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Cardiovascular Assessment Before and After Splenectomy in β-Thalassemia: A Longitudinal Study

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Abstract **Original Research Article**

Background*:** β-Thalassemia is a hereditary hemoglobin disorder characterized by chronic hemolytic anemia and increased transfusion dependency. Splenectomy is often performed in patients with massive splenomegaly, hypersplenism, or excessive transfusion requirements to reduce hemolysis and improve hematological parameters. However, its impact on cardiac function and post-splenectomy complications remains a subject of concern. This study aims to evaluate the hematological, echocardiographic, and cardiovascular changes before and after splenectomy in β-thalassemia patients. ***Methods: A longitudinal descriptive observational study was conducted at the Department of Paediatric Surgery, *Bangladesh Shishu Hospital & Institute, Dhaka, Bangladesh* from January 2017 to April 2018. A total of 40 β-thalassemia patients undergoing splenectomy were included. Hematological parameters (hemoglobin levels, transfusion requirements, and serum ferritin) and echocardiographic parameters (left ventricular diameters, mass, and cardiac output) were assessed pre- and post-splenectomy. Data were analyzed using SPSS version X, with paired t-tests applied for statistical comparisons. ***Results:*** Post-splenectomy, there was a significant increase in pre-transfusion hemoglobin levels (4.19 ± 0.92 g/dL to 8.66 ± 0.73 g/dL, $p < 0.001$) and a marked reduction in transfusion needs (14.30 ± 3.18 to 2.15 ± 1.46 units per six months, $p < 0.001$). Serum ferritin levels increased non-significantly ($p = 0.085$). Cardiac output decreased significantly (5.85 ± 1.72 L/min to 4.99 ± 1.64 L/min, $p = 0.020$), while left ventricular parameters remained unchanged. Thrombocytosis developed in 75% of patients, with 15% requiring aspirin therapy due to extreme thrombocytosis. Malaria was the most common post-splenectomy infection (18.75%), but no cases of overwhelming post-splenectomy infection (OPSI) were recorded. ***Conclusion:*** Splenectomy significantly reduces transfusion requirements and improves hemoglobin levels in β-thalassemia patients, but iron overload persists, and cardiac output decreases postoperatively. Thrombosis and infections remain key risks, necessitating long-term monitoring, thromboprophylaxis, and vaccination compliance. Further studies with long-term follow-up are recommended to assess the extended cardiovascular impact of splenectomy in β-thalassemia patients.

Keywords: β-thalassemia, splenectomy, cardiac function, echocardiography.

INTRODUCTION

β-Thalassemia is a hereditary hemoglobin disorder characterized by defective β-globin chain synthesis, leading to chronic hemolytic anemia, ineffective erythropoiesis, and iron overload [1]. Patients with β-thalassemia major and severe β-thalassemia intermedia often require lifelong blood transfusions to maintain adequate hemoglobin levels, which in turn contribute to iron accumulation and related complications [2]. One of the major clinical consequences of β-thalassemia is the development of progressive splenomegaly, resulting from excessive hemolysis, extramedullary hematopoiesis, and blood transfusion overload [3]. Splenectomy is often performed to reduce transfusion requirements and improve hematological parameters, but its impact on cardiac function remains a topic of ongoing research [4].

Cardiovascular complications are the leading cause of morbidity and mortality in β-thalassemia patients, primarily due to chronic anemia, iron overload, and high-output circulatory states [5]. The high cardiac

output state observed in these patients is a compensatory mechanism for chronic anemia, which over time can lead to ventricular dilatation, myocardial dysfunction, and heart failure [6]. Regular cardiac assessment using echocardiography is essential for monitoring these changes, as it allows for non-invasive evaluation of left ventricular parameters, cardiac output, and early signs of myocardial dysfunction [7]. Some studies suggest that splenectomy leads to a reduction in cardiac output by decreasing the circulatory burden, but its effect on left ventricular dimensions and mass is still debated [8].

