

Association Between Arteriovenous Fistula (AVF) and Hemoglobin Levels in Hemodialysis-Dependent End-Stage Renal Disease (ESRD) Patients

AVF and Hemoglobin Levels in Hemodialysis-Dependent ESRD Patients

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ABSTRACT

Objective: To investigate the association between arteriovenous fistula (AVF) creation and hemoglobin levels in hemodialysis-dependent end-stage renal disease (ESRD) patients.

Study Design: A cross-sectional study

Place and Duration of Study: This study was conducted at the Central Park Medical College and Teaching Hospital in collaboration with Department of Nephrology, Choudhary Muhammad Akram Teaching Hospital, Lahore from December 2022 to June 2023.

Methods: Patients on hemodialysis were included, while those on peritoneal dialysis or not undergoing dialysis were excluded. Sociodemographic details, medical history, and dialysis access information were recorded. Hepatitis B and C screening was performed, and vascular access was categorized into AVF and lines. Hemoglobin levels were assessed, and statistical analysis was conducted using SPSS version 26.

Results: Out of 72 ESRD patients, 37.5% had AVF, and 62.5% had access via lines. Hemoglobin levels were significantly higher in patients with AVF (mean Hb \approx 9.26 g/dL) compared to those without AVF (mean Hb \approx 8.07 g/dL) with a p-value of 0.003. AVF presence was associated with a lower rate of infections (7.40%) compared to patients without AVF (60%) with a p-value of 0.0001.

Conclusion: Arteriovenous fistula (AVF) may be associated with higher hemoglobin levels and a reduced risk of infections in hemodialysis-dependent end-stage renal disease (ESRD) patients.

Key Words: End-stage renal disease, hemodialysis, arteriovenous fistula, hemoglobin levels, infection risk.

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INTRODUCTION

End-stage renal disease (ESRD) is a debilitating condition that affects millions of individuals worldwide, presenting a formidable challenge to the healthcare community.⁽¹⁾ Patients with ESRD require renal replacement therapy, and one of the most common modalities is hemodialysis. Hemodialysis is a life-sustaining treatment that involves the removal of waste products and excess fluids from the bloodstream, thereby mimicking the essential functions of the kidney.

Despite its critical role in maintaining the health of ESRD patients, hemodialysis is not without its complications and limitations.^(2,3)

One of the major complications often encountered in hemodialysis-dependent ESRD patients is anemia.⁽⁴⁾ Anemia is characterized by a decreased number of red blood cells or a reduced amount of hemoglobin in the blood, leading to diminished oxygen-carrying capacity and fatigue. In ESRD patients, anemia frequently arises due to the reduced production of erythropoietin, a hormone normally produced by the kidneys that stimulates red blood cell production.⁽⁵⁾ Consequently, anemia can significantly impair the quality of life for these patients and may contribute to increased morbidity and mortality. Recognizing the pivotal role of hemoglobin in oxygen transport and the body's overall physiological well-being, investigating factors that influence hemoglobin levels in hemodialysis-dependent ESRD patients is of paramount importance.^(6,7)

Arteriovenous fistulae (AVF) have emerged as a crucial aspect of the hemodialysis process. An AVF is a surgical connection between an artery and a vein, typically in the arm, that provides a suitable access point for hemodialysis.⁽⁸⁾ It allows for high blood flow

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rates, making the dialysis procedure more efficient and effective. The creation of an AVF is a standard practice in hemodialysis, and its benefits, such as improved patency and reduced risk of infection compared to other vascular access options, have been well-documented.⁽⁹⁾

However, the association between AVF and hemoglobin levels in hemodialysis-dependent ESRD patients is a subject that has not been comprehensively explored.

Moreover, the association between AVF creation and hemoglobin levels may have broader implications beyond anemia management. Hemoglobin levels serve as a surrogate marker for various aspects of an ESRD patient's health. Therefore, this study is warranted for the assessment of AVF creation and hemoglobin levels in hemodialysis-dependent ESRD patient along the risk of infection development.

