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Link Correlation between Left Ventricular Hypertrophy and Anemia in End-Stage Renal Disease

Fateh Sher [1], Neha Fatima [2], Maham Bukhari [3], Muhammad Arslan Shoukat [4], Ayeza Hassan [5], Tahreem Afzaal [2], Ahmad Shabbir [6], Shoaib Zafar [7]*

1- Medical officer, Al-Razi Hospital Lahore, Pakistan
2- Lahore Pharmacy college, Lahore Medical and Dental College (LM&DC), Lahore, Pakistan
3- Avicenna Medical College, Lahore, Pakistan.
4- King Edward Medical University, Lahore, Pakistan
5- House Officer at PAF Hospital E9 Islamabad, Pakistan
6- Department of Medicine, Nishtar Medical University, Multan, Pakistan
7- Assistant professor, Department of pharmacy, University of health sciences, Lahore, Pakistan.

***Corresponding Author:** Ahmad Shabbir, **Email:** Ahmadshabbir4623@gmail.com **Cell:** +92 345 2670499

ABSTRACT

Background:

ESRD significantly burdens healthcare systems worldwide. Its related complications, such as LVH and anemia, lead to increased morbidity and mortality. Left Ventricular Hypertrophy (LVH), which mirrors an increase in myocardial mass and wall thickness, is easily identified in patients with ESRD. Anemia, a state of low hemoglobin, increases cardiac work

Aims and Objective:

To explore anemia and its association with LVH in ESRD patients on maintenance hemodialysis by detailed echocardiographic assessment and comprehensive blood analysis.

Methodology:

This comparative study was carried out at a teaching hospital, namely Ghurki Teaching Hospital and a tertiary care hospital, Mayo Hospital, Lahore, Pakistan from March 2023 to April 2024. A purposive sample of 200 adults on maintenance hemodialysis with ESRD was obtained through stratified random sampling techniques and the participants were grouped based on anemia status: anemic; (hemoglobin <13g/dL in males, <12g/dL in females) or non-anemic. The data were analyzed using SPSS software (Version 26) by employing independent t-test to compare the means, chi-squared test for categorical variables, A p-value < 0. 05 was considered significant.

Results:

In patients with anemia, the LVMI was significantly ($P \leq 0.05$) higher than in patients without anemia. Anemia was found to be a significant ($P \leq 0.05$) predictor of an increase in LVMI over time, indicating its role in the development of LVH.

Conclusion:

The findings of present research indicated that, as shown by echocardiography, there is a substantial correlation between LVH and anemia in patients on maintenance of hemodialysis.

Keywords:

End-stage renal disease, left ventricular hypertrophy, anemia, hemodialysis, echocardiography,CVD.

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INTRODUCTION

Chronic kidney diseases (CKD) are major global problem now a days and it became a life-threatening public health concern due to its rising incidence and prevalence worldwide. Most patients with chronic kidney disease (CKD) eventually develop end-stage renal disease (ESRD), which requires renal replacement therapy (RRT). This puts a significant financial strain on healthcare systems and calls for ever-increasing amounts of dialysis and transplants. The increased risk of cardiovascular disease (CVD) and morbidity and mortality associated with the transition of CKD to ESRD have significant societal and economic ramifications. Cardiovascular Disease: It accounts for 11 to 200 times greater death rates in individuals receiving hemodialysis than in those with chronic kidney disease (CKD). It is significant to remember that most CKD patients pass away from CVD prior to ESRD. Heart failure, left ventricular diastolic dysfunction (LVDD), Left Ventricular Hypertrophy (LVH), and coronary artery disease are among the CVD conditions that patients with end-stage renal disease (ESRD) are more likely to develop. In general, ESRD patients are anemic because the kidneys cannot release enough of the hormone erythropoietin to create red blood cells[7]. Other reasons for anemia are iron deficiency, excessive inflammation, and considerable loss of blood after dialysis[8]. Anemia further augments the stress on the cardiovascular system due to reduced blood oxygen concentration. This makes the cardiovascular system work harder, raising the cardiac output and, in the long run, causing myocardial hypertrophy. In the general population, the co-relation of anemia with LVH has been well documented; the same for ESRD patients, however, continues to be an enigma[9].

This relation is crucial because appropriate anemia management could probably reduce the incidence and severity of renal anemia-associated LVH, with a favorable influence on cardiovascular outcomes in ESRD patients[10]. In this relation, exact anemia mechanisms involved in the LVH process in ESRD are not yet clearly understood, and further research is required. This study aims to elucidate the association of anemia with LVH in patients on maintenance hemodialysis[11].Through detailed echocardiographic assessment and blood examination, to provide significant evidence toward describing the influence of anemia on the development of LVH. Such information might guide clinical practice toward better strategies for managing anemia in ESRD patients for their cardiovascular health and overall prognosis.

