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Original Article

Effect of Hypotension and Cardiac Failure Over Maturation of Arterio-Venous Fistula

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ABSTRACT

Background: Arteriovenous fistula (AVF) is the preferred vascular access for patients with end-stage renal disease undergoing long-term hemodialysis because of its superior patency and lower complication rates compared to other access modalities. Successful use of an AVF depends on adequate maturation, which is influenced by both local vascular factors and systemic hemodynamic conditions. Hypotension and cardiac failure may adversely affect access flow and venous remodeling, leading to delayed maturation or early fistula failure.

Objectives: To assess the effect of hypotension on AVF maturation, to evaluate the impact of cardiac failure on AVF outcomes, and to determine the overall influence of these factors on AVF maturation and patency in patients undergoing hemodialysis.

Methods: A prospective observational study was conducted over six months at a tertiary care center. Fifty patients with chronic kidney disease undergoing AVF creation were enrolled. Preoperative evaluation included blood pressure measurement, echocardiographic assessment of ejection fraction, and Doppler mapping of upper limb vessels. Hypotension was defined as systolic blood pressure <100 mmHg, and cardiac failure as ejection fraction <40%. AVFs were created using standard surgical techniques and followed clinically and by Doppler ultrasonography. Fistula maturation and patency were assessed at six weeks and six months. Data were analyzed using appropriate statistical tests, with $p < 0.05$ considered statistically significant.

Results: Of the 50 patients, 60% had hypotension and 60% had reduced ejection fraction. AVF failure occurred in 73.3% of hypotensive patients compared to 20.0% among normotensive patients ($p = 0.0006$). Similarly, 80.0% of patients with ejection fraction <40% experienced AVF failure compared to 30.0% among those with preserved cardiac function ($p = 0.0012$). At six-month follow-up, 48% of AVFs were functional, while 52% had failed due to thrombosis or non-maturation.

Conclusion: Hypotension and cardiac failure are significant predictors of AVF non-maturation and failure. Optimization of hemodynamic status before AVF creation and close postoperative surveillance may improve fistula outcomes.

Keywords*: Arteriovenous fistula, Hypotension, Cardiac failure, Hemodialysis, Fistula maturation.*

INTRODUCTION

Arteriovenous fistula (AVF) is widely regarded as the optimal vascular access for patients with end-stage renal disease receiving long-term hemodialysis because it offers better durability, lower infection rates, and fewer complications

compared with grafts and central venous catheters[1]. However, the successful clinical use of an AVF depends on appropriate maturation, a process that involves progressive venous dilatation, wall thickening, and structural adaptation following exposure to arterial blood flow[2]. Despite improvements in surgical techniques and preoperative planning, failure of AVF maturation remains a frequent and clinically significant problem.

The maturation of an AVF is influenced by multiple factors related to patient characteristics, vascular anatomy, and systemic hemodynamic status. Preoperative assessment of arterial and venous anatomy has been shown to improve outcomes, and routine vessel mapping is now recommended to guide fistula creation[3],[4]. Prospective studies have demonstrated that larger vessel diameters are associated with higher rates of successful maturation and long-term patency[5]. Nevertheless, even in the presence of favorable vascular anatomy, a proportion of fistulas fail to mature, suggesting the contribution of non-anatomical factors.

Systemic blood pressure plays a crucial role in determining fistula blood flow and the shear stress necessary for venous remodeling. Persistent hypotension and dialysis-related drops in blood pressure have been associated with inadequate access flow, increased thrombosis, and early AVF failure[6],[7]. Evidence from a recent systematic review and meta-analysis further supports preoperative hypotension as an independent risk factor for early AVF failure[8].

Cardiac function is another important determinant of AVF performance. In patients with heart failure and reduced ejection fraction, diminished cardiac output may result in insufficient flow through the fistula, thereby impairing the maturation process[9]. In addition, venous congestion and elevated central venous pressure in heart failure can adversely affect venous remodeling and predispose to stenosis and thrombosis[10],[11]. The relationship between AVF flow and cardiac function is complex, as high-flow fistulas may worsen cardiac workload, while impaired cardiac function may prevent adequate fistula development[12].

Although hypotension and cardiac failure have each been associated with poor AVF outcomes, limited data are available regarding their combined effect on AVF maturation, particularly in the Indian population. This study was therefore conducted to evaluate the impact of hypotension and cardiac failure on AVF maturation and patency among patients undergoing hemodialysis.

