



EARLY RENOVASCULAR HEMODYNAMIC ALTERATIONS IN PEDIATRIC BETA-THALASSEMIA: A DOPPLER SONOGRAPHY STUDY

Radio-Diagnosis

Taori Abhijeet*

Assistant Professor, Department Of Radiodiagnosis, SAMC And PGI, Indore
*Corresponding Author

Malpani Divya

Consultant, Department Of Radiodiagnosis, Suyash Hospital, Indore.

ABSTRACT

The objective of this study was to evaluate early changes in renal vascular resistance in pediatric patients with beta-thalassemia major using doppler sonography, despite having normal routine urinary lab parameters. Renal resistive and pulsatility indices derived from Doppler sonography demonstrate early hemodynamic alterations in children with beta-thalassemia. These findings can facilitate timely interventions, guiding early surveillance strategies and potentially delaying the onset of irreversible renal injury.

KEYWORDS

INTRODUCTION

Beta-thalassemia major is a hereditary hemoglobinopathy marked by ineffective erythropoiesis and chronic anemia. The chronic transfusion dependency and systemic iron overload in these patients often result in multiorgan involvement, including subclinical renal dysfunction. Although renal impairment is typically considered a late manifestation, microvascular changes may precede any detectable laboratory abnormality.

Chronic hypoxia and oxidative stress are implicated in the pathogenesis of early nephropathy in thalassemia. Standard imaging often fails to detect these changes in the preclinical stage. However, Doppler sonography provides a non-invasive modality to evaluate renal vascular hemodynamics through resistive index (RI) and pulsatility index (PI) ⁽¹⁻³⁾.

This study investigates whether these Doppler indices can serve as early indicators of renovascular dysfunction in young beta-thalassemia patients with normal serum creatinine, blood urea, and urine microscopy.

MATERIALS AND METHODS

Subjects:

A total of 100 children aged 6–18 years were included in this prospective study. Group A consisted of 60 beta-thalassemia major patients (confirmed by HPLC) with at least 3 years of transfusion history and no overt renal pathology. Group B included 40 age- and sex-matched healthy controls with no renal, hematologic, or cardiovascular conditions.

Exclusion Criteria:

Patients with known hypertension, febrile illness, acute hemolytic crises, or elevated serum creatinine (>0.95 mg/dL) were excluded. Also excluded were those with proteinuria, RBC casts, or urinary abnormalities detected on routine tests.

Ultrasound Technique:

Renal Doppler was performed using a Philips Affinity 70 system with a 5–7 MHz transducer. Doppler waveforms were obtained from main renal, segmental, and interlobar arteries bilaterally. PI and RI were calculated using standard formulae. Average of three readings from each zone was used for analysis.

Laboratory Tests:

All patients underwent urinalysis, spot urine albumin estimation, and serum creatinine testing. Only those with values within normal pediatric reference ranges were included.

Statistical Analysis:

Mean RI and PI values were compared using independent t-tests. Correlation analysis was performed to evaluate relationships between vascular indices and transfusion burden or serum ferritin. A p-value < 0.05 was considered statistically significant. ROC curves were generated to determine cutoff values for early detection.

RESULTS

The mean age of beta-thalassemia patients was 12.3 ± 3.4 years and that of controls was 12.1 ± 3.7 years. Doppler indices were significantly elevated in the patient group compared to controls:

- **RI (Mean):** 0.69 ± 0.06 in thalassemia group vs. 0.58 ± 0.04 in controls
- **PI (Mean):** 1.21 ± 0.10 in thalassemia group vs. 0.98 ± 0.07 in controls ($p < 0.001$ for both)

Segmental and interlobar arteries showed consistent trends across patients. ROC analysis revealed that an RI cutoff of 0.68 had 92% sensitivity and 75% specificity, whereas a PI cutoff of 1.15 showed 88% sensitivity and 80% specificity.

No significant correlation was found between renal Doppler indices and serum ferritin ($r = 0.12$, $p = 0.09$) or cumulative transfusion units ($r = 0.15$, $p = 0.07$).

DISCUSSION

Our findings underscore the presence of early renovascular changes in children with beta-thalassemia major, detectable even before conventional biochemical markers indicate renal compromise. Elevated PI and RI values reflect increased vascular impedance, likely due to endothelial dysfunction and iron-induced oxidative damage in the renal vasculature ⁽¹⁻⁴⁾.

Previous literature has documented similar findings in conditions like sickle cell anemia and systemic lupus erythematosus ⁽¹⁻³⁾. Limitations include the modest sample size and lack of long-term follow-up data. Future longitudinal studies could assess the predictive value of these indices for overt nephropathy and their response to iron chelation.

CONCLUSION

Renal Doppler indices, particularly RI and PI, serve as sensitive non-invasive markers for detecting early renovascular alterations in beta-thalassemia patients. Integration of Doppler evaluation into routine screening protocols may aid in timely intervention, minimizing the burden of future renal complications.

REFERENCES

1. Saif A, Soliman N, Abdelhamid A. Doppler assessment of renal hemodynamic alterations in homozygous sickle cell disease and sickle beta-thalassemia. *J Med Ultrasound Technol*. 2015;33(1):10–17. doi:10.1177/0161734614553831
2. Mohammed AE, Gar-el-nabi ME, Omer MA, Osman A, Abdallah EA. Impact of sickle cell disease in renal arteries blood flow indices using ultrasonography. *Int J Med Imaging*. 2017;5(2):9–13. doi:10.11648/j.ijmi.20170502.11
3. Patre V, Chandrakar N, et al. The pattern of renal artery Doppler indices in patients with sickle cell disease. *J Ultrason*. 2024;24(97):1–4. doi:10.15557/jou.2024.0017
4. Radermacher J, et al. Renal resistive index from renal hemodynamics to cardiovascular risk: diagnostic, prognostic, and therapeutic implications. *Biomedicines*. 2025;13(6):519. doi:10.3390/biomedicines13061519