

# Comparison of one-year patency rates of end-to-side and side-to-side anastomosis technique in proximal forearm region radial-cephalic fistulas

Vascular

0(0) 1–6

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DOI: 10.1177/1708538120977023

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## Abstract

**Objectives:** In this study, the effects of anastomosis techniques on the results of patients with autogenous radial-cephalic proximal forearm fistula were investigated.

**Methods:** Patients who underwent radial-cephalic proximal forearm fistula surgery (arteriovenous fistula) between April 2015 and August 2017 at the Department of Cardiovascular Surgery of Ordu University were compared retrospectively in terms of the results of anastomosis techniques. The study included 131 patients who had arteriovenous fistulas created by side-to-side and end-to-side anastomosis technique.

**Results:** There was no significant difference in demographic data, comorbidities, radial artery, and cephalic vein diameters in patients undergoing radial-cephalic proximal forearm fistula surgery. However, it was observed that fistula maturation was earlier in the group with end-to-side anastomosis technique, and the one-year patency rates were higher in the group with side-to-side anastomosis technique.

**Conclusion:** In Arteriovenous fistulas created in the proximal forearm region, the one-year patency rate of the side-to-side anastomosis technique was higher, while the maturation of the end-to-side technique observed earlier.

## Keywords

Arteriovenous fistula, side-to-side, end-to-side, hemodialysis, fistula patency, fistula maturation

## Introduction

Chronic kidney disease (CKD) is a common public health problem worldwide.<sup>1</sup> Chronic renal failure (CRF) occurs as a result of the progression of CKD. Although the main treatment of CRF is kidney transplant treatment, patients often need hemodialysis due to donor deficiency. Arteriovenous fistulas (AVFs) are the most effective and long-term use for the treatment of hemodialysis. Many studies have stated that the one-year AVF patency rate is between 80 and 95% regardless of the fistula region and anastomosis type.<sup>2</sup> The first choice for AVFs is the distal part of the non-dominant arm. However, if the fistulas cannot be used for various reasons, a new fistula is created proximal to the same arm. AVFs in the forearm region are usually created due to the failure of the fistula in the distal region.<sup>3</sup> It is rarely created as the first choice if the cephalic vein or distal region of the radial artery cannot be used for surgery.<sup>4</sup> Surgical anastomosis

techniques change according to the surgeon's preference, the state of the surgical site, and the patient's vascular structures when creating the fistula in this area. Although the surgical technique in the forearm region is generally preferred as end-to-side, the side-to-side technique is also used. In this study, proximal forearm region radiocephalic AVFs created in the side-to-side and end-to-side technique were evaluated retrospectively.

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## Material and methods

This study was carried out by the decision of the Ethics Committee of Sivas Cumhuriyet University numbered 2020–01/04. In the study, patients who had autogenous radial-cephalic proximal forearm region fistulas created at Ordu University Cardiovascular Surgery department were compared retrospectively in terms of anastomosis techniques. Proximal forearm radial-cephalic AVF surgery was performed on 156 patients between April 2015 and August 2017. Eight patients were excluded from the study because no intraoperative thrill was assessed. In addition, 17 patients without a one-year follow-up were excluded from the study.

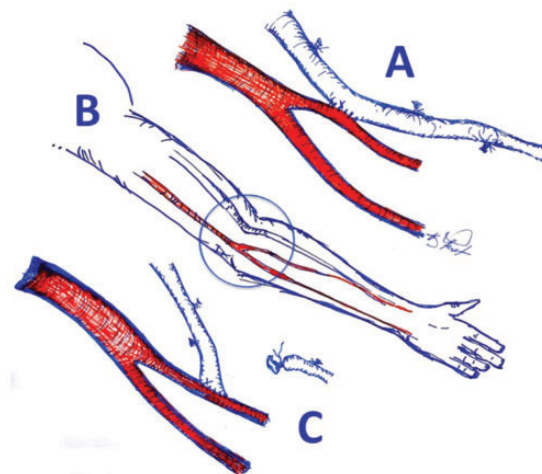
All patients had previously undergone distal radiocephalic AVF operation. The second AVF operation from the same extremity was performed by our center. Surgical procedures were performed by the same surgeon according to the same surgical standards. All patients had a history of distal radiocephalic AVF surgery. All patients were operated under local anesthesia after sterile staining and covering (Figure 1). In patients who underwent end-to-side anastomosis, cephalic vein was released and inflated than anastomosed with 7.0 prolene. In the side-to-side group, the cephalic vein was not inflated and anastomosis was done with 7.0 prolene (Figure 2). All patients were heparinized before anastomosis. No limitations or criteria were determined in the preference of anastomosis type. The choice of anastomosis type was entirely the surgeon's preference. After standard surgical procedures, all patients were followed up in the hospital overnight. Patients underwent hemodialysis from AVF was considered successful maturation. In the study, primary patency rates and other parameters of the fistulas created between the same artery and the vein of the patients were compared according to the anastomosis types.

