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Simultaneous laparoscopic splenectomy and cholecystectomy in children with hereditary spherocytosis: Experience from a cohort of pediatric hematologic disorders

Hasan Deliağa, Hakan Özcan, Merve Öztürk, Esra Özçakır, Mete Kaya

Hemolytic anemias, including hereditary spherocytosis (HS), sickle cell disease (SCD), thalassemia, and enzyme or hemoglobin synthesis disorders, are among the most common hematologic indications for splenectomy in children.[1] Chronic hemolysis, hypersplenism, and recurrent sequestration episodes may require surgical removal of the spleen.[2] Additionally, excessive hemolysis in these diseases alters bile composition, increasing the risk of cholelithiasis.[3,4] It has been stated that approximately 6% to 16% of children with HS eventually require cholecystectomy for gallbladder disease, while gallbladder disease occurs in about 6.9% of patients with SCD.[5] Although cholecystectomy is a well-established indication in cases of symptomatic gallstone disease, the management of asymptomatic cholelithiasis in HS and SCD remains controversial. The debate mainly arises from the fact that some asymptomatic

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Correspondence: Hasan Deliağa, MD.

E-mail: drhasandeliaga@hotmail.com

Department of Pediatric Surgery, University of Health Sciences, Bursa Faculty of Medicine, Bursa, Türkiye

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Abstract

Objectives: This study aimed to compare perioperative and postoperative outcomes of simultaneous laparoscopic splenectomy (LS) and laparoscopic cholecystectomy (LC) with those of isolated procedures in children.

Patients and methods: A single-center retrospective cohort study was conducted on pediatric patients who underwent LS, LC, or simultaneous LS and LC between January 2014 and June 2024. Demographic characteristics, operative details, complications (Clavien-Dindo classification), transfusion requirements, hospital stay, and long-term hematologic parameters were analyzed.

Results: A total of 31 patients (17 male, 14 female; mean age: 10.6 ± 3.9 years; range, 4 to 17 years) were included and divided into three groups according to the surgical procedure performed: the LS group (n = 12), the LC group (n = 8), and the LS+LC group (n = 11). The mean operative time was significantly longer in the LS+LC group (199.0 ± 88.2 min) compared to LS (138.0 ± 48.8 min) and LC (86.4 ± 25.4 min) ($p < 0.05$). Hospital stay was also longer in the combined group (9.7 ± 4.0 days, $p < 0.05$). However, complication rates, transfusion requirements, and conversion rates were comparable across groups. One case of portal vein thrombosis occurred in the LS group. No mortality was observed.

Conclusion: Simultaneous LS and cholecystectomy is a feasible surgical option for carefully selected children with hematologic disorders requiring both procedures. Although combined surgery was associated with longer operative time and hospital stay, the severity of postoperative complications did not differ significantly among the surgical groups. No portal vein thrombosis or mortality occurred in the combined group. These findings support the potential benefits of a single-stage approach in avoiding separate operations and repeated anesthetic exposures, while highlighting the need for larger studies to confirm its safety and comparative effectiveness.

Keywords: Children, concomitant surgery, hemolytic anemia, hereditary spherocytosis, laparoscopic cholecystectomy, laparoscopic splenectomy.

patients may remain symptom-free for years, whereas surgery itself carries potential risks and complications.[3] Conversely, some authors advocate for prophylactic cholecystectomy at the time of splenectomy, arguing that patients with hemolytic anemia have a higher risk of recurrent gallstone formation and that gallbladder disease may become more pronounced after splenectomy.[5,6] However, there are currently no clear international guidelines addressing the necessity of prophylactic cholecystectomy in asymptomatic cases, and decisions are typically based on institutional experience and individual patient characteristics. Moreover, evidence regarding the effect of concurrent cholecystectomy on the outcomes of laparoscopic splenectomy (LS) is limited.

While splenectomy and cholecystectomy have traditionally been performed by both laparotomy and laparoscopy as separate procedures, advances in minimally invasive techniques have made simultaneous LS and laparoscopic cholecystectomy (LC) feasible. However, data in pediatric populations remain limited. This study aimed to compare perioperative and postoperative outcomes of simultaneous LS+LC with isolated procedures (LS or LC) in children with hematologic disorders.

PATIENTS AND METHODS

This was a single-center, retrospective, observational cohort study conducted at Bursa Yüksek İhtisas Training and Research Hospital, Department of Pediatric Surgery, between January 2014 and June 2024.

