

## Arteriovenous fistula creation using the Brescia-Cimino technique compared to the fish-mouth anastomosis technique for hemodialysis access

Hemodiyaliz erişimi için balık ağzı anastomoz tekniğine kıyasla Brescia-Cimino tekniği ile arteriyovenöz fistül oluşturulması

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### ABSTRACT

**Objectives:** This study aims to compare the success rates of two different anastomotic techniques using Doppler ultrasound (US) in patients undergoing forearm arteriovenous fistula creation surgery for hemodialysis access.

**Patients and methods:** Between January 2010 and March 2011, 40 patients (8 males, 32 females; mean age 52.7 years; range, 28 to 63 years) who underwent the forearm arteriovenous fistula procedure due to end-stage renal disease were included in this study. The patients were divided into two groups, depending on the surgical technique employed. Group 1 included 20 patients operated using the Brescia-Cimino technique, while Group 2 included 20 patients operated using the fish-mouth technique. The diameters of the radial artery and cephalic vein were measured pre- and at postoperative Days 1, 7, and 30. The arteriovenous fistula flow rate was measured using Doppler US at postoperative Day 30.

**Results:** The mean preoperative cephalic vein diameters were 2.48±0.4 mm in Group 1 and 2.03±0.4 mm in Group 2 (p=0.004). The mean preoperative radial artery diameters were 2.46±0.5 mm in Group 1 and 2.04±0.2 mm in Group 2 (p=0.003). The mean arteriovenous fistula flow rates at Week 4 were 547±149 mL/min in Group 1 and 745±108 mL/min in Group 2 (p<0.001). Early complication rates and surgery times were lower in the fish-mouth group.

**Conclusion:** Fish-mouth anastomosis appears to be an efficient and safe technique for arteriovenous fistula creation with a lower complication rate and shorter operation time.

**Keywords:** Arteriovenous fistula; Doppler ultrason; fish-mouth anastomosis technique.

### ÖZ

**Amaç:** Bu çalışmada hemodiyaliz erişimi için ön kolda arteriyovenöz fistül oluşturulan hastalarda Doppler ultrason (US) ile iki farklı anastomoz tekniğinin başarı oranı karşılaştırıldı.

**Hastalar ve Yöntemler:** Bu çalışmaya Ocak 2010 - Mart 2011 tarihleri arasında son dönem böbrek yetmezliği nedeniyle ön kolda arteriyovenöz fistül ameliyatı yapılan 40 hasta (8 erkek, 32 kadın; ort. yaş 52.7 yıl; dağılım, 28-63 yıl) alındı. Hastalar uygulanan cerrahi tekniğe göre iki gruba ayrıldı. Grup 1'e Brescia-Cimino tekniği uygulanan 20 hasta alınırken, Grup 2'ye balık ağzı tekniği uygulanan 20 hasta alındı. Ameliyattan önce ve sonrasında 1, 7 ve 30. günlerde radyal arter ve sefalik ven çapları ölçüldü. Arteriyovenöz fistül debileri, ameliyattan sonra 30. günde Doppler US ile ölçüldü.

**Bulgular:** Ameliyat öncesi ortalama sefalik ven çapı Grup 1'de 2.48±0.4 mm, Grup 2'de 2.03±0.4 mm olarak bulundu (p=0.004). Ameliyat öncesi ortalama radyal arter çapı Grup 1'de 2.46±0.5 mm, Grup 2'de 2.04±0.2 mm olarak bulundu (p=0.003). Hastaların dördüncü haftada arteriyovenöz fistül debileri Doppler US ile Grup 1 ve Grup 2'de sırasıyla 547±149 mL/dk. ve 745±108 mL/dk. olarak ölçüldü (p<0.001). Erken komplikasyon oranları ve cerrahi süresi, balık ağzı grubunda daha düşüktü.

**Sonuç:** Balık ağzı anastomozu, daha düşük komplikasyon oranı ve daha kısa ameliyat süresi ile arteriyovenöz fistül oluşturmada etkili ve güvenli bir teknik olarak görünmektedir.

