Original Article

Turkish Journal of Vascular Surgery 2020;29(x):i-v

DOI: 10.9739/tjvs.2020.597
www.turkishjournalofvascularsurgery.org

Early- and late results of anastomosis techniques for creation of brachiocephalic fistulas for hemodialysis

Aykut Şahin

Department of Cardiovascular Surgery, Eskişehir Osmangazi University, Faculty of Medicine, Eskişehir, Turkey

ABSTRACT

Objectives: In this study, we present our early and late results of different anastomosis techniques for the creation of brachiocephalic fistulas for hemodialysis.

Patients and methods: Between January 2012 and December 2016, a total of 61 patients (37 males, 24 females; median age 59 years; range 44 to 72 years) who underwent arteriovenous fistula (AVF) operation for hemodialysis were retrospectively reviewed. Side-to-side (STS) and end-to-side (ETS) anastomosis techniques in the brachial region were compared in terms of patency and complication rates in the early- and late-term.

Results: There were 29 patients in the STS group and 32 patients in the ETS group. Although there was a proportional difference in the patency rates and complications between the groups, it was not statistically significant, particularly in the long-term period. The patency rates of STS and ETS at two years were 69% and 59.4%, respectively, indicating that none of the techniques was superior to the other. The presence of peripheral arterial disease and diabetes mellitus was the most significant factors affecting the patency rates.

Conclusion: Both ETS and STS anastomosis techniques should be planned individually. Although both techniques yield a similar patency rate, fistulas are superior to grafts and catheters. Fistulas, which may be the last chance of a patient, can be safely created using both techniques.

Keywords: Arteriovenous fistula, brachiocephalic, hemodialysis, patency.

Arteriovenous fistula (AVF) is the most desirable option for hemodialysis given its improved patency and lower infection rates.[1,2] They are also superior to catheters and grafts in terms of mortality, infection, and thrombosis.[3,4] The success of AVFs depends on the structure of the selected region, vessel diameter, vein-side flow and subsequent venous site for hemodialysis.[5] Patient compliance, anatomical structure, and experience of the hemodialysis center are also important factors for improved AVF patency. Cimino-Brescia performed the first AVF in 1966, and many different techniques have been developed since then.

Arteriovenous fistula locations are radiocephalic (wrist, snuff-box), brachiocephalic (elbow), or brachiobasilic. Brachiobasilic transposition are uncommon and often needs basilic vein elevation. The first choice is mostly radiocephalic AVFs. Anastomosis location may affect the flow of AVF.

On the other hand, maturation process of AVFs is complex. Anastomosis should be created with adequate flow for hemodialysis. In addition, the surgeon should avoid arterial steal syndrome and poor hemodynamic conditions. In most cases, the surgeon demands less technical view for fistula creation.

In the present study, we reviewed our early and late results of brachiocephalic AVFs for hemodialysis and to evaluate complication rates and primary and secondary patency rates of side-to-side (STS) and end-to-side (ETS) techniques.

Received: December 05, 2019 ***Accepted:*** December 27, 2019 ***Published online:*** January 10, 2020

Correspondence: Aykut Şahin, MD. Eskişehir Osmangazi Üniversitesi Tıp Fakültesi Kalp ve Damar Cerrahisi Anabilim Dalı, 26480 Meşelik, Eskişehir, Türkiye.
e-mail: draykutsahin@gmail.com

Citation:
Şahin A. Early- and late results of anastomosis techniques for creation of brachiocephalic fistulas for hemodialysis. Turk J Vasc Surg 2020;29(x):i-v

©2020 Turkish National Vascular and Endovascular Surgery Society. All rights reserved.