MATERIAL AND METHODS

This prospective observational study was carried out in the Department of Urology at Adichunchanagiri Hospital and Research Centre, B.G. Nagara, Mandya, over a six-month period. The study population consisted of patients with chronic kidney disease who underwent creation of an arteriovenous fistula (AVF) for haemodialysis access during the study period. A total of 50 patients were included after obtaining written informed consent.

Patients aged more than 40 years who were on regular haemodialysis and willing to participate were eligible for inclusion. Patients younger than 40 years, those with a history of previous AVF failure, severe valvular heart disease, significant cardiac arrhythmias, or those unwilling to provide consent were excluded from the study.

Prior to surgery, all participants underwent a detailed clinical evaluation, including measurement of baseline systolic blood pressure and assessment of cardiac function using two-dimensional echocardiography. Hypotension was defined as a systolic blood pressure of less than 100 mmHg, and cardiac failure was defined as an ejection fraction below 40%. Preoperative assessment of the upper limb vasculature was performed using clinical examination and Doppler ultrasonography to determine arterial and venous suitability for fistula creation.

Arteriovenous fistulas were preferentially created in the nondominant upper limb. A radiocephalic fistula at the wrist was considered the first option, and a brachiocephalic fistula was created when distal vessels were unsuitable. All surgical procedures were performed by experienced surgeons under local anesthesia using standard operative techniques. An end-to-side anastomosis was constructed between the selected artery and vein, and immediate postoperative assessment of thrill and bruit was recorded.

Postoperative follow-up included regular clinical examination to assess the presence of thrill, signs of thrombosis, and limb perfusion. Fistula maturation was evaluated at six weeks using clinical assessment and Doppler ultrasonography, and maturation was defined by adequate flow and venous dilatation sufficient to permit dialysis cannulation. Patients were followed for a total duration of six months to assess fistula patency and functional outcome.

Data were collected prospectively using a structured proforma and entered into a computerized database. Quantitative variables were expressed as mean with standard deviation, while qualitative variables were presented as frequencies and percentages. Associations between categorical variables were analyzed using the Chi-square test or Fisher's exact test as appropriate, and continuous variables were compared using Student's t-test. Statistical analysis was performed using SPSS software, and a p value of less than 0.05 was considered statistically significant.

All procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Approval was obtained from the institutional ethics committee prior to commencement of the study, and confidentiality of patient information was strictly maintained throughout the study period.

RESULTS

A total of 50 patients with chronic kidney disease undergoing arteriovenous fistula (AVF) creation were included in the study. The majority of participants were aged between 45 and 60 years, with 40.0% in the 45–50 year age group, followed by 30.0% each in the 51–55 and 56–60 year groups. The sex distribution was nearly equal, with males constituting 52.0% and females 48.0% of the study population (Table 1, **Figure 1**).

Preoperative systolic blood pressure assessment showed that 60.0% of patients had hypotension (systolic BP <100 mmHg), while 40.0% had normal blood pressure. Cardiac evaluation revealed that 60.0% of patients had an ejection fraction below 40%, whereas 40.0% had preserved cardiac function (Table 1).

With respect to fistula characteristics, brachiocephalic fistulas were created in 90.0% of patients, while radiocephalic fistulas accounted for 10.0%. Preoperative Doppler mapping demonstrated good venous quality in 68.0% of patients and poor venous quality in 32.0%. Postoperatively, an immediate thrill was present in 74.0% of patients, while 26.0% had absent thrill (Table 1).

A statistically significant association was observed between preoperative hypotension and AVF outcome. Among patients with hypotension, 73.3% experienced AVF failure, whereas only 26.7% had functional fistulas. In contrast, among patients with normal blood pressure, 80.0% had functional AVFs and 20.0% experienced failure ($\chi^2 = 11.62$, $p = 0.0006$) (Table 2, **Figure 2**).

Cardiac function was also significantly associated with AVF outcome. Among patients with ejection fraction below 40%, 80.0% developed AVF failure, while only 20.0% had functional fistulas. In comparison, patients with ejection fraction ≥40% demonstrated a higher proportion of functional AVFs (70.0%) and a lower failure rate (30.0%) ($\chi^2 = 10.50$, $p = 0.0012$) (Table 3).

Assessment of AVF maturation time showed that 25 fistulas matured within 6 weeks, while delayed maturation was observed in a subset of patients beyond 10 weeks. Four patients developed early thrombosis before maturation time could be documented (**Figure 3**).

