

New Probing and Warm Washing Technique in Arteriovenous Fistula Surgery: Early Results of a Single Center

Arteriyovenöz Fistül Cerrahisinde Yeni Prob Kontrolü ve Ilık-Yıkama Tekniği: Tek Bir Merkezin Erken Dönem Sonuçları

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ABSTRACT Objective: Arteriovenous fistulas (AVF) are frequently used in patients with end-stage renal failure. Several anastomosis have been defined for creating AVF. In this paper, we aimed to describe a novel approach to AVF surgery with an additional maneuver which can be applied in all surgical techniques, and to present our early results with this novel approach. **Material and Methods:** Thirty one patients with end-stage renal failure presented to our department for AVF surgery. There were 24 males and 7 females with a mean age of 58 years. We performed end-to-side anastomosis technique together with our novel method in all of our patients. In surgical technique, classical maneuvers were performed until the end of the anastomosis. At this time, vein lumen was washed with low-dose heparinized warm fluid using a simple catheter, which was inserted into the vein lumen, as the probes used in coronary anastomosis. **Results:** Mean vein diameter before surgery was 2.87 ± 0.37 mm. Mean flow rate was 200.15 ± 49.37 ml/min 24 hours, 299.03 ± 81.34 ml/min one week, and 505.98 ± 161.1 ml/min 3 weeks after surgery ($p < 0.001$). Three patients needed surgical revision in first month, all of which were secondary to insufficient venous diameter and blood flow. **Conclusion:** We used this novel technique as an additional method in our patients with good results, and without any complications. We believe that this method may increase the early patency rates of fistulas by preventing thrombus formation and vasospasm.

Key Words: Arteriovenous fistula; hemodialysis

ÖZET Amaç: Arteriyovenöz fistüller (AVF) son dönem böbrek yetmezliği olan hastalarda sıklıkla kullanılmaktadır. AVF cerrahisinde zaman içerisinde çeşitli teknikler tanımlanmıştır. Bu yazımızda, tüm cerrahi tekniklere ek olarak kullanılabilir yeni bir manevrayı tanımlamak ve bu teknik ile yaptığımız işlemlerin erken dönem sonuçlarını paylaşmayı amaçladık. **Gereç ve Yöntemler:** AVF cerrahisi için kliniğimize başvuran ve son dönem böbrek yetmezliği tedavisi alan 31 hasta çalışmaya dahil edildi; 24 hasta bayan, 7 hasta erkek idi. Hastaların yaş ortalaması 58 yılıdır. Tüm hastalarımıza "uç-yan anastomoz tekniği"ne ek olarak yeni metodumuzu kullandık. Cerrahi teknikte anastomozun tamamlanması aşamasına kadar klasik cerrahi yöntemler uygulandı. Bu aşamada koroner baypas cerrahisinde kullanılan proba benzer şekilde, ven lümenine doğru ilerletilen bir katater kullanılarak, lümen düşük doz heparinli ılık serum ile yıkandı. **Bulgular:** Preoperatif ven çapı $2,87 \pm 0,37$ mm idi. Akım debisi 24'üncü saatte $200,15 \pm 49,37$ ml/dk, birinci haftada $299,03 \pm 81,34$ ml/dk ve üçüncü haftada $505,98 \pm 161,1$ ml/dk olarak saptandı ($p < 0,001$). İlk ay içerisinde yetersiz akım debisine ve ven çapına bağlı olarak 3 hastada cerrahi revizyon gereksinimi oldu. **Sonuç:** Tüm hastalara bu tekniği ek bir manevra olarak komplikasyon yaratmadan başarı ile uyguladık. Bu tekniğin trombus oluşumunu ve vazospazmı önleyerek AVF cerrahisinde erken dönem açıklık oranlarını arttıracığını düşünmekteyiz.

Anahtar Kelimeler: Arteriyovenöz fistül; hemodiyaliz

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Despite the advances in transplantation medicine, hemodialysis is still the most frequently used treatment modality in patients with end-stage renal failure.¹ Several communities such as The National Kidney Foundation Dialysis Outcomes Quality Initiative, The Fistula First Breakthrough Initiative, and The Society for Vascular Surgery, stated that AVFs were the best available access for hemodialysis.^{2,3} Creation of an AVF is mainly in the field of cardiovascular surgery, however hemodialysis and the other interventions are usually in the field of nephrology. Several anastomosis techniques have been defined for creating AVF, such as end-to-side, side-to-side, and end-to-end anastomosis.^{4,5} Regardless of the surgical technique, the main aim of surgery is to provide the flow patency as long as possible, without any additional interventions. Early occlusion secondary to vasospasm and/or thrombus formation is the most frequent etiologic factor for surgical failure in AVF.^{1,3}

In this paper, we aimed to present technical details of a new probing and warm-wash out technique, and share our early results.

