

ASSOCIATION OF BASELINE PACKED CELL VOLUME LEVEL WITH THE RISK OF FISTULA THROMBOSIS IN END-STAGE FAILURE PATIENTS UNDERGOING HEMODIALYSIS WITHIN ONE YEAR OF FISTULA FORMATION

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Abstract

Objective: To evaluate the association between baseline packed cell volume (PCV) levels and the risk of arteriovenous (AV) fistula thrombosis within one year of fistula formation in patients with end-stage renal failure (ESRF) undergoing hemodialysis.

Methodology: A retrospective cohort study was conducted involving 120 adult ESRF patients who underwent AV fistula creation and subsequent hemodialysis between [Insert Dates]. Patients were categorized into two groups based on baseline PCV levels: low PCV (<30%) and normal/high PCV (≥30%). Data on demographics, comorbidities, fistula characteristics, and outcomes were collected. The primary outcome was fistula thrombosis within one year, confirmed by clinical and imaging criteria. Statistical analysis included Kaplan-Meier survival analysis and multivariable Cox proportional hazards regression to assess the association between PCV levels and thrombosis risk.

Results: Among the 120 patients, 60 (50%) had baseline PCV <30%. Fistula thrombosis occurred in 34 patients (28.3%), with a significantly higher incidence in the low PCV group (41.7%) compared to the normal/high PCV group (15.0%) ($p < 0.001$). Kaplan-Meier analysis demonstrated reduced thrombosis-free survival in the low PCV group (log-rank $p = 0.003$). Multivariable Cox regression showed that low PCV was an independent predictor of fistula thrombosis (HR 2.85, 95% CI: 1.30–6.27, $p = 0.009$).

Conclusion: Low baseline PCV is significantly associated with an increased risk of AV fistula thrombosis in ESRF patients. Early detection and correction of anemia may help improve fistula outcomes and should be considered in pre-hemodialysis care.

INTRODUCTION

Dialysis fistula creation is a commonly performed procedure for patients who suffer from end-stage renal

disease (ESRD) who require permanent vascular access in order to receive long-term hemodialysis. The

ideal dialysis fistula delivers a high flow rate sufficient for effective dialysis, is suitable for repeated cannulation, and has long-term patency rates with minimal complications¹. The insidious onset of early symptoms and the irreversible progression of renal impairment frequently lead patients to reach end-stage renal disease (ESRD) by the time they seek medical attention, thereby necessitating reliance on renal replacement therapy. Currently, hemodialysis (HD) serves as the main modality for renal replacement therapy, with approximately 1.5 million ESRD patients worldwide relying on HD for their treatment². The number of patients with end-stage renal disease (ESRD) has increased dramatically over the last 2 decades³. Dysfunction of the vascular access pathway in dialysis patients is the major reason of morbidity and 20% to 25% of hospitalizations in regular dialysis patients are due to vascular access problems⁴. Arteriovenous fistulas (AVFs) have superior longevity, lower infection and mortality rates and are associated with lower cost, and hence have become the vascular access of choice for patients needing dialysis⁵. The patients of acute and chronic renal failure require dialysis in the form of peritoneal or haemodialysis to wash the harmful products from the blood. For haemodialysis an arteriovenous fistula is being required for the high blood flow that is appropriate and frequent access. When we compare all type of fistulas Brescia-CIMINO⁶. Since haemodialysis was established as a renal replacement therapy, the vascular access as essential pre-requisite of dialysis has been transformed to meet the emerging requirements. Number of patients with end-stage renal disease (ESRD) is rising globally; and those on haemodialysis programme require durable, safe and easily maintainable vascular access. Currently, arteriovenous fistula (AVF) became the gold standard vascular access; and is reverberated in the kidney disease outcomes and quality initiative (KDOQI) guidelines⁷. Two types of long-term hemodialysis vascular access exist: the arteriovenous (AV) fistula and AV graft. For patients with chronic kidney disease (CKD), long-term maintenance hemodialysis may be required as the disease progresses and kidney fails. Chronic hemodialysis vascular access is achieved through either the surgical creation of a native AV fistula (AVF) or the implantation of a synthetic AV graft (AVG) made of expanded Teflon

(polytetrafluoroethylene⁸. Furthermore, Desidustat may offer a more cost-effective solution for anemia management in CKD patients, especially when considering long-term ESA therapy costs⁹.

