survival.

The limitation of this study is its retrospective nature. Patients were not randomized to either a basilic vein transposition or a PTFE loop procedure; the choice for vascular access was based on guidelines and patient-specific factors as described before. Furthermore, selection bias in comparing nonrandomized patients was also a limitation of this study.

CONCLUSIONS

In this nonrandomized study, basilic vein transposition had better patency and fewer complications and reinterventions compared with PTFE loop. Time to cannulation was significantly longer in the basilic vein transposition group. This study identified several factors that influenced the patency rates of both procedures. The results of this study might aid in the creation of future guidelines for tertiary vascular access. Reviewing the results of our study combined with the outcomes of previous studies, basilic vein transposition seems the better choice in tertiary vascular access, especially when urgent cannulation is of less importance. Further research on patient-related factors might be of use in the creation of a patient-specific vascular access policy.

AUTHOR CONTRIBUTIONS

Conception and design: JD, CB, CZ
Analysis and interpretation: JD, AR
Data collection: JD, CB, JO
Writing the article: JD
Critical revision of the article: JD, CB, AR, JO, CZ
Final approval of the article: JD, CB, AR, JO, CZ
Statistical analysis: Not applicable
Obtained funding: Not applicable
Overall responsibility: JD

REFERENCES

1. Tordoir JH, Mickley V. European guidelines for vascular access: clinical algorithms on vascular access for haemodialysis. EDTNA ERCA J 2003;29:131-6.
2. Vascular Access Work Group. Clinical practice guidelines for vascular access. Am J Kidney Dis 2006;48(Suppl 1):S248-73.
3. Lok CE. Fistula first initiative: advantages and pitfalls. Clin J Am Soc Nephrol 2007;2:1043-53.
4. Sidawy AN, Spergel LM, Besarab A, Allon M, Jennings WC, Padberg FT, et al. The Society for Vascular Surgery: clinical practice guidelines for the surgical placement and maintenance of arteriovenous hemodialysis access. J Vasc Surg 2008;48(Suppl):2S-25S.
5. Oliver MJ, McCann RL, Indridason OS, Butterly DW, Schwab SJ. Comparison of transposed brachiobasilic fistulas to upper arm grafts and brachiocephalic fistulas. Kidney Int 2001;60:1532-9.
6. Keuter XH, De Smet AA, Kessels AG, van der Sande FM, Welten RJ, Tordoir JH. A randomized multicenter study of the outcome of brachial-basilic arteriovenous fistula and prosthetic brachial-antecubital forearm loop as vascular access for hemodialysis. J Vasc Surg 2008;47:395-401.
7. Lazarides MK, Georgiadis GS, Papasideris CP, Trellopoulos G, Tzilalis VD. Transposed brachial-basilic arteriovenous fistulas versus prosthetic upper limb grafts: a meta-analysis. Eur J Vasc Endovasc Surg 2008;36:597-601.
8. Almasri J, Alsawas M, Mainou M, Mustafa RA, Wang Z, Woo K, et al. Outcomes of vascular access for hemodialysis: a systematic review and meta-analysis. J Vasc Surg 2016;64:236-43.
9. Woo K, Ulloa J, Allon M, Carsten CG, Chemla ES, Henry ML, et al. Establishing patient-specific criteria for selecting the optimal upper extremity vascular access procedure. J Vasc Surg 2017;65:1089-103.e1.
10. Dember LM, Beck GJ, Allon M, Delmez JA, Dixon BS, Greenberg A, et al. Effect of clopidogrel on early failure of arteriovenous fistulas for hemodialysis: a randomized controlled trial. JAMA 2008;299:2164-71.
11. Lomonte C, Basile C. Preoperative assessment and planning of haemodialysis vascular access. Clin Kidney J 2015;8:278-81.
12. de Leur K, Ozturk C, Van Zeeland ML, de Groot HG, Heyligers JM, Vriens PW, et al. Vascular access outcome in the elderly dialysis patient in combination with the quality of life. Vasc Endovascular Surg 2013;47:444-8.
13. Cooper J, Power AH, DeRose G, Forbes TL, Dubois L. Similar failure and patency rates when comparing one- and two-stage basilic vein transposition. J Vasc Surg 2015;61:809-16.
14. Doelman C, Duijm LE, Liem YS, Froger CL, Tielbeek AV, Donkers-van Rossum AB, et al. Stenosis detection in failing hemodialysis access fistulas and grafts: comparison of color Doppler ultrasonography, contrast-enhanced magnetic resonance angiography, and digital subtraction angiography. J Vasc Surg 2005;42:739-46.
15. Robbin ML, Chamberlain NE, Lockhart ME, Gallichio MH, Young CJ, Deierhoi MH, et al. Hemodialysis arteriovenous fistula maturity: US evaluation. Radiology 2002;225:59-64.
16. van Loon MM, Kessels AG, Van der Sande FM, Tordoir JH. Cannulation and vascular access-related complications in hemodialysis: factors determining successful cannulation. Hemodial Int 2009;13:498-504.
17. Lee HW, Allon M. When should a patient receive an arteriovenous graft rather than a fistula? Semin Dial 2013;26:6-10.
18. Dagher F, Gelber R, Ramos E, Sadler J. The use of basilic vein and brachial artery as an A-V fistula for long term hemodialysis. J Surg Res 1976;20:373-6.
19. Fitzgerald JT, Schanzer A, McVicar JP, Chin AI, Perez RV, Troppmann C. Upper arm arteriovenous fistula versus forearm looped arteriovenous graft for hemodialysis access: a comparative analysis. Ann Vasc Surg 2005;19:843-50.

Submitted Jan 18, 2018; accepted Jun 7, 2018.