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New probing and warm-wash-out technique improves early patency rates in arteriovenous fistula surgery

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Abstract. – OBJECTIVE: Arteriovenous fistulas (AVFs) are commonly used during hemodialysis. Early failure of AVFs is quite common with incidence of 43% to 63%. In this study we aimed to describe a novel approach to AVF surgery for improving early patency rates.

PATIENTS AND METHODS: Patients were divided into two groups according to use of probing and warm-wash-out technique. Group I consisted of 31 patients with additional probing technique. Group II consisted of 32 patients without additional maneuver. End-to-side anastomosis were used to all patients. Technical success was defined as having palpation of a thrill on fistula. Flow rates of draining vein was measured at 1st hour, 24th hour, 1st week and 3rd week of surgery. Surgical technique. Classical maneuvers were performed until end of the anastomosis. At this time, vein lumen was washed by low-dosed heparinized warm fluid, with assistance of a simple catheter.

RESULTS: Technical success was similar in both groups at 1st hour and 24th hour, while there were significantly differences between groups at 1st week (p = 0.042) and 3rd week (p = 0.05) assessments. Flow rates were also measured significantly higher in Group I at 1st hour (p = 0.011) and 24th hour (p = 0.016). Flow rates were almost similar in two groups at 1st and 3rd weeks but overall success rate was higher in Group I comparing with Group II (96.8% vs. 81.3%, respectively, p = 0.05).

CONCLUSIONS: Probing and warm-wash out technique will simply increase the surgical success and flow rate of draining vein.

Key Words:
Arteriovenous fistula surgery, Hemodialysis, Patency rates.

Introduction

End-stage renal failure is common in worldwide population with the incidence of more than 1,000,000 patients in a year, who are undergone renal replacement therapy[1]. Hemodialysis is simple, cost effective and most common treatment modality in patients with end-stage renal failure[2-4]. The National Kidney Foundation Dialysis Outcomes Quality Initiative, The Fistula First Breakthrough Initiative, and The Society for Vascular Surgery, recommend arteriovenous fistula (AVF) as the best available access for hemodialysis[3,5,6]. Several techniques of anastomosis were defined in many years about creating AVF such as end-to-side, side-to-side, and end-to-end[3,7-9]. Regardless of the surgical technique, main aim of the surgery is to provide the flow patency as long as possible, without additional interventions. Early failure secondary to vasospasm and/or thrombus formation is the most seen etiologic factor of surgical failure[3,5].

Recently, we described a simple additional technique for increasing early patency rates of AVF surgery[3]. In this study, we aimed to present our early results comparing with control group.

Patients and Methods

This study was approved from the Ethical Committee of our local institution.

Patients

Between October 2011 and June 2015, data of 63 patients, who underwent AVF surgery secondary to end-stage renal failure, was collected. Patients were divided into two groups. Group I was consisted of 31 patients to whom additional probing technique was used. Group II was consisted the remaining 32 patient. Demographic data of patients, concomitant disorders, surgical side and locations, preoperative arterial and venous diameters were recorded.

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Doppler Ultrasonography

In order to follow fistula maturation and possible necessity of additional interventions; flow and patencies of the fistulas were routinely controlled at 1st hour, 24th hour, 1st week and 3rd week following surgery in our department.

Ultrasonography was performed in upright-seated position. The arm was rotated externally and extended from body approximately 45° angle. The analysis were performed at the 10 cm distal part of draining vein. Anastomosis line, feeding artery and draining vein, venous diameter and flow velocity were calculated with gentle transducer pressure. The flow rate in milliliters per minute was calculated according to the relation $Q = V \times A = V \times (\pi d^2)/4$, where "V" is flow velocity, "d" is luminal diameter, and "A" is the area of the vessel[8]. LOGIQ Book XP scanner (GE Medical Systems, USA) was used with a 12-MHz linear probe.

Surgical Technique

End-to-side anastomosis was performed in all patients. Probing and warm-wash-out technique was applied to patients in Group I. As previously detailed, draining vein lumen was washed by low-dosage, heparinized (500 IU), warm fluid (+30 C, 10 cc) with the assistance of a simple catheter just before completion of anastomosis (Figure 1)[3]. With this technique, patency of anastomosis was controlled and possible thrombosis and/or vasospasms were detected. In order to avoid further damage and/or rupture of suture line, catheter should be inserted very gently.

Data Collection

Arterial and venous diameters, fistula patency, flow rates, fistula related morbidities such as infection, thrombosis etc., were collected from patients' files.