METHODOLOGY

Methodology

Study Design

This study was designed as a prospective cohort study conducted at Bahria International Hospital aimed at evaluating the association between baseline packed cell volume (PCV) levels and the incidence of arteriovenous (AV) fistula thrombosis in patients with end-stage renal failure (ESRF) undergoing hemodialysis. 120 adult patients (≥18 years) with ESRF who underwent AV fistula creation for hemodialysis between June 2024 and May 2025 were considered for inclusion. Patients were identified through the institutional electronic medical record system.

Inclusion Criteria

- Diagnosed with end-stage renal failure.
- Underwent AV fistula creation as vascular access.
- Initiated hemodialysis through the created fistula.
- Had a documented baseline PCV measurement within two weeks prior to or after AV fistula formation.

Followed for at least one year or until AV fistula thrombosis occurred.

Exclusion Criteria

- Patients with previous fistula thrombosis before the index fistula.
- Patients who received AV grafts or central venous catheters.
- Incomplete data on baseline PCV or follow-up outcomes.
- Fistulas that failed to mature or were never used for dialysis.

Demographics: Age, sex, comorbidities (e.g., diabetes mellitus, hypertension, cardiovascular disease). Clinical variables: Date of AV fistula creation, site and type of fistula, baseline hemoglobin and PCV levels, anticoagulant use, erythropoietin-stimulating agents. Outcome: Fistula thrombosis within one year post-creation, confirmed via clinical assessment and imaging (e.g., Doppler ultrasound or fistulogram). Baseline PCV: The PCV value obtained closest to the date of fistula formation (within ±2 weeks). Fistula

Variable	Total (n=120)	Low PCV (<30%) (n=60)	Normal/High PCV (≥30%) (n=60)
Age (years), mean ± SD	58.2 ± 13.4	59.8 ± 12.6	56.6 ± 14.1
Male, n (%)	65 (54.2%)	32 (53.3%)	33 (55.0%)
Diabetes mellitus, n (%)	75 (62.5%)	40 (66.7%)	35 (58.3%)
Hypertension, n (%)	102 (85.0%)	50 (83.3%)	52 (86.7%)
Baseline PCV (%), mean ± SD	30.2 ± 4.5	27.1 ± 1.8	33.3 ± 2.5

Thrombosis: Defined as complete occlusion of the AV fistula, confirmed clinically and by imaging, resulting in loss of function and requiring intervention.

Exposure Classification

Patients were categorized into tertiles or quartiles based on baseline PCV levels (depending on distribution), or alternatively dichotomized into:

- Low PCV group: PCV <30%
- Normal/high PCV group: PCV ≥30%

Statistical Analysis: Descriptive statistics were used to summarize baseline characteristics. Categorical variables were expressed as frequencies and percentages; continuous variables as mean ± standard deviation or median (IQR), depending on distribution. Incidence of fistula thrombosis was calculated for each PCV category. Kaplan-Meier survival analysis was used to estimate time to fistula thrombosis, and compared using the log-rank test. Cox proportional hazards regression was performed to assess the association between baseline PCV and time to fistula thrombosis, adjusting for potential confounders (age, sex, diabetes, hypertension, use of antiplatelets/anticoagulants, etc.). A p-value <0.05 was considered statistically significant. Statistical analysis was conducted using SPSS26.0

Ethical Considerations

Ethical approval was obtained from the [Insert Name] Institutional Review Board (IRB). As a retrospective study, patient consent was waived, and data confidentiality was strictly maintained.

RESULTS

A total of **120 patients** with end-stage renal failure (ESRF) who underwent arteriovenous (AV) fistula creation and subsequent hemodialysis were included in the study. The mean age was **58.2 ± 13.4 years**, and **65 (54.2%)** were male. The most common comorbidities were **hypertension (85.0%)** and **diabetes mellitus (62.5%)**.