METHODS

As per guidelines of Helsinki, a cross-sectional study was conducted at Central Park Medical College and Teaching Hospital in collaboration with Department of Nephrology, Choudhary Muhammad Akram Teaching Hospital, Lahore for the assessment of causes of anemia in patients of renal replacement therapy in lieu of arteriovenous fistula from December 2022 to June 2023. In which 72 patients with age range of 40 to 60 years were recruited after obtaining prior written informed consent, ethical approval was also obtained from institutional review board of Central Park Medical College and Teaching Hospital Lahore (CPMC/IRB-No/2234). All the patients who were on hemodialysis were included while patients who were not on hemodialysis or were on peritoneal dialysis were excluded from this study.

Sociodemographic details including age gender were recorded, details of medical history and access for dialysis. All patients were screened for hepatitis B and hepatitis C. Vascular access for hemodialysis was categorized into two groups: arteriovenous fistula (AVF) and lines (including both temporary and permanent lines). Serum hemoglobin level was assessed using hemoglobinometer in g/dL by obtaining 1 cc venous blood under aseptic conditions. Patients in the study receiving subcutaneous troponin & iron therapy were also recorded.

Statistical Analysis: Anonymized data was entered in Microsoft Excel 2019 and was compared for errors and omissions and after cross-checking data was exported into Statistical Packages Software for Social Sciences (SPSS) version 26 and statistical analysis were made. Qualitative data were presented in terms of frequencies and percentages. Normality for serum hemoglobin level was assessed and independent sample t test was employed. Stratification based on presence of AVF was made and chi-square test and correlation was employed

based on stratification parameters and a p value less than 0.05 was regarded as significant.

RESULTS

A total of 72 patients of End Stage Renal Disease (ESRD) on maintenance with mean age of 48.08 + 8.49 were recruited for the study. Out of these 72, male population was 48 (66.7%) while 24 (33.3%) were female patients. Screening for hepatitis B and C were done for these patients, 16 (22.2%) were positive for hepatitis C antibodies while no patients was positive for hepatitis B surface antigen.

Table No. 1: Gender and Viral Hepatitis Distribution Among Study Population.

Variables	N	Percentages (%)
Gender		
Male	48	66.7%
Female	24	33.3%
Hepatitis C	16	2.22%
Hepatitis B	0	0%

Method for access for hemodialysis were defined as; arteriovenous fistula (AVF) and line (including both temporary and permanent lines), 27 patients (37.5%) had AVF while rest 45 patients (62.5%) had access via lines. Moreover, all the patients were receiving troponin injections subcutaneously twice to thrice weekly. Only 2 patients (2.8%) were receiving iron injections intravenously. Out of these 72 patients, 29 patients (40.3%) had clinical infections.

Hemoglobin levels were assessed, and mean hemoglobin level for whole study cohort was noted as 8.49 + 1.23 g/dl showing overall decreased hemoglobin and persistent anemia in study population. Then hemoglobin levels were compared in study population based on presence and absence of AVF (dialysis access) by as explained in table 2. The results suggest a significant difference in Hemoglobin levels between the two groups. Patients with AVF (mean Hb ≈ 9.26 g/dL) have significantly higher Hemoglobin levels compared to those without AVF (mean Hb ≈ 8.07 g/dL) with p-value of 0.003. This suggests that AVF might be associated with higher Hemoglobin levels.

Table No. 2: Comparison of Serum Hemoglobin Levels in dialysis dependent Patients with and without AVF.

Variables	Mean + St. Dev	Mean Difference	T-value	p-value
Hemoglobin (No AVF)	8.07 + 1.32	-1.183	-3.305	0.003
Hemoglobin (AVF)	9.26 + 1.87			

On appliance of chi-square test to assess the role of AVF in development of infection, it was noted that rate of AVF was negatively associated with infections;

those who had AVF only 7.40 percent developed infections while on the other hand those who don't have AVF 60 percent developed infections with p vale of 0.0001 suggestive of lower rate of infections in patients

with AVF. No significant differences for the other variables were noted in study groups as explained in table 3.

Table No. 3: Comparison of Study Variables in Lieu of AVF by employing Chi-Square Test.