**Anahtar sözcükler:** Arteriyovenöz fistül; Doppler ultrason; balık ağzı anastomoz tekniği.

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The optimal treatment for patients with end-stage renal disease is kidney transplantation. However, the proportion of patients with end-stage renal disease who can benefit from this therapeutic modality is severely restricted in Turkey due to insufficient numbers of organ donors. Those patients who are unable to receive transplantation are, therefore, often treated with dialysis. The need for a vascular access route is a distinguishing component of hemodialysis, in terms of morbidity and mortality, in patients with end-stage renal disease. Functional vascular access is essential for effective hemodialysis.<sup>[1]</sup>

Arteriovenous fistulas (AVF), which were originally introduced by Brescia-Cimino in 1966, remain the gold standard, despite the many advances made in the field of graft technology, and are still favored as the first choice dialysis access route in patients with end-stage renal disease.<sup>[2]</sup> The European Guidelines and the National Kidney Foundation recommend radiocephalic AVFs as the first choice route for hemodialysis.<sup>[3,4]</sup>

In this study, we aimed to compare two different anastomotic techniques, Brescia-Cimino and fish-mouth anastomosis, for the creation of radiocephalic AVFs in patients requiring vascular access for hemodialysis.

## PATIENTS AND METHODS

Forty patients (8 males, 32 females; mean age 52.7 years; range, 28 to 63 years) who were admitted to the Cardiovascular Surgery Department for the first AVF creation in the forearm due to end-stage renal disease between January 2010 and March 2011 were enrolled in this study. Radial artery and cephalic vein diameters were measured in all patients using color Doppler ultrasound (US) on the day of surgery. Radiocephalic AVF creation was scheduled for patients with an anatomically suitable cephalic vein and radial artery. Patients were randomly assigned into one of two groups. Inclusion criteria were as follows: being scheduled for the first AVF, absence of bleeding disorder, age between 15 and 75 years, and voluntary participation. Based on the color Doppler US findings, the Brescia-Cimino anastomosis was performed in 20 patients with normal peripheral veins (Group 1, n=20), and fish mouth anastomosis was performed in the other 20 patients (Group 2, n=20). A written informed consent was obtained from each patient. The study protocol was approved

by the Medicine Faculty of Kahramanmaraş Sütçü İmam University Ethics Committee and the study was conducted in accordance with the principles of the Declaration of Helsinki.

### Surgical technique

In Group 1, the vein was first separated and the radial artery was, then, prepared. The vein was ligated and severed at the distal end. A longitudinal incision was made in the radial artery. Cephalic vein and radial artery end-to-side anastomosis was performed with 7/0 polypropylene sutures using the Brescia-Cimino anastomosis and continuous suture techniques. In Group 2, similar procedures were followed, except after arteriotomy, a fish-mouth shaped incision was made to both lips of the radial artery to enlarge the lumen. Similarly to Group 1, cephalic vein and radial artery end-to-side anastomoses were performed with a continuous suture technique using 7/0 polypropylene sutures.

Cephalic and radial artery measurements were performed using Doppler US on postoperative Days 1, 7, and 30. The fistula flow rate was also measured on Day 30. Early complications and duration of operation were recorded.

### Statistical analysis

Statistical analysis was performed using the PASW version 18.0 software (SPSS Inc., Chicago, IL, USA). Constant data were expressed in mean  $\pm$  standard deviation (SD), and nominal data in number. The Student's t-test was used to compare mean differences between the two groups. The incidences of complete thrombus removal and post-thrombotic syndrome were compared using the chi-square test. A *p* value of <0.05 was considered statistically significant.

## RESULTS

Baseline characteristics of the patients are shown in Table 1. No significant differences were found between the two groups in terms of age and sex distribution, incidences of diabetes, hypertension, or coronary artery disease, or creatinine, blood urinary nitrogen and hemoglobin values. However, blood urea nitrogen (BUN) was slightly higher in the fish-mouth anastomosis group (77.9 vs. 62.8 mg/dL, *p*=0.04). The mean preoperative diastolic blood pressure was also slightly higher in the fish-mouth anastomosis group (87.4 vs 78.2 mmHg, *p*=0.02). However, the mean

**Table 1. Baseline demographic and clinical characteristics of patients**

	Group 1 (n=20) Brescia-Cimino			Group 2 (n=20) Fish-mouth			p
	n	%	Mean±SD	n	%	Mean±SD	
Age			53.5±11.6			50.5±11.3	0.40
Gender							
Male	8	40		14	70		0.11
Diabetes mellitus	14	70		11	55		0.51
Hypertension	14	70		13	65		1.00
Coronary artery disease	3	15		2	10		1.00
Creatinine (mg/dL)			5.2±2.0			5.8±2.2	0.40
Blood urinary nitrogen (mg/dL)			62.8±24.6			77.9±21.6	0.04
Hemoglobin (g/dL)			9.9±1.2			9.8±1.8	0.80

SD: Standard deviation.