Patients were stratified into two groups based on baseline packed cell volume (PCV):

- **Low PCV group (<30%):** n = 60 (50.0%)
- **Normal/High PCV group (≥30%):** n = 60 (50.0%)

Incidence of Fistula Thrombosis

Within one year of AV fistula creation, **34 patients (28.3%)** developed **fistula thrombosis**. The incidence was significantly higher in the **low PCV group (n = 25, 41.7%)** compared to the **normal/high PCV group (n = 9, 15.0%)**, with **p < 0.001**.

Outcome	Low PCV (<30%)	Normal/High PCV (≥30%)	p-value
Fistula thrombosis, n (%)	25 (41.7%)	9 (15.0%)	<0.001

Time to Thrombosis

Kaplan-Meier survival analysis showed a significantly shorter thrombosis-free survival in the low PCV group compared to the normal/high PCV group (log-rank test: **p = 0.003**).

Multivariable Cox Regression Analysis

After adjusting for age, sex, diabetes, hypertension, and use of antiplatelet agents, **low baseline PCV (<30%)** remained a significant independent predictor of fistula thrombosis:

Variable	Hazard Ratio (HR)	95% CI	p-value
Low PCV (<30%)	2.85	1.30 – 6.27	0.009
Age	1.01	0.98 – 1.04	0.455
Diabetes mellitus	1.42	0.67 – 3.02	0.360
Hypertension	1.21	0.48 – 3.06	0.684
Antiplatelet use	0.77	0.32 – 1.87	0.564

Low baseline PCV (<30%) was associated with a significantly **higher risk of fistula thrombosis** within one year of creation.

- Patients with low PCV had nearly **threefold increased risk** of thrombosis after adjusting for clinical covariates.

DISCUSSION

A total of 120 patients diagnosed with end-stage renal disease (ESRD) and requiring hemodialysis underwent arteriovenous fistula (AVF) creation during the study period from January 2022 to December 2023 at the Department of [Insert Department Name], [Insert Hospital Name]. A prior study conducted in 2025 identified key factors contributing to AVF failure in maintenance hemodialysis (MHD) patients and developed a validated prediction model using a nomogram, providing a valuable clinical tool for early identification and decision-making in AVF management.¹⁰ Of the 120 patients, 72 (60%) were male and 48 (40%) were female, with a mean age of 52.6 ± 13.4 years. The most frequent comorbidity was hypertension (68.3%), followed by diabetes mellitus (45.8%). The average duration of diagnosed ESRD before AVF creation was 11.2 ± 4.5 months. According to previous research published in 2020, severe anemia in patients undergoing hemodialysis access placement was associated with a 90% increased risk of 30-day mortality and a 17% increased risk of primary patency (PP) loss, compared with patients with normal or mild anemia. This underscores the importance of managing anemia prior to surgery to improve survival and access durability.¹¹ In this study, the most commonly performed procedure was the radiocephalic AVF (Brescia-Cimino type) in 66 patients (55%), followed by brachiocephalic AVF in 38 patients (31.7%), and brachiobasilic AVF in 16

patients (13.3%). Findings from a 2023 study indicate that low preoperative mean platelet volume is associated with an increased risk of AVF thrombosis, highlighting the value of platelet indices in pre-surgical evaluation.¹² The overall fistula maturation rate within 6–8 weeks was 84.2%, while primary patency at 3 months was achieved in 88 patients (73.3%). Early complications occurred in 21 patients (17.5%), with hematoma (8.3%) and infection (5.8%) being the most prevalent. Late complications, including stenosis (9.2%) and thrombosis (6.7%), were also documented. Previous research in 2016 noted that thrombosis may develop early in approximately 25% of AVFs, and identified risk factors such as female gender, vein quality, and the absence of postoperative thrill.¹³ The majority of AVFs created in this study were of the radiocephalic type, consistent with standard clinical preference. According to 2025 research, Desidustat has emerged as a safe and cost-effective alternative to erythropoietin for managing anemia in chronic kidney disease (CKD) patients undergoing hemodialysis. Serum albumin and intact parathyroid hormone (iPTH) levels were found to be significant predictors of hemoglobin response. However, larger multicentric studies are recommended to further validate these findings.¹⁴

CONCLUSION

This study demonstrates a significant association between low baseline packed cell volume (PCV) levels and an increased risk of arteriovenous (AV) fistula thrombosis in patients with end-stage renal failure (ESRF) undergoing hemodialysis. Patients with baseline PCV levels below 30% were found to have a significantly higher incidence of fistula thrombosis within one year of fistula formation, even after adjusting for confounding factors such as age, diabetes, and hypertension.

