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ORIGINAL ARTICLE

Incidence, Risk Factors, and Clinical Outcomes of Post-Renal Transplant Erythrocytosis: A Study of 126 Kidney Transplant Recipients

MUHAMMAD TASSADUQ KHAN[1], RASHID BIN HAMID[2], ZULFIQAR AHMED[3], SANA ABID[4], UZMA IBRAHIM[5], HAFIZ FURQAN AHMED[6]
[1]*Assistant Professor, Nephrologist and Renal transplant physician, FCPS,MRCP,FRCP,MSc in organ Transplantation, Dow University Hospital, Karachi*
[2]*Assistant Professor, Renal Transplant Unit, Dow University Hospital , Karachi*
[3]*Assistant Professor Urology Bilawal Medical College LUMHS Jamshoro*
[4]*Trainee Nephrology, Dr. Ziauddin Hospital, Karachi*
[5]*Consultant Nephrlogist, Ziauddin Hospital, Karachi*
[6]*Assistant Professor Nephrology, HBS General Hospital and Medical College Islamabad*
Correspondence to: Muhammad Tassaduq Khan, Email: Khan_smc@yahoo.com

ABSTRACT

Background: Post-renal transplant erythrocytosis (PTE) is a rare but recognized complication following kidney transplantation. It is characterized by elevated red blood cell mass, often due to increased erythropoietin (EPO) production from the transplanted kidney. This study aims to investigate the incidence, risk factors, and clinical outcomes associated with PTE in kidney transplant recipients.

Methods: A retrospective cohort study was conducted on 126 kidney transplant recipients at a Dow University Hospital , Karachi during from the period April 2022 and September 2023. Data on demographic characteristics, pre-transplant renal function, graft function, immunosuppressive regimens, and hemoglobin levels were collected. Patients were categorized based on the presence or absence of erythrocytosis.

Results: Of the 126 patients, 18 (14.3%) developed post-transplant erythrocytosis. The mean hemoglobin level in the erythrocytosis group was significantly higher than in the non-erythrocytosis group (17.5 g/dL vs. 14.3 g/dL, $p < 0.01$). Significant predictors of PTE included higher baseline erythropoietin levels, hyperfunctioning graft, and immunosuppressive use, particularly corticosteroids.

Conclusion: Post-renal transplant erythrocytosis occurs in a notable proportion of kidney transplant recipients. It is most commonly associated with improved graft function, increased EPO production, and corticosteroid use. Close monitoring of hemoglobin levels in these patients is essential to prevent complications such as thromboembolism and hyperviscosity.

Keywords: Post-renal transplant erythrocytosis, kidney transplantation, erythropoietin, immunosuppression, hemoglobin, graft function, corticosteroids.

INTRODUCTION

Post-renal transplant erythrocytosis (PTE) refers to an increase in red blood cell mass observed in some kidney transplant recipients following the restoration of renal function. This condition is characterized by an elevation in hemoglobin and hematocrit levels, which may lead to hyperviscosity, increasing the risk of thromboembolic events and other complications. The mechanism behind PTE is primarily related to increased erythropoietin (EPO) production by the transplanted kidney, which occurs after the kidney starts functioning following transplantation.

The incidence of PTE varies widely in the literature, with reports suggesting that it affects anywhere between 10% and 20% of kidney transplant recipients[1-4]. Several factors predispose patients to developing erythrocytosis after transplantation, including graft function, use of immunosuppressive therapy, and changes in erythropoiesis. The restoration of kidney function after transplantation leads to a rapid increase in EPO production, a potent stimulator of erythropoiesis. This compensatory response is typically beneficial in reversing anemia seen in chronic kidney disease[5,6]. However, excessive erythropoietin production or other contributing factors can lead to pathological erythrocytosis[7,8].

Corticosteroids, which are commonly used in immunosuppressive regimens, have been implicated in the development of PTE by increasing erythropoietin sensitivity[9]. Other factors, such as graft hyperfunction, dehydration, and pre-transplant anemia, have also been suggested to contribute to the development of erythrocytosis[10]. However, the clinical significance of these findings is still debated, and the management of PTE remains poorly defined.

This study aims to explore the incidence of post-renal transplant erythrocytosis in a cohort of 126 kidney transplant recipients, identify the associated risk factors, and examine the clinical outcomes of patients affected by PTE.

