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Comparison of arteriovenous fistulas constructed with main or internal branch of the cephalic vein: a retrospective analysis of 32 cases

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Abstract

Objective: To evaluate the effect on the maturation of arteriovenous fistulas (AVFs) when using the internal branch of the cephalic vein compared with the main branch of the cephalic vein.

Methods: The study enrolled patients with end-stage renal disease and divided them into an internal branch group (AVF constructed using the internal branch of the cephalic vein) or a main branch group (AVF constructed using the main branch of the cephalic vein). The surgical outcomes including complications were observed in these patients after 12 weeks.

Results: Thirty-two patients with end-stage renal disease were included in the study. There were 16 patients in each group. The demographic and clinical characteristics were not significantly different between the two groups. The diameter of the arteries and veins were not significantly different between the two groups before the operation. In the internal branch group, significantly more ($n = 7$) patients failed to mature or required surgical intervention compared with the main branch group ($n = 1$).

Conclusion: For veins of the same diameter, these findings suggest that constructing AVFs using the main branch of the cephalic vein instead of the internal branch was more suitable for patients with end-stage renal disease requiring haemodialysis.

Keywords

Arteriovenous fistula, vascular access, wall shear stress, intimal hyperplasia

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Introduction

Haemodialysis is a common renal replacement therapy for end-stage renal disease (ESRD). The establishment of vascular access for dialysis is a prerequisite for patients to receive high-efficiency dialysis. Arteriovenous fistula (AVF) is the best vascular access for most patients receiving maintenance haemodialysis.[1] AVF has the advantages of good durability and a low infection rate,[2] but unfortunately, a large number of patients are at risk of AVF maturation failure.[3] There are three main types of AVF anastomoses used in uraemic patients: end-to-side (ETS) anastomosis, end-to-end (ETE) anastomosis and side-to-side (STS) anastomosis. Some studies supported a higher rate of failures in AVFs constructed by means of ETE anastomosis than by ETS anastomosis;[4,5] and ETS anastomosis provided better results regarding complications and primary survival than did ETE anastomosis.[6] Arterial steal syndrome was more significantly associated with STS anastomosis than with ETS anastomosis.[7] Therefore, ETS anastomosis may be the preferable anastomosis approach for most patients. Research has suggested that the diameter of the vessel is an important factor affecting the prognosis of AVF.[8,9] However, the position to choose for anastomosis has not been reported.

Most patients have internal/external branches of the cephalic vein near their wrist (Figure 1).[10]The inner branch is the vessel that many surgeons choose to establish AVF. However, the main costs associated with AVFs are not for construction, but for maintenance.[11] Improving the maturation probability of AVF after construction and avoiding postoperative surgical intervention at the same time are issues of concern for vascular access surgeons. The main diameter of the main branch of the cephalic vein is usually larger than that of the internal branch, and the course of the main branch is also straight. Therefore, if the internal fistula is constructed directly by the main branch, it may achieve better surgical results. The purpose of this current study was to explore the effect of choosing the main branch or the internal branch on the outcome of AVF, to reduce the cost of medical treatment and lessen the pain and economic burden of patients.

Patients and methods

Study population

This retrospective study enrolled patients with ESRD undergoing AVF surgery for the first time in the Department of Blood Purification, Qilu Hospital, Medical School

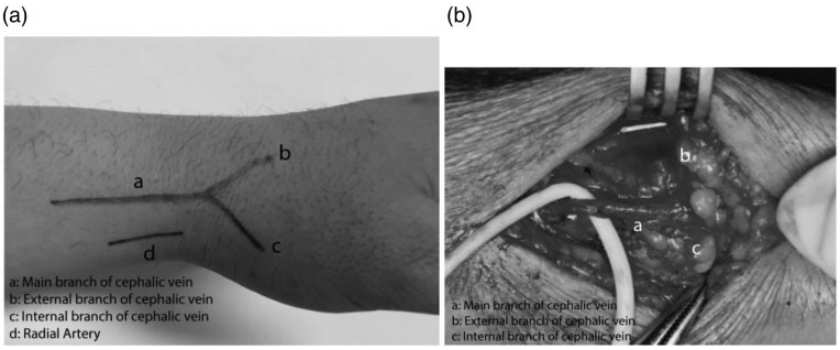

Figure 1. Surface projection of the internal/external branches of the cephalic vein near the wrist (a). Anatomy of the vessels (b).

of Shandong University, Jinan, Shandong Province, China between January 2019 and March 2020. The patients were retrospectively collected using the medical record management system of the hospital. The inclusion criteria were as follows: (i) chronic kidney disease stage 5 according to the American Society of Nephrology standard; (ii) red blood cells, platelets and fibrinogen in the normal range after treatment; (iii) age 18–80 years old; (iv) AVF performed with the ETS method. The exclusion criteria were as follows: (i) arteriovenous fistula operation history or renal transplantation history; (ii) severe vascular calcification; (iii) vascular disease or blood disease.