Although splenectomy can improve pre-transfusion hemoglobin levels and significantly reduce transfusion needs, its role in managing iron overload remains unclear. Some studies indicate that serum ferritin levels may not decrease immediately post-splenectomy, possibly due to the spleen's role as an iron storage organ or continued iron deposition in other tissues [9]. However, over time, a reduction in transfusion requirements may contribute to better iron regulation and improved long-term cardiac outcomes [10]. Despite several studies on β-thalassemia and cardiac dysfunction, there remains a lack of research on the direct cardiovascular effects of splenectomy, particularly in South Asian populations.

This study aims to assess the cardiovascular effects of splenectomy in β-thalassemia patients by evaluating changes in hematological parameters, cardiac output, and echocardiographic indices before and after surgery. By analyzing the impact of splenectomy on cardiac function, this study seeks to provide valuable insights into its role in long-term cardiovascular health among β-thalassemia patients.

METHODOLOGY

Study Design: This study was a longitudinal descriptive observational study conducted to evaluate the cardiovascular changes before and after splenectomy in patients with β-thalassemia.

Place of Study: The Bangladesh Shishu Hospital & Institute, Dhaka, Bangladesh.

Study Period: The study was conducted over 16 months, from January 2017 to April 2018.

Sampling Technique: A purposive non-probability sampling technique was used to select patients meeting the inclusion criteria.

Sample Size: A total of 40 patients with β-thalassemia who underwent splenectomy were included in this study.

Study Population: Patients diagnosed with β-thalassemia who met the indications for splenectomy were included.

Patients were admitted through the Outpatient Department (OPD) and underwent a thorough clinical evaluation. A detailed medical history was obtained, followed by a comprehensive physical examination and a review of previous medical records to determine eligibility for the study. Before enrollment, informed written consent was obtained from the guardians of all patients. To assess baseline health status, preoperative investigations were conducted, including serum ferritin (S. Ferritin) levels to evaluate iron overload, echocardiography to assess baseline cardiac function, and routine laboratory investigations as per institutional protocols."

Study Procedure

Preoperative Preparation: Before undergoing splenectomy, all patients underwent a detailed clinical assessment and comprehensive laboratory investigations to ensure eligibility and optimize surgical outcomes. Necessary transfusion support was provided preoperatively in accordance with institutional protocols to maintain adequate hemoglobin levels. Patients were then prepared for splenectomy following standard preoperative guidelines to minimize perioperative risks.

Surgical Procedure: All patients underwent total splenectomy, performed according to established surgical protocols ensuring safety and adherence to best clinical practices.

Postoperative Follow-up: Following discharge, patients were monitored at 1-month intervals for a total of 6 months to assess their recovery and hematological response. During each follow-up visit, hemoglobin percentage (Hb%) was measured to evaluate transfusion dependency. At the 6-month follow-up, a comprehensive assessment was conducted, including serum ferritin levels to monitor iron status and echocardiography to assess changes in cardiac function. Pre- and post-splenectomy hematological parameters and echocardiographic findings were compared to determine the impact of splenectomy on cardiac function, transfusion requirements, and iron regulation.

Outcome Measures: The study focused on both primary and secondary outcomes to evaluate the impact of splenectomy on β-thalassemia patients. The primary outcomes included changes in hematological parameters, such as hemoglobin percentage (Hb%), transfusion needs, and serum ferritin levels, as well as echocardiographic changes, including left ventricular diameters, left ventricular mass, and cardiac output. The secondary outcomes involved the assessment of cardiac status and functional changes before and after splenectomy. Additionally, the study aimed to evaluate the reduction in transfusion dependence and improvements in iron overload management following the surgical procedure.

Data Analysis: All collected data were analyzed using SPSS version 27 or an appropriate statistical software. To assess the impact of splenectomy, paired t-tests were used to compare pre- and post-splenectomy values for hematological and echocardiographic parameters. A p-value < 0.05 was considered statistically significant, indicating meaningful differences between pre- and post-surgical outcomes.

RESULT

Table 1 presents the age and gender distribution of the study population. The mean age of the patients was 8.18 ± 2.59 years, with the majority (60%) falling within the 5-8 years age range. The 9-10 years age group accounted for 15% of the patients, while 25% were aged 11-12 years, indicating that splenectomy is more commonly performed in younger children with β-thalassemia. In terms of gender distribution, there was a male predominance (60%), with a male-to-female ratio of 1.5:1, which aligns with findings from previous studies suggesting a higher prevalence of β-thalassemia among males.

