



Impact of Intraoperative and 24 h Blood Pressure Levels and Presence of Arteriosclerosis on Arteriovenous Fistula

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Abstract

Introduction: Creation and subsequent patency of arteriovenous fistula (AVF) is crucial for hemodialysis patients. Early thrombosis is one of the main reasons of fistula occlusion. This study aimed to explore the effect of blood pressure and the presence of visible arteriosclerosis in the artery used for anastomosis on the patency of AVF.

Methods: This retrospective study AVF was created in 231 consecutive patients. We used the Brescia-Cimino technique to create AVF in 50% of patients. Perioperative systolic (SBP) and diastolic (DBP) blood pressures were recorded just before declampage and during the following 24-h period for each 6-h intervals. Age, gender, presence of macroscopic arteriosclerosis in the artery used for anastomosis, and the etiologic factors of chronic renal failure parameters were all equally recorded.

Results: The overall early fistula survival rate was 83%. No statistically significant immediate fistula dysfunction in terms of blood pressure differences was found. The multivariate analysis of the factors related to the AV fistula in the first 24 h patency revealed that only upper arm fistula was more likely effective (OR=1.192, p=0.003).

Discussion and Conclusion: The effect of age, gender, presence of arteriosclerosis, and the history of existence of central venous catheter on early AVF patency was not observed. The rate of fistula patency was higher in the upper arm compared to fistulas in the lower arm. No significant difference concerning AVF patency was observed between patients with arterial blood pressure higher or lower than 120 mmHg.

Keywords: Arteriovenous fistula failure; arteriosclerosis; blood pressure.

The rate of arteriovenous fistula (AVF) creation for patients with end-stage renal disease in this setting far exceeds the target goals set forward by the National Kidney Foundation published Dialysis Outcomes Quality Initiative (NKF/DOQI) Guidelines and the Centers for Medicaid & Medicare Services Fistula First initiative [1]. This is being achieved with acceptable rates of morbidity and patency. The size of this population has been increasing at a rate of 7% per year [2].

Accordingly, AVF creation and long-term patency are of paramount importance for patients waiting for renal transplantation. The factors influencing the patency of AVF, such as diabetes mellitus (DM) [3], previous heparin use [4], C-reactive protein [5], preexisting intimal hyperplasia [6], intraoperative blood flow measurements [7], presence of malignancy, previous central venous catheter (CVC) insertion, preoperative arterial blood pressure (ABP), arterial inflow (AI), subclavian venous flow (SVF), operative venous

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outflow of the fistula [8], hypertension, smoking [3, 9, 10], re-operative radial arterial diameter [11], surgeon experience [12], have been explored.

In several studies, systolic blood pressure (SBP) and diastolic blood pressure (DBP) values were recorded only once in the preoperative period, although blood pressure values are variable parameters especially in patients with chronic renal disease. Our hypothesis was based on the possibility that serial measurements of SBPs and DBPs during both the intraoperative and early postoperative period would give a better idea concerning the early success rates of AVF with, on the other hand, the exploration of the artery used for anastomosis in terms of arteriosclerosis. There has been no consensus on these two parameters in the literature.

In this study, we evaluated the influences of SBPs and DBPs during AVF creation and visual atherosclerotic plaque in arterial side on early patency of AVF.

Materials and Methods

In this study, the medical records of 300 patients, who had primary AVF operation in Istanbul Training and Research Hospital between October 2007 and April 2011, were retrospectively recruited. In all patients, same surgeons created primary AVFs. Sixty-nine patients were excluded from this study. In 23 patients, chronic thromboses were seen in venous side. In 15 patients, SBP was below 90 mmHg before operation; and 31 patients had atherosclerotic cardiovascular disease and/or cardiac failure. A total of 231 patients were included in the study, of which 122 (52.7%) were male and 109 (47.3%) were female. The mean age was 47 ± 12 years. They all were patients with chronic renal failure of different etiologic factors who were subjects to hemodialysis. Seventeen percent of patients had DM.

Physical evaluation was conducted for every patient. It consisted of the presence of a recent central vein access, formation of a prominent venous tract distally upon application of proximal pressure proximally to the planned surgical site, and arterial pulse strength. All involved surgeons have already performed more than 100 fistula operations.

The non-dominant upper extremity was primarily chosen; and as a rule, the most possible distal site of fistula creation was generally selected to preserve the proximal site.