Factors	Categories	AVF Presence		p-value
		AVF Present (n=27(%))	AVF Not Present n=45(%)	
Infection.	Yes	2 (7.40)	27(60)	0.0001*
	No	25(92.6)	18(40)	
Hepatitis C	Yes	6(22.22)	10(22.22)	0.620
	No	21(77.78)	35(77.78)	
Troponin Injection	Yes	27(100)	45(100)	0.899
	No	0(0)	0(0)	
Iron Levels	Yes	27(100)	45(100)	0.137
	No	0(0)	0(0)	
Ferritin Levels	Yes	27(100)	45(100)	0.743
	No	0(0)	0(0)	
Iron Injection	Yes	3(11.11)	1(2.22)	0.552*
	No	25(88.89)	44(97.88)	
Results Acted	Yes	7(25.92)	18(40)	0.308
	No	20(74.08)	27(60)	

DISCUSSION

The current study sought to investigate the association between arteriovenous fistula (AVF) creation and hemoglobin levels in hemodialysis-dependent end-stage renal disease (ESRD) patients, shedding light on a crucial aspect of renal replacement therapy and its implications for patients' anemia status and infection risk. Anemia is a prevalent and well-documented complication in hemodialysis-dependent ESRD patients.⁽¹⁰⁾ It is primarily attributed to the decreased production of erythropoietin, a hormone responsible for stimulating red blood cell production. As our results demonstrated, the mean hemoglobin level in the study cohort was 8.49 g/dL, indicating the persistence of anemia in this patient population. Anemia is a significant concern in ESRD patients, as it leads to diminished oxygen-carrying capacity, fatigue, and a reduced quality of life. Additionally, it has been associated with increased morbidity and mortality, underlining the importance of addressing anemia in this population.⁽¹¹⁾

One of the central findings of this study was the association between AVF creation and hemoglobin levels. Patients with AVF had significantly higher hemoglobin levels compared to those without AVF, with a mean hemoglobin level of approximately 9.26 g/dL in the AVF group versus 8.07 g/dL in the non-AVF group. The observed difference was statistically significant (p-value = 0.003), suggesting that AVF might be associated with higher hemoglobin levels. This finding is of particular significance as it points to a potential relationship between vascular access choice

and the management of anemia in hemodialysis-dependent ESRD patients.⁽¹²⁾ While the exact mechanisms underlying this association warrant further investigation, several hypotheses can be considered. One possibility is that AVF, with its higher blood flow rates and more efficient dialysis, may lead to improved removal of uremic toxins and excess fluids, resulting in a better balance of erythropoietin production and potentially higher hemoglobin levels. It is also important to consider that patients with AVF may experience fewer complications, including infections, which could indirectly contribute to improved overall health and hemoglobin levels.^(11, 12)

The study also explored the relationship between AVF and the risk of infections. The results demonstrated a notable inverse association between the presence of AVF and infection development. Among patients with AVF, only 7.40% developed infections, whereas 60% of patients without AVF experienced infections. This significant difference, with a p-value of 0.0001, suggests a lower rate of infections in patients with AVF. The lower infection rate associated with AVF is consistent with existing literature, as AVF is well-established as a superior vascular access choice in terms of infection risk. This study reinforces the importance of selecting AVF as the primary vascular access method in hemodialysis-dependent ESRD patients not only for its well-documented infection-related benefits but also for the potential improvement it may offer in managing anemia.⁽¹³⁾

The findings of this study have several important implications for clinical practice. Healthcare providers who care for hemodialysis-dependent ESRD patients

should consider the potential impact of AVF selection on patients' hemoglobin levels and overall well-being. While this study does not establish causality, it suggests that AVF may be a valuable component in addressing anemia in these patients.

The study findings are limited and cannot be generalized due to cross-sectional design, the relatively small sample size, and the absence of a causative relationship between AVF and hemoglobin levels. Future research should explore the mechanisms by which AVF may impact erythropoietin production and hemoglobin levels in a larger and more diverse patient population.

CONCLUSION

AVF may be associated with higher hemoglobin levels and a reduced risk of infections. This knowledge should guide healthcare providers in making informed decisions about vascular access selection and anemia management in this vulnerable patient population, ultimately improving their quality of life and overall health.

Author's Contribution:

Concept & Design of Study:	Muhammad Azhar Waheed Khan
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