

Assessment of The Effect of Blood Pressure on The Maturation of Arteriovenous Fistula and Grafts

Fatemeh Shajiee Rood Majani¹, Fatemeh Sadeghipour-Kermani¹,
Gholamhosein Kazemzadeh^{1*}, Maryam Saberi-Karimian¹

¹Vascular and Endovascular Surgery Research Center, Mashhad University of Medical Sciences, Mashhad, Iran.

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ABSTRACT

Introduction: Chronic kidney disease is an ailing condition that in the final stages can lead the patient to renal replacement therapies such as dialysis. An arteriovenous fistula (AVF) with proper function and maturation is needed with this regard. The aim of this study was to evaluate the effect of blood pressure on the function and maturation of AVF and AVG.

Materials and Methods: This retrospective cross-sectional study was performed between September 2016 and March 2019 on all patients with chronic renal failure, who referred to the Alavi Vascular Surgery Hospital as candidates for hemodialysis and underwent AVF implementation by the researchers. Using a predesigned checklist, the hospital records of all patients were reviewed and data including the demographic information of patients (age and sex), previous medical history (diabetes, hypertension), smoking status and blood pressure of the patient before and after surgery were extracted. In order to follow the patients and evaluate the function and maturation of the fistula, the dialysis centers in Mashhad were contacted and information about the successful dialysis of the patients was recorded. Data were extracted from the forms and entered into SPSS software and at the end, patients' blood pressure was compared between functional and unfunctional groups and also in terms of access type.

Results: Totally, 298 cases were enrolled in the study and classified into two groups including 242 (81.2%) functional AVFs and 56 (18.8%) unfunctional AVFs. The mean age of the patients was 55.15±17.93 years and the median was 58.5 (67.0-43.0) years old. Moreover, 152 patients (51.0%) were male and 146 patients (49.0%) were female. There was no significant difference regarding age ($p=0.057$) and gender ($p=0.290$) between the two study groups. Furthermore, underlying diseases (diabetes and hypertension) showed significant difference between the two study groups ($p<0.001$). Only, diabetes relative frequency showed significant difference between fistula and graft groups ($p=0.022$). The median systolic (SBP) and diastolic blood pressure (DBP) was significantly higher in functional group compared to the unfunctional ($p<0.05$). However, there was no significant difference regarding the median SBP and DBP between the two types of access including fistula and graft ($p>0.05$).

Conclusion: Our study revealed that probably blood pressure plays an important role in the function and maturation of AVF.

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*Corresponding author: Gholamhosein Kazemzadeh, Vascular and Endovascular Surgery Research Center, Mashhad University of Medical Sciences, Mashhad, Iran, 99199-91766, Tel: +985138047205, Fax: +985138047205, Email: kazemzadehgh@mums.ac.ir.

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Introduction

End-stage renal disease is a chronic disease requiring treatment with dialysis or renal transplantation. With the widespread availability of dialysis, the lives of thousands of patients with ESRD have been extended (1). In Iran alone, there are more than 40,000 patients with ESRD (kidney failure that requires dialysis or transplantation) being treated, most of whom require dialysis (2). In general, to perform hemodialysis permanently, a method must be adopted to access the patient's vessels for hemodialysis. Arteriovenous fistula (AVF) is an abnormal connection between an artery and a vein (3). In patients with chronic renal failure, achieving a good and safe vascular route for hemodialysis is very important (3).

One of the most important problems related to AVF is the immaturity or obstruction of these fistulas and in about 20 to 54% of people whose fistula fails, one of these two problems is the main cause (4). Prediction of fistula efficacy is made with the help of Doppler ultrasound (5). It may be possible to improve the results of vascular access by having a more comprehensive picture of the factors involved in the effective maturation of fistulas. Previous studies on risk factors such as cardiovascular disease, hyperlipidemia, and hypertension have shown conflicting results in AVF immaturity, leading to research on other risk factors such as hemodynamics or vascular morphology (6). Endothelial cell function is impaired in patients with high blood pressure, which reduces vasodilation and the penetration of inflammatory cells into blood vessels (7, 8). Macrophages and T cells that penetrate the vessel wall cause the development and progression of atherosclerosis in the arteries. Therefore, the success rate and longevity of AVF may be low in patients with hypertension (9). In recent years, studies have been conducted to investigate the risk factors for the immaturity of venous arterial fistulas, some of which have identified high blood pressure as a risk factor. For example, a 2003 study of 434 patients who were candidates for AV Fistula implantation by Feldman et al. Was from people with normal blood pressure. Also, mean arterial pressure at admission less than 85 mm Hg was associated with a lower probability of AVF maturation. Therefore, it

can be concluded that both hypotension and hypertension can reduce the chance of AVF maturation (10).