At 6-month follow-up, 24 AVFs (48.0%) were functional and suitable for hemodialysis, whereas 26 AVFs (52.0%) had failed due to thrombosis or inadequate maturation (Table 3).

Table 1. Baseline demographic and clinical characteristics of study participants (n = 50)

Characteristic	Category	n (%)
Age group (years)	45–50	20 (40.0)
	51–55	15 (30.0)
	56–60	15 (30.0)
Sex	Male	26 (52.0)
	Female	24 (48.0)
Preoperative systolic BP	<100 mmHg (Hypotension)	30 (60.0)
	≥100 mmHg (Normal)	20 (40.0)
Ejection fraction	<40%	30 (60.0)
	≥40%	20 (40.0)
Type of AV fistula	Brachiocephalic	45 (90.0)
	Radiocephalic	5 (10.0)
Preoperative venous mapping	Good veins	34 (68.0)
	Poor veins	16 (32.0)
Postoperative thrill	Present	37 (74.0)
	Absent	13 (26.0)

Table 2. Association between preoperative hypotension and AV fistula outcome (n = 50)

Preoperative blood pressure	Failed AVF n (%)	Functional AVF n (%)	Total	p value*
Hypotension (<100 mmHg)	22 (73.3)	8 (26.7)	30	**0.001***
Normal BP (≥100 mmHg)	4 (20.0)	16 (80.0)	20	
Total	26	24	50	

Chi-square test

AVF = arteriovenous fistula; BP = blood pressure.

Table 3. Association between cardiac function and AV fistula outcome (n = 50)

Cardiac function	Failed AVF n (%)	Functional AVF n (%)	Total	p value*
EF <40% (Heart failure)	24 (80.0)	6 (20.0)	30	**0.001***
EF ≥40%	6 (30.0)	14 (70.0)	20	
Total	30	20	50	

Chi-square test.

EF = ejection fraction; AVF = arteriovenous fistula.