**Table 2. Changes in radial artery and cephalic vein diameters throughout the study period based on Doppler ultrasound measurements**

	Group 1 Brescia-Cimino	Group 2 Fish-mouth	p
	Mean±SD	Mean±SD	
Changes in radial artery diameter (mm)			
Preoperative	2.5±0.5	2.0±0.2	0.003
Postoperative Day 1	2.9±0.5	2.3±0.2	<0.001
Postoperative Day 7	3.3±0.5	2.7±0.7	<0.001
Postoperative Day 30	3.7±0.6	3.1±0.5	0.002
Changes in cephalic vein diameter (mm)			
Preoperative	2.5±0.4	2.0±0.4	0.004
Postoperative Day 1	3.4±0.7	3.0±0.5	0.010
Postoperative Day 7	4.1±0.8	3.9±0.8	0.600
Postoperative Day 30	4.9±0.9	5.0±0.9	0.700

SD: Standard deviation.

preoperative systolic blood pressures were similar between the groups (138.9 vs 145.8 mmHg,  $p=0.3$ ). Two patients died and two fistulas were thrombosed before the follow-up visit scheduled for postoperative Day 30 and 36 (90%) patients were available for the final measurements.

Changes in the radial artery and cephalic vein diameters are shown in Table 2. Preoperatively, the fish-mouth anastomosis group had significantly lower radial artery and cephalic vein diameters. The difference in radial artery diameters between the two groups remained stable throughout the study period. However, the difference in cephalic vein diameters disappeared after seven days postoperatively, and the groups had similar mean cephalic vein diameters at seven and 30 days postoperatively. Despite lower arterial and venous diameters at baseline, the mean fistula flow was higher in the fish-mouth anastomosis

group at the 30<sup>th</sup> postoperative day, compared to the Brescia-Cimino group (745±108 vs 547±149 mL/min,  $p<0.001$ ). In addition, duration of operation was shorter in the fish-mouth anastomosis group (35.2±4.5 vs 46.7±11.1 min,  $p<0.001$ ).

The first dialysis session was performed using the fistula after a mean period of 28±3 days. Early fistula failure developed in five patients (25%) in the Brescia-Cimino group, but in none of the patients in the fish-mouth anastomosis group. In contrast, bleeding developed in one (5%) and five patients (25%) in the Brescia-Cimino and fish-mouth groups, respectively.

## DISCUSSION

The mortality rate in patients with end-stage renal disease is approximately 20 to 30-fold higher than in healthy subjects, mostly due to the dramatic increase in

the rate of cardiovascular deaths. Problems associated with the vascular access route are also a leading cause of hospitalization in this patient group.<sup>[5-7]</sup> The presence of a suitable and accessible vascular access route represents the single most important factor determining the efficacy of hemodialysis. In this regard, using radiocephalic AVFs for hemodialysis is the current standard approach for establishing an access route.<sup>[8]</sup>

However, a number of factors, including the growing numbers of elderly individuals with concomitant conditions such as diabetes and accompanying cardiovascular disease, have resulted in an increase in AVF failure rates. One recent meta-analysis revealed primary and secondary patency rates of 63% and 66% in radio-cephalic fistulas, respectively, after one year.<sup>[9]</sup>

In addition, AVF failure was attributed to inappropriate vascular access during surgery. Preoperative colored Doppler US enables the selection of appropriate vascular access routes and increases the success rate in AVF. Allon and Robbin<sup>[10]</sup> reported that preoperative US was associated with an increased rate of fistula success. According to the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF-DOQI) recommendations, AVF should be constructed in patients with a creatinine level >4 mg/dL, creatinine clearance <25 mg/dL or when hemodialysis is planned within one year.<sup>[11]</sup> High blood urea concentrations with potential effects on all organ systems and 17 to 35% one-year mortality in patients who started hemodialysis indicate that physical examination should not be limited to the vascular system alone.<sup>[12]</sup>