However, some studies do not support high blood pressure as a major risk factor for AVF immaturity. Kim et al., conducted a cohort study in 2011 to assess patient factors, venous diameter, and the ability of the radiocephalic vein to enlarge in the wrist (11). Study analysis found no positive association between AVF maturity and factors such as hypertension, diabetes, and patient gender. However, the sample size did not appear to be large enough to detect the effect between AVF maturity and blood pressure. In another study conducted in 2009 by Lauvao et al., the authors evaluated 298 venous arterial fistulas implanted over four years in a central US hospital. The results of this study showed that patients with high blood pressure and diabetes were not significantly associated with the maturity of venous arterial fistulas (12). Overall, as mentioned, high blood pressure is one of the most common comorbidities in AVF surgery candidates. However, few studies have been performed on the role of blood pressure (BP) in fistula survival. They do not match. Therefore, this study aimed to determine the effect of blood pressure and puberty of arterial fistulas.

Materials and methods:

Study design and approval

This cross-sectional study was conducted in Alavi Hospital, during September 2018 to December 2020. The study was in accordance with the ethical codes of Helsinki declaration and was approved by the Ethics Committee of Mashhad University of Medical Sciences (approval code: IR.MUMS.REC.1400.449).

All patients with chronic renal failure who were candidates for hemodialysis referred to Alavi Hospital who underwent fistula implantation or grafts were included in the study.

Data collection

The records of all patients were reviewed. Demographic information (age and sex), past medical history (diabetes, hypertension) and smoking and blood pressure of the patient before and after surgery were extracted from the records and recorded in the data collection form. In order to follow up the

patients and evaluate the function and maturation of the fistula, the Dialysis centers in Mashhad were contacted and information about the successful dialysis of the patients was recorded.

Statistical analysis

All the analyses were performed using SPSS software (version 23 for Windows; IBM Statistics, Chicago, IL). A $P < .05$ was considered statistically significant.

Result

Totally, 298 patients were enrolled in the study including 242 cases (81.2%) in the functional group and 56 cases (18.8%) in the unfunctional group. The mean age of the patients was 55.15 ± 17.93 years old and the

median was 58.5 (67.0-43.0) years old. There was no significant difference in the case of the median age between functional and unfunctional groups ($p=0.057$). Moreover, 152 cases (51.0%) were male and 146 cases (49.0%) were female. There was no significant difference in the case of gender between functional and unfunctional groups. However, there was a significant difference in the case of underlying diseases ($p<0.001$) and smoking ($p=0.008$) between the two study groups. Table 1 shows the details of these comparisons.

Table 2 compares age, gender, underlying disease, and smoking between fistula and graft access types. There was only a significant difference in the case of diabetes between the two groups ($p=0.022$).

Table 1. Comparing age, gender, underlying disease, smoking, and access type between functional and unfunctional groups.

Features		Group		p-value
		Functional	Unfunctional	
Age years; median (IQR)		58 (66-42)	62 (71.5-50)	*0.057
Gender N (%)	Male	127 (52.5)	25 (44.6)	**0.290
	Female	115 (47.5)	31 (55.4)	
Diabetes N (%)	No	130 (53.7)	45 (80.4)	**<0.001
	Yes	108 (44.6)	10 (17.9)	
	Unknown	4 (1.7)	1 (1.8)	
Hypertension N (%)	No	81 (33.5)	41 (73.2)	**<0.001
	Yes	159 (65.7)	15 (26.8)	
	Unknown	2 (0.8)	0 (0.0)	
Smoking N (%)	No	209 (86.4)	55 (98.2)	**0.008
	Yes	27 (13.6)	1 (1.8)	
Access type N (%)	Fistula	117 (47.3)	28 (50.0)	**0.882
	Graft	125 (50.2)	28 (50.0)	
	Unknown	6 (2.5)	0 (0.0)	

* Compared using Mann-Whitney test;

** Compared using Chi-square test

Table 2. Comparing age, gender, underlying disease, and smoking between two different access types

Features		Access type		p-value
		Fistula	Graft	
Age years; median (IQR)		57 (67-40)	59 (66-50)	*0.362
Gender N (%)	Male	80 (55.2)	72 (47.1)	**0.161
	Female	65 (44.8)	81 (52.9)	
Diabetes N (%)	No	95 (65.5)	80 (52.3)	**0.022
	Yes	48 (33.1)	70 (45.7)	
	Unknown	2 (1.4)	3 (2.0)	
Hypertension N (%)	No	68 (46.9)	54 (35.3)	**0.052
	Yes	77 (53.1)	97 (63.4)	
	Unknown	0 (0.0)	2 (1.3)	
Smoking N (%)	No	128 (88.3)	136 (88.9)	**0.739
	Yes	14 (11.7)	13 (11.1)	

* Compared using Mann-Whitney test;

** Compared using Chi-square test

In the case of, comparing diastolic and systolic blood pressure before and after surgery between functional and unfunctional groups; functional cases had significantly higher systolic and diastolic blood pressure compared to the unfunctional cases ($p < 0.05$). Table 3 shows these comparisons.