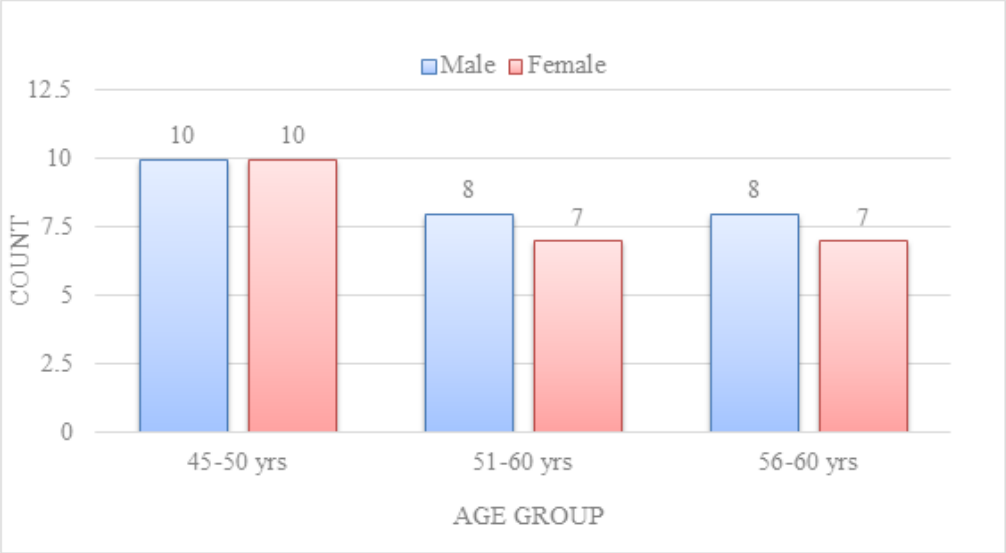

Figure 1: Bar diagram showing age and sex distribution of study participants

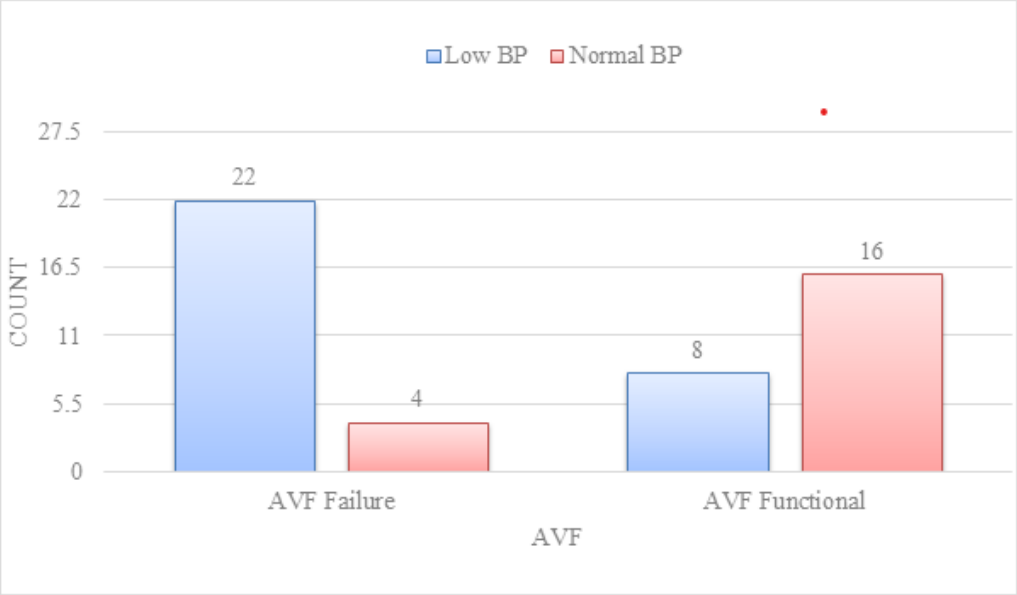

Figure 2: Bar diagram showing association between preoperative blood pressure and AV fistula outcome

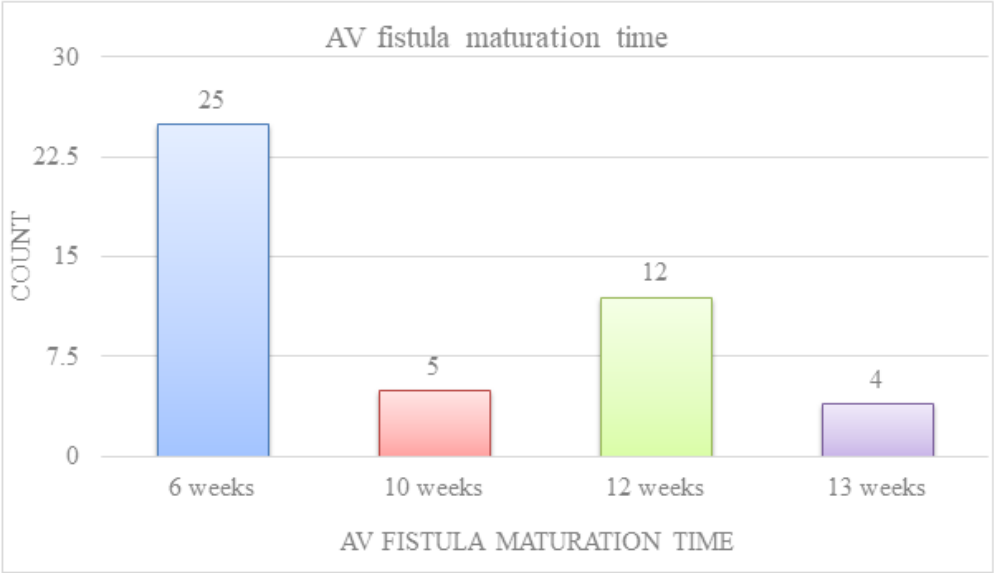

Figure 3: Bar diagram showing AV fistula maturation time

DISCUSSION

The present study demonstrates that both hypotension and impaired cardiac function significantly influence AVF maturation and long-term functionality. Despite the predominance of brachiocephalic fistulas and generally acceptable venous anatomy in the study population, the overall rate of functional fistulas at six months was relatively low, underscoring the importance of systemic hemodynamic factors.

A strong association was identified between preoperative hypotension and AVF failure. Patients with low systolic blood pressure experienced a substantially higher rate of fistula failure compared with those who had normal blood pressure. These findings are consistent with previous reports indicating that inadequate perfusion pressure compromises arterial inflow and reduces shear stress, both of which are essential for venous remodeling[6,7]. The results also align with findings from a recent meta-analysis that identified hypotension as an independent predictor of early AVF failure[8].