## Statistical analysis

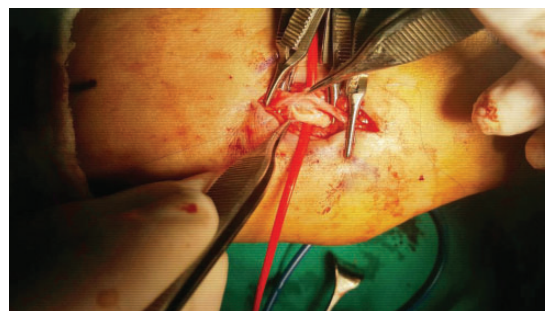
All data analyses were performed with IBM SPSS 23 (StataCorp LP, College Station, TX, USA) program for statistical evaluation in the study. The difference between groups was made with Chi-square test in non-parametric variables and parametric variables were made with independent-t test. All parameters are tested in a 95% confidence interval.  $p$  Value  $< 0.05$  was accepted as statistically significant.

## Results

Proximal forearm radial-cephalic AVF surgery was performed in 156 patients between April 2015 and August 2017. Eight patients were excluded from the



**Figure 1.** (a) Side-to-side anastomosis region. (b) Arteriovenous fistula surgical region. (c) End-to-side anastomosis region.



**Figure 2.** The operation performed with the side-to-side anastomosis technique is seen.

study because no intraoperative thrill was assessed. In addition, 17 patients without a one-year follow-up were excluded from the study.

Side-to-side anastomosis was performed in 58 patients and end-to-side anastomosis in 73 patients. The data of the groups are given in Table 1. Accordingly, there were no statistically significant differences between the two groups in many parameters such as age, gender, additional disease, and surgical complications. While hematoma was seen in four patients (6.8%) in the side-to-side group, it was seen in six patients (8.2%) in the end-to-side group. In addition, hand edema was seen in two patients (3.4%) in the side-to-side group and one patient (1.3%) in the end-to-side group. However, it was observed that fistula maturation was statistically significantly earlier in the end-to-side anastomosis group ( $p < 0.041$ ). On the other hand, the one-year patency rate was statistically significantly higher in the side-to-side anastomosis group ( $p < 0.044$ ).

**Table 1.** Demographic, intraoperative, and postoperative data.

	Side-to-side anastomosis (n = 58)	End-to-side anastomosis (n = 73)	p Values
Age in years (mean, SD)	64.3 ± 13.3	65.1 ± 14.1	0.753
Sex			
Female, n (%)	28 (48.2)	34 (46.5)	0.846
Male, n (%)	30 (51.8)	39 (53.5)	
Body mass index (mean, SD)	29.9 ± 2.6	30.4 ± 2.6	0.663
Tobacco use			
Active user, n (%)	10 (17.2)	15 (20.5)	
Ex smoker, n (%)	10 (17.2)	14 (19.1)	0.821
Never smoked, n (%)	38 (65.6)	44 (60.4)	
Diabetes, n (%)	23 (39.6)	29 (39.7)	0.993
Hypertension, n (%)	32 (55.1)	42 (57.5)	0.787
Anticoagulant use, n (%)	28 (48.2)	34 (46.5)	0.846
Coronary artery disease, n (%)	22 (37.9)	30 (41.1)	0.713
Congestive heart failure, n (%)	6 (10.3)	9 (12.3)	0.723
Peripheral arterial disease, n (%)	16 (27.5)	21 (28.7)	0.881
Cerebrovascular disease, n (%)	7 (12)	9 (12.3)	0.964
Thromboembolic disease, n (%)	6 (10.3)	5 (6.8)	0.474
Malignancy, n (%)	4 (6.8)	6 (8.2)	0.777
Radial artery diameter (mean, SD)	4.5 ± 0.49	4.4 ± 0.37	0.079
Cephalic vein diameter (mean, SD)	3.7 ± 0.61	3.7 ± 0.64	0.431
Side of fistula			
Right, n (%)	24 (41.3)	26 (35.6)	0.500
Left, n (%)	34 (58.7)	47 (64.4)	
Hematoma, n (%)	4 (6.8)	6 (8.2)	0.777
Hand edema, n (%)	2 (3.4)	1 (1.3)	0.430
Maturation time (days) (mean, SD)	24.8 ± 5.5	21.0 ± 4.2	<0.041
Primary patency (one year), n (%)	55 (94.8)	61 (83.5)	<0.044