Still, there was no significant difference in the case of diastolic and systolic blood pressure before and after surgery between fistula and graft access types. Table 4 demonstrates the details of these comparisons.

Discussion

Our results demonstrated that the frequency of hypertension was notably higher in those with successful maturation. Moreover, there was a considerably higher amount of both systolic and diastolic blood pressure before and after surgery in the patients with functional dialysis access. All these suggest that there may be a relation between systolic blood pressure and dialysis access maturation.

Similar to our findings several studies proposed in line results. Feldman et al., proposed that patients with pre-surgery hypotension, have less success rate of maturation for AV fistulas (13). Similarly,

Thomsen et al., reported that patients with SBP less than 110 mmHg have a higher chance of AVF failure during a four-week follow-up (14). Moreover, it is demonstrated that higher pre-operative blood pressure is associated with a greater primary patency rate (15). Besides all these, it is postulated that patients with higher blood pressure have significantly lower maturation times (16).

Still, there are some opposing results in other studies compared to our findings. Siddiqui et al., reported no significant difference in the case of blood pressure between functional and unfunctional groups (17). This shows that other moderator and confounder factors may interfere with the role of blood pressure and the effect of SBP and DBP on AVF maturation should be weighed in the context of other related factors.

Some believe that gender may have a role in AVF maturation. Siddiqui et al., reported that males have a two-folded better maturation rate than females (17). In line with their finding, Miller et al., found that AVF maturation is more successful in men than in women (18). Similar results were obtained by Lyem et al (19). In our study, there was no significant difference in case of gender between functional and unfunctional cases.

Table 3. Comparing diastolic and systolic blood pressure before and after surgery between functional and unfunctional groups.

Features		Group		p-value
		Functional median (IQR)	Unfunctional median (IQR)	
Before surgery	SBP (mmHg)	130 (150-120)	120 (135-100)	<0.001
	DBP (mmHg)	79.5 (80-70)	70 (80-60)	<0.001
After surgery	SBP (mmHg)	145 (160-130)	140 (150-120)	0.009
	DBP (mmHg)	85 (90-80)	80 (80-70)	0.003

SBP= systolic blood pressure;
DBP= diastolic blood pressure

Table 4. Comparing diastolic and systolic blood pressure before and after surgery between functional and unfunctional groups.

Features		Group		p-value
		Fistula median (IQR)	Graft median (IQR)	
Before surgery	SBP (mmHg)	130 (140-110)	130 (140-120)	0.227
	DBP (mmHg)	80 (80-70)	80 (88-70)	0.108
After surgery	SBP (mmHg)	140 (160-130)	140 (160-130)	0.837
	DBP (mmHg)	90 (80-70)	90 (80-78)	0.923

SBP= systolic blood pressure;
DBP= diastolic blood pressure

Another important factor is vein size. Mendes et al., reported that, when the diameter of the cephalic veins exceeded 2 mm, then there was a 76% success rate of functional dialysis access, whereas, if the diameter was less than 2 mm, then there was only a 16% success rate (20). Siddiqui et al., revealed that a preoperative vein diameter of more than 2.5 mm resulted in a fivefold increase in fistula maturation as compared with a vein size of less than 2.5 mm (17). Another study proposed a cut-off of 6 mm for vein diameter (21).

In fact, besides the role of the blood pressure on arteriovenous fist-ula or graft maturation, the creation of a dialysis access can lead to a decrease in blood pressure. Therefore, patients with lower pre-operative blood pressure are more prone to post-operative hypotension (22). It is reported that hypotension is the one of the most important causes of AVF failure (23). Moreover, it is expected that the high arterial blood pressure causes a remodeling in venous wall and these further provides a good blood flow during dialysis. It seems that the higher the pre-operative systolic and diastolic blood pressure, the lower the time of maturation, and the lower the rate of access failure. It is revealed that after the development of AVF, a sudden increase in the venous pressure is developed and subsequently venous wall shear stress and tensile stress are increased. All these mechanisms are responsible for vessel remodeling and proper AVF function, and blood pressure plays a substantial role with this regard (24).

Conclusion

It seems that blood pressure may predict the success of a dialysis access. However, this should be assessed in the background of other factors. However, it is better to manage the blood pressure of the patient before AVF creation, in order to achieve better results. Further studies are needed to complete these results.

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