Cardiac dysfunction was similarly associated with poor AVF outcomes. Patients with an ejection fraction below 40% exhibited significantly higher failure rates than those with preserved cardiac function. Reduced cardiac output in heart failure can limit access flow and interfere with the maturation process[9,12]. Furthermore, venous congestion related to heart failure has been implicated in the development of venous hypertension, intimal hyperplasia, and thrombosis, thereby contributing to fistula failure[10,11].

Although brachiocephalic fistulas are generally associated with better maturation rates, early thrombosis and non-maturation were common in this cohort. This suggests that favorable anatomical characteristics may not be sufficient to overcome the adverse effects of systemic hypotension and cardiac dysfunction. Similar observations have been reported in prospective studies evaluating predictors of AVF maturation[5].

The presence of an immediate postoperative thrill was found to be a useful early clinical indicator of fistula success, with absence of thrill frequently preceding thrombosis and failure. This supports existing recommendations emphasizing careful postoperative clinical assessment and early Doppler surveillance to identify non-maturing fistulas and facilitate timely intervention[13].

The study is limited by its relatively small sample size and the absence of multivariate analysis to control for potential confounders. Nevertheless, the findings highlight the need for comprehensive preoperative evaluation and optimization of blood pressure and cardiac function to improve AVF maturation and long-term patency.

CONCLUSION

The present study highlights the significant influence of systemic hemodynamic factors on arteriovenous fistula (AVF) maturation and long-term functionality in patients undergoing hemodialysis. Preoperative hypotension and reduced cardiac function were strongly associated with higher rates of AVF failure, despite the use of favorable fistula sites and adequate venous anatomy in many patients. These findings emphasize that anatomical suitability alone is insufficient to ensure successful AVF maturation. Comprehensive preoperative evaluation, including optimization of blood pressure and cardiac function, along with careful postoperative surveillance, is essential to improve AVF outcomes and ensure reliable vascular access for long-term hemodialysis.

REFERENCES

1. Al-Jaishi AA, Liu AR, Lok CE, Moist LM. Arteriovenous fistula maturation rates and influencing factors: a systematic review. **BMC Nephrol**. 2020;21:1–14.
2. Roy-Chaudhury P, Sukhatme VP, Cheung AK. Hemodialysis vascular access dysfunction: a cellular and molecular viewpoint. **J Nephrol**. 2006;19(2):213–25.
3. Al Shakarchi J, Houston JG, Jones RG. Vessel mapping for arteriovenous fistula creation. **Diagnostics (Basel)**. 2023;15(1):88.
4. Abdelbary SA, Sheashaa HA, Abdelkader MA, et al. Preoperative vascular diameters as predictors of AVF maturation. **Ann Vasc Surg**. 2024;95:112–9.
5. **Abdelhalim A, Elalfy M, Amer M, Elsaid T. Predictors of arteriovenous fistula maturation: a prospective analysis. Menoufia Med J. 2019;32(3):1083–8.**
6. Charra B, Calemard E, Chazot C. Chronic hypotension and arteriovenous fistula failure. **Pak J Med Sci**. 2006;22(4):425–30.
7. Arhuidese IJ, Orandi BJ, Nejim B, Malas MB. Blood pressure as a predictor of early arteriovenous fistula failure. **J Vasc Surg**. 2019;70(5):1658–66.
8. Vinh TT, Li J, Rahman M, Lee T. Preoperative hypotension is an independent predictor of early AVF failure: a systematic review and meta-analysis. **Patient Saf Surg**. 2025;19:9.
9. Patel M, Dessouky R, Ahmed O, et al. Impact of heart failure with reduced ejection fraction on vascular access outcomes. **J Vasc Surg**. 2023;78(3):789–97.
10. Heffernan M, et al. Venous congestion and the failure of arteriovenous fistulas in heart failure patients. **Vasc Med**. 2017;22(3):225–32.
11. Köhler H, et al. Endothelial dysfunction and impaired arteriovenous fistula maturation in heart failure. **J Vasc Surg**. 2019;69(2):567–74.
12. Ibrahim A, Elkholy KO, Mohamed AA, Elsheikh M. Access flow changes and cardiac function in dialysis patients with heart failure. **Clin Kidney J**. 2023;dfad078.
13. Khan FI, et al. Hypotension as a risk factor for failure of AV fistula maturation. **J Clin Nephrol**. 2018;32(4):462–7.