MATERIAL AND METHODS

This study was approved by the local ethical committee of our institution. Informed consents were obtained from all patients.

PATIENT SELECTION

Data of 31 patients who underwent AVF surgery due to end-stage renal failure between October 2011 and November 2013 were collected. Demographic data of the patients, concomitant disorders such as hypertension, diabetes mellitus and peripheral arterial diseases were also recorded. Preoperative diameters of target vessels were measured sonographically. Previous arteriovenous fistula surgeries were detailed for success.

The only exclusion criterion was use of synthetic grafts.

STUDY PROTOCOL

All patients enrolled the study underwent AVF surgery using standard techniques at various surgi-

cal fields such as snuffbox, radiocephalic or antecubital fossa. Local anesthesia was performed.

Duration of anastomosis, and thus the occlusion period of vessels were recorded for each patient. Need for additional sutures which may affect the patency rate was also recorded.

Arterial and venous diameters were calculated sonographically at the level of anastomosis area preoperatively. Furthermore, venous diameter and blood flow velocity were also measured on the distal 10 cm part of anastomotic vein, and blood flow rates were calculated 24 hours, one week, and 3 weeks after surgery. LOGIQ Book XP scanner (GE Medical Systems, USA) was used with a 12-MHz linear probe. In the last six months, all patients were followed up with monthly visits.

SURGICAL TECHNIQUE

End-to-side anastomosis was performed in usual way. Before finishing anastomosis, vein lumen was washed with low-dose heparinized (500 IU), warm fluid (+30 C, 10 ml) using a simple catheter. The catheter was inserted into the vein lumen, as the probes used in coronary anastomosis, and then connected to a simple injector (Figure 1). In this way, patency of anastomosis was controlled mechanically. In addition, possible thrombosis and/or vasospasm was detected and managed with this simple intervention. In order to avoid additional damage and/or rupturing of suture line, catheter was inserted very gently.

Technical success was defined as the palpation of a thrill on fistula 30 minutes after surgery.

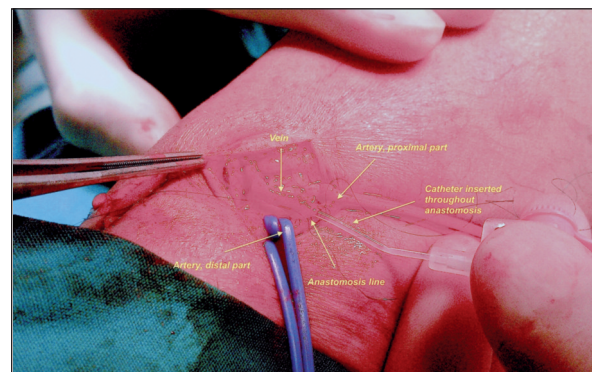


FIGURE 1: Surgical view of the technique.

STATISTICAL ANALYSIS

SPSS for Mac 20.0 package program (SPSS Inc, Chicago, IL) was used for statistical analysis. Descriptive statistics were expressed as mean \pm standard deviation for normally distributed, continuous variables. Medians (quartile) were given for abnormally distributed, continuous variables. Categorical variables were reported as numbers and percentages. Before analysis, Kolmogorov-Smirnov test was used to analyze the distribution pattern of data. Comparisons of the groups were performed with student-t test for normally distributed data, and with Mann-Whitney U test for abnormally distributed data. Pearson's Chi-square and Fisher's exact tests were used for the comparisons of categorical variables. One-way ANOVA and multiple analysis of one-way ANOVA were used for repeated measures of variables, according to their distribution patterns. Bonferroni correction was used for multivariate analysis.

A p value <0.05 was considered as statistically significant with a 95% confidence interval.