Two patients in our study died due to chronic renal failure before their fistulas (5%) were matured. High venous pressure has an adverse effect on AVF patency.<sup>[13,14]</sup> Secondary stenosis is the main cause of these high-pressure veins. Since high venous pressure is an important determinant of short-term patency rates, certain sites should be avoided when creating AVFs, such as where venous hypertension is present and veins in which venous catheters have been used previously.<sup>[14]</sup> Doppler US readily detects areas of stenosis and venous hypertension with a sensitivity and specificity of 90% and 99%, respectively, in the examination of upper extremity arteries. Pre- and postoperative Doppler examinations are also strongly recommended for the evaluation of veins and fistulas.<sup>[15]</sup> In this study, extremities previously used

for catheterization and venous stenosis detected by Doppler US were avoided. Education of patients and hemodialysis unit staff has been found to increase long-term patency rates. Fistulas with decreased thrill amplitude, high urea recirculation, and high pressure on the venous side of the dialysis machine should be promptly evaluated due to the possibility of occlusion. In our study, thrombosis developed in five patients and flow was reestablished in four of these after immediate intervention. In addition, one patient's fistula was reopened proximally. Early AVF failure has been reported in 40 to 55% of patients in studies from the United States.<sup>[16,17]</sup> and in 7 to 10% of patients in studies from Europe.<sup>[18,19]</sup> It may be speculated that the use of Doppler US for the determination of appropriate vascular structures might have led to further reductions in these figures. Silva et al.<sup>[20]</sup> reported early AVF failure in 3% of their patients who underwent Doppler US before anastomotic creation. Many authors suggest the use of colored Doppler US for determining the appropriate vein for AVF before surgery.<sup>[21,22]</sup> In this study, colored Doppler US was also used for preoperative evaluation and detection of early AVF failure in 20% and 0% of the patients in Groups 1 and 2, respectively. The most common early and late complication reported after AVF construction is fistula thrombosis.<sup>[23]</sup> In our study, the most common complications were thrombosis in Group 1 (20%) and bleeding in Group 2 (20%). We attributed the absence of thrombosis in Group 2 to the use of enlarged radial arteriotomy, which allows maintenance of blood flow even in the presence of arterial spasm. Michelle et al.<sup>[24]</sup> reported relatively higher fistula success rates with wrist and arm vein diameters of 2 to 2.5 mm and 3.0 mm, respectively. In our study, the mean preoperative cephalic vein diameter was  $2.5 \pm 0.4$  mm in Group 1 and  $2.0 \pm 0.4$  in Group 2, indicating statistically significant difference ( $p=0.04$ ). Manne et al.<sup>[25]</sup> concluded that a decrease in vein diameter results in a considerable increase in flow resistance. Despite a lower cephalic vein diameter in Group 2, no thrombosis or failure occurred, probably due to the use of fish-mouth anastomosis. These results suggest that this technique can be particularly suitable for patients with a small cephalic vein diameter.

Several previous studies have shown that the internal diameter of the radial artery is one of the determinants of a successful radiocephalic AVF at the wrist level. The success rates reported by Kherlakian

for a radial artery diameter of greater than 1.5 mm versus those of less than 1.5 mm were 92% and 45%, respectively. The corresponding patency rates in the same study at the end of 12 weeks were 83% and 36%, respectively.<sup>[26]</sup> In our study, the mean preoperative radial artery diameters were  $2.5 \pm 0.5$  mm in Group 1 and  $2.0 \pm 0.2$  in Group 2. After one month of follow-up, 80% of the fistulas in Group 1 and 100% in Group 2 were patent, despite a lower radial artery diameter in Group 2. Goksin et al.<sup>[27]</sup> reported short- and long-term patency rates of 36.4% and 42.3%, respectively, in a group of patients undergoing surgical revision as required. In our study, the patency rate was 75%, including one patient in whom patency was maintained with revision in Group 1. No complications requiring early surgical reoperation occurred in Group 2. None of the patients in Group 2, in which the fish-mouth technique was used and in which a higher AVF flow rate was expected due to the greater radial artery aperture, had a flow rate  $\geq 2000$  mL/min. The mean duration of surgery in this study was  $46.7 \pm 11.1$  min in Group 1 and  $35.2 \pm 4.5$  min in Group 2, suggesting that the fish-mouth technique is also associated with a reduced surgery time.

In conclusion, based on our study results, the fish-mouth technique appears to be a reliable and feasible surgical technique capable of reducing early complication rates and duration of surgery.

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