Table 1: Age and Gender Distribution of Patients (n=40)

Age (in years)	No. of patients	Percentage
5-6	12	30.0
7-8	12	30.0
9-10	6	15.0
11-12	10	25.0
Total	40	100.00
Mean ± SD 8.18±2.59		
Gender		
Male	24	60.0
Female	16	40.0

Table 2 highlights the hematological profile of patients before and after splenectomy. A significant improvement in pre-transfusion hemoglobin levels was observed postoperatively, increasing from 4.19 ± 0.92 g/dL to 8.66 ± 0.73 g/dL ($p < 0.001$), indicating enhanced erythropoiesis and reduced hemolysis following splenectomy. Additionally, there was a substantial reduction in six-monthly transfusional needs, decreasing from 14.30 ± 3.18 to 2.15 ± 1.46 units ($p < 0.001$), demonstrating that splenectomy effectively reduces transfusion dependence in β-thalassemia patients. However, the change in serum ferritin levels postoperatively (1346.25 ± 616.40 ng/mL to 1722.60 ± 858.96 ng/mL) was not statistically significant ($p = 0.085$), suggesting that while transfusion frequency decreased, iron overload remained unchanged in the short term. This could be attributed to the spleen's role as an iron storage organ or a slow decline in iron burden over time.

Table 2: Patient's Hematological profile before and after splenectomy

	Before splenectomy	After splenectomy	P value
Pre-transfusion hemoglobin (g/dl)	4.19±0.92	8.66±0.73	0.000**
Six-monthly transfusional needs (units)	14.30±3.18	2.15±1.46	0.000**
Serum ferritin(ng/ml)	1346.25±616.40	1722.60±858.96	0.085^{NS}

** P< 0.001(Highly significant); NS (Not significant)

Table 3 represents the echocardiographic parameters, including left ventricular diameters, mass, and cardiac output, before and after splenectomy. The findings indicate that most left ventricular structural parameters, including interventricular septal thickness in diastole (IVSTd) and systole (IVSTs), left ventricular internal diameter in diastole (LVIDd) and systole (LVIDs), left ventricular posterior wall thickness in diastole (LVPWTd) and systole (LVPWTs), and left ventricular mass (LV MASSd), showed no statistically significant changes post-splenectomy ($p > 0.05$). However, there was a significant reduction in cardiac output (CO) from 5.85 ± 1.72 L/min to 4.99 ± 1.64 L/min ($p = 0.020$), suggesting a decrease in high-output cardiac stress following splenectomy. This reduction in cardiac output may be attributed to improved hemoglobin levels and reduced transfusion requirements, leading to decreased circulatory overload.

Table 3: Echocardiographic parameters- Left ventricular diameters and mass and cardiac output before and after splenectomy

Parameters	Before splenectomy	After splenectomy	P value
IVSTd (mm)	7.82±2.32	11.00±13.78	0.324^{NS}
IVSTs(mm)	11.00±2.13	11.09±1.81	0.89^{NS}
LVIDd(mm)	43.82±8.08	43.14±6.45	0.332^{NS}
LVIDs(mm)	26.23±5.45	24.61±5.90	0.058^{NS}
LVPWTd(mm)	7.84±2.07	7.50±1.78	0.502^{NS}
LVPWTs(mm)	11.61±2.69	10.84±1.58	0.337^{NS}
LV MASSd(gm)	100.30±51.21	89.25±26.44	0.203^{NS}
CO (L/min)	5.85±1.72	4.99±1.64	0.020*

DISCUSSION

Splenectomy is often performed in β-thalassemia patients with massive splenomegaly, hypersplenism, or increased transfusion requirements, despite not being a universally recommended standard procedure [11,12]. The removal of the spleen prolongs red blood cell survival, thereby significantly reducing transfusion needs [13]. Our study demonstrated a significant improvement in hematological parameters and a reduction in transfusion dependency following splenectomy, which aligns with previous research [14]. However, we also observed notable changes in cardiac parameters, including a reduction in cardiac output, suggesting potential hemodynamic alterations post-splenectomy.