SD: standard deviation.

## Discussion

Since the AVF that Cimino and Brescia first described, it has been performed in many different localization and techniques.<sup>5</sup> End-stage CKD is one of the leading causes of morbidity and mortality worldwide. In 2010, 2618 million people worldwide received renal replacement therapy.<sup>6</sup> Vascular access dysfunction is another cause of mortality and morbidity in hemodialysis patients.<sup>7</sup> There are many factors that determine the patency rate of fistulas. These factors depend on the patient, the hemodialysis application, and the surgical technique experience. Factors known to affect fistula patency positively or negatively are as follows: age, gender, diabetes, hypotension, artery diameter, atherosclerosis, arterial flow, vein diameter, venous expandability, smoking, obesity, early hemodialysis, anastomosis type, vascular clip use, antiplatelet therapy, use of systemic heparin, first hemodialysis timing, cannulation technique, and follow-up.<sup>8</sup> Acipayam and colleagues stated that the most important factors adversely affecting the fistula patency were diabetes, cephalic vein diameter < 2 mm, and female gender.

They reported positively affecting factors as postoperative thrill presence and male gender.<sup>9</sup> Sahasrabudhe and colleagues have also achieved similar results.<sup>10</sup> Schinstock and colleagues revealed that the most important factor determining the fistula patency was the artery diameter.<sup>11</sup> In our study, cephalic vein diameter was similar in both groups. On the other hand, patients who did not take intraoperative thrill were not included in both groups. Although many factors affecting fistula patency and maturation have been identified, patient-based risks should be considered separately.<sup>12</sup> Although there are many risk factors for early failure in AVFs, the rate of failure due to surgical procedures was found to be 29%.<sup>13</sup> It is recommended to start from the distal of the nondominant arm for the first AVF to be created.<sup>3</sup> However, for various reasons, there may be no chance of a new fistula in the upper extremity, which is the most preferred for AVF. For this reason, although very rare, lower extremity fistulas can also be preferred and created.<sup>14</sup> In our study, it was seen that both groups were similar in terms of limb side.

Many different ratios have been reported in the literature regarding the patency and maturation of AVFs. Mousa and colleagues reported the maturation rates of AVF as 55% and the patency rates as 65%, regardless of the anastomosis type.<sup>15</sup> The most ideal time for fistula maturation was found to be 2–4 months after surgery and the best time for hemodialysis.<sup>16</sup> In our study, it was observed that fistula maturation was earlier in the group who underwent end-to-side anastomosis. It was thought that this effect may be the result of inflating of the cephalic vein in the end-to-side anastomosed group. On the other hand, the first hemodialysis entry time was found as the  $21.0 \pm 4.2$  day in the end-to-side anastomosis group and the  $24.8 \pm 5.5$  day in the side-to-side anastomosis group. It is stated that one of the factors that increase the secondary patency rate after first episode of thrombosis is to perform the removal of clot surgically. Secondary patency was observed to be short-lived in patients undergoing endovascular method.<sup>17</sup>

As seen in the literature, many factors that determine the patency and maturation of AVFs have been studied. Although these factors are mentioned such as the experience of the surgeon performing the surgery, the anastomosis preferences in surgery are rarely mentioned. Although factors being assessed have included the experience of the surgeon performing the surgery, the anastomosis used in surgery is rarely mentioned. Whether an AVF anastomosis will be side-to-side or end-to-side depends on the condition of the patient and the surgical site, the preference of the surgeon is at a considerable rate. Although end-to-side fistulas are often preferred for many advantageous reasons, Konner noted that the most important disadvantage in this type of anastomosis is the diameter mismatch between the artery and vein.<sup>18</sup> Konner and colleagues likewise emphasized that the most important disadvantage for end-to-side fistulas is diameter mismatch.<sup>19</sup> Various techniques have also been proposed for AVFs created with the end-to-side technique. One of them is the no-touch technique. However, there was no difference between this technique and conventional groups in terms of any patency.<sup>20</sup>