PATIENTS AND METHODS

Between January 2012 and December 2016, a total of 61 patients (37 males, 24 females; median age 59 years; range 44 to 72 years) who underwent AVF operation for hemodialysis were retrospectively analyzed. We preferred brachiocephalic AVFs, as neither these patients had any good vascular structure at any other side of the upper extremity nor their recent fistulas became mature properly or thrombosed. All patients underwent upper extremity examination using Doppler ultrasonography. Those with missing ultrasonography and missing medical records were excluded from the study. If the arterial or venous diameter was under 1 mm, brachiocephalic fistula was preferred. The vessel diameter, arterial flow rates, and configuration of the antecubital region were examined. Patients with a less than 1 mm vessel at the antecubital region were excluded from the study. Fifteen patients had a recent fistula, and these fistulas were not patent due to thrombosis, immature venous side, arterial occlusion, or infection. Also, two patients had a venous aneurysm and underwent ligation and aneurysmectomy. A written informed consent was obtained from each patient. The study protocol was approved by Osmangazi University, Faculty of Medicine, Ethics Committee (2019-320). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Operative technique

If the brachial artery and cephalic vein were close to each other, STS anastomosis technique was preferred owing to its simplicity. If the brachial artery and cephalic vein were distant to each other, ETS anastomosis technique was used. The technique to be used was at the discretion of the surgeon. The vessel diameter, damaged sections, and antecubital region specifications were the main determinants of the technique to be selected.

All surgical procedures were performed under local anesthesia using 1% prilocaine. Brachial artery and cephalic vein were explored and secured with nylon tapes. After 5,000 IU intravenous heparin injection, the artery and vein were clamped. The vein incision was 1.5 times greater than the arteriotomy incision. All anastomoses were performed with continuous technique using 7/0 polypropylene sutures. After completion of the anastomosis, the vein was explored distally for side branches with the potential to reduce blood flow. These branches were ligated. Following bleeding control, the skin was closed with 3/0 polypropylene sutures.

The patients were divided into two groups according to the anastomosis technique as STS (Group 1, n=29) and ETS (Group 2, n=32). In Group 1, the cephalic vein was ligated 5 to 10-mm proximal to the anastomosis site. Preoperative arterial and venous Doppler ultrasonography was performed in all patients. In the postoperative period, arterial and venous Doppler ultrasonography was performed at one month, and one and two years. If the venous blood flow was above 200 mL/min, the AVF was accepted as patent and having an adequate flow. Patients with a venous diameter exceeding 1.5 cm were considered to have a fistula aneurysm. The patient who had venous fistula aneurysms with symptomatic complications such as hand ischemia, thrombus, pain or bleeding were operated through aneurysmectomy, ligation, or graft interposition.

Table 1. Demographic and clinical data of patients

	Group 1 (n=29)				Group 2 (n=32)				
	n	%	Median	Min-Max	n	%	Median	Min-Max	*p*
Age (year)			58	44-72			59	44-71	0.418*
Gender									
Male	18	62.1			19	59.4			0.830†
Diabetes mellitus	23	79.3			25	78.1			0.910†
Arterial hypertension	20	69			21	65.6			0.781†
Smoking	20	69			22	68.8			0.986†
Hyperlipidemia	16	55.2			17	53.1			0.873†
Coronary artery disease	8	27.6			8	25			0.819†
Peripheral arterial disease	4	13.8			4	12.5			1.0‡
Previous fistula	9	31			6	18.8			0.266†
Postoperatively thrill	26	89.7			29	90.6			1.0‡
Preoperatively vein diameter (mm)			2.2	2.0-3.1			2.1	2.0-3.0	0.222*

* Mann-Whitney U test, † Pearson chi-square test, ‡ Fisher exact test (continuity correction).

Table 2. Follow-up data of patients

	Group 1 (n=29)				Group 2 (n=32)				
	n	%	Median	Min-Max	n	%	Median	Min-Max	*p*
Flow rate (mL/min) (1st month)			220	120-300			230	150-300	0.096*
Patency (6th month)	26	89.7			30	93.8			0.909‡
Patency (1st year)	22	75.9			23	71.9			0.724†
Patency (2nd year)	20	69			19	59.4			0.436†
Aneurysm (2nd year)	5	17.2			3	9.4			0.597‡
Thrombosis (2nd year)	4	13.8			6	18.8			0.860‡

* Mann-Whitney U test, † Pearson chi-square test, ‡ Fisher exact test (continuity correction).

Statistical analysis

Power analysis was performed using the G*Power version 3.1.9.4 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) and sample size was calculated. The power of the study was found to be 80% at an alpha value of 0.05. Statistical analysis was performed using the PSPP version 1.2.0 software (Free Software Foundation Inc., Boston, MA, USA). Non-normally distributed continuous variables were presented in median (min-max), while categorical variables were presented in number and frequency. Continuous variables between the two groups were compared using the Mann-Whitey U test, while the categorical variables were compared using the chi-square test or Fisher's exact test with the continuity correction. Multivariate analysis was performed to identify significant variables. A p value of <0.05 was considered statistically significant.

