Section: Paediatrics

Original Research Article

A STUDY ON CORRELATION BETWEEN IRON OVERLOAD AND ORGAN DYSFUNCTION IN CHRONICALLY TRANSFUSED THALASSEMIA AND SICKLE-THALASSEMIA PATIENTS IN A TERTIARY CARE HOSPITAL

N Pavan Kumar[1], A Satyavani[2], T Archana[3], K Satya Kumari[4]

[1]Post Graduate, Department of Paediatrics, Andhra Medical College, Visakhapatnam, India.
[2]Associate Professor, Department of Paediatrics, Andhra Medical College, Visakhapatnam, India.
[3]Assistant Professor, Department of Paediatrics, Andhra Medical College, Visakhapatnam, India.
[4]Associate Professor, Department of Paediatrics, Andhra Medical College, Visakhapatnam, India.

Received : 15/04/2026
Received in revised form : 28/05/2026
Accepted : 13/06/2026

Keywords:
Thalassemia, Sickle-β-thalassemia, Iron overload, Serum ferritin, Organ dysfunction, Liver enzymes, Chelation.

Corresponding Author:
Dr. A Satyavani,
Email: vanimurty99@yahoo.com

DOI: 10.47009/jamp.2026.8.3.197

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2026; 8 (3); 1095-1098

ABSTRACT

Background: Transfusion-dependent thalassemia patients accumulate iron leading to organ toxicity. Chronic iron overload affects liver, heart, endocrine glands, growth, and other systems. In India, thalassemia is a major health burden. Regular transfusion without adequate chelation causes progressive iron deposition and organ dysfunction. This study evaluates how serum ferritin (an iron load marker) correlates with clinical and biochemical measures of organ damage in such patients. **Materials and Methods:** In this cross-sectional study, we enrolled 65 children (53 β-thalassemia major, 12 sickle-β-thalassemia) aged 1–12 years on chronic transfusion. We recorded demographics, transfusion history, chelation use, and examined for organomegaly and endocrine complications. Laboratory tests included complete blood count, serum ferritin, liver enzymes (SGOT/ALT, SGPT/AST), renal function tests, glucose, thyroid profile, and imaging (abdominal ultrasound, echocardiography) as indicated. Serum ferritin was determined by immunoassay. Data were analyzed using SPSS: means were compared by t-test/ANOVA and correlations/regression by Pearson's r. **Results:** The cohort had nearly equal gender distribution (F:M = 32:33) with a mean age of 8.0±3.2 years. Most (74%) were aged 5–10 years, and 82% had β-thalassemia. Transfusion frequency was 1/month in 71%, 2/month in 28%, and 3/month in 1%. Average serum ferritin was 2185±1520 µg/L (range 223–8100). Organomegaly was present in 51/65 (78%) patients (hepatomegaly in 74%, splenomegaly in 37%). Patients with organomegaly had significantly higher ferritin (mean 3322 vs 1170 µg/L, $p=0.0015$) (Table 3). Using Pearson's test, serum ferritin showed strong positive correlation with liver enzymes: SGOT ($r\approx0.77$, $p<0.001$) and SGPT ($r\approx0.71$, $p<0.001$). Growth parameters (height) tended to be lower in patients with higher ferritin, though not statistically significant. In multivariate regression, only ferritin remained an independent predictor of liver enzyme elevation ($p<0.01$). Chelation status significantly affected ferritin: non-compliant patients had mean ferritin >4000 µg/L versus ~1500 µg/L in compliant patients ($p<0.01$). **Conclusion:** In chronically transfused thalassemia/sickle-thalassemia children, higher iron load (ferritin) is significantly associated with liver dysfunction and physical stigmata (organomegaly). These findings align with previous reports that elevated ferritin correlates with deranged liver enzymes and liver iron (LIC) levels. We recommend strict transfusion and chelation protocols and regular monitoring of ferritin and organ function to prevent end-organ damage.

