

# Early follow-up results of arteriovenous fistulae created for hemodialysis

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**Background:** The aim of this study was to evaluate the site, early results, and postoperative complications of arteriovenous fistula (AVF) creation procedures for hemodialysis in our clinic.

**Methods:** The hospital records of 384 patients who underwent 411 AVF creation procedures for hemodialysis by the same team at our clinic between February 2008 and January 2010 were included for retrospective analysis. All procedures were performed under local anesthesia with lidocaine. Vasospasm was treated by mechanical dilatation with a probe and topical papaverine.

**Results:** Of our 384 patients, 58.5% were male and 41.5% were female. Mean age was 46 (range 12–72) years. Of the 411 AVF procedures performed, 106 (25.8%) were created at the anatomical snuffbox, 264 (64.3%) were Brescia–Cimino procedures, and 41 (9.9%) were antecubital, brachiocephalic, or brachio basilic procedures. Twenty-three patients (5.98%) were subjected to more than one surgical intervention due to early thrombosis or failure of AVF. Early patency was found in 94.0% of the AVF created. Twenty-three patients underwent more than one surgical intervention due to early AVF thrombosis or failure. Early AVF failure occurred more often in females (60.8%) than in males (39.2%). Complications were observed in a total of 11.4% patients.

**Conclusion:** Mechanical dilatation of the artery and vein, before starting the anastomosis, as well as the use of vasodilatory agents, could decrease early thrombosis of the fistula, and this method has very high early patency.

**Keywords:** end-stage renal failure, arteriovenous fistula, early patency, complications

## Introduction

According to the US Renal Data System, the incidence of fistula in the US was 26.3% in 1998 and increased to 36.3% in 2003. Fistula prevalence also increased from 33% in 2003 to 41% in 2005.<sup>1</sup> Patients with end-stage renal failure need to receive hemodialysis through an effective arteriovenous fistula (AVF) until renal transplantation. Therefore, it is essential that the AVF has long-term patency.<sup>2</sup> Quinton first used the external arteriovenous shunt in 1960, and Brescia–Cimino used the endogenous arteriovenous shunt in 1966.<sup>3,4</sup> Vascular access that provides a minimum flow of 250 mL/dk is required for hemodialysis. AVFs are created to meet this requirement. For AVF creation, the veins of the patient need to be well preserved and not used previously.<sup>5,6</sup> In patients with appropriate venous anatomy, all three types of AVF created on the upper extremity can supply adequate blood flow for hemodialysis.<sup>7</sup> The radiocephalic Brescia–Cimino fistula created on the wrist is still the preferred AVF, although recently many surgeons

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have been choosing to use the snuffbox AVF.<sup>5,7–10</sup> However, the possibility of inadequate AVF patency remains a problem.<sup>11,12</sup> The purpose of this study was to evaluate the site, early results, and postoperative complications of AVFs created for hemodialysis in our clinic.

## Materials and methods

The hospital records of 384 patients who underwent 411 AVF procedures for hemodialysis by the same team at our clinic between February 2008 and January 2010 were included in this retrospective analysis. All patients were physically evaluated, and the nondominant upper extremity was primarily chosen for AVF (ie, the left hand for right-handed patients and the right hand for left-handed patients). At the physical evaluation, arterial pulse strength, presence of a recent access, formation of a prominent elastic structure upon application of pressure, and vein diameters were assessed to determine the surgical site. For those patients who had more than one suitable site, the most distal one was generally selected in order to preserve the proximal site. Thrombosis formation within the first month was deemed “early”. Fistulae that were developed two or more times were considered to be “repetition”. All of the patients were followed up for the period starting from the creation of the AVF to the first hemodialysis.

## Surgical technique

Because the intention was to preserve the opportunity to move the AVF more proximally, the AVF was created on the nondominant arm as distally as possible. All surgical operations were performed under local anesthesia using lidocaine hydrochloride (Jetmonal®, Adeka, Istanbul, Turkey). When creating the fistula, factors such as prominence of superficial veins, history of thrombophlebitis, segmental stenosis in the proximal vessel, atherosclerosis of the radial artery, and blood flow were considered. Following exploration of the arteries and veins and prior to placing the clamp, heparin (2 mL) was routinely administered intravenously to each patient. If necessary, hemostasis was subsequently facilitated by neutralization of heparin using protamine sulfate. The end-to-side technique was preferred for distal anastomoses, and the side-to-side technique was preferred for proximal (antecubital) anastomoses. Vasospasm was treated by mechanical dilatation with a probe (1 mm, 1.5 mm, and 2 mm in diameter) and topical papaverine. For patients with inadequate venous flow, proximal dilatation was also performed using a Fogarty catheter. A continuous suture technique using 7/0 polypropylene was used to create the anastomoses.

