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Original article

Impact of preoperative Blood Pressure Levels on Arteriovenous Fistula Failure

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Abstract

The effect of pre-operative blood pressure on maturation and failure of arteriovenous fistula (AVF). In this study, we evaluated the effect of systolic blood pressure (SBP), diastolic blood pressure (DBP) and pulse pressure in end-stage renal disease (ESRD) in Tehran, Iran. In this cross sectional study, 400 patients (264 men and 136 women) with ESRD were assessed after AVF creation and maturation and failure were evaluated.

Low diastolic blood pressure before surgery was significantly associated with more AVF failure. SBP was not associated with change in result of failure or maturation in these patients. Higher pulse pressure was accompanied with more failure but it was not significant statistically. Also, we achieved SBP point of 189.5 mmHg with sensitivity and specificity at 67% and 96%, respectively. Using DBP cut-off point of 64 mmHg achieved sensitivity and specificity at 93% and 8%, respectively, and AUC with 95% CI was 0.36 (0.26-0.46). The effect of preoperative blood pressure on maturation was not different among these patients. Our results suggest that preoperative low diastolic blood pressure and wide pulse pressure can be associated with more AVF failure in comparison with patients without these risk factors.

Keywords: End-stage renal disease; Arteriovenous failure; Systolic blood pressure; Diastolic blood pressure; Pulse pressure.

Introduction

The prevalence of end-stage renal disease (ESRD) is increasing around the world and it is considered that the number of dialysis patients will reach 5.5 million in 2030 [1].

Hemodialysis (HD) is the most commonly used method in ESRD patients, so they require vascular access (VA) [2]. Arteriovenous fistula (AVF) is recommended in different countries for this purpose due to less morbidity and mortality [2, 3].

The goal of AVF creation is to have suitable access for dialysis. This means that the AVF must be of adequate size and provide adequate blood flow. Maturation of AVF has been occurred when the diameter of the fistula is at least 4-5 mm, and has a flow rate of at least 500 mL per minute. Therefore, evaluation of a new access 4 to 6 weeks after creation should be considered to assess fistula maturation or early failure [4, 5].

Hence, nonmature AVF may be defined clinically when there is insufficient development of vessel or a fistula has not matured enough to allow successful hemodialysis after at least eight weeks after creation [6]. On the other hand, primary failure of AVF is diagnosed as thrombosis fistula and not ready for dialysis within 3 months of creation [7].

There are associations between several characteristics of ESRD patients with AVF failure [2]. Adverse hemodynamic characteristics (poor-quality vessels) are the most important factors contributing to AVF failure [3, 8]. Older age, female gender, clinical comorbidities such as diabetes mellitus, and obesity are other risk factors for failure of AVF maturation. [8-10] Other factors that may affect the outcomes of AVF include the site of fistula creation [3, 10], the experience of the surgeon, and technical factors. [8]

Although some studies reported a direct association between a history of hypertension and AVF failure in HD patients, one study detect that those who had a positive history of hypertension before vascular surgery had a low risk for AVF failure, comparing with nonhypertensive patients [2]. On the other hand, no significant difference was observed between patients with intraoperative arterial blood pressure higher or lower than 120 mmHg in AVF failure outcome. Although, current literature supports the effects of pre-dialysis hypotension on AVF patency [3] and lower diastolic blood pressure was associated with higher odds of AVF failure [9, 11]. Various studies have proved that hypotension before hemodialysis is associated with AVF thrombosis and failure. In one study, the authors show that patients with early failure of AVF have lower preoperative blood pressure. Although, a larger study is required to substantiate their findings and define target preoperative blood pressure for AVF creation [11].

Throughout the world, the rate of inadequate maturation and functional failure of AVF is alarmingly high [2]. Such failure rates translate to significant morbidity, hospitalization, and mortality. Also, the number of ESRD patients has increased in recent decades, and the costs for AVF-related morbidity are high. So, detecting the factors that cause AVF failure can reduce repeating VA surgeries and hospitalization and improve the quality of life in ESRD patients [2, 12].

Mindfully, there is a lack of a study that specifically studies the impact of the preoperative hemodynamic state on AVF fistula. In this study, we evaluated the influence of preoperative systolic blood pressure (SBP) and diastolic blood pressure (DBP) on the maturation of AVF, and provide information on the impact of preoperative blood pressures on the early failure of fistula.