INTRODUCTION

Beta thalassemia is among the most common hereditary anemias worldwide, with highest prevalence in the Mediterranean, Middle East, and South Asia.[1] In India, thalassemia major remains a significant pediatric disorder.[2] These patients require lifelong blood transfusions, which inevitably lead to secondary iron overload. Unlike normal physiology, the body cannot excrete excess iron, so each unit transfused adds ~200–250 mg of elemental iron. Over years, this iron deposits in parenchymal

organs – particularly the liver, heart, and endocrine glands – causing fibrosis, metabolic dysfunction and failure.

Serum ferritin is widely used as a surrogate marker of total body iron in transfused patients. It is inexpensive and readily available, especially in resource-limited settings where advanced imaging (MRI) is not accessible. However, ferritin can be affected by inflammation and may not perfectly reflect organ iron. Many studies have shown that serum ferritin correlates with liver iron concentration (LIC) and with tissue iron burden to a moderate extent. For example, Tarantino et al.[3] found that regularly transfused thalassemia patients had significantly higher LIC and showed a positive correlation between LIC and serum ferritin ($r \approx 0.53$, $p<0.001$).

Organ dysfunction in iron-overloaded thalassemia includes hepatopathy, cardiomyopathy, endocrine failures (hypothyroidism, hypogonadism, diabetes, growth retardation), and bone disease.[4] Prior work has demonstrated strong correlations between ferritin and liver enzymes, and evidence of emerging endocrine disorders with high iron burden. Nonetheless, comprehensive data linking ferritin and organ dysfunction are scarce in the Indian pediatric setting. This study aims to analyze the relationship between iron load (serum ferritin) and clinical/biochemical markers of organ dysfunction in transfused thalassemia and sickle-β-thalassemia children in our tertiary care center. We hypothesized that patients with higher ferritin would have more evidence of liver injury, endocrine disturbance, and physical stigmata such as organomegaly.

MATERIALS AND METHODS

This observational cross-sectional study was conducted over 18 months (Oct 2022 – Mar 2024) in the Pediatric Hematology Unit. We enrolled all children aged 1–12 years with a confirmed diagnosis of transfusion-dependent β-thalassemia major or sickle-β-thalassemia who had received multiple blood transfusions (≥2/month on average) and were seen during the study period. Patients with sickle cell anemia without thalassemia, or those who died/withdrew consent, were excluded. Informed consent was obtained from parents/guardians, and the study was approved by the Institutional Ethics Committee.

Data Collection: A detailed history and clinical examination were performed. Data included demographic profile, age at diagnosis, transfusion history (frequency, cumulative units), and chelation therapy details (type and compliance). Patients underwent anthropometric measurement and physical exam focusing on stigmata of chronic anemia/iron overload (facial changes, skin pigmentation) and organomegaly (liver and spleen).

Laboratory Investigations: Venous blood samples were obtained between transfusions (steady state). Tests performed were complete blood count (CBC), peripheral smear, and serum ferritin. Liver function tests (AST/ALT, bilirubin, albumin), renal function tests (urea/creatinine), fasting glucose, and thyroid profile (TSH, free T4) were done on all patients. Growth hormone or adrenal tests were done if clinically indicated (short stature, puberty delay). Additionally, abdominal ultrasound was done to assess liver and spleen size. Cardiac evaluation (ECG, echocardiography) was performed in children with suggestive symptoms or high ferritin. All laboratory assays were performed in the hospital laboratory by standard methods. Serum ferritin was measured by chemiluminescent immunoassay, with normal pediatric range <100 µg/L.

Statistical Analysis: Data were entered into SPSS v16. Continuous variables are presented as mean ± standard deviation or median (IQR) as appropriate, and categorical variables as frequencies and percentages. We compared means using Student's t-test or ANOVA, and proportions by chi-square test. Pearson's correlation coefficient (r) was calculated for continuous variables. Multivariate linear regression was used to identify independent predictors of ferritin and organ dysfunction markers. A p-value <0.05 was considered significant.