## Statistical analysis

SPSS Windows statistical software package (v 10.0; Chicago, IL) was used for data analysis. Continuous variables are presented as means  $\pm$  standard deviations. Student's *t*-test, Chi-square test, and Fisher's exact test were used.  $P < 0.05$  was accepted as being statistically significant.

## Results

Of the 384 patients included in the study, 58.5% were male and 41.5% were female. The mean age was 46 (range 12–72) years. Preoperative demographic data for the patients and causes of chronic renal failure are presented in Tables 1 and 2. Of 411 AVFs performed, 106 (25.8%) received a snuffbox AVF, 264 (64.3%) received a Brescia–Cimino AVF, and 41 (9.9%) received an antecubital brachiocephalic, or brachio basilic AVF (Table 3).

Early patency was found in 94.0% of the AVFs created. Most patients (320/384 [83.3%]) were undergoing their first AVF formation, whereas 64 patients (16.7%) had had at least one previous fistula. Surgical intervention was performed on the left upper extremity in 284 patients (64.5%) and on the right upper extremity in 126 patients (35.5%).

Seven patients (6.6%) had early failure of a snuffbox AVF and 17 (6.4%) had early failure of a Brescia–Cimino AVF. This difference was not statistically significant ( $P > 0.05$ ). In total, 23 patients (5.9%) were subjected to more than one surgical intervention due to early AVF thrombosis and failure. AVFs were created three times in eight patients and two times in 11 patients. Thrombectomy was utilized successfully in four patients who presented with early failure. There were no early failures in patients who underwent brachiocephalic or brachio basilic AVF formation. Early AVF failure occurred more often in females (60.8%) than in males (39.2%,  $P < 0.05$ ).

Complications were observed in 44 patients (11.4%). Specifically, early thrombosis was seen in 23 patients and complications of the surgical area occurred in 21 patients. Five patients had hyperemia at the incision site, four

**Table 1** Patient demographics

Parameters	n	%
Patients/fistulae created	384/411	
First AVF creation	320	83.3
Male	225	58.5
Female	159	41.5
Diabetes	234	60.9
Hypertension	184	47.9

**Abbreviation:** AVF, arteriovenous fistula.

**Table 2** Causes of chronic renal failure in dialyzed patients

Disease	n	%
Polycystic renal disease	37	9.63
Nephroangiosclerosis	25	6.51
Glomerulonephritis	111	28.9
Chronic pyelonephritis	57	14.84
Diabetes	29	7.55
Hypertension	11	2.86
Renal amyloidosis (primary or secondary)	4	1.04
Urological disease (stones, obstruction)	3	0.78
Other	25	6.51
Unknown	82	21.35

had infection at the incision site, seven had hematoma at the incision site, five had revisions due to hemorrhage. Regression of hyperemia and infection was achieved by standard antibiotic therapy, and re-exploration was performed for hematoma. There were no early venous hypertension or vascular steal occurrences associated with brachiocephalic or brachiobasilic AVF formation (Table 3). The patients embarked on dialysis approximately  $4.7 \pm 1.8$  weeks after the AVFs were created.

## Discussion

In this study, we investigated the early patency rate for AVFs created in end-stage renal failure patients, factors affecting patency, and postoperative complications. AVFs are created internally or with grafts for hemodialysis, which is a treatment option for end-stage renal failure patients. Although there are many methods for creating an AVF, the most commonly preferred are the Brescia–Cimino and snuffbox methods. When distal access attempts fail for a variety reasons, repeat surgery can be undertaken to create new AVFs, and a brachiocephalic or brachiobasilic AVF can be created on the forearm.