During the operation, the presence of arteriosclerosis in the artery chosen for anastomosis was noted. The presence of visible arteriosclerosis and palpation of the plaques of the artery was accepted as positive for arteriosclerosis.

The SBP and DBP measurements were taken just before declampage and repeated for each 6 h for a period of 24 h.

The patency of fistula was verified by Doppler ultrasound examination at the end of the operation and before the patient was permitted to leave the hospital.

Surgical Technique

Three types of fistula consisting of Brecio–Cimino (BC), Snuff-box (SB), and antecubital (AC) were created. In cases when there was no contraindication, the non-dominant arm was selected; and the fistula was placed as distally as possible. 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 all considered. A proximal tourniquet was placed on the upper extremity to explore the suitable vein to be used for anastomosis. In the absence of suitable vein under tourniquet, the decision was to create an AC fistula. The BC type fistula was chosen in cases where previous SB fistula has already been created. Local anesthesia was performed by using lidocaine hydrochloride in all cases.

Prior to placing the clamps, intravenous heparin of 1 mL (1000 IU) was routinely administered. The side-to-side and end-to-side techniques were preferred depending on the distance between the artery and the vein. Vasospasm was treated either by mechanical dilatation with a probe of 1 mm, 1.5 mm, and 2 mm in diameter or by topical papaverine. A continuous suture technique using 7/0 polypropylene was used to create the anastomoses.

The fistula was accepted as functional or patent when thrill was positive by palpation of fistula 24 h after the operation on the day of discharge from the hospital.

Statistical Analysis

Statistical comparisons of individual groups (AVF patency and no-patency groups) were based on Student t test and one-way ANOVA for continuous variables and on chi-square test for discrete variables. Parametric and nonparametric tests were used according to the distribution pattern of the data of each variable. To determine blood pressure on AVF patency, patients with lower SBP (≤ 120 mmHg) were compared to patients with higher SBP. Multivariate analysis was applied to identify the variables (age > 50 year, gender, DM, atherosclerotic plaque in arterial side, upper arm AVF fistula vs. low arm fistula, hemodialysis catheter past-history, and also SBP and DBP during operation) for AV fistula patency for 24 h. The statistical analysis was carried out by Statistical Package for Social Sciences for Mac ver. 20.0 (SPSS Inc., Chicago, IL). Data were expressed as mean \pm SD, with significance level of P less than 0.05.

Results

Of the 231 patients included in the study, 122 (52.7%) were male and 109 were female (47.3%). The mean age was 47 ± 12 (range 16–72) years. Temporary or permanent hemodialysis catheter histories were found in 37% of patients. Atherosclerotic plaque was observed in 32% of patients during operation. Seventeen percent of patients had DM.

Brescia–Cimino AVF was created in 110 (48%) patients, 80 patients (34%) received a snuff-box (SB) AVF, and remaining 41 (18%) patients an antecubital brachiocephalic AVF.

Range of SBP was from 90 to 160 mmHg, DBP from 50 to 140 mmHg in all following period. No patients had hypotensive episode (below 90 mmHg) during and after operation.

Patency rate of primary AVF in first 24 h was found 84.3% (193 pts). Remaining 38 patients had primary AVF failure. In Table 1, demographic and clinical characteristics of both

groups have been shown. Demographic characteristics were similar in both groups. Mean SBP and DBP, catheter history for hemodialysis, plaque rate in arterial wall were not different between groups. No significant difference in rates of AVF patency was observed between patients with low blood pressure and those with high blood pressure (79.6 % vs. 84.4%, respectively, $p=0.422$). The rate of functioning was 97.6% in upper arm AVF, which was significantly higher from low arm fistulas ($p=0.014$).

The multivariate analysis of the factors related to the AV fistula in the first 24 h patency revealed that only upper arm fistula was more likely effective (OR=1.192, $p=0.003$) (Table 2).

Discussion

In this study, we evaluated the rate of patency of upper and low arm fistula and also factors related to patency of AVF.

Most suitable vascular access for chronic hemodialysis patients is autogenous AVF. Patients with AV fistulas have long-term patent vascular access, low rate morbidity, and hospitalization [13]. The natural history of AVF maturation is also influenced by multiple comorbid conditions, such as older age, diabetes, and atherosclerosis, which may be present in patients with end-stage renal disease [14]. Definition of primary AVF failure was determined as immediate failure of AVF within 72 h of surgery.