RESULTS

PATIENT CHARACTERISTICS

The median age was 58 (27-68) years, and 7 patients (22.5%) were females. Fifteen patients had smoking history, and 5 of them still insisted on smoking at the time of the study. There was one comorbid disorder in 3 patients, there were two comorbid disorders in 5 patients, and there were three or more comorbid disorders in 8 patients. There were no comorbid disorders in the remaining 15 patients. Twenty two patients were undergoing hemodialysis with a temporary catheter at the time of surgery while remaining patients had their first hemodialysis session after maturation of fistula. Demographic data of patients are given in Table 1.

SURGICAL DATA

Left arm was preferred for surgery in 25 patients since their right arms were dominant. Snuffbox localization was preferred in 27 patients, wrist localization in 3 patients and antecubital localization in

TABLE 1: Demographic characteristics of the patients.

Age (year) (25-75%)	58 (27-68)
Gender (male/female)	24 / 7
Smoking (n)	15
Comorbidity (n, %)	
Diabetes mellitus	12 (38.7%)
Hypertension	16 (51.6%)
Peripheral artery disease	3 (9.7%)
Coronary artery disease	7 (22.6%)
Chronic obstructive lung disease	6 (19.3%)

one patient. Three patients had history of previous fistula operation. The mean anastomosis period was defined as clamping-declamping time to proximal artery, and it was calculated as 19.22 ± 5.16 minutes. Additional sutures were used for bleeding control at anastomosis line in 7 patients, which were also recorded and compared to the other patients about patency and flow rates. In one patient, proximal part of the anastomosis was found occluded with an accidental suture at the time of our new probing and warm-wash out technique. In this patient, all sutures were removed, and re-anastomosis was performed immediately, without any other complications.

ULTRASONOGRAPHIC ANALYSIS

Mean vein diameters were almost the same on preoperative and 24th hour measurements in all patient population (2.87 ± 0.37 vs. 2.89 ± 0.36 mm respectively, $p > 0.05$). On the other hand, there was a statistically significant increase in vein diameters and flow rates in the repeated measurements performed at different time points ($p < 0.001$). Post-hoc multiple variance analysis showed significant differences in flow rates in all time points ($p < 0.001$) while there were no significant difference for vein diameter between preoperative and 24th hour measurements ($p > 0.05$). The ultrasonographic changes are given in Table 2.

NEED FOR REVISION

A re-operation was required in 3 patients due to fistula occlusion in postoperative follow up. Re-operation was performed as soon as possible after diagnosis the lack of flow patency. Mean time to

TABLE 2: Ultrasonographic changes.

Definition		Mean value	Standard deviation	p
Vein diameter (mm)	Preoperative	2.87	0.37	<0.001
	24 th hour	2.89	0.36	
	1 st week	3.04	0.38	
	3 rd week	3.36	0.44	
Flow rate (ml/min)	24 th hour	200.15	49.37	<0.001
	1 st week	299.03	81.34	
	3 rd week	505.98	161.1	

re-operation was 23.33 ± 4.04 days. Demographic data and ultrasonographic changes of these three patients are given in Tables 3 and 4, respectively.

SUBGROUP ANALYSIS

Comparison of the patients with need for revision and the patients with patent fistulae, did not reveal any statistically significant differences for demographic (age, gender, smoking history, underlying diseases, comorbid disorders) or surgical variables (arterial diameter, anastomosis time and additional suture necessity) ($p > 0.05$). However, vein diameters and flow rates of patients were statistically significantly different in these subgroups. Subgroup comparisons are summarized in Table 5.

DISCUSSION

Several techniques have been used for the creating AVF, and advantages and disadvantages about these techniques have been reported.^{1,3,6} Different maneuvers have also been used for increasing patency rates.

Most of the studies revealed different results about surgical techniques and their advantages, while some current papers recommend end-to-side anastomosis strongly. They concluded that end-to-side technique had the highest proximal venous flow patency and a relatively low venous hypertension risk when compared to other modalities.²

Based on our experience and according to our clinical protocol in our institution, we initially use distal peripheral veins for venous preservation, and try to use end-to-side anastomosis as much as possible.

In our study population, we used end-to-side anastomosis technique in our all patients with a new probing and warm washing technique just before the completion of anastomosis. In this technique, we aimed to increase the early patency rates of surgery with a simple approach. However, we could not find any method resembling ours in the literature. In some studies, proximal or distal anastomosis lines were controlled using a dilatator as in coronary surgery, which may just provide a mechanical control.^{2,3} However in our technique, not only anastomosis controlled mechanically, but also vein lumen was washed with a warm and heparinized fluid.