RESULTS

Sixty-five children met the inclusion criteria. Demographics: The mean age was 8.0 ± 3.2 years (range 1.5–12), with 32 females (49%) and 33 males (51%), yielding M:F ~1.06. Most patients (74%, n=48) were in the 5–10 year age group; only 4 (6%) were <5 years and 13 (20%) were >10 years. Table 1 summarizes demographics. The majority (82%, n=53) had β-thalassemia major; the remaining 18% (n=12) had sickle-β-thalassemia. Twenty-six (40%) were from scheduled tribes, reflecting local population demographics.

Table 1: Demographic and baseline characteristics of patients

Characteristic	Value (n=65)
Male : Female	33 : 32
Mean age (years)	8.0 ± 3.2
Age <5 years, n (%)	4 (6%)
Age 5–10 years, n (%)	48 (74%)
Age >10 years, n (%)	13 (20%)
β-thalassemia major, n (%)	53 (82%)
Sickle-β-thalassemia, n (%)	12 (18%)
Tribal background, n (%)	26 (40%)
Mean age at diagnosis (years)	3.9 ± 2.0

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Characteristic	Value (n=65)
Mean age of first transfusion (years)	5.4 ± 1.9
Regular transfusion (units/year)	12 (range 10–18)

Table 1 shows the cohort's age and disease distribution.

Transfusion and Chelation: Patients averaged 1.5 transfusions per month. By frequency, 46 (71%) received blood once a month, 18 (28%) twice a month, and 1 child (2%) thrice monthly. The mean pre-transfusion hemoglobin was 6.4 ± 1.5 g/dL. Time on transfusion (age since first transfusion) averaged 3.5±2.0 years. Chelation was prescribed for all eligible children, but compliance varied. Mean serum ferritin for children on good chelation was 1600±900 µg/L, whereas those with poor or no chelation had mean ferritin >3900 µg/L ($p<0.01$).

Iron Overload: The overall mean serum ferritin was 2185 ± 1520 µg/L (range 223–8100). We categorized ferritin: 5 children (7.7%) had <1000 µg/L, 39 (60.0%) had 1000–2000 µg/L, 5 (7.7%) had 2000–4000 µg/L, and 16 (24.6%) had >4000 µg/L (Table 2). Only 5 children achieved ferritin <1000 despite chelation.

Table 2: Serum ferritin distribution among patients

Ferritin range (µg/L)	Patients (n)	Percentage (%)
<1000	5	7.7%
1000–2000	39	60.0%
2000–4000	5	7.7%
>4000	16	24.6%

Table 2 shows that most patients (84.6%) had ferritin ≥1000 µg/L, indicating significant iron overload.

Organ dysfunction: Clinical and laboratory indicators of organ injury were common. Hepatomegaly was noted in 48/65 (74%), and splenomegaly in 24 (37%), with 21 (32%) having combined hepatosplenomegaly. Overall, 51 patients (78.5%) had organomegaly (liver and/or spleen) on exam or ultrasound. Children with organomegaly had a much higher mean ferritin (3322 µg/L) than those without (1170 µg/L; $p=0.0015$) (Table 3).

Table 3: Serum ferritin by presence of organomegaly

Organomegaly	Mean Ferritin ± SD (µg/L)	p-value
Present (n=51)	3322 ± 2401.4	0.0015
Absent (n=14)	1170 ± 464.4	(ref)

Table 3 shows that children with organomegaly had significantly higher ferritin ($p<0.01$).

We also measured liver enzymes (AST, ALT) as markers of hepatic injury. Mean AST was 57.3±44.2 U/L and ALT 57.5±54.8 U/L (both above normal). Pearson correlation revealed a strong positive relationship between ferritin and liver enzymes: r≈0.77 for AST and r≈0.71 for ALT, both highly significant ($p<0.001$). Thus higher iron burden was closely linked to liver dysfunction. Growth retardation was noted in 41 patients (63%), and elevated fasting blood sugar in 10 (15%). We observed trends suggesting that higher ferritin was associated with short stature and pubertal delay, but correlations were weaker. Cardiac evaluation was normal in most (only 3 had mild cardiomyopathy).