Children aged 0-18 years who underwent LS, LC, or simultaneous LS+LC were included. The inclusion criteria were patients who had completed surgery and had a minimum postoperative follow-up of six months. Exclusion criteria included patients with incomplete medical records or those who had undergone operations in other centers. Written informed consent was obtained from the parents or legal guardians of all participating pediatric patients prior to inclusion. The study protocol was approved by the Institutional Ethics Committee of Bursa Yüksek İhtisas Training and Research Hospital (Date: January 31, 2024, IBR: 2024-TBEKN2025/08-03). The study was conducted in accordance with the principles of the Declaration of Helsinki.

The indication for surgery was determined through a multidisciplinary evaluation involving pediatric surgeons and pediatric hematologists. All patients were under regular follow-up by the pediatric hematology department, and surgical decisions were made after multidisciplinary case discussions. Laparoscopic splenectomy was performed in patients who met the accepted hematologic indications for splenectomy. Laparoscopic cholecystectomy was performed in patients with cholelithiasis. Simultaneous LS and LC was reserved for patients who fulfilled the indications for both procedures, namely those with hematologic disease requiring splenectomy and concomitant cholelithiasis. Patients who met the indication for only one procedure underwent either LS or LC alone. None of the patients had biliary obstruction at the time of surgery. Some patients had experienced previous episodes of cholestatic symptoms, which resolved following hydration and oral ursodeoxycholic acid treatment before surgery. Elective surgery was performed only after resolution of cholestatic findings and clinical stabilization.

Demographic and clinical variables included age, sex, weight, and underlying diagnosis, such as HS, SCD, thalassemia, immune thrombocytopenia, and glucose-6-phosphate dehydrogenase (G6PD) deficiency. Operative variables included operative time, conversion to open surgery, need for blood transfusion, use and duration of drains, and hospital stay. Postoperative outcomes included complications (graded according to Clavien-Dindo classification), readmissions within one year, infections (fever, wound infection, intra-abdominal abscess), and portal vein thrombosis (PVT). Long-term hematologic data (hemoglobin, reticulocyte count, and bilirubin levels) were noted six months postoperatively.

The surgical technique was performed as described before for standard LC and LS. The patient was placed in the supine position with the left side elevated approximately 45 degrees using pads under the back. A 10-mm optical port was introduced into the peritoneal cavity using the Hasson technique, and pneumoperitoneum was established at a pressure of 12 cm H_2O. Cholecystectomy was performed first, with the operating table tilted 30 degrees to the left and in a reverse Trendelenburg position,

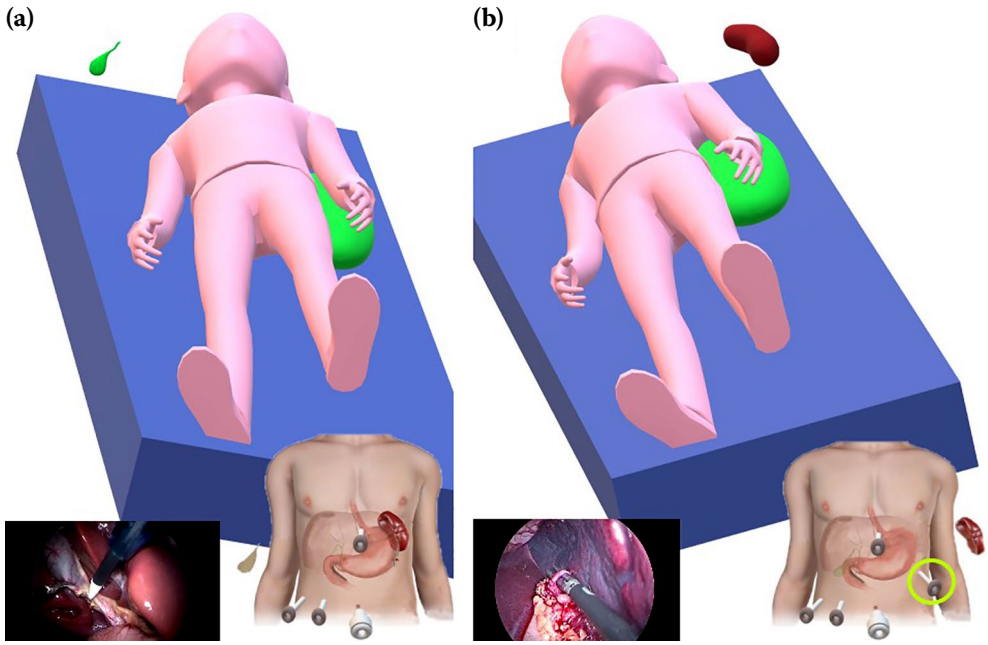


Figure 1. Operative details of simultaneous laparoscopic splenectomy and cholecystectomy. The patient is placed in the supine position, with the left side elevated by 45° using pads to achieve a left-oblique position. An umbilical optical port is inserted. **(a)** The operating table is tilted 30° to the left and placed in the reverse Trendelenburg position for cholecystectomy, using three working ports (indicated by the green gallbladder icon in Panel A). **(b)** The table is then tilted 40° to the right, and an additional working port (green circle) is inserted in the left hypochondrium to complete the splenectomy (indicated by the red spleen icon in Panel B).