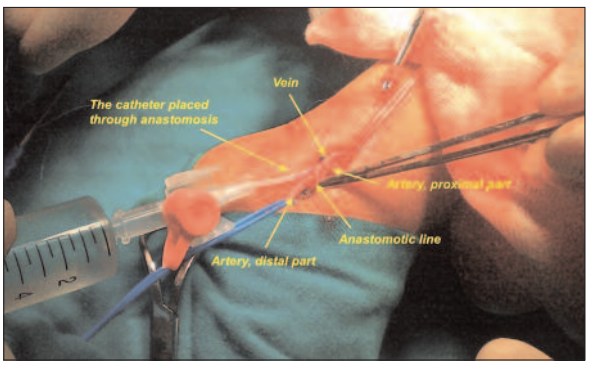

Figure 1. Surgical view of the technique.

Statistical Analysis

SPSS for Mac 20.0 package program (SPSS Inc., Chicago, IL, USA) was used for statistical evaluation. Descriptive results were expressed as mean ± standard deviation for normally distributed continuous variables and median (Quartiles) values for abnormally distributed continuous variables. Categorical variables were reported as numbers and percentages. Before analyses, Kolmogorov-Smirnov test was used for analyzing the distribution pattern of data. Comparisons of the groups were performed with Student's *t*-test for normally distributed groups and with Mann-Whitney U-test with abnormally distributed groups. Pearson's Chi-square test and Fisher's exact test were used for the comparisons of categorical variables.

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

Results

Patients' Characteristics

The median age was 58 (27-68) in Group I, and 57.5 (47.5-65.75) in Group II. Seven of patients were female in Group I, while 10 patients were female in Group II. Fifteen patients in Group I and 17 patients in Group II had smoking history, and totally 22 of them were still active smoker. At the time of surgery 23 patients in Group I, and 26 of patients in Group II were underwent hemodialysis therapy with temporary catheter, while remaining patients have taken their first hemodialysis therapy after fistula maturation. There were not any statistically significant differences on demographic data of patients (Table I).

Surgical Data

There was no statistically significant difference between groups in surgical data (Table I). Three patients in Group I, and 5 patients in Group II had previous fistula operation history. Mean anastomosis period was defined as clamping – declamping time to proximal artery and it was calculated as 19.77 ± 4.75 and 21.5 ± 5.5 minutes for Group I and Group II respectively ($p > 0.05$). Additional sutures were used for bleeding control at anastomosis line at 5 patients in Group I and at 4 patients in Group II. These 9 patients were also recorded and compared to the other patients about patency and flow rates ($p > 0.05$). In one patient, proximal

Table I. Demographic and surgical variables.

	Group I	Group II	*p*-value
Age (25%-75%)	58 (27-68)	57.5 (47.5-65.75)	> 0.05
Gender (M/F)	24/7	22/10	> 0.05
Smoking	15 (48.4%)	17 (53.1%)	> 0.05
Diabetes mellitus	19 (61.3%)	21 (65.6%)	> 0.05
Hypertension	18 (58.1%)	17 (53.1%)	> 0.05
Peripheral artery disease	3 (9.7%)	3 (9.4%)	> 0.05
Ischemic heart disease	7 (22.6%)	6 (18.8%)	> 0.05
Chronic obstructive lung disease	6 (19.4%)	3 (9.4)	> 0.05
Side (L/R)	25/6	24/8	> 0.05
Location			
Snuffbox	27	26	> 0.05
Radiocephalic	3	5	
Antecubital	1	1	
Arterial diameter (mm)	2.37 ± 0.16	2.42 ± 0.19	> 0.05
Venous diameter (mm)	2.87 ± 0.37	2.81 ± 0.43	> 0.05
Anastomosis time (min)	19.77 ± 4.75	21.5 ± 5.5	> 0.05

part of the anastomosis was found occluded with an accidental suture at the time of probing technique in Group I. In this patient, all sutures were removed and re-anastomosis was performed immediately, without any other complication.

Technical Success

Fistula failure was recorded in six patients [1st hour (n = 1), 24th hour (n = 2), 1st week (n = 1), 3rd week (n = 2)] in Group II, while only in one patient at 3rd week in Group I. Success rate was found significantly higher in Group I (100% vs. 87.5% for 1st week, $p = 0.042$ and, 96.8 vs. 81.3 for 3rd week, $p = 0.05$. respectively) (Table II).

Ultrasonographic Analysis

Flow rate was relatively higher in Group I at all recorded times. In early time of surgery (1st hour and 24th hour), there was a statistically significant difference on flow rates between groups. Although not statistically significant, flow rates were also higher in Group I at 1st week and 3rd week measures. The ultrasonographic variables are given in Table III.

Discussion

Early failure of AVF is reported up to 60% incidence by National Institutes of Health[11]. Juxta-

Table II. Technical success rate.