RESULTS

The median age was 58 (range, 44 to 72) years in Group 1 and 59 (range, 44 to 71) years in Group 2 (p>0.05). Eighteen patients (62.1%) in Group 1 and 19 patients (59.4%) in Group 2 were males (p>0.05). There was no statistically significant difference between the two groups in terms of the history of smoking, diabetes mellitus, hypertension, hyperlipidemia, coronary artery disease, and peripheral arterial disease. Baseline demographic and preoperative data are shown in Table 1.

Table 3. Multivariate analysis results

Outcome	Variable	OR (95% CI)	*p*
Patency (6th month)	PAD	15.3 (2.1-114.3)	0.008
	CAD	9.1 (0.8-105.3)	0.076
Patency (1st year)	DM	26.2 (2.1-329.7)	0.012
	PAD	42.1 (2.8-660.6)	0.008
Patency (2nd year)	PAD	6.9 (1.3-38.1)	0.026

OR: Odds ratio; CI: Confidence interval; PAD: Peripheral arterial disease; CAD: Coronary artery disease; DM: Diabetes mellitus.

The median preoperative cephalic vein diameter was 2.2 (range, 2.0 to 3.1) mm in Group 1 and 2.1 (range, 2.0 to 3.0) mm in Group 2, indicating no significant difference between the groups (p>0.05). Thrill of the vein-side was confirmed in 89.7% patients (n=26) in Group 1 and 90.6% patients (n=29) in Group 2. The patency rates (venous side flow above 200 mL/min) were 89.6% (n=26) in Group 1 and 93.8% (n=30) in Group 2. Although there was no postoperative thrill in the early postoperative period, the flow increased with the maturation of the AVF in one patient in Group 2. Therefore, the number of patients in Group 2 with a patent fistula reached 30. At the end of the first year, the patency rates were 75.9% in Group 1 and 71.9% in Group 2. The patency rate in Group 2 decreased after one year. However, there was no statistically significant difference between the two groups (p>0.05). After the second year, an aneurysm was detected in five patients (17.2%) in Group 1 and three patients (9.4%) in Group 2. Although the aneurysm rate was relatively low in Group 2, there was no significant difference between the groups. At the end of the second year, AVF thrombosis was detected in four patients (13.4%) in Group 1 and six patients (18.8%) in Group 2. The rate of patients without any complication and a patent fistula at the end of the second year were 69% (n=20) in Group 1 and 59.4% (n=19) in Group 2. The patients with partial fistula thrombosis or who were unable to run hemodialysis due to infection were reoperated for the management of complications and were divided into the non-patent fistula group. Therefore, the rate of patent fistulas at the end of two years was found to be relatively low (Table 2).

Multivariate analysis revealed that peripheral arterial disease was a significant variable for patency and complication rates. Accordingly, the patency rates were found to be lower in the patients with peripheral arterial disease. In addition, diabetes mellitus was found to be a significant variable for fistula patency at the first year (p<0.05) (Table 3).

DISCUSSION

Renal transplantation is the gold-standard treatment modality in the treatment of chronic renal failure owing to its successful survival rates and improved quality of life. However, the need for chronic dialysis continues for most of patients, at least with the aim of bridging to transplantation. These patients need hemodialysis until renal transplantation or for lifetime. Although brachiocephalic fistulas are not the first choice, it would be the last chance of these patients. On the other hand, these fistulas are not preferred by some surgeons due to the high shunt rates, although it is safer than vascular grafts.[9] If the right diameter of fistula anastomosis (under 5 mm) is chosen, the flow remains its physiological limits.[6] Therefore, the surgeon should choose the anastomosis technique carefully.