using three 5-mm ports in the conventional manner, as shown in Figure 1a. To perform splenectomy, the table was then tilted 40 degrees to the opposite side, creating an approximately 55-degree oblique position. An additional working port was inserted into the left hypochondrium, as shown in Figure 1b. The splenocolic and gastrosplenic ligaments were divided, and the short gastric vessels were sealed and divided using a Vessel-Sealing device (LigaSure™ Maryland Vessel Sealer; Medtronic, Minneapolis, MN, USA). The splenic artery was isolated, clipped, or ligated with silk sutures, and then divided. The splenic vein was ligated and divided as a single or double ligation. The remaining ligaments and attachments of the devascularized spleen were dissected using a vessel-sealing device to complete the splenectomy. Both the gallbladder and spleen were put into an endobag and removed through the umbilical port site after fragmentation. A penrose drain was placed in the cholecystectomy or splenectomy bed in cases of suspected bleeding or possible pancreatic tail injury for at least 24 h. Oral intake with clear liquids was initiated on postoperative day one in patients with confirmed bowel passage.

Postoperatively, all patients underwent routine clinical monitoring, including serial complete blood counts with platelet measurements and coagulation profiles. Patients were encouraged to mobilize early after surgery. Doppler ultrasonography and anticoagulant therapy were not routinely performed but were reserved for patients with clinical suspicion of PVT.

Statistical analyses

Data were analyzed using IBM SPSS version 26.0 software (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation or median (interquartile range, IQR). Categorical variables were compared using chi-square or Fisher's exact test. Nonparametric tests (Kruskal-Wallis with Dunn's post-hoc test) were applied for continuous

TABLE 1
Demographic characteristics of patients

	LS (n = 12)		LC (n = 8)		LS+LC (n = 11)		Total (n = 31)		
	n	Mean ± SD	n	Mean ± SD	n	Mean ± SD	n	Mean ± SD	*p*
Age (year)		10.6 ± 4.1		10.2 ± 4.2		10.8 ± 3.7		10.6 ± 3.9	> 0.05
Sex Female Male	 5 7		 3 5		 6 5		 14 17		> 0.05
Diagnosis									
Hereditary spherocytosis	4		3		11		17		< 0.05*
Sickle cell disease	1		1		-		2		
Thalassemia	3		2		-		5		
Idiopathic thrombocytopenic purpura	3		-		-		3		
Glucose-6-phosphate dehydrogenase deficiency	-		2		-		2		
Glycogen storage disease	1		-		-		1		

LS, laparoscopic splenectomy; LC, laparoscopic cholecystectomy; SD, standard deviation; * The LS+LC group was compared separately with the LS and LC groups, and statistically significant differences were observed in both comparisons.

TABLE 2
Operative findings and outcomes

	LS (n = 12)		LC (n = 8)		LS+LC (n = 11)		Total (n = 31)		
	n	Mean ± SD	n	Mean ± SD	n	Mean ± SD	n	Mean ± SD	*p*
Conversion	7		-		2		9		< 0.05*
Operative time (min)		138.0 ± 48.8		86.4 ± 25.4		199.0 ± 88.2		149.1 ± 76.8	< 0.05†
Drain placement	-		1		1		2		> 0.05

LS, laparoscopic splenectomy; LC, laparoscopic cholecystectomy; SD, standard deviation; * The LS group was compared separately with the LC and LS+LC groups; † The LS and LS+LC groups were each compared with the LC group.

variables. A *p*-value < 0.05 was considered statistically significant.

RESULTS

A total of 31 patients (17 male, 14 female; mean age: 10.6 ± 3.9 years; range, 4 to 17 years) were included and divided into three groups according to the surgical procedure performed: the LS group (n = 12), the LC group (n = 8), and the LS+LC group (n = 11). The underlying diseases were HS (n = 17), thalassemia (n = 5), idiopathic thrombocytopenic purpura (n = 3), SCD (n = 2), G6PD deficiency (n = 2), and glycogen storage disease (n = 1), as shown in Table 1.