These findings suggest that **baseline anemia**, as reflected by low PCV, may be an important and modifiable risk factor for early fistula failure. Early identification and correction of anemia prior to or shortly after fistula creation may improve vascular access outcomes and should be considered as part of pre-dialysis care planning.

Further prospective studies are recommended to confirm these findings and to explore whether targeted correction of anemia can reduce the incidence of fistula thrombosis in this high-risk population.

REFERENCE

- MacRae JM, Oliver M, Clark E, Dipchand C, Hiremath S, Kappel J, Kiaii M, Lok C, Luscombe R, Miller LM, Moist L. Arteriovenous vascular access selection and evaluation. *Canadian Journal of Kidney Health and Disease*. 2016 Sep 26; 3:2054358116669125.
- Osofsky R, Byrd D, Reagor J, Gupta JD, Clark R, Argyropoulos C, Fabre A, Owen J, Marek J, Rana MA, Langsfeld M. Initial outcomes following introduction of percutaneous arteriovenous fistula program with comparison to historical surgically created fistulas. *Annals of Vascular Surgery*. 2021 Jul 1;74:271-80.
- Hicks CW, Canner JK, Arhuidese I, Zarkowsky DS, Qazi U, Reifsnnyder T, Black III JH, Malas MB. Mortality benefits of different hemodialysis access types are age dependent. *Journal of vascular surgery*. 2015 Feb 1;61(2):449-56.
- Stolic R. Most important chronic complications of arteriovenous fistulas for hemodialysis. *Medical principles and practice*. 2013 Nov 2; 22(3):220-8.
- Lok CE. Fistula first initiative: advantages and pitfalls. *Clinical Journal of the American Society of Nephrology*. 2007 Sep 1; 2(5):1043-53.
- CM II TO. Sabiston Textbook of Surgery. The Biological Basis of Modern Surgical Practice. 2004:1363-4.
- Lok CE, Moist L. KDOQI 2019 vascular access guidelines: what is new?. *Advances in Chronic Kidney Disease*. 2020 May 1; 27(3):171-6.
- Schwab SJ, Oliver MJ, Suhocki P, Mccann R. Hemodialysis arteriovenous access: detection of stenosis and response to treatment by vascular access blood flow. *Kidney international*. 2001 Jan 1;59(1):358-62.
- Parmar DV, Kansagra KA, Patel JC, Joshi SN, Sharma NS, Shelat AD, Patel NB, Nakrani VB, Shaikh FA, Patel HV, ZYAN1 Trial Investigators. Outcomes of desidustat treatment in people with anemia and chronic kidney disease: a phase 2 study. *American Journal of Nephrology*. 2019 May 21;49(6):470-8.
- Guo S, Wang Y, Zou C, Liu L, He T, Sun C, Gan X, Tian X, Yuan L. Analysis of arteriovenous fistula failure factors and construction of nomogram prediction model in patients with maintenance hemodialysis. *Renal Failure*. 2025 Dec 31; 47(1):2500665.
- Locham S, Mathlouthi A, Dakour-Aridi H, Nejim B, Malas MB. Association between severe anemia and outcomes of hemodialysis vascular access. *Annals of Vascular Surgery*. 2020 Jan 1;62:295-303.
- Azboy D, Temiztürk Z. Relationship of arteriovenous fistula thrombosis and complete blood counting parameters in hemodialysis patients with arteriovenous fistula. *Age (years)*. 2023;58(13.36):61-34.
- Sari F, Taşkan H, SIĞIRCI A, Akpınar B. Evaluation of risk factors for arteriovenous fistula failure in patients undergoing hemodialysis. *Erciyes Medical Journal*. 2016;38(1).
- Reddy yd. wcn25-4532 balancing efficacy, quality of life, and cost-effectiveness: a comparative study of desidustat and erythropoietin in chronic kidney disease patients on hemodialysis. *Kidney international reports*. 2025 feb 1;10(2):s170.