

The effect of surgeon's fatigue on early term patency and complications of arteriovenous fistulas: A prospective cohort study

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Abstract

Aim: Examining the effect of surgeon's fatigue on early term patency and complications of arteriovenous fistula (AVF).

Material and Methods: AVFs created for hemodialysis in patients with end-stage renal failure were included in the study. The patients were divided into 2 groups as those operated in the first operation of that day (Group 1) and those operated after the first or second operations (Group 2). The patients were compared with respect to clinical, demographics, postoperative, surgical variables, and operation duration.

Results: A total of 100 patients underwent AVF operation. No statistically significant differences were found between the groups with respect to clinical, demographic, surgical, and postoperative variables. Efficiency of dialysis was found to be higher and complication rate lower in Group 1. But no statistical significance was obtained in terms of early dialysis efficiency and complication rates in between the groups ($p>0.05$). Complication rate was higher in Group 2 when compared according to operation time as 120, 120-240, and 240< minutes. But no statistical significance was obtained in this manner ($p>0.05$).

Conclusions: Although not statistically significant, surgical fatigue factor and long operation time increase the rate of early complications and reduce early dialysis efficiency. We think that early term patency of AVF can also be affected by the complication rate. The effect of this variable can be statistically significant with studies having larger sample size.

Keywords: Arteriovenous Fistula; Operation Duration; Complication; Surgeon's Fatigue; Hemodialysis Access.

INTRODUCTION

End-stage renal disease (ESRD) remains a significant public health issue affecting both societies and individuals. Despite recent advances in renal transplantation and the increase in the number of transplant surgeries, the number of dialysis-dependent patients has been more rapidly increasing in recent years (1,2). Renal transplantation continues to be the definitive therapy for ESRD patients. However, renal transplantation operations are far from desired numbers due to an insufficient number of kidney donations both worldwide and at home. There is a need for well-functioning vascular access routes, i.e. arteriovenous fistulas (AVFs), for a successful, prolonged, and safe hemodialysis procedure (3). The continuous increase in the number of dialysis-dependent patients due to an insufficient number of kidney transplantations

worldwide makes AVF operations even more important. AVF operation is a life-saving operation for ESRD patients, which is readily performed under local anesthesia with a success rate over 80% (4). In ESRD patients, complications and dysfunctions related to AVF, which is one of the vascular access routes, are among the most common reasons of hospital visits (5,6).

A successful AVF operation will provide patient with an increased quality of life and an effective hemodialysis in ESRD patients. Patient and surgery-related factors affecting early stage AVF patency have been defined. However, there are no studies specifically investigating the effects of surgeon's daytime fatigue, his/her time spent in operation room before AVF operation, and the types and durations of operations that s/he performs on early term patency and complications of AVF.

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In the present study it was aimed to investigate surgeon's fatigue on early term patency and complications of AVF.

MATERIAL and METHODS

This study included AVFs created at Baskent University Adana Dr. Turgut Noyan Teaching and Research Center between September 2013 and February 2015 to be used for hemodialysis sessions in ESRD patients. This study was approved by Baskent University Institutional Review Board and supported by Baskent University Research Fund (KA13/217). The study population was divided into 2 groups as those operated in the first operation of that day (Group 1, n: 50) and those operated after the first or second operations (Group 2, n: 50). Patients who did not comply with the operation sequence or give informed consent were excluded. The following parameters and information were recorded for each patient: age, sex, comorbidities, etiology of ESRD, duration of CRF, number of previous AVFs, type of current AVF, side of AVF, findings on physical examination, arterial, venous, and anastomosis diameter, fistula site, anastomosis technique, venography and Doppler ultrasonography applications before the operation, postoperative heparin use, natural or synthetic vein use, the sequence of the operation, the combined duration of the previous operations, anesthesia technique during AVF operation, secondary interventions due to complications such as bleeding, thrombus etc., presence of complications such as hematoma, bleeding, infection, and thrombus affecting early term patency, performance of angiographic or surgical interventions against complications, time to first dialysis and AVF's effectiveness, catheterization during the operation, duration of the AVF operation, effectiveness of dialysis, body mass index (BMI), functionality of vascular access (presence of thrill or murmur), 21st day control, presence and side of central catheter prior to the operation, and presence of a simultaneously opened second AVF. Preoperative evaluation was performed by the same surgeon in all patients. The patients were operated in accordance with the randomization sequence. A venography was carried out in patients with a history of multiple AVF operations or problems in venous structures while a Doppler ultrasonography was performed in patients in whom an arterial problem was considered to exist. Patients without adequate thrill after the operation received IV heparin 100 U/kg as continuous infusion for 12 hours. Coraspin 100 mg was started at the 1st day after the operation. Control visits were scheduled at the end of 1st, 2nd, and 3rd weeks. Patients with functional AVF underwent hemodialysis at the end of 4th week. Absence of any problems during hemodialysis was defined as "effective dialysis".