Mean operative time was significantly longer in the LS+LC group (199.0 ± 88.2 min) compared to LS (138.0 ± 48.8 min) and LC (86.4 ± 25.4 min) ($p < 0.05$). Conversion to open surgery occurred in nine cases: 7 (LS), 0 (LC), and 2 (LS+LC) ($p < 0.05$). Drains were used in two cases (1 LC, 1 LS+LC). Blood transfusion was required in 15 patients (48%), predominantly those undergoing splenectomy ($p > 0.05$), as shown in Table 2.

Median Clavien-Dindo grade did not differ significantly among groups [LS: 0.5 (0-1.75); LC: 0.0 (0-0.75); LS+LC: 1.0 (0-1)] ($p > 0.05$). Mean hospital stay was significantly longer in the LS+LC group (9.7 ± 4.0 days) compared to LS (6.0 ± 3.0 days) and LC (4.0 ± 0.7 days) ($p < 0.05$). Portal vein thrombosis occurred in one patient following LS; no cases occurred in the combined group, as shown in Table 3. Within one year, two patients required readmission for minor infections, one of which was PVT. No mortality was recorded.

DISCUSSION

In the present study, we evaluated the surgical outcomes of LS, LC, and simultaneous LS+LC in children with hematologic disorders. Our study results showed that the combined procedure was associated with longer operative time and hospital stay, while postoperative complication severity did not differ significantly among the groups. These findings suggest that simultaneous LS and LC is a feasible option for selected pediatric patients requiring both procedures, potentially avoiding multiple operations and repeated anesthetic exposures.

Splenectomy may be required in a variety of hematologic disorders, particularly when associated with hypersplenism or transfusion dependence. Concurrently, chronic hemolysis in these patients predisposes to gallstone formation, making cholecystectomy necessary in selected cases. Laparoscopic techniques have been shown to be safe for both procedures, and performing them simultaneously offers the benefits of single anesthesia, reduced hospital stay, and faster recovery compared with staged operations. The first report of combined LS and LC was published by Trias and Targarona[7] in 1994, describing its application in a 55-year-old man with HS. Since then, several studies have studied the safety, feasibility, and effectiveness of this approach.[8-10]

The sequence of these combined procedures has been described in previous reports, which recommend performing cholecystectomy first and using five ports for optimal exposure.[10] In our series, all combined procedures were performed laparoscopically, with the gallbladder removed first, followed by splenectomy after repositioning the patient to a left-lateral 30-35° inclination. Five ports were typically used for concomitant surgery, with the standard three-port configuration for cholecystectomy and one or two additional ports for splenectomy. Initially, the patient was positioned with a 45° elevation of the left side, which allowed both procedures to be performed by simply tilting the operating table without the need for repositioning or re-draping. The splenic hilum was managed using clips and ligatures, and drains were selectively placed in the subphrenic space for at least 24 h.

Although the combined approach offers distinct advantages, it is technically more demanding and

TABLE 3
Postoperative outcomes and complications

	LS (n = 12)			LC (n = 8)			LS+LC (n = 11)			Total (n = 31)			
	n	Mean ± SD	Median (IQR)	n	Mean ± SD	Median (IQR)	n	Mean ± SD	Median (IQR)	n	Mean ± SD	Median (IQR)	*p*
Clavien-Dindo grade			0.5 (0-1.75			0.0 (0-0.75)			1.0 (0-1)			-	> 0.05
Postoperative transfusion	6			2			7			15			> 0.05
Hospital stay (days)		6.0 ± 3.0			4.0 ± 0.7			9.7 ± 4.0			6.8 ± 3.9		**< 0.05***
Portal vein thrombosis	1			-			-			1			> 0.05
Readmission	2			-			-			2			> 0.05

LS, laparoscopic splenectomy; LC, laparoscopic cholecystectomy; SD, standard deviation; IQR, interquartile range; * Statistically significant differences were observed when the LS+LC group was compared separately with the LS and LC groups.

often requires longer operative times. In our series, the mean duration was 199 min for simultaneous procedures, which was longer than for single operations. In adult laparoscopic series, the mean operative time has been reported as approximately 170 min,[10] while in pediatric cohorts, Mack et al.[5] reported a mean duration of 182 min, and Pal[11] reported 160 min in a series of 21 patients. Larger spleen size and complex hilar anatomy were the main factors contributing to prolonged surgery, particularly when splenic weight exceeded 2000 g.[9]

Previous authors have described several technical modifications, including variations in port placement, order of procedures, and extraction methods for spleen and gallbladder.[12] The gallbladder is generally retrieved through the umbilical port, while the spleen can be removed through the enlarged optical port or via specimen bag extraction. Our technique was consistent with these recommendations, using conventional instruments without single-site devices.