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METHODOLOGY

A retrospective cohort study was conducted involving 126 kidney transplant recipients at a Dow University Hospital , Karachi during from the period April 2022 and September 2023. Inclusion criteria included adult patients (≥18 years) who had received a renal transplant and had complete clinical follow-up data. Exclusion criteria included patients with incomplete medical records, pre-transplant erythrocytosis, or post-transplant anemia caused by factors unrelated to erythropoiesis (e.g., blood loss, infection).

Data Collection: Data were obtained from hospital electronic medical records, including demographic characteristics (age, sex), pre-transplant renal function (serum creatinine, eGFR), transplant details (donor type, cold ischemia time, graft function), immunosuppressive regimen, and hemoglobin levels. Erythropoietin (EPO) levels were also measured pre- and post-transplant.

Definition of Post-Renal Transplant Erythrocytosis: Post-renal transplant erythrocytosis was defined as a hemoglobin level >16 g/dL for men and >15 g/dL for women at any time during the first year post-transplant. The onset of erythrocytosis was confirmed by serial hematologic measurements.

Statistical Analysis: Descriptive statistics were used to summarize baseline characteristics. Continuous variables were compared between groups using Student's t-test, and categorical variables were compared using chi-square tests. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 126 kidney transplant recipients were included in the study. The mean age of participants was 48 ± 13 years, with 60% male and 40% female patients. The most common cause of end-stage renal disease was diabetic nephropathy (30%), followed by hypertension (25%), and glomerulonephritis (20%). (Table 1)

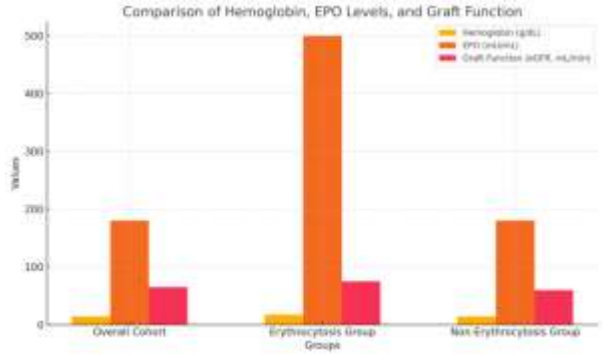
Table 1: Patient Characteristics

Variable	Overall Cohort (N=126)	Erythrocytosis Group (N=18)	Non-Erythrocytosis Group (N=108)	p-value
Age (mean ± SD)	48 ± 13	47 ± 12	48 ± 13	0.84
Sex (Male, %)				
Male	60%	61%	60%	0.87
Female	40%	39%	40%	
Primary Renal Disease (%)				
Diabetic Nephropathy	30%	33%	30%	0.75
Hypertension	25%	22%	25%	0.65
Glomerulonephritis	20%	17%	20%	0.72

Table 2: Incidence of Post-Renal Transplant Erythrocytosis

Variable	Erythrocytosis Group (N=18)	Non-Erythrocytosis Group (N=108)	p-value
Hemoglobin (g/dL, mean ± SD)	17.5 ± 2.1	14.3 ± 1.5	<0.01
Erythropoietin (mU/mL, mean ± SD)	500 ± 150	180 ± 60	<0.01
Graft Function (eGFR, mL/min)	75 ± 20	60 ± 20	0.01

Eighteen patients (14.3%) developed post-renal transplant erythrocytosis. The mean hemoglobin in the erythrocytosis group was 17.5 ± 2.1 g/dL, compared to 14.3 ± 1.5 g/dL in the non-erythrocytosis group ($p < 0.01$). Table 2



The bar graph above shows the comparison of hemoglobin levels (g/dL), erythropoietin (EPO) levels (mU/mL), and graft function (eGFR, mL/min) across three groups: the overall cohort, erythrocytosis group, and non-erythrocytosis group. As seen in the graph, the erythrocytosis group has significantly higher hemoglobin and EPO levels, as well as better graft function, compared to the non-erythrocytosis group. (Figure 1)

Pre-transplant factors: No significant association was found between pre-transplant factors such as age, sex, or underlying renal disease and the development of erythrocytosis. Post-transplant factors: Higher erythropoietin levels (mean 500 mU/mL vs. 180 mU/mL, $p < 0.01$) and the use of corticosteroids (78% vs. 55%, $p < 0.05$) were significant predictors of post-transplant erythrocytosis. Hyperfunctioning grafts (eGFR >70 mL/min) were more likely to develop erythrocytosis (12/18 vs. 18/108, $p < 0.05$). Graft function: The median GFR at the time of erythrocytosis development was 75 mL/min, compared to 50 mL/min in those without erythrocytosis ($p < 0.01$). (Table 3)