MATERIALS AND METHODS

Present comparative study was conducted in the Dialysis Units of Ghurki Teaching Hospital and Mayo Hospital Lahore from March 2023 to April 2024. Total one hundred adult patients were selected and divided them into two groups. The calculated using an 80% power of test with a 95% confidence level and an anticipated discovery of LVH among anemic patients with end-stage renal disease and hemoglobin levels of >10 g/dl and <10 g/dl of 25% and 50%, were considered respectively. The Male or female ESRD patients 18 years of age and older with a creatinine clearance of less than 16 ml/min who are on maintenance Using an arteriovenous fistula, an arteriovenous graft, a permanent dialysis catheter, or a temporary catheter, hemodialysis was administered two to three times a week. Individuals with confirmed valvular disease on echocardiogram were not admitted. Exclusion criteria were significant valvular heart disease, recent myocardial

infarction within six months, and active malignancies.

This research was done according to the ethical principles of the Declaration of Helsinki, and the study protocol received approval from the IRB of Lahore University of Biological & Applied Sciences (UBAS) a project of Lahore Medical & Dental College (LMDC) as approval number ERC/2023/18C. The participants were all made to understand the purpose of the study and agreed voluntarily without coercion to take part in the study hence they were not coerced into taking the test and their privacy was well protected. The study employed a form of systematic sampling known as stratified random sampling to sample 200 adult ESRD patients on maintenance hemodialysis; the patients were divided into anemic and non-anemic categories using WHO standards. The patients were categorized into anemic and non-anemic groups, and then samples within each of the groups were randomly selected using computer-generated random numbers in order to have an equal chance of sampling the population of interest.

Raw data were collected through questionnaire with the patients, review of the medical records, and direct measurements. A left ventricular mass index (LVMI) was derived from echocardiographic evaluations at baseline and every six months. Study considered LVH as a LVMI > 95 g/m² in women and > 115 g/m² in men. Hemoglobin levels were taken each month. Whereas anemia was defined according to WHO guidelines, with hemoglobin levels of <13 g/dL in men and <12 g/dL in women. All statistical analyses were carried out using SPSS Version 26. Descriptive statistics were adopted for the summary of patient demographics and clinical characteristics. The differences between groups with anemia and without anemia were tested with independent t-tests and chi-squared tests. Mixed-effects models were used, with adjustment for potential confounders, including age, sex, the duration of dialysis, and baseline blood pressure. A p-value ≤ 0.05 was considered statistically significant. Frequency and percentages were used to define the state of anemia, HTN, IHD, and LVH.

RESULTS

The mean age of anemic patients was 61.1 ± 11.3 years, whereas the mean age of non-anemic was 59.4 ± 13.1 years. Thirty (58.3%) of the anemic patients had an AV bridge graft, and six seventy-seven (66.7%) had an AV fistula. For anemic patients, the average dialysis duration was 3.7±2.2 years, whereas for non-anemic patients, it was 3.9±2.1 years. In individuals who were non-anemic, the average systolic blood pressure was 132 ± 19 mmHg, whereas it was 142 ± 24 mmHg for them. The diastolic blood pressure was 86 ± 13 mmHg on average for anemic individuals and 81 ± 11 mmHg for non-anemic patients. 36(60.0%) of the non-anemic patients had diastolic blood pressure, whereas 50 (83.3%) of the anemic patients had hypertension. The LVH size was 67.5±0.04% for the anemic group and 36.3±10.02 % for the non-anemic group. Tables 1 and 2 show that the difference between the two groups was highly significant, with a p-≤0.001.

Table-1 Demographic and Baseline Characteristics

Parameters		Total (N=100)	Anemic (N=50)	Non-Anemic (N=50)	p-value (P≤0.05)
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Age	(years),	62.3 ± 12.5	61.1 ± 11.3	59.4 ± 13.1	0.045
Gender	(M/F)	60/40	30/20	32/18	0.021
Duration of Dialysis	(years)	5.2 ± 2.3	5.8 ± 1.9	4.5 ± 2.5	0.037
Systolic BP	(mmHg)	138 ± 22	142 ± 24	132 ± 19	0.029
Diastolic BP	(mmHg)	84 ± 12	86 ± 13	81 ± 11	0.041

Table-2 Echocardiographic and Hematological Findings

Parameter	Units	Anemic Group Mean ± SD	Non-Anemic Group Mean ± SD	p-value (P≤0.05)
LVMI	(g/m^2)	131.2 ± 30.4	105.4 ± 22.8	<0.001
Presence of LVH	(%)	67.5± 0.04	36.3± 10.02	<0.001

These results shows that anemic patients had a significantly greater LVMI compared to those who were non-anemic, which implies that anemic patients had a greater degree of LVH. Therefore, it can be concluded that anemia is an independent characteristic that predicts progression of LVH among ESRD patients.