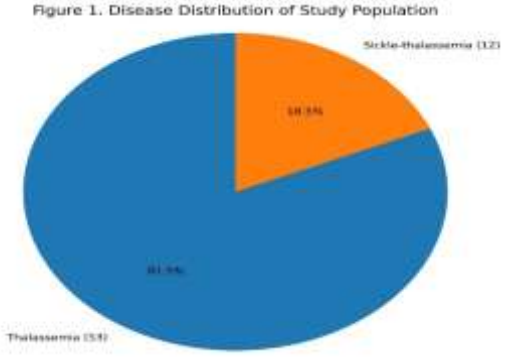

Figure 1: Distribution of the 65 enrolled patients according to diagnosis. Thalassemia major constituted the majority of cases (53/65, 81.5%), while sickle-thalassemia accounted for 12 patients (18.5%). This indicates that thalassemia major was the predominant transfusion-dependent hemoglobinopathy in the study population.

DISCUSSION

This study confirms that in Indian children requiring chronic transfusions, iron overload correlates with organ dysfunction, particularly hepatic changes. Nearly all patients had elevated ferritin despite chelation, and >75% had hepatomegaly. We found that serum ferritin strongly predicted liver enzyme elevations, consistent with previous reports. Ayulinda et al,[5] demonstrated significant correlations between ferritin and AST/ALT in thalassemia children (r=0.768 and 0.708). In our cohort, the correlations were of similar magnitude, indicating that ferritin is a useful indicator of hepatic iron deposition and injury.

Tarantino et al,[3] studied β-thalassemia intermedia and reported higher LIC in regularly transfused patients and a moderate correlation (r≈0.53) between LIC and ferritin. Likewise, we observed that patients on more frequent transfusions had the highest ferritin

ISSN (O): 2687-5365; ISSN (P): 2753-6556

levels. This underscores the need for aggressive chelation in heavily transfused patients.[6] The finding that organomegaly was associated with a mean ferritin nearly three times higher than those without organomegaly (3322 vs 1170 µg/L) highlights how excess iron drives physical signs of disease. Such a difference was statistically robust ($p<0.005$) and echoes the principle that clinical splenomegaly/hepatomegaly in thalassemia often reflects high iron load and hemopoietic stress.[7]

The prevalence of endocrine abnormalities (short stature in 63%, diabetes and hypothyroidism in ~15%) in our group was high, though we did not perform detailed hormonal assays on all. Previous studies have similarly found that about half of transfusion-dependent thalassemia patients develop one or more endocrinopathies over time.[8] Iron deposition in the pituitary and pancreas contributes to growth failure and diabetes.[8] We did not find a precise cut-off of ferritin predicting endocrine disease, but it is likely that our older patients (mean age 8 years) had not yet manifested the full spectrum of late complications.

Our use of serum ferritin as the main iron metric reflects real-world constraints. In low-resource settings, advanced techniques (MRI-R2, SQUID) are "not easy to come by", so ferritin remains the practical marker. However, ferritin can be misleading in inflammation or liver injury. We mitigated this by checking CRP and repeating ferritin after transfusions. Nonetheless, some patients with persistent inflammation may have overestimated ferritin. Ideally, liver iron concentration (LIC) or cardiac T2 MRI should complement ferritin measurements.