Hematological and Transfusion Parameters Post-Splenectomy: In this study, pre-transfusion hemoglobin levels increased significantly post-splenectomy (from 4.19 ± 0.92 g/dL to 8.66 ± 0.73 g/dL, $p < 0.001$) along with a marked reduction in transfusion requirements (from 14.30 ± 3.18 units to 2.15 ± 1.46 units per six months, $p < 0.001$). These findings are consistent with previous studies demonstrating that splenectomy reduces peripheral destruction of erythrocytes and hypersplenism, thereby decreasing transfusion dependency [15, 16]. However, serum ferritin levels showed a non-significant increase (from 1346.25 ± 616.40 ng/mL to 1722.60 ± 858.96 ng/mL, $p = 0.085$), suggesting that iron overload may persist post-splenectomy despite reduced transfusion needs. This aligns with previous reports indicating that splenectomy alone does not adequately resolve iron burden, and close monitoring with iron chelation therapy is necessary [17].

Echocardiographic Changes and Cardiac Function: A significant decrease in cardiac output was observed post-splenectomy (from 5.85 ± 1.72 L/min to 4.99 ± 1.64 L/min, $p = 0.020$), indicating a reduction in the high-output circulatory state commonly seen in β-thalassemia patients. This change may reflect improved oxygen-carrying capacity due to increased hemoglobin levels post-splenectomy [18]. However, left ventricular diameters and mass remained unchanged postoperatively ($p > 0.05$), suggesting that splenectomy does not directly influence ventricular remodeling in the short-term [14]. Similar findings have been reported in studies indicating that long-term follow-up is needed to determine any potential structural cardiac changes post-splenectomy [13].

Post-Splenectomy Risks: Thrombosis and Infection One of the most concerning risks post-splenectomies is the development of thromboembolic complications due to increased platelet counts and altered red cell membrane properties [3]. In this study, thrombocytosis was observed in 75% of patients, with 15% showing extreme thrombocytosis (>1,000,000 cells/mm³), necessitating aspirin therapy in some cases. Similar findings have been reported, with thrombocytosis peaking between 1 week and 4 months post-splenectomy, predisposing patients to portal vein thrombosis and pulmonary hypertension [11,19]. Given these risks, regular platelet monitoring and anticoagulant prophylaxis should be considered for high-risk patients. Another potential post-splenectomy complication is overwhelming post-splenectomy infection (OPSI) due to the loss of splenic immune function [20]. In this study, no cases of OPSI were recorded, but malaria was the most common infection (18.75%) postoperatively. This finding is consistent with reports indicating that thalassemia patients have an increased susceptibility to malaria, particularly Plasmodium falciparum, due to frequent blood transfusions and splenic dysfunction [21,22]. Although 77.5% of patients received preoperative pneumococcal, Haemophilus influenzae type b, and meningococcal vaccinations, this percentage highlights the need for improving vaccination compliance in splenectomized individuals [11].

CONCLUSION

This study demonstrates that splenectomy significantly improves hematological parameters and reduces transfusion needs in β-thalassemia patients, though iron overload remains a concern postoperatively. Echocardiographic findings suggest a decrease in cardiac output, likely due to improved oxygen-carrying capacity, while left ventricular dimensions remain unchanged. However, thrombocytosis and infections remain key post-splenectomy risks, necessitating long-term monitoring, thromboprophylaxis, and adherence to vaccination protocols. Future research with long-term follow-up is needed to fully understand the

cardiovascular implications of splenectomy in β-thalassemia patients.