Materials and Methods

This cross sectional study was conducted using data of hemodialysis patients who had undergone their first AVF from 14 July 2001 to 7 August 2018 at a tertiary hospital in

Tehran. The research was performed on 400 ESRD patients who were admitted and underwent AVF operation by the same surgeon in our center to receive HD. The patients were informed about the research, and their written consents were obtained.

Four weeks after AVF creation, the patients were referred to our clinic for patency control.

There were three types of outcomes at the end of this study: primary early failure (thrombosed fistula in first evaluation at one-month lapse surgery), mature AVF (functional for hemodialysis), nonmature AVF (not met criteria of maturation even to 12 weeks after creation). Before surgery, Blood pressure measurements were performed according to the recommendations of the American Heart Association valid at the time of data collection [13]. Blood pressure was measured following the same technical procedures at baseline. Pulse pressure was the difference between systolic and diastolic blood pressures [14].

After surgery, the patients were visited about one month later and evaluated for early failure or maturation of fistula. If the fistula had trill on palpation, we followed them a maximum of 12 weeks for approved maturation. These evaluations and examinations were performed by one surgeon and he did not aware of the previous data of each patient.

We compared maturated and non-maturated groups for systolic and diastolic blood pressure and pulse pressure. Also, we assessed the effect of blood pressure on the failure of AVF.

Statistical comparisons of individual groups were based on the Student t-test and one-way ANOVA for continuous variables and the chi-square test for discrete variables. Parametric and nonparametric tests were used according to the distribution pattern of the data of each variable. The statistical analysis was carried out by Statistical Package for Social Sciences for Windows ver. 24.0 (SPSS Inc., Chicago, IL). Data were expressed as mean ± SD, with a significance level of P less than 0.05. The optimal cut-off point of SBP and DBP in the patients with AVF failure was calculated by utilizing the receiver operating characteristic (ROC) curve.

Results

Of the 400 patients included in the study, 264 (65.8%) were male and 136 were female (34.2%). The mean age was 52.82±16.94 years. None of the patients had a history of previous AVF. Antecubital AVF was created in 144 (36.8%) patients, 247 patients (63.2%)

Table 1. Demographic and clinical characteristics of the patients

Characteristics	
Age	52.82±16.94
Gender	
Male	264 (65.8%)
Female	136 (34.2%)
BMI (kg/m^2)	25.09±4.80
Weight (Kg)	68.46±14.48
Site of AVF n (%)	
Wrist	247 (63.2%)
Antecubital	144 (36.8%)
SBP mmHg (mean ± SD)	138.66 ± 23.04
SBP ranges n (%)	
80-100 mmHg	23 (5.8%)
101-120 mmHg	81 (20.3%)
121-140 mmHg	155 (38.8%)
141-180 mmHg	81 (20.3%)
181-200 mmHg	60 (15%)
DBP mmHg (mean ± SD)	80.79 ± 11.61
DBP ranges n (%)	
55-75 mmHg	120 (30.2%)
76-95 mmHg	233 (58.5%)
96-115 mmHg	42 (10.6%)
116-135 mmHg	3 (0.8%)

BMI, Body Mass Index; SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure

received a wrist AVF. The range of SBP was from 80 to 200 mmHg, DBP from 50 to 122 mmHg. In Table 1, all of the demographic and clinical characteristics of both groups have been shown.

Table 2. Association of SBP and DBP with AVF outcome

Variables	AVF failure (Thrombosed)	AVF Non-failure (Mature and nonmature)	P value
SBP (mmHg)	134.33±24.21	139.01±22.94	0.29
80-100	2 (6.7%)	21 (5.7%)	
101-120	9 (30%)	72 (19.5%)	0.52
121-140	11 (36.7%)	144 (38.9%)	
>140	8 (26.7%)	133 (35.9%)	
DBP (mmHg)	76.10±9.59	81.17±11.69	0.02
50-70	14 (46.7%)	93 (25.1%)	
71-90	13 (43.3%)	226 (61.1%)	0.062
91-100	3 (10%)	38 (10.3%)	
>100	0 (0%)	13 (3.5%)	
Pulse Pressure (mmHg)	58.23±18.58	57.84±17.30	0.90

There were 30 patients with AVF failure and the calculated failure rate of AVF in this study was 7%. First, we assessed failure and non-failure (Sum of mature and non-mature) AVF in these patients. There was no significant difference was between the two groups about systolic blood pressure (p-value = 0.29) but diastolic pressure was significantly different between the groups (76.10±9.59 vs 81.17±11.69, p-value = 0.02). Pulse pressure (p-value=0.90) was not significantly different. Also, when we categorized diastolic blood pressure, 14 patients (46.7%) in the failure group had a DBP from 50-70 mmHg while 93 (25.1%) of patients without failure had a similar DBP range. Also, 27 patients (90%) in the failure group had a DBP from 50 to 90 mmHg. The details of this comparison was shown in table 2.