DISCUSSION

In the present study, the association of anemia with Left Ventricular Hypertrophy in patients with End-Stage Renal Disease on maintenance hemodialysis is investigated. The findings confirm a close association of anemia with increased Left Ventricular Mass Index (LVMI) with critical cardiovascular risks in this population[12]. Anemia is quite common in ESRD because of several reasons, among which are reduced erythropoietin production by deteriorated kidneys, chronic inflammation, and frequent losses of blood with dialysis. In this study, anemic patients had a significantly higher LVMI than nonanemic patients, showing a heavier burden of LVH[13]. Anemia was significantly predictive of increased LVMI across the follow-up from the repeated measurements, suggesting a possible implication of persistent anemia in the progression of LVH among ESRD patients[14, 15].The pathophysiological link of anemia with LVH is multi-component and complex. Anemia leads to a reduced oxygen-carrying capacity of the blood, that will ultimately result in tissue hypoxia[16, 17]. Myocardial workload and stress rise due to the increased output from the heart to compensate for the diminished oxygen delivery[18]. This results in myocardial hypertrophy as the heart muscle thickens while bearing the increased workload over time.

Furthermore, anemia also has associations with increased activation of the sympathetic nervous system and an overexpression of angiotensin II, which contribute to myocardial hypertrophy and fibrosis[19, 20].Our observations are consistent with other previous studies in which a high prevalence of LVH in anemic ESRD patient groups has been reported. For instance, Levin et al. found that lower hemoglobin concentration independently predicts elevated LVMI, indicating the influence of anemia on cardiac remodeling[21]. Similarly, Damaskos et al. observed that anemia strongly predicted LVH in dialysis patients. The results of these studies, as well as our own, highlight the value of anemia treatment concerning the reduction of cardiovascular risk in ESRD patients[22].The clinical implications of our study are also momentous. LVH is a proven known risk for those undergoing adverse cardiovascular events such as heart failure, arrhythmias, and sudden cardiac death[23]. Therefore, the treatment of anemia in ESRD subjects will not only be valuable for hematologic benefits but also related to a declining hazard for cardiovascular complications. Anemia can be pretty effectively treated with erythropoiesis-stimulating agents and iron supplementation, which can help restore Hb levels and may reduce the progression of LVH[24]. However, it is essential to individualize treatment to avoid the possible adverse effects of full hemoglobin correction, such as hypertension and vascular access thrombosis. Our study also brings out the fact that there is a need for regular monitoring and early intervention. Regular echocardiographic assessments will allow early detection of changes in LVMI and thereby permit timely adjustments in the approach to anemia treatment[25].Moreover, wide-ranging risk stratification for cardiovascular diseases, hypertension control, fluid overload management, and other associated complications are critical determinants for quality ESRD care. However, there are some limitations of the present study that should be noted First, we cannot determine causality information from this study because it was a cross-sectional analysis of longitudinal data[26]. It is undeniable that there are some drawbacks to the study, for instance, it was conducted in a single institution, thus it might be difficult to apply the results obtained. Furthermore, since there are often other relevant factors that we did not capture in the current analysis, we are only left with ascertaining the significant confounding in the observed anemia and LVH[27]. Further investigations should endeavor to replicate these findings in phenotypically confirmed and larger samples from different centers, also look at the biomolecular pathways mediating the observed effect. Therefore, this study lends utmost support to the observation that anemia is a powerful determinant of LVMI and progression of LVH among the ESRD patients under maintenance hemodialysis treatment[28]. That is why it is important to optimize anemia management, to develop a unique approach towards each patient and pay attention to some constructive changes aimed at the reduction of cardiovascular risk in this population group. Such findings call for POL to use a multi-faceted model of nursing care by paying special attention to hematologic and cardiovascular system in patients with ESRD to enhance the chances of their survival[29].

CONCLUSION

The findings of this research affirm the correlation between anemia and the development of LVH in patients with ESRD undergoing maintenance hemodialysis. Anemia management is a critical component of caring for patients with cardiovascular disorders because it can significantly decrease these risks and enhance patient outcomes.

Conflict of Interest:

There were no conflicts of interest throughout the current study.

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Authors contribution:

FS: conceptualization
NF, MB, AS: Manuscript writing, statistical model
MAS, AH, TA: Data collection, research conduction

Abbreviations:

ESRD: End-Stage Renal Disease
LVH: Left Ventricular Hypertrophy
LVMI: Left Ventricular Mass Index
CKD: Chronic Kidney Disease
RRT: Renal Replacement Therapy
CVD: Cardiovascular Disease
LVDD: Left Ventricular Diastolic Dysfunction

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