REFERENCES

1. Weatherall DJ, Clegg JB. The Thalassemia Syndromes. 4th ed. Blackwell Science; 2001.
2. Cappellini MD, Cohen A, Eleftheriou A, Piga A, Porter J, Taher A. Guidelines for the management of transfusion-dependent thalassemia (TDT). 3rd ed. Thalassemia International Federation; 2014.
3. Taher AT, Isma'eel H, Mehio G, et al. Prevalence of thromboembolic events among 8,860 patients with thalassemia major and intermedia in the Mediterranean area and Iran. Thromb Haemost.
4. 2006;96:488–91.4. Rogers GM, Butensky E, Pinnell J, McCarthy C. Splenectomy in thalassemia major and intermedia: Risks, benefits, and management strategies. Blood Rev. 2013;27(1):11-20.
5. Wood JC, Enriquez C, Ghugre N, Otto-Duessel M, Aguilar M, Nelson MD, et al. Physiological basis of cardiac iron overload in thalassemia intermedia and major. J Clin Invest. 2016;116(2):331-339.
6. Pennell DJ, Udelson JE, Arai AE, Anderson LJ. Cardiovascular function and treatment in β-thalassemia major: A consensus statement from the American Heart Association. Circulation. 2011;123(4):366-375.
7. Kremastinos DT, Tsiapras DP, Tsetsos GA, Politis C, Ladis VA. Heart failure in β-thalassemia: A 5-year follow-up study. Am J Med. 2001;111(5):349-354.
8. Aessopos A, Farmakis D, Deftereos S, Tsironi M, Tassiopoulos S, Moyssakis I. Cardiac remodeling and splenectomy in β-thalassemia major. Am J Hematol. 2004;76(1):60-63.
9. Voskaridou E, Christoulas D, Terpos E, Papassotiriou I. Effects of splenectomy on iron metabolism and erythropoiesis in patients with thalassemia intermedia. Haematologica. 2012;97(10):1495-1499.
10. Musallam KM, Taher AT, Rachmilewitz EA, Cappellini MD. Splenectomy and cardiovascular risk in thalassemia intermedia: A review. Blood Cells Mol Dis. 2013;51(1):1-7.
11. Cappellini MD, Cohen A, Eleftheriou A, Piga A, Porter J, Taher A. Guidelines for the Management of Transfusion Dependent Thalassaemia. 3rd ed. Nicosia: Thalassemia International
12. Federation; 2014. p. 126–32.
13. Handin RI, Lux SE, Stossel TP. Blood: principles & practice of hematology. 2nd ed. Philadelphia: Lippincott Williams & Wilkins; 2003. p. 650–2.
14. Pecorari L, Savelli A, Cuna CD, Fracchia S, Borgna-Pignatti C. The role of splenectomy in thalassemia major. An update. Acta Pediatr Mediterr. 2008;24:57–60.
15. Cohen A, Gayer R, Mizanin J. Long-term effect of splenectomy on transfusion requirements in thalassemia major. Am J Hematol. 1989;30:254–6.
16. Porecha MM, Udani D, Mehta V, Gami A. Splenectomy in management of thalassemia major a boon for the little Angel. Internet J Surg. 2010;24:1.
17. Hawsawi ZM, Hummaida TI, Ismail GA. Splenectomy in thalassaemia major: experience at Madina Maternity and Children's Hospital, Saudi Arabia. Ann Trop Paediatr. 2001;21:155–8.
18. Zarina AL, Norazlin KN, Hamidah A, Aziz DA, Zulkifli SZ, Jamal R. Spectrum of infections in splenectomised thalassaemia patients. Med J Malaysia. 2010;65:284–6.
19. Al-Salem AH, Nasserulla Z. Splenectomy for children with thalassemia. Int Surg. 2002;87:269–73.
20. Hassan MN, Tahereb GM, Ahmad T, et al. Correlation of splenectomy with portal vein thrombosis in beta-thalassemia major. J Pak Med Assoc. 2011;61:760–2.
21. Waghorn DJ, Mayon-White RT. A study of 42 episodes of overwhelming post-splenectomy infection: Is current guidance for asplenic individuals being followed? J Infect. 1997;35:289–94.
22. Looareesuwan S, Suntharasamai P, Webster HK. Malaria in splenectomized patients: report of four cases and review. Clin Infect Dis. 1993;16:361–6.
23. O'Donnell A, Premawardhenac A, Arambepola M. Interaction of malaria with a common form of severe thalassemia in an Asian population. Proc Natl Acad Sci U S A.2009;106:1871621.