The optimal cut-off point of SBP was 189.5 mmHg with sensitivity and specificity at 67% and 96%, respectively. The corresponding area under the curve (AUC) of the ROC

curve was 0.42 (95% confidence interval (CI), 0.31 to 0.53) (Figure 1). Using DBP cut-off point of 64 mmHg achieved sensitivity and specificity at 93% and 8%, respectively, and AUC with 95% CI was 0.36 (0.26-0.46) (Fig. 2).

When we compared between mature AVF and non-mature AVF patients, there was no significant difference was between mature and non-mature AVF groups about systolic blood pressure (138.68 ± 21.48 vs 138.60 ± 26.04, p-value 0.97), and diastolic pressure (79.93 ± 12.13 vs 81.21 ± 11.35, p-value= 0.30) respectively. Pulse pressure (p-value=0.52) was not significantly different. The non-difference was repeated when we categorized SBP and DBP.

According to Roc curve, there is a cut-off of 153 mmHg and 91.5 mmHg for systolic and diastolic blood pressure. (supplement 1).

Discussion

This study reported that only 30 patients were complicated as AVF failure and the rate of AVF failure in the presented study was 7% that lower than other's reports**.** In this study, we found diastolic pressure is the effective factor for AVF failure. In this way, in our study patients with AVF failure had a lower diastolic pressure (76.10 ± 9.59). Also, after categorizing DBP, most of the patients with AVF failures had a DBP from 50 to 90 mmHg. Systolic blood pressure in the AVF failure group was lower than the success group but this

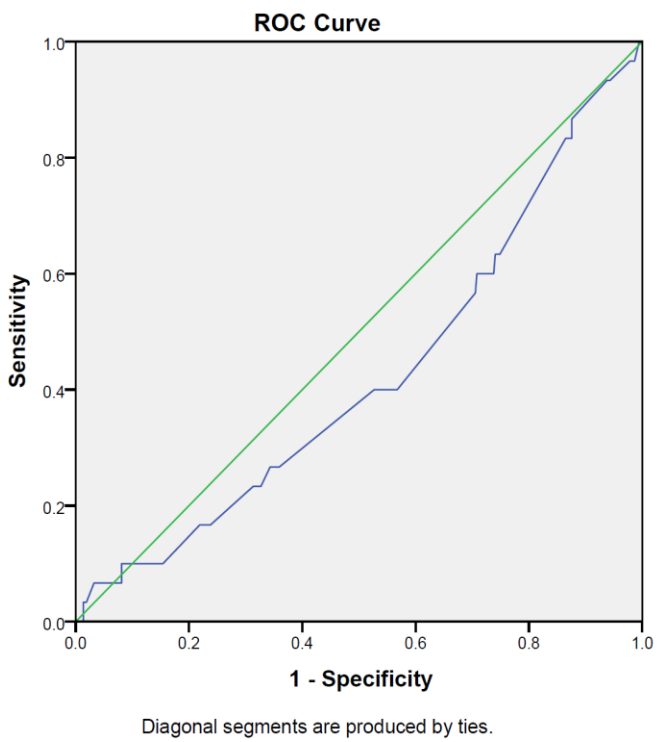

Figure 1. The ROC curve for AVF failure prediction using SBP. SBP of 189.5 mmHg has a sensitivity of 67%, and specificity of 96%; AUC (95% CI)= 0.42 (0.31-0.53); ROC, receiver operating characteristic; SBP, systolic blood pressure; AUC, area under the curve; CI, confidence interval

difference was not significant (p-value =0.29). The failure AVF had a higher pulse pressure than success AVF but the reported p-value was 0.90.

Earlier studies suggested that low blood pressure before surgery was associated with an increased rate of AVF thrombosis and early primary AVF failure [11, 15-17]. In this regard, Pandey et al. evaluated the effects of preoperative blood pressure on the early failure rate of AVF in the prospective observational study. They reported that early failure was seen in 62 patients of 224 patients (27.7%) in their study. They showed patients with early failure of AVF had lower preoperative blood pressure. In that study systolic, diastolic, and mean arterial pressure were significantly lower in patients with early failure. They reported, lower preoperative DBP and mean arterial pressure were predictors for early failure of distal AVF. They reported that patients with early AVF failure had a lower DBP of 88.4 mmHg compared to 91.2mmHg in patients without AVF failure. Although, there was a limitation of the small number of cases and also, they evaluated only distal AVF [11].