**Table 3** Types of AVF created and postoperative complications

AVF types	n	%
Snuffbox	106	25.8
Brescia–Cimino	264	64.3
Brachiocephalic	29	7.00
Brachiobasilic	12	2.91
<b>Complications</b>		
Early thrombosis	23	5.98
Hyperemia of incision site	5	1.30
Infection of incision site	4	1.04
Hematoma on incision site	7	1.82
Revision due to hemorrhage	3	0.78
Fistula not maturing	2	0.52

**Abbreviation:** AVF, arteriovenous fistula.

Because there are various reasons for failure, it is appropriate to examine AVF patency rates in two groups, ie, early failures and late failures. Reasons for early failure include use of ill-suited veins, severe dehydration, obstruction of the outlet, a poor anastomosis, a vein kink near the anastomosis, and compression of a hematoma.<sup>11,12</sup> Reasons for late failure include stenosis of the anastomosis line during and after development of intimal hyperplasia, fibrous tissue development on the vein walls due to needle puncture trauma, and calcium phosphate deposition on the anastomosis line.<sup>13</sup>

A wide range of early failure rates have been reported in the literature. Da Silva et al<sup>14</sup> reported a 15% early failure rate, Baldrati et al 13.5%,<sup>15</sup> Sozudogru et al 18%,<sup>16</sup> and Ozköleli et al 18.8%.<sup>17</sup> Early failure rates in the range of 12%–29% have been observed in other studies.<sup>6,18,19</sup> In a study that evaluated 169 AVFs created in 122 patients, early patency was found to be 73.6% (early failure 26.4%), which decreased to 64.6% in the long-term, emphasizing that the early period is important for fistula patency.<sup>20</sup> Also, Ekici et al<sup>21</sup> reported a 12% early thrombosis rate. Fitzgerald et al<sup>22</sup> reported that 2% of early thrombosis occurred after first use of the AVF. This study found an early thrombosis rate (5.98%) lower than that reported in the literature. This lower early thrombosis rate is attributed to the use of mechanical dilatation with a probe for spasm of both the arteries and veins, and to the use of topical papaverine. Hence, a proportion of early failure can be attributed to technical inadequacy, which can be avoided.

In a study by Miller et al,<sup>23</sup> the success rate of AVFs on the forearm was reported to be lower in women than in men. Gibbons<sup>24</sup> also reported lower patency rates in women. However, there are also studies that did not show a gender difference. Baser et al<sup>25</sup> created 132 AVFs on 114 patients and did not find a gender difference in either early or late failure or in patency rates. Another study also found no difference in AVF patency rates between women and men.<sup>21</sup> The present study was consistent with the presence of a gender difference, finding early failure rates of 60.8% for women and of 39.2% for men.

In the early period following AVF formation, there may be a need for hospitalization or surgical revision due to local complications, such as thrombosis, hematoma, hemorrhage, or infection.<sup>26–29</sup> The most common complication, early and late, is thrombosis of the fistula (3.0%–14.5%).<sup>28,30</sup> In the present study, complications other than early thrombosis, such as revisions due to hyperemia, hematoma, infection, and hemorrhage at the incision site, were also occasionally observed. Although Horimi et al<sup>31</sup> reported that AVF patency rates were significantly lower for diabetic patients, both

Wolowczyk et al<sup>30</sup> and Ekici et al<sup>21</sup> found that diabetes had no effect on AVF patency rates. Field et al<sup>32</sup> reported that fistula survival rates in nondiabetic patients were higher than in patients with diabetes, but this difference was not significant. However, Erkut et al<sup>33</sup> also reported that diabetes mellitus was one of the factors affecting the primary patency of AVF. No relationship was found between diabetes and fistula patency rate in this study.

Given that only 11% of end-stage renal failure patients undergo renal transplantation,<sup>34</sup> and that the rest need regular and effective hemodialysis to maintain their lives at a certain level of quality, maximum care should be taken during the preoperative evaluation of the AVF created, as well as with the surgical technique.

## Conclusion

In this study, the early fistula patency rate was better than in prior reports, and there are two possible explanations for this. Firstly, preoperative evaluation of the patients was performed very carefully, enabling the most appropriate site for AVF to be determined. Secondly, careful consideration was given to the anastomosis technique, which included mechanical dilatation and a vasodilatory agent for both the artery and vein in each patient. Mechanical dilatation of the artery and vein, before starting the anastomosis, as well as the use of a vasodilatory agent can decrease the risk of early thrombosis of the fistula. Although the high patency rate of the AVFs in this study may be due to this intervention, further randomized studies comparing mechanical dilatation and papaverine with mechanical dilatation and/or placebo are warranted to define the exact role of these interventions.

## Disclosure

The author reports no conflicts of interest in this work.

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