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Original Research Article

COMPARATIVE ANALYSIS OF LAPAROSCOPIC SPLENECTOMY VERSUS OPEN SPLENECTOMY IN PEDIATRIC PATIENTS: A RETROSPECTIVE STUDY

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ABSTRACT

Background: Splenectomy, the surgical removal of the spleen, has become integral in managing pediatric hematological and oncological conditions. Traditionally performed through open surgery, splenectomy has evolved with minimally invasive techniques like laparoscopy. Laparoscopic splenectomy (LS) offers benefits including reduced pain, shorter hospital stays, and improved cosmetics. Indications for LS in children have expanded, encompassing various splenic pathologies. Despite challenges in pediatric application, studies show LS efficacy with lower morbidity. This study aims to comprehensively compare LS and open splenectomy (OS) outcomes in pediatric patients, guiding optimal surgical approaches.

Materials and Methods: A retrospective analysis was conducted on pediatric patients (<18 years) who underwent LS or OS for various indications between June 2013 and May 2023 among pediatric patients in general surgery department at tertiary care hospital, Andaman and Nicobars Islands. Demographic data, operative details including operative time, blood loss, and approach type, postoperative outcomes, and complications were collected and compared between the two groups. Statistical analysis was performed using independent t-tests, and chi-square tests.

Results: A total of 82 pediatric patients were included in the analysis, with 41 patients in each group (LS and OS). The mean age was 9.6 years in the LS group and 9.9 years in the OS group (p = 0.686). LS was associated with significantly shorter operative time (LS: 122.4 ± 33.6 minutes vs. OS: 145.7 ± 44.3 minutes, p = 0.009) and reduced blood loss (LS: 192.8 ± 90.8 mL vs. OS: 288.3 ± 118.6 mL, p = 0.011) compared to OS. However, intraoperative complications rates were similar between LS and OS groups (LS: 9.8% vs. OS: 12.2%, p = 0.728). Postoperatively, both groups demonstrated comparable rates of overall complications (LS: 14.6% vs. OS: 19.5%, p = 0.557), with LS associated with a significantly shorter postoperative length of stay (LS: 4.5 ± 1.5 days vs. OS: 6.0 ± 2.0 days, p = 0.0002).

Conclusion: Our study demonstrates that LS offers advantages over OS in terms of shorter operative time, reduced blood loss, and shorter postoperative length of stay in pediatric patients undergoing splenectomy. However, both approaches exhibit comparable safety profiles in terms of intraoperative and postoperative complications.

Keywords: Laparoscopic splenectomy, open splenectomy, pediatric patients, operative details, postoperative outcomes, complications.

INTRODUCTION

Splenectomy, the surgical removal of the spleen, has become a cornerstone in the management of various pediatric hematological and oncological conditions.[1] Traditionally performed through open surgery, splenectomy has undergone a significant transformation with the introduction of minimally invasive techniques, particularly laparoscopy.[2]

Laparoscopic splenectomy (LS) was pioneered in the early 1990s and has since gained widespread acceptance due to its associated benefits, including reduced postoperative pain, shorter hospital stays, faster recovery, and improved cosmetic outcomes compared to open surgery. Initially reserved for select adult patients, the indications for LS have gradually expanded to encompass pediatric populations with diverse splenic pathologies.[3]

Pediatric splenic conditions necessitating surgical intervention encompass a spectrum of disorders, including hematological conditions such as hereditary spherocytosis, immune thrombocytopenia purpura (ITP), and hemoglobinopathies, as well as splenic tumors, cysts, and traumatic injuries [4]. These conditions collectively contribute to a significant burden on pediatric healthcare, with estimates suggesting a prevalence of approximately 1 in 500 to 2000 live births for hereditary spherocytosis and an incidence of 2 to 5 cases per 100,000 children per year for ITP.[5]

In cases where medical management fails to adequately control symptoms or prevent complications, splenectomy remains a crucial therapeutic option.[6] The primary goals of splenectomy in pediatric patients include alleviating symptoms, such as anemia, thrombocytopenia, and pain, as well as reducing the risk of splenic rupture and associated morbidity.[6]

Despite the established benefits of LS in adults, its application in pediatric patients presents unique challenges. Anatomical differences, smaller abdominal cavities, and the need for meticulous preservation of immune function necessitate specialized techniques and perioperative care. Nevertheless, advancements in surgical instrumentation and perioperative management have facilitated the safe and effective performance of LS in children across various age groups.[7]

Studies evaluating the outcomes of LS in pediatric patients have consistently reported favorable results, including comparable efficacy to open surgery with lower morbidity rates and improved patient satisfaction.[8,9] However, long-term follow-up studies are warranted to assess outcomes such as infectious complications, immunological function, and the potential for splenic regeneration following LS in children.[9]

Given the evolving landscape of pediatric surgery and the increasing demand for minimally invasive approaches, there is a critical need to evaluate the role of LS in the management of pediatric splenic disorders. This study aimed to aims to comprehensively compare the operative details, postoperative outcomes, and complications between LS and OS in pediatric patients. By elucidating the benefits and limitations of LS in children, this study seeks to inform clinical decision-making and optimize patient care in pediatric surgery.

MATERIAL AND METHODS

Study Design and Setting

This retrospective study