In our cohort, the conversion rate in patients undergoing simultaneous LS and LC was 18% (2 of 11 patients), which was higher than the 3% rate reported in larger series.[9,13] This discrepancy likely reflects the learning curve and bleeding, differences in spleen size or anatomical variations during the early adoption phase of laparoscopy in our center. Importantly, intraoperative bleeding was minimal, and no conversion was due to uncontrollable hemorrhage.

The need for blood transfusion in our series was not related to intraoperative bleeding but rather to the underlying hemolytic disease of the patients. This observation agrees with Wang et al.,[14] who reported that transfusion requirements are primarily determined by the hematologic disease rather than the surgical technique.

The overall morbidity rate of combined LS and LC has been reported between 10% and 20%, including pulmonary infections (6.5%), PVT (4.6%), and bleeding (3.7%).[9,10,15] In our series, no cases of PVT occurred among patients undergoing simultaneous LS and LC, although one patient who underwent isolated LS developed PVT during the postoperative period. Therefore, our findings do not allow conclusions regarding factors associated with PVT prevention. Given the potentially serious consequences of this complication, careful postoperative clinical and laboratory monitoring remains important, with further evaluation performed when clinically indicated. When evaluated according to the Clavien-Dindo classification, complication rates in the simultaneous group were comparable to those of isolated splenectomy or cholecystectomy, indicating that the combined approach does not increase morbidity.

The postoperative hospital stay was longer in the simultaneous surgery group than in patients undergoing isolated procedures and exceeded the duration reported in most published series (9.7 *vs.* 5.4 days).[10] This finding may partly be explained by the conversion to open surgery in two patients, which likely prolonged postoperative recovery. In addition, our institution routinely maintains pediatric patients with hematologic disorders under closer postoperative observation to enable early detection and management of potential complications, including bleeding, PVT, and hematologic abnormalities. Therefore, the longer hospital stay observed in our series probably reflects both the impact of conversion in a small number of patients and our institutional postoperative management strategy rather than the laparoscopic approach itself.

Concomitant LS and LC has been shown to be a safe and feasible approach for patients requiring both procedures, providing the well-recognized benefits of minimally invasive surgery, including reduced postoperative pain, shorter hospital stay, faster recovery, improved cosmetic outcomes, and avoidance of a second anesthesia and hospitalization, particularly in children.[13] In their systematic review, Schizas et al.[10] further demonstrated that the complication and conversion rates of the combined procedure are comparable to those of LS or LC performed alone, although they emphasized the need for further studies and standardization of the operative technique. Nevertheless, potential disadvantages include increased technical complexity, the lack of consensus regarding patient positioning, trocar placement, and the sequence of procedures, as well as splenectomy-related complications such as postoperative bleeding and splenoportal vein thrombosis. In contrast to the postoperative bleeding reported by Nobili et al.,[13] no patient in our series required conversion to open surgery or developed major perioperative complications. Furthermore, consistent with the selective approach advocated by Ruparel et al.,[6]

we performed simultaneous LS and LC only in children who had independent indications for both procedures, supporting the safety and effectiveness of a carefully selected single-stage laparoscopic strategy.

This study has several limitations. It is a single-center retrospective analysis with a relatively small number of patients. Additionally, different surgeons performed the procedures over the study period, introducing variability in technique and learning curve effects. The retrospective nature and non-randomized design also limit the generalizability of our findings.

In conclusion, our experience demonstrates that simultaneous LS and LC can be safely performed in pediatric patients with hematologic disorders. Operative time and hospital stay are longer than for isolated procedures, but complication rates are similar, and no increase in morbidity was observed. The technique offers the benefits of minimally invasive surgery, avoids repeated anesthesia, and can be recommended for appropriately selected patients, and vigilant postoperative monitoring for PVT is essential.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: H.D.: Conceptualization, study design, data collection, data analysis, manuscript drafting, and final approval of the manuscript; H.Ö.: Data collection, surgical management of patients, critical revision of the manuscript, and final approval; M.Ö.: Data acquisition, literature review, manuscript revision, and final approval; E.Ö.: Data analysis, interpretation of results, manuscript revision, and final approval; M.K.: Study supervision, methodological oversight, critical revision of the manuscript, and final approval.

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