This study was approved by the Ethics Committee of Qilu Hospital of Shandong University (ethics audit number: 2020054). As a retrospective study, the requirement for informed consent was waived. The reporting of this study conformed to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[12]

Study methods

Patients that fulfilled the inclusion criteria were divided into the internal branch group (AVF constructed using the internal branch of the cephalic vein/radial artery) and the main branch group (AVF constructed using the main branch of the cephalic vein/radial artery) (Figure 2). The general data and vascular condition were compared before the operation. Postoperative maturation condition and complications at 12 weeks were also observed. Radial artery diameter and cephalic vein diameter were obtained from the surgical data and anastomotic width was measured at 1 month. The outcomes were mainly divided into two groups, including composite poor outcomes (referring to all situations requiring surgical intervention, including fistula dysmaturity, thrombosis and stenosis) and composite good outcomes (maturation success without surgical intervention). According to one multicentre study, an AVF diameter/nearby vessel diameter <0.5 was regarded as stenosis.[13] If the effect of dialysis was still far from satisfactory at 12 months after conservative treatment, then this was considered to be the criterion for surgical intervention.

All vessel data were measured by the same surgeon (N.G.) with the same ultrasound machine (Clover series Ultrasonic Diagnostic System; Shenzhen Wisonic Medical Technology, Shenzhen, China) and all operations were performed by the same surgical team (N.G. & J.T.) in the same operating room.

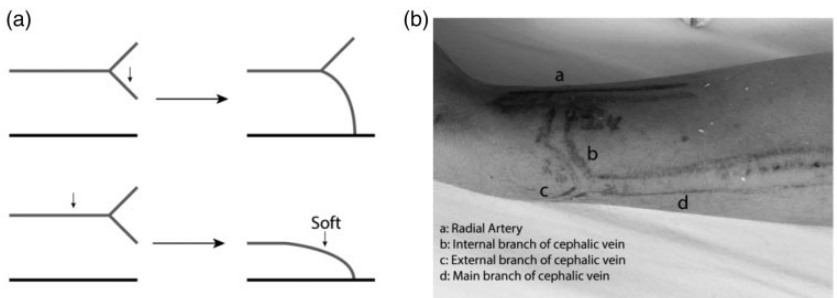

Figure 2. Ideograph of two different arteriovenous fistulas (AVFs) (a). Surface projection of the AVF using the internal branch/radial artery (b).

Statistical analyses

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean ± SD. Discontinuous variables are described as event numbers. The F-test was used to assess the homogeneity of variance. The difference between groups was assessed using Student's *t*-test and Fisher's probabilities test for continuous and discontinuous variables, respectively. A *P*-value <0.05 was considered statistically significant.

Results

After screening, this retrospective study enrolled 32 patients: 16 into the internal branch group and 16 into the main branch group. The demographic and clinical characteristics were not significantly different between the two groups (Table 1). The diameter of the arteries and veins were not significantly different between the two groups before the operation (Table 2). At 1 month after the operation, there was no significant difference in the anastomotic width between the two groups.

Table 1. Demographic and clinical characteristics of patients ($n = 32$) enrolled in a retrospective study of the effect of choosing the main branch or the internal branch of the cephalic vein on the outcome of arteriovenous fistulas used for the treatment of end-stage renal disease.

	Internal branch group $n = 16$	Main branch group $n = 16$
Age, years	49.75 ± 13.17	48.25 ± 12.67
Sex, male/female	8/8	7/9
Race, Han/others	16/0	15/1
Preoperative creatinine, μmol/l	879.87 ± 112.09	916.87 ± 101.46
Cardiac ejection fraction	0.51 ± 0.03	0.52 ± 0.04
Systolic blood pressure, mmHg	151.06 ± 8.17	148.25 ± 7.57
Diastolic blood pressure, mmHg	91.56 ± 6.00	89.44 ± 7.82
Fasting plasma glucose, mmol/l	6.86 ± 0.66	6.92 ± 0.52

Data presented as mean ± SD or *n* of patients.
No significant between-group differences ($P \geq 0.05$); continuous data were compared using Student's *t*-test and categorical data were compared using Fisher's probabilities test.

Table 2. Preoperative diameters of arteries and veins and the anastomotic width 1 month after the operation in patients ($n = 32$) enrolled in a retrospective study of the effect of choosing the main branch or the internal branch of the cephalic vein on the outcome of arteriovenous fistulas used for the treatment of end-stage renal disease.

	Internal branch group $n = 16$	Main branch group $n = 16$
Preoperative radial artery diameter, cm	1.95 ± 0.12	1.98 ± 0.13
Preoperative cephalic vein diameter, cm	2.51 ± 0.32	2.69 ± 0.34
Postoperative anastomotic width, cm	0.66 ± 0.11	0.68 ± 0.08

Data presented as mean ± SD.
No significant between-group differences ($P \geq 0.05$); continuous data were compared using Student's *t*-test.