Approach preliminary evaluation

The patients referred for surgery were evaluated and operated with the standard approach (4). All patients were provided with detailed information about the procedure and all gave written informed consent. The distal part of the non-dominant upper extremity was selected as the

target vein and anatomical location as far as possible. For this purpose, a physical examination was performed first. The criteria for performing surgery without any further tests were as follows: 1) Confirming an adequate arterial circulation with Allen test; 2) An arterial pulse strength of 2 out of 4 on semi-quantitative assessment; 3) Venous diameter of at least 1 mm on assessment without tourniquet and at least 2 mm with tourniquet, and returning of the vein to its original diameter when tourniquet is opened; 4) Visibility of the vein for at least 5 cm and its easy compressibility. Patients without the above mentioned favorable characteristics underwent preoperative Doppler ultrasonographic mapping. Patients with a suitable vein determined by the mapping procedure were operated as the patients who were found to have suitable vein characteristics on physical examination.

Surgical technique

Patients in whom a suitable anatomic site and vein were found were operated under local anesthesia upon cleaning the area to be operated and covering under operating room conditions or according to the preference of the patients and the patients in whom multiple operations were planned, general anesthesia was performed. A longitudinal incision was usually performed for the forearm and a transverse incision was performed for antecubital region followed by dissection and freeing of the artery and vein. At this point care was taken to free the vein in a way to avoid its angulation and kinking. The vein was then approximated to the artery in the anatomical position suitable for anastomosis. Heparin 5000 IU/1 cc was administered before the anastomosis. A longitudinal venotomy was performed for the planned anastomosis site; then 10 ml isotonic saline was injected with pressure through a plastic cannula. After confirming venous suitability the artery was suspended and a longitudinal arteriotomy was performed. An end-to-side anastomosis was made with the "parachute technique" using 7/0 prolene suture in the native vessels and 6/0 prolene suture when polytetrafluoroethylene (PTFE) was used. The anastomosis diameter was determined in a way not to exceed approximately 2 folds of the venous diameter. The suspension sutures were removed after anastomosis was completed. The operation was terminated once complete filling, pulse, and vibration were detected in the vein. When no vibration could be felt, excessive angulation and kinking in the proximal vein were controlled and both artery and vein were re-catheterized from the distal part of the vein. The operation was terminated when AVF was still non-functional. The wound dressing was performed in a way not to place any adhesive tape on the vein or not to apply any pressure on it.

Follow-up

The patients were waited in the anesthesia recovery room for 30 minutes. They were then sent to their rooms after vibration was checked. They were advised not to flex their elbows too much and to perform fisting exercise that is considered to augment blood flow to the anastomosis. After 1-day monitoring period and checking the vibration

over the area of anastomosis the patients were sent home to come back for follow-up at days 7, 14, and 21. During this period, when the sensation of vibration was lost the patients were re-operated to make an incision from the upper part of the vein or re-catheterize the vein from the point where the branching takes place and open a new AVF as necessary. Early term patency and "effective dialysis" were defined as absence of any problems after dialysis at the end of 28 days and presence of vibration and/or murmur.

