

Oxidative Stress as a Link between Anemia and Renal Dysfunction in Chronic Kidney Disease

Sonal Tiwari

Ph.D Scholar, Department of Biochemistry, MGM Medical College, Navi Mumbai, Maharashtra, India

Dr. Parineeta Samant *

Professor, Department of Biochemistry, MGM Medical College, Navi Mumbai, Maharashtra, India

Abstract

Background: Chronic Kidney Disease (CKD) is a major global health burden frequently complicated by anemia, arising from reduced erythropoietin synthesis, chronic inflammation, iron dysregulation, and shortened erythrocyte survival. Concurrently, accumulation of reactive oxygen species and lipid peroxidation overwhelms antioxidant defenses, generating oxidative stress that may mechanistically bridge anemia and progressive renal impairment.

Aim: To evaluate whether oxidative stress serves as a mechanistic link between anemia and renal dysfunction in patients with CKD.

Methodology: A case-control study was conducted on 40 CKD patients (stages 3–5, aged 18–70 years) and 40 age-matched healthy controls. Venous blood samples were analyzed for renal function, haematological indices, iron profile, and oxidative stress biomarkers—malondialdehyde (MDA) and total antioxidant capacity (TAC). Patients with acute infection, malignancy, liver disease, haemolytic anemia, or recent transfusion were excluded. Statistical significance was set at $p < 0.05$.

Results: CKD patients showed significantly lower hemoglobin (8.9 ± 1.87 vs 13.21 ± 0.74 g/dL) and eGFR (5.7 ± 2.03 vs 100.15 ± 12.9), alongside markedly elevated creatinine (8.9 ± 1.6 vs 0.89 ± 0.1 mg/dL) and ferritin (691.4 ± 17.8 vs 122.6 ± 13.3 ng/mL) compared with controls (all $p < 0.0001$). Oxidative stress was evident from higher MDA (4.9 ± 1.17 vs 2.9 ± 0.63 μ mol/L) and reduced TAC (0.8 ± 0.32 vs 1.7 ± 0.09 mmol/L) in cases ($p < 0.0001$).

Conclusion: CKD patients exhibited impaired renal function, anemia, iron metabolism abnormalities, heightened oxidative stress, and diminished antioxidant capacity, supporting oxidative stress as a key mechanistic link between anemia and renal dysfunction. MDA and TAC may serve as valuable biomarkers for monitoring disease progression and therapeutic response.