In this study, the majority of the patients were males. In previous studies, both genders are equal. In addition, Simoni et al.[7] and Demirkılıç et al.[8] showed that ETS fistulas were more patent than the STS fistulas; however, we found no significant difference in the patency rates at the end of two years. When the patency rates were examined, there was a rapid decrease in the STS AVFs in the first year. It may be thought that a smaller anastomosis can be performed to balance the shunt rate in STS anastomosis technique. In our department, STS anastomosis technique is routinely performed with 3 to 4 mm anastomosis diameter. Indeed, this procedure (not to exceed 3 mm in the shunt area) was performed for safety of the shunt flow, which may turn into stenosis in patients with anastomotic site intimal hyperplasia. Using the STS anastomosis technique, the surgeon must have a good balance of patency and shunt ratio. In almost all cases, large anastomoses and high flow rates are the main causes of steal syndrome.[18] In case of brachial steal syndrome, treatment becomes complicated. In such cases, the surgeon should reoperate the patient and balance the flow. If balancing of flow is impossible, the anastomosis must be ligated.

In their study, Fitzgerald et al.[9] reported that the AVFs performed in the antecubital region had 47% complication rate, and 43% of these AVFs required a new procedure. In addition, one-year patency rate was 74%. In our study, we observed similar one-year patency rates, which were 75.9% in Group 1 and 71.9% in Group 2. Different risk factors might have affected the current patency rates. The major risk factors include other interventions at the antecubital region (i.e., cannulation, or blood sampling), education and experience of hemodialysis nurses or technicians, quality of intervention materials, experience of the surgeon, peripheral arterial disease, and protection of extremity with fistula.[1,10]

Furthermore, color Doppler ultrasonography mapping (CDUM) of the upper extremity affects planning of the fistula type and location. Also, the patency rates are higher with CDUM, as it offers a good location and sufficient vessels.[15] In this study, we used CDUM, as we must choose the right location and technique. If the patients had good arterial and venous structure at the elbow, we preferred radiocephalic or snuff-box fistulas.

In our study, the complication of fistula (aneurysm and thrombosis) was low (15%) than the literature.[5,9,10] Treatment for fistula complications is of utmost importance for the patients' quality of life and a successful hemodialysis access. Aneurysm and thrombosis have been reported more frequently with brachiocephalic fistulas than radiocephalic fistulas.[16,17] However, despite the low complication rates in our study, similar patency rates suggest that other interventions and patient-related risk factors affected the patency rates. The patency rate was lower in the patients with peripheral arterial disease. Previous studies have also demonstrated that intimal hyperplasia, diabetes mellitus, and peripheral arterial disease can affect the patency rates.[9-11,14] In our study, there was no statistically significant difference in the patency rates between the STS and ETS groups, consistent with the previous studies.[9,12] However, Moini et al.[13] found that the patency rate of the STS technique was higher than the others, while the complication rates were similar. The authors concluded that ETS had no superiority to STS, although they were unable to fully explain why the patency rate was higher in the STS group.

Retrospective design is the main limitation of this study. Despite relatively small sample size, it remained sufficiently large for power analysis. Nonetheless, Further, large-scale, prospective studies are needed to confirm our findings.

In conclusion, considering lifetime hemodialysis for patients with chronic renal failure, we need to choose the AVF creation technique which has a good patency rate in long-term and is the farthest from complications. Therefore, AVF surgery should start from the wrist region, and brachiocephalic fistulas should be reserved as the last resort. According to our study results, the patency and complication rates of brachiocephalic AVFs were similar between the

ETS and STS anastomosis techniques at the end of the second year. We believe that STS technique can be preferred for its ease and simplicity, although the anastomosis diameter should be considered due to the shunt rate. On the other hand, ETS technique provides better shunt control; however, it needs to be done in the hands of experienced surgeons. Overall, both techniques do not have significant advantages in terms of brachiocephalic AVFs. Therefore, it is necessary to make a patient-based decision. Finally, fistulas, which may be the last chance of a patient, can be safely created using both techniques.

Declaration of conflicting interests

The author declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The author received no financial support for the research and/or authorship of this article.