Statistical analysis

Statistical analysis was performed using the statistical package SPSS (Version 17.0, SPSS Inc., Chicago, IL, USA). If continuous variables were normal, they were described as the mean±standard deviation ($p>0.05$ in Kolmogorov-Smirnov test or Shapiro-Wilk ($n<30$)), and if the continuous variables were not normal, they were described as the median. Comparisons between groups were applied using Mann Whitney U test for the data not normally distributed. Pre-post measures data were analyzing Wilcoxon Test. The categorical variables between the groups were analyzed by using the Chi square test or Fisher's Exact Test. Values of $p < 0.05$ were considered statistically significant.

RESULTS

A total of 100 patients underwent AVF operation. Comparison of the clinical and demographic properties of the groups revealed no significant differences. The data of the patient groups were summarized on Table 1. Twenty three (46%) patients in Group 1 and also 20 (40%) patients in Group 2 had more than one comorbidity (diabetes mellitus, hypertension, coronary artery disease, etc.). No significant differences were observed between the groups with respect to the postoperative variables. The postoperative variables were summarized on Table 2. The surgical variables pertaining to patient, anastomosis technique, vein/anastomosis diameter, and surgeon were compared between the groups. However, there was not statistically significant difference. The surgical variables were summarized on Table 3. Early phase efficiency of dialysis was found to be higher and complication rate lower in Group 1. But no statistical significance was obtained in terms of early dialysis efficiency and complication rates in between the groups ($p>0.05$). Complication rate was higher in Group 2 when compared according to operation time as 120, 120-240 and 240< minutes. But no statistical significance was obtained in this manner ($p>0.05$). Due to AFT failure, a new AVF was created at a proximal level in 2 of the patients in Group 2 and in a patient in Group 1.

DISCUSSION

ufficiently large caliber vein should be accessed in order to provide an effective hemodialysis therapy with a reproducible dialysis blood flow of sufficient output. An ideal vascular access should not affect daily activity, provide adequate blood flow supply for dialysis, preserve the normal vein anatomy, have a low complication rate, and function effectively for a prolonged duration

(7,8). Early failure of AVFs occurs in 30% of patients and its most common cause is the operative errors (9). Long-term functionality of an AVF depends on patient age, comorbidities, anatomic structure of the veins, localization of the anastomosis, surgeon experience, selection of appropriate technique, presence of a previous AVF operations, and appropriate vessel dissection and preservation of vascular integrity (10,11). Complications such as bleeding, thrombosis, extremity ischemia, infection, edema, venous hypertension, and aneurysm are frequently encountered in AVFs created for hemodialysis. Such complications adversely affect quality of life and prognosis of patients (12). The most common complications occurring after AVF surgery are thrombosis and vein occlusions as a result of stenosis (13,14). The main reasons of early occlusion are factors related to anastomosis technique, inadequate venous calibration and blood supply, hypotension, and compressive effect of hematoma that occurs due to early use of anastomosis (13).

Many studies in the literature investigated a large body of parameters belonging to patient, anastomosis technique, and surgeon that may determine early term patency rates of AVF. However, no study yet has examined the effect of daily operative performance and fatigue of operator on early term patency rates and complications of AVFs performed by the same operator. Our study specifically sought for this association and detected complications in 2 (%4) patients in Group 1 and 9 (%18) patients in Group 2. But no statistical significance was obtained in between the groups ($p>0.05$). However, we are of the opinion that a significant difference may be observed in future randomized studies with larger sample size. When groups were compared according to the early phase dialysis efficiency, success rate was 90% in Group 1 and 80% in Group 2. But no statistical significance was observed in between the groups ($p>0.05$).