Actually, most important benefit of our method is washing the vein lumen, which may be occluded by thrombosis within the creation of anastomosis period. The other benefits include:

TABLE 3: Demographic data of the patients who needed revision.

Definition	Value
Age (year)	65,33 @ 5,51
Gender (male/female)	1/2
Smoking (n)	0
Primary disorder (n)	
Nephropathy	3
Nephritis (glomerulonephritis etc.)	0
Comorbidity (n, %)	
Diabetes mellitus	3 (100%)
Hypertension	3 (100%)
Peripheral arterial disease	1 (33.3%)
Coronary artery disease	1 (33.3%)
Chronic obstructive lung disease	2 (66.7%)

TABLE 4: Ultrasonographic changes of the patients who needed revision.

Definition		Mean value	Standard deviation	p
Vein diameter (mm)	Preoperative	2.26	0.20	0.57
	24 th hour	2.33	0.25	
	1 st week	2.36	0.30	
	3 rd week	2.43	0.41	
Flow rate (ml/min)	24 th hour	112.26	32.63	0.84
	1 st week	119.66	47.74	
	3 rd week	112.90	76.40	

TABLE 5: Subgroup comparisons.

Variables	Patent fistula patients (n=28)	Revised patients (n=3)	p value
Age (year) (25-75%)	47 (26.3-67.3)	65.3 ±5.5	>0.05
Arterial diameter (mm)	23.6±1.7	24.7±1.1	>0.05
Anastomosis time (minute)	18.8±4.7	23.7± 8.1	>0.05
Additional suture required (n)	5	2	>0.05
Vein Diameter (mm)			
Preoperative	2.93±0.33	2.26±0.20	0.002
24 th hour	2.95±0.32	2.33±0.25	0.003
1 st week	3.11±0.31	2.36±0.3	0.001
3 rd week	3.46±0.32	2.43±0.41	<0.001
Flow rate (ml/min)			
24 th hour	209.57±40.98	112.26±32.63	0.003
1 st week	318.25±56.8	119.66±47.74	<0.001
3 rd week	545.97±106.14	112.90±76.40	<0.001

controlling the patency of anastomosis by mechanical maneuver as in coronary surgery, and preventing the vasospasm through warm fluid.

In our patient population, 12 patients (38.7%) had vasospasm in their veins, which were also solved with the injection of warm fluid. In one patient, proximal part of the anastomosis was sutured accidentally, which was also detected by the mechanical effect of the catheter before the completion of anastomosis.

The most important complication of this method may be the endothelial damage of the catheter. Increased bleeding rates and rupture of the sutures of anastomosis are the other possible complications, which can be avoided with gentle manipulation.

Although our patient population was too small, analysis of the possible causes of early failure revealed that the vein diameter could be an important factor. In our population, the initial vein diameter was 2.26±0.20 mm in patients that needed revision whereas it was 2.93±0.33 mm in rest of the patients (p=0.002). Smith et al. defined the factors that affected the patency rates of AVFs as follows: increasing age, presence of diabetes, smoking, peripheral vascular disease and vessel characteristics (vein diameter smaller than 2.0 mm).⁷ Similarly, several studies suggested the importance of preoperative mapping for early patency rates, especially

for vein diameter.¹⁻³ Many of these studies concluded that a vein diameter below 2.5 mm was an important factor for early failure, as in our patient population.^{4,7-10}

In addition to vein diameter, flow rate 24 hours after surgery could be another important indicator of failure. In our patients, flow rate 24 hours after surgery was 112.26±32.63 ml/min in patients with that needed revision while it was 209.57±40.98 ml/min in patients with flow patency (p=0.003). We recommend early revision surgery in patients with flow rates below 120 ml/min. Therefore, surgery can be performed more easily in the same region, without possible fibrosis, which could occur in second surgery. In addition to surgical advantages, early repair of fistulas could save the patients from possible future fistula areas.

In our study, other possible factors of early failure such as age, gender, and comorbid disorders were not found significant. However, it must keep in mind that our patient population was too small for a definitive decision about those variables.

CONCLUSION

We concluded that our new probing and warm washing technique would simply increase the early patency rates after AVF. However, further randomized studies are needed to confirm the effectiveness of this procedure. In addition, preoperative

assessment of vein diameter either sonographically or angiographically, as well as measuring the flow rates in early postoperative period could be important indicators for surgical success.

Conflict of Interest

Authors declared no conflict of interest or financial support.

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