REFERENCES

1. Ravani P, Palmer SC, Oliver MJ, Quinn RR, MacRae JM, Tai DJ, et al. Associations between hemodialysis access type and clinical outcomes: a systematic review. J Am Soc Nephrol 2013;24:465-73.
2. Malas MB, Canner JK, Hicks CW, Arhuidese IJ, Zarkowsky DS, Qazi U, et al. Trends in incident hemodialysis access and mortality. JAMA Surg 2015;150:441-8.
3. Pisoni RL, Arrington CJ, Albert JM, Ethier J, Kimata N, Krishnan M, et al. Facility hemodialysis vascular access use and mortality in countries participating in DOPPS: an instrumental variable analysis. Am J Kidney Dis 2009;53:475-91.
4. Dalrymple LS, Mu Y, Nguyen DV, Romano PS, Chertow GM, Grimes B, et al. Risk factors for infection-related hospitalization in in-center hemodialysis. Clin J Am Soc Nephrol 2015;10:2170-80.
5. Casey JR, Hanson CS, Winkelmayer WC, Craig JC, Palmer S, Strippoli GF, et al. Patients' perspectives on hemodialysis vascular access: a systematic review of qualitative studies. Am J Kidney Dis 2014;64:937-53.
6. Bae E, Lee H, Kim DK, Oh KH, Kim YS, Ahn C, et al. Autologous arteriovenous fistula is associated with superior outcomes in elderly hemodialysis patients. BMC Nephrol 2018;19:306.
7. Simoni G, Bonalumi U, Civalleri D, Decian F, Bartoli FG. End-to-end arteriovenous fistula for chronic haemodialysis: 11 years' experience. Cardiovasc Surg 1994;2:63-6.
8. Demirkılıç U, Kuralay E, Yilmaz AT. Snuffbox bölgesinde farklı anastomoz teknikleri ile yapılan arteriovenöz fistüllerin karşılaştırılması. Turk J Vasc Surg 1997;6:24-30.
9. Fitzgerald JT, Schanzer A, Chin AI, McVicar JP, Perez RV, Troppmann C. Outcomes of upper arm arteriovenous fistulas for maintenance hemodialysis access. Arch Surg 2004;139:201-8.
10. Al-Jaishi AA, Oliver MJ, Thomas SM, Lok CE, Zhang JC, Garg AX, et al. Patency rates of the arteriovenous fistula for hemodialysis: a systematic review and meta-analysis. Am J Kidney Dis 2014;63:464-78.
11. Bashar K, Conlon PJ, Kheirelseid EA, Aherne T, Walsh SR, Leahy A. Arteriovenous fistula in dialysis patients: Factors implicated in early and late AVF maturation failure. Surgeon 2016;14:294-300.
12. Mozaffar M, Fallah M, Lotfollahzadeh S, Sobhiyeh MR, Gholizadeh B, Jabbehdari S, et al. Comparison of efficacy of side to side versus end to side arteriovenous fistulae formation in chronic renal failure as a permanent hemodialysis access. Nephrourol Mon 2013;5:827-30.
13. Moini, M, Rasouli MR, Williams, GM, Najafizadeh S, Sheykholeslami G. Comparison of side-to-side brachiocephalic arteriovenous fistula with ligation of the perforating vein with end-to-side brachiocephalic arteriovenous fistula. EJVES Extra 2009;17:7-10.
14. Zeebregts CJ, Tielliu IF, Hulsebos RG, de Bruin C, Verhoeven EL, Huisman RM, et al. Determinants of failure of brachiocephalic elbow fistulas for haemodialysis. Eur J Vasc Endovasc Surg 2005;30:209-14.
15. Ilhan G, Esi E, Bozok S, Yürekli I, Özpak B, Özelçi A, et al. The clinical utility of vascular mapping with Doppler ultrasound prior to arteriovenous fistula construction for hemodialysis access. J Vasc Access 2013;14:83-8.
16. Ilhan G, Bozok Ş, Destan B, Karamustafa H, Ozan Karakisi S, Ergene Ş, et al. Surgical treatment for complications of arteriovenous fistulas in hemodialysis patients. Chirurgia 2013;26:345-9.
17. Tordoir JH, Dammers R, van der Sande FM. Upper extremity ischemia and hemodialysis vascular access. Eur J Vasc Endovasc Surg 2004;27:1-5.
18. Karaca OG, Kunt A, Koç A. Treatment of steal syndrome in patients with arteriovenous fistula: Narrowing the arterial part of anastomosis. Turk J Vasc Surg 2018;27:166-71.