Anastomosis techniques affect possible complications and fistula patency. Early occlusion rates have been reported 40% for side-to-side anastomoses and 60% for end-to-side anastomoses (13). An end-to-side anastomosis technique was preferred and an early term patency rate of 85% was achieved. The most common early complication of fistula operations is thrombosis, which has an incidence of 9.4% to 38% (15-17). In cases with low blood pressure this rate may goes up to 54% (16). We observed thrombosis in 5 (5%) patients, all of whom were in Group 2. We attitude the situation of low rates of thrombus formation in our general patient population with respect to the literature to our technique of irrigation of the artery and vein with saline both prior to AVF formation and after the anastomosis just before tying for possible leakage and thrombus formation. We also think that, our early heparin infusion procedure to the patients in whom thrill was not detected lowers thrombus formation.

Vein diameter and blood flow are the most important factors determining AVF flow. Fistulas created in small

veins (<1.5-2 mm) carry a risk of early occlusion (18). We chose Cimino-Brescia type fistula in this instance. We found no significant differences between both groups with regard to diameters of vein, artery, and anastomosis. However, the proximal AVFs had a better early term patency. We regard the operations by using PTFE grafts as the last resort owing to literature data suggesting lower patency rates associated with these grafts (19). A grafted AVF operation was performed in 1 patient in Group 1 and 2 patients in Group 2. No complication was seen in these patients and they had a complete early term patency rate.

An end-to-side anastomosis patency not more than 5 mm will reduce possible arterial ischemia, venous hypertension, and aneurysm development (20). Thus, native AVF anastomoses created in our study were equal to or smaller than 5 mm. Only the diameter of anastomosis was 6 mm in grafted AVF.

Factors adversely affecting AVF patency in ESRD patients reportedly include diabetes, female gender, and a cephalic vein diameter smaller than 2 mm; the factors favorably affecting AVF patency rates include presence of thrill after the operation and male gender (21). Another study reported that among factors affecting AVF success were sex, vein selection, vein diameters, and anatomical location. We detected no statistically significant differences between the study groups with respect to demographic, clinical, surgical, and postoperative variables.

AVF patency rates have shown great variability in previous studies (10-22). This may have stemmed from that the procedures in former studies were performed by more than one surgeon and with different techniques. To eliminate these potential sources of variability, all patients were operated by the same surgeon using the same technique. The results may also be influenced by differing levels of education and experience between centers. Literature data have suggested an early term patency rate of 57% to 89% (23,24). Overall, we found an early term patency rate of 85%. However, we could not reveal any significant difference between both groups' early term patency rates.

It has been shown that use of antiplatelet and anticoagulant medications during intraoperative and postoperative period increase primary fistula patency rates (25). Therefore, we began postoperative IV heparin infusion at a dose of 100U/kg and continued it for 12 hours in patients with no adequate thrill after the anastomosis. We also started the patients on acetylsalicylic acid (Coraspin®, Bayer, Istanbul, Turkey) on the first day after the operation. The groups were not statistically different regarding use of these medications.

In literature, many variables have been compared with regard to complication rates and duration of early term patency and differing results have been reported. But in none of studies in literature, patients had been evaluated preoperatively and then operated on by the same surgeon. For this reason, surgeon-dependent determining factors had been ignored. In our study all the patients were

examined preoperatively and operated on by a unique surgeon. Thus, the surgeon-dependent determining factors were homogenized in all patients. Two patients in Group 1 and 9 patients in Group 2, 11 patients in general, experienced complications in our study. In addition, early patency rates were higher for group 1. The two groups were not significantly different with respect to complication rates and effectiveness of dialysis. Although there were no significant differences between the groups, we suggest that future studies with larger and homogenous patient groups in which one surgeon will perform all operations may show the effect of "surgeon's fatigue" on early term patency rates.

CONCLUSION

Surgical fatigue factor and long operation time increase the rate of early complications and reduce early dialysis efficiency. But, no statistical significance was observed in between the groups when compared in terms of complications and early dialysis efficiency. We think that early term patency of AVF can also be affected by the complication rate. The effect of this variable can be statistically significant with studies having larger sample size.

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