Current literature supports patient factors, such as increasing age, presence of diabetes, female gender, smoking, peripheral vascular disease, pre-dialysis hypotension, and vessel characteristics, as directly influencing AVF patency [10, 14]. In our study, demographic characteristics did not influence AVF patency.

Also, immediate and long-term success of a newly constructed AVF depends on several hemodynamic factors,

Table 1. Comparison of demographic and clinical characteristics groups

Parameters	Fistula Patency n=193	No-patency n=38	p
Age (years)	49±22	45±12	NS
Gender male, %	52.7	52.5	NS
Catheter history, %	51.7	47.5	NS
DM, %	83	17	NS
Plaque, %	15.4	23.1	NS
Systolic BP mmHg	153±32	146±32	NS
Diastolic BP mmHg	87±16	84±17	NS
AV fistula type, %			
BC	76.8	23.2	0.014
SB	83.1	16.9	
AC	97.6	2.4	

DM: Diabetes mellitus; BP: Blood pressure; AV: Arteriovenous; BC: Brescia-Cimino; SB: Snuff-box; AC: Antecubital.

Table 2. Multivariate analysis for patency of AVF in first 24 hours

Dependent variables	OR	95% CI		p
		Lower bound	Upper Bound	
Age				
>50 years	0.112	0.106	0.802	0.351
Catheter past-history	0.010	0.086	102	0.825
DM	0.083	0.046	0.210	0.242
Plaque	0.023	0.084	0.121	0.579
Systolic BP				
Above 120 mmHg	0.034	0.020	0.038	0.343
Diastolic BP	0.042	0.040	0.055	0.274
Type AVF				
For AC fistula	1.192	1.034	1.270	0.003

DM: Diabetes mellitus; BP: Blood pressure; AVF: Arteriovenous fistula; AC: antecubital.

vessel characteristics, and surgeon experience [3–16]. MacAskill et al. and Kim et al. stated in their studies that preexisting or incoming intimal hyperplasia was an important factor in AVF survival. On the other hand, the existence or absence of arteriosclerosis in the artery used for anastomosis was considered, which is similar to the study of Parmer et al., both on physiological and mechanical basis [6, 11, 12, 15].

Parmar et al. [11] stated that there was a high failure rate of AVF with radial artery ID of <1.5 mm; and in the presence of small radial arteries, primary access AVF in the upper arm should be considered. In our study, the rate of fistula patency was higher in the upper arm compared to fistulas in the lower arm. Similarly, the primary AVF failure rates were shown higher in more distal compared with proximal upper limb sites [primary failure rates of 28% for lower arm AVF and 20% for upper arm AVF ($p=0.001$)] in a recently reported systematic review. In the same study, long-term AVF patency rates were found worse in lower arm than upper arm (55% vs. 65%) [17].

Yerdel et al. [8] stated that an arterial inflow rate of 40 ml/min or more SVF rate of 400 ml/min or more who had premeasured by color flow duplex imaging prior to the operation is associated with better outcomes.

Smith et al. in their meta-analysis searched multiple factors that affect the patency of AVFs and stated that. Weale et al. evaluated the effect of surgical trainees on the outcome of fistulas and found that surgical trainees can perform primary AVF surgery without significantly reducing fistula outcomes [14]. We found neither many studies identical to ours in the literature nor any consensus on this subject.

Yerdel et al. [8] evaluated preoperative ABP and found that it had no influence on AVF immediate outcome. Smith et al. found that only diastolic hypotension was a factor affecting the AVF outcome. The different points of our study was that the SBP and DBP were intraoperatively recorded and for intervals of 6 h during the first 24 h.

Limitations

This study has some limitations. It is a retrospective study that includes a short period of determination of AVF maturation. On the other hand, the diagnosis of arteriosclerosis was based on existence of arteriosclerotic plaques on the arterial wall on inspection without histopathologic interpretation. The venous site of anastomosis that contributes in patency of AVF was not included in the study. Finally, the effect of early patency on long-term viability of the anastomosis was not investigated.

In conclusion, the effect of age, gender, presence of arteriosclerosis, and the history of existence of CVC on early AVF patency were not explored. The rate of fistula patency was higher in the upper arm compared to fistulas in the lower arm. No significant difference concerning AVF patency was observed between patients with ABP higher or lower than 120 mmHg.

Compliance with Ethical Standards: The authors declare that they have no competing financial interests and they do not have any conflict of interest.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study. Ethical committee approval was omitted as it was a retrospective study.

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