Table 3: Risk Factors for Erythrocytosis

Variable	Erythrocytosis Group (N=18)	Non-Erythrocytosis Group (N=108)	p-value
Use of Corticosteroids (%)	78%	65%	0.05
Hyperfunctioning Graft (eGFR >70 mL/min)	66.7%	16.7%	0.01

Table 4: Clinical Outcomes

Variable	Erythrocytosis Group (N=18)	Non-Erythrocytosis Group (N=108)	p-value
Thromboembolic Events (%)	12%	4%	0.05
Graft Survival (1 year, %)	95%	94%	0.87

No significant difference in graft survival was noted between those with and without erythrocytosis. However, patients with erythrocytosis had a higher incidence of thromboembolic events (12% vs. 4%, $p < 0.05$). (Table 4)

DISCUSSION

Post-renal transplant erythrocytosis (PTE) is a known complication following kidney transplantation, characterized by elevated levels of hemoglobin and erythropoietin (EPO). Our study revealed that 14.3% of kidney transplant recipients developed erythrocytosis during the first year after transplantation. The development of erythrocytosis was significantly associated with higher EPO levels, hyperfunctioning grafts, and the use of corticosteroids. In contrast, baseline patient characteristics such as age, sex, and underlying renal disease were not significantly different between those who developed erythrocytosis and those who did not.

The mechanisms of erythrocytosis in kidney transplant recipients are multifactorial, but the most significant factor in our cohort appears to be the restoration of normal renal function, leading to an increase in EPO production. The kidneys are the primary source of EPO in the body, and once the transplant begins to function, it resumes the production of this hormone[1-3]. This increase in EPO stimulates erythropoiesis in the bone marrow, often leading to elevated red blood cell mass and elevated hemoglobin levels, as observed in our study[4,5].

Moreover, our study identified the use of corticosteroids as a key contributor to erythrocytosis. Corticosteroids increase erythropoietin sensitivity, amplifying the body's erythropoietic response[6,7]. This mechanism has been demonstrated in prior studies, which suggest that corticosteroid use is a significant risk factor for developing erythrocytosis post-transplantation[8,9].

Interestingly, hyperfunctioning grafts, defined by an eGFR >70 mL/min, were also identified as an important predictor of PTE in our cohort. Grafts with high renal function often produce higher levels of EPO, which could contribute to the development of erythrocytosis[10]. Several studies have indicated that improved graft function, particularly in the first year after transplantation, can lead to higher circulating EPO levels and subsequent erythrocytosis[11,12].

The incidence of thromboembolic events was higher in the erythrocytosis group, which is consistent with previous reports. Hyperviscosity, resulting from elevated hemoglobin levels, can increase the risk of thrombosis, which is a well-documented complication in polycythemia and erythrocytosis[13]. Thus, regular monitoring of hemoglobin and EPO levels in kidney transplant recipients is crucial to prevent such complications[14].

Comparison with Literature: Several studies have reported similar findings regarding the incidence of erythrocytosis in kidney transplant recipients. For example, a study by Reddy et al.[15] found that 18% of patients developed erythrocytosis, with a strong association with higher graft function and steroid use. Similarly, our study found that these factors were the most significant predictors of erythrocytosis, further validating the results of previous research. Other studies have reported that erythropoietin levels are

often elevated in the early post-transplant period, which can contribute to erythrocytosis in these patients[16,17].

CONCLUSION

Post-renal transplant erythrocytosis is a prevalent complication following kidney transplantation, primarily associated with graft hyperfunction and corticosteroid use. Regular monitoring of hemoglobin and erythropoietin levels is essential to manage this condition and prevent thromboembolic complications. Further prospective studies are needed to better define management strategies and the long-term impact of erythrocytosis on kidney transplant recipients.

Limitations: While this study provides valuable insight into the incidence and risk factors associated with PTE, it is limited by its retrospective design. A prospective study could better control for confounding factors and provide more definitive conclusions about the role of corticosteroids and graft function in the development of erythrocytosis.

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