Success rate	Group I	Group II	*p*-value
1st hour	31/31 (100%)	31/32 (96.9%)	0.32
24th hour	31/31 (100%)	29/32 (90.6%)	0.081
1st week	31/31 (100%)	28/32 (87.5%)	0.042
3rd week	30/31 (96.8%)	26/32 (81.3%)	0.05

Table III. Comparison of flow rate.

Flow rate	Group I	Group II	*p*-value
1st hour (ml/min)	218.92 ± 37.81	194.81 ± 34.24	0.011
24th hour (ml/min)	236.75 ± 41.78	213.93 ± 27.89	0.016
1st week (ml/min)	325.95 ± 41.70	307.48 ± 36.78	0.078
3rd week (ml/min)	645.76 ± 74.39	621.14 ± 45.94	0.150

anastomotic stenosis is defined as a major cause of early AVF failure with the prevalence of 43% to 63%[12]. Although juxta-anastomotic stenosis can develop in all surgical regions, distal surgical fields have more frequency. Other factors that may affect surgical success include; surgical technique, arterial and venous diameter, arterial blood flow and velocity, occlusion time of vessels, patient-related conditions, surgeon's experience and technical errors[3,11-13].

There are various techniques for AVF surgery with several advantages and disadvantages. End-to-side anastomosis is recommended in many studies[3,4,6,9]. It is notified as the highest proximal venous flow patency and a relatively low venous hypertension risk, when compared to other modalities[3,5,6].

Independent from surgical technique, various maneuvers have been described in time to improve surgical success. O'Banion et al[14] used 1.3 to 1.5 cm side-to-side anastomosis with distal vein ligation successfully. Bharat et al[12] described their novel technique as "piggyback straight line onlay technique". They used end-to-side technique with a simple maneuver and therefore they improve late patency rates in their study. Hong et al[4] used a dilatator for controlling the anastomosis in their study. They used a simple probe for controlling mechanically the suture lines similar to our technique.

Based on our case series and according to our clinical protocol, we routinely use end-to-side anastomosis at distal peripheral veins as an initial surgical field. In addition, probing and warm-wash-out technique was performed in Group I, just before the completion of anastomosis. Different from other studies, with our technique, anastomotic line controlled not only mechanically, but also vein lumen was washed out with warm and heparinized fluid. Actually, most important benefit of this technique is washing the vein lumen, which may be occluded by thrombosis and/or vasospasm within anastomosis period. In our study population, there was a significant vasospasm on draining veins at 12 patients (38.7%) in Group I. Probing and warm-wash-out technique provided vasodilatation and increased flow patency in these patients.

In our investigation, early failure occurred in one patient at 1st hour and in two-patients at 24th hour. All the three patients were in non-probing group, while all the patients in Group I had working fistula in the same period. We consider that, although it was not significant, this difference mainly depends on the probing and warm-wash-out technique, which improve the surgical success with mechanically controlling of anastomotic line, and increasing the flow rates by decreasing the vasospasm. Success rate was decreasing to 87.5% in non-probing group, while with 100% success in Group I at 1st week controls (p = 0.042). Overall surgical success was 96.8% for Group I and 81.3% for Group II, with one failure in Group I, and six failures in Group II (p = 0.05). These results indicate the probing and warm-wash-out technique has positive effects on surgical success at first 3rd week.

Our work also showed that probing and warm-wash-out technique significantly affects blood flow rates, especially in the early period. Even at 1st hour measurements, flow rates were significantly higher in Group I, indicating the vasodilator effects of technique. Similarly, 24th hour flow rates were higher in Group I significantly. We consider these results mainly depend on the vasodilator and anticoagulant effects of this technique. Although it is not statistically significant, overall flow rates were higher in Group I in the 1st and 3rd week measurements.

Our technique has two-basic effect; first mechanically control of anastomotic line, resulting with an increase on early success rate, and second; washing the draining vein lumen with warm and heparinized fluid, resulting with a significant improve on the blood flow by preventing vasospasm and early thrombosis. We consider the technical success mainly depends on the mechanic control, while improvement on flow rates is secondary to washing the lumen.

Most important complication of this technique may be endothelial damage. Increased bleeding rates and suture line rupture are the other possible complications, which can be avoided by gentle approach.

In our study, other possible factors of early failure such as age, gender, co-morbid disorders, arterial and venous diameters were not different between two groups. Thus, we consider that the differences between groups mainly depend on probing technique.

Our paper also has some limitations. Our patient population was small for making generalized comments. It was a retrospective study and not designed for prospective study. In order to generalizing suggesting this technique for routine usage, further prospective studies with larger population are required. Furthermore, for

prospective studies a short acting vasodilator such as papaverin may be added to warm fluid besides to heparin.

Conclusions

Our probing and warm-wash out technique increase the surgical success and flow rate of draining vein according to our results. Therefore, we suggest that surgical outcomes as well as patency rates could be improved with this technique.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

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