Seven patients (three thrombosis, three stenosis and one dysmaturity) in the internal branch group experienced composite poor outcomes, while there was only one patient with stenosis in the main branch group ($P = 0.037$) (Table 3). All of the blood flow of the draining vein in the eight patients with composite poor outcomes failed to reach 500 ml/min. For the patients with stenosis, percutaneous transluminal angioplasty (PTA) was performed; and for patients with thrombosis, thrombectomy was performed, with both interventions achieving good outcomes. For the case of dysmaturity, PTA was not effective; thus, a new AVF operation was performed.

Discussion

Although AVF is currently the most ideal vascular access for most patients requiring dialysis,[1] the high risk of its maturation failure cannot be ignored.[3] Intimal hyperplasia is considered the main cause of maturation failure,[14,15] which is prone to occur in areas with low and oscillating wall shear stress,[16–18] such as the inner wall of the proximal anastomotic vein or the narrow part of the blood vessel.[19–23] Based on the results of this current study, it is believed that compared with selecting the internal branch for vascular anastomosis, selecting the main branch has a lower rate of maturation failure. The potential reasons are as follows: (i) there was a sharper vein-to-artery angle in the inner branch group, while the anastomosis angle of the main branch group was smoother, avoiding the occurrence of vortex and reverse flow and to a certain extent reducing the possibility of maturation failure (Figure 3). A previous study suggested that the overall decrease in wall shear stress was related to outward remodelling and maturation of vascular accesses.[4] Based on this notion, it can be speculated that the local pathway curve of the main branch for anastomosis may have

Table 3. Postoperative outcomes at 12 weeks in patients ($n = 32$) enrolled in a retrospective study of the effect of choosing the main branch or the internal branch of the cephalic vein on the outcome of arteriovenous fistulas used for the treatment of end-stage renal disease.

	Composite good outcomes	Composite poor outcomes[a]	Statistical analysis[b]
Internal branch group	9	7	$P = 0.037$
Main branch group	15	1	

Data presented as *n* of patients.

[a]Composite poor outcomes referred to all situations requiring surgical intervention, including fistula dysmaturity, thrombosis and stenosis; according to Kidney Disease Outcomes Quality Initiative clinical practice guidelines and clinical practice recommendations for vascular access, arteriovenous fistulas diameter/nearby vessel diameter < 0.5 was regarded as stenosis.

[b]Fisher's probabilities test.

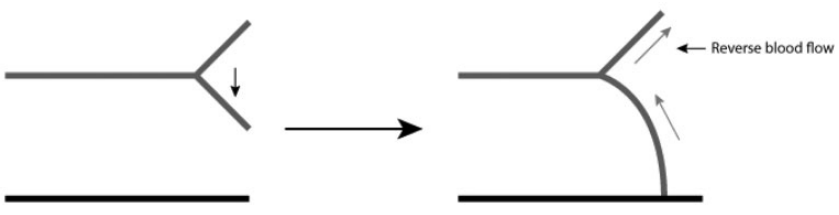

Figure 3. Ideograph of the reverse blood flow.

an effect on accelerating the maturation process; (ii) vein valves are often present at the place where two branches of the cephalic vein converge, causing stenosis at this site (Figure 4). When blood flows through, a vortex is generated, inducing intimal hyperplasia.[14,15,23] If the internal branch is selected for anastomosis, blood is likely to flow to the lateral branch to a certain extent when it passes through the confluence, coupled with the presence of venous valves, leading to disturbed flow. The presence of a venous valve also represents an unstable factor associated with the occurrence of vascular stenosis; (iii) anastomosis with the main branch completely eliminates the reflux caused by the external branch of the cephalic vein, promoting the maturation of AVF and avoiding congestion of the hand. Meanwhile, compared with the internal branch, the use of main branch anastomosis can provide a longer distance to inversely puncture the artery for PTA.

This current study had several limitations. First, as the sample size was small, it was difficult to further analyse the relationship between a specific poor outcome and the surgical procedure. Therefore, larger multicentre studies are needed. Secondly, the follow-up time was short, so the longer-term prognosis could not be observed.

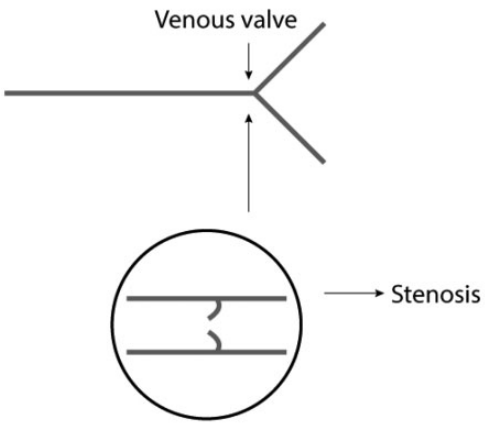

Figure 4. Ideograph of the stenosis in the cephalic vein.

In conclusion, these current results suggest that, for veins of the same diameter, main branch anastomosis has a lower secondary surgical intervention rate than internal branch anastomosis. The data demonstrated that main branch anastomosis was a better choice for patients with ESRD undergoing AVF surgery.

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Declaration of conflicting interest

The authors declare that there are no conflicts of interest.

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