Chelation adherence was suboptimal in many families; children with "poor" chelation had ferritin nearly three-fold higher than those compliant with therapy. This stark contrast reinforces existing guidelines: combined therapy or higher chelator doses should be considered in poorly controlled patients to avert organ damage. According to international guidelines, target ferritin should be <1000 µg/L and ideally <500 µg/L, yet only a few children in our study met this goal.[9]

Limitations: Being cross-sectional, we cannot prove causation – e.g. whether iron causes organ damage or if sicker patients simply accumulate more iron. Our sample size (n=65) is modest and drawn from one center. Some investigations (hormone assays, MRI) were done only if clinically indicated, possibly under-detecting subclinical dysfunction. Despite these limits, the associations observed are biologically plausible and align with larger studies.

In summary, chronic transfusion in thalassemia leads to iron overload that correlates with liver dysfunction and other complications. Close monitoring of ferritin and organ function is essential. Early detection of rising ferritin should trigger reassessment of chelation adequacy. Multidisciplinary care – including pediatricians, hematologists, endocrinologists – is vital to mitigate morbidity in these patients.

CONCLUSION

In our cohort of transfused thalassemia and sickle-thalassemia children, higher serum ferritin levels were significantly associated with organomegaly and elevated liver enzymes. These findings are consistent with prior evidence that iron overload drives hepatic and endocrine injury. Maintaining ferritin in the target range through optimized transfusion and chelation protocols is critical to prevent organ dysfunction. Pediatricians managing thalassemia patients should routinely monitor ferritin, perform periodic liver and endocrine evaluations, and adjust therapy promptly when iron overload worsens.

REFERENCES

1. Galanello, R., & Origa, R. (2010). Beta-thalassemia. Orphanet journal of rare diseases, 5, 11. https://doi.org/10.1186/1750-1172-5-11
2. Sumedha, D., & Anita, K. (2023). Prevalence of beta thalassemia carriers in India: a systematic review and meta-analysis. Journal of community genetics, 14(6), 527–541. https://doi.org/10.1007/s12687-023-00683-7
3. Tarantino G, et al. Elevated liver iron concentration is a marker of increased morbidity in patients with β thalassemia intermedia. Haematologica. 2005;90(7):953–960
4. Farmakis, D., Porter, J., Taher, A., Domenica Cappellini, M., Angastiniotis, M., & Eleftheriou, A. (2022). 2021 Thalassaemia International Federation Guidelines for the Management of Transfusion-dependent Thalassemia. HemaSphere, 6(8), e732. https://doi.org/10.1097/HS9.0000000000000732
5. Correlation of Increased Serum Ferritin with SGOT, SGPT, and Albumin Levels in Children with β-Thalassemia Major . (2022). Archives of Pediatric Gastroenterology, Hepatology, and Nutrition, 1(3), 1-7. https://doi.org/10.58427/apghn.1.3.2022.1-7
6. Cappellini MD, Cohen A, Porter J, Taher A, Viprakasit V. Guidelines for the Management of Transfusion-Dependent Thalassaemia (TDT). 4th ed. Thalassaemia International Federation; 2021.
7. Musallam, K. M., Cappellini, M. D., Wood, J. C., Motta, I., Graziadei, G., Tamim, H., & Taher, A. T. (2011). Elevated liver iron concentration is a marker of increased morbidity in patients with β thalassemia intermedia. Haematologica, 96(11), 1605–1612. https://doi.org/10.3324/haematol.2011.047852
8. De Sanctis, V., Elsedfy, H., Soliman, A. T., Elhakim, I. Z., Soliman, N. A., Elalaily, R., & Kattamis, C. (2016). Endocrine profile of β-thalassemia major patients followed from childhood to advanced adulthood in a tertiary care center. Indian journal of endocrinology and metabolism, 20(4), 451–459. https://doi.org/10.4103/2230-8210.183456
9. Viprakasit, V., Lee-Lee, C., Chong, Q. T., Lin, K. H., & Khuhapinant, A. (2009). Iron chelation therapy in the management of thalassemia: the Asian perspectives. International journal of hematology, 90(4), 435–445. https://doi.org/10.1007/s12185-009-0432-0.

ISSN (O): 2687-5365; ISSN (P): 2753-6556