Similarly, a retrospective review of 1051 patients found early primary failure was occurred in lower DBP compared to patients without failure. [15] Also, See et al. showed the same results about DBP, they reported that lower diastolic blood pressure before surgery (OR for higher DBP 0.85, 95% CI 0.74-0.99) is associated with AVF failure [9]. In another study, lower DBP and mean arterial pressure before AVF creation were associated with an increased risk of AVF failure. Similar to our study, they found a higher pulse pressure was associated with a higher rate of AVF failure but was not statistically significant [18].

We found the cut-off point of 189.5 mmHg for SBP and 64 mmHg for DBP associated with AVF failure according to Roc curve, these cut points were different when assessed maturation (153 mmHg and 91.5 mmHg for systolic and diastolic blood pressure). In another study, there is a report of DBP of 79.7mmHg in the AVF patients with AVF failure compared to 83.1mmHg in those with non-failure outcome [15].

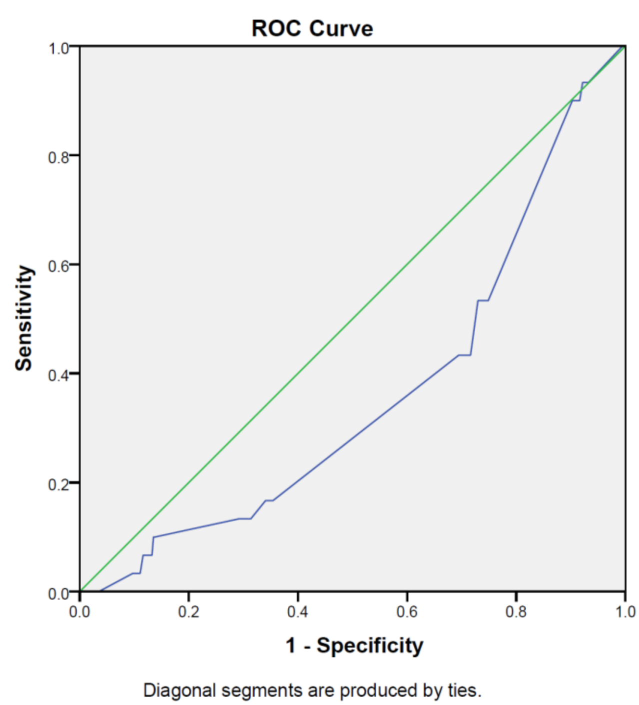

Figure 2. The ROC curve for AVF failure prediction using DBP. DBP of 64 mmHg has a sensitivity of 93%, and specificity of 8%; AUC (95% CI)= 0.36 (0.26-0.46); ROC, receiver operating characteristic; SBP, systolic blood pressure; AUC, area under the curve; CI, confidence interval.

Also, Chang et al. reported more than 50% of AVF failure has occurred at a DBP of 80 mmHg or lower [18]. To our knowledge, the cut-off point about SBP and AVF failure was not reported in other studies. Lower diastolic pressure can lead to venous stasis that predisposing the fistula to thrombosis and early failure. On the other hand, low vascular compliance can be lead to wider pulse pressure and therefore impairing fistula maturation [19].

The strength of this study is that patients were evaluated in a tertiary centre and they can be represented of all ESRD patients throughout our country. In this study, we detected cut-off points of SBP and DBP for AVF failure and maturation separately but the acquired curve in this study was not above the diagonal and all values were below 0.8, so it may not be able to separate and represent the optimal or best threshold for SBP and DBP in this regard.

Conclusion

In conclusion, these results highlight the importance of pre-operative blood pressure in ESRD patients who are candidates for AVF creation. We found AVF failure to be associated with low blood pressure especially DBP and high pulse pressure. Although, these findings were not achieved when evaluated the effects of blood pressure on AVF maturation. Most of the AVF failures in our study had a DBP of 50-70 mmHg. So, avoidance of preoperative hypotension may lead to better AVF outcomes. We suggested that a larger study in multi centre may help to achieve a confirmed cut-off point for increasing the success rate of AVF access for haemodialysis in ESRD patients.

Author contribution

All authors contributed equally in all parts of article and approving the final version of the manuscript before submission

Conflict of Interest

Authors declare no conflicts of interest.

Ethical declaration

There was no ethical declaration.

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