The study, in which the side-to-side fistulas were almost completely rejected, was done by Wedgwood et al.<sup>21,22</sup> Wedgwood and colleagues reported that side-to-side fistulas should not be preferred for AVF because of hyperemia in hand, low flow, and increased need for revision. However, the study did not specify whether the distal radial artery or proximal radial artery of end-to-side and side-to-side fistulas were localized. Therefore, it is unclear which location of fistulae should not be preferred in the study. On the other hand, our study was almost incompatible with the results of Wedgwood et al. Hyperemia in hand was

similar in both groups, which was due to stenosis or occlusion in the proximal venous outflow tract. Moreover, valves in the cephalic vein are the biggest obstacle to hand edema or hyperemia. The low flow rate indicated by Wedgwood et al. is a result of the lack of inflation of the side-to-side fistulas and the flow extending to the distal and proximal regions. As a matter of fact, in our study, the side-to-side fistula group showed a later maturation than the end-to-side group. The need for revision may be a parameter that may change depending on the experience of the center performing the surgery. As a matter of fact, the revision needs between the groups were similar in our study.

On the other hand, Moini and colleagues stated that the fistulas created with side-to-side anastomosis at the elbow level results are very good and the use of this technique is wise when wrist use is not possible.<sup>23</sup> Venous configuration is very important in AVF maturation. As a matter of fact, Bharat and colleagues showed that fistula maturation was 9% better with piggyback straight-line onlay technique.<sup>24</sup> Ligation of the perforator veins is recommended for side-to-side anastomoses at elbow level. The binding of perforators not only prevents steal syndrome, but also regresses the current steal syndrome.<sup>23,25</sup> However, whether side-to-side or end-to-side anastomosis is performed, the main goal in creating AVF is to close the vein branches anyway. In our study, perforator veins and other branches were completely closed in both groups. Creation of side-to-side AVF is not only done in the forearm region. This method is also used in the creation of radio-cephalic fistulas in the distal region. Hong and colleagues found that one-month primary patency rate was 96% and one-year primary patency rate was 93% in anastomoses that performed side-to-side in the distal radio-cephalic region.<sup>26</sup>

In addition to the clinical results of side-to-side and end-to-side fistulas, Hull and colleagues compared them with mathematical modeling on computers. According to this study, it was revealed that the wall shear stress properties of side-to-side anastomoses were more uniform than end-to-side anastomoses.<sup>27</sup> The conclusion to be drawn from this mathematical model reveals that if there is no anatomical obstacle, side-to-side anastomoses can achieve better clinical results. In mathematical modeling developed by Van Canneyt et al. for end-to-side anastomosis, the presentations showed that the configuration, size, and angle of anastomosis are affected.<sup>28</sup>

In the light of all these findings, the reason for the increased patency rate in the side-to-side group can be explained by the regular anastomosis configuration. At the same time, delayed maturation time can be explained by the lack of inflation in side-to-side fistulas



and the distribution of arterial flow to both the distal and proximal of the cephalic vein.

## Conclusion

Side-to-side anastomoses should be kept in mind in radial-cephalic proximal forearm fistulas due to ease of surgical application and higher one-year primary patency rates. On the other hand, it should not be forgotten that there are relatively late maturation time and rarely negative aspects such as hand edema. When evaluated cumulatively, side-to-side anastomoses seem more preferable than end-to-side anastomoses in this region AVF surgery.

## Limitations

The fact that our study is single-centered and retrospective is an important limitation. Surgeons did not use any criteria when creating side-to-side or end-to-side anastomosis. However, after the cephalic vein was released, those who were too close to the radial artery usually preferred side-to-side anastomosis. In addition, our study includes one-year results. Therefore, changes in patency and complication rates can be seen in long-term results. We believe that the results will be more clear if similar studies are conducted in other centers in a prospective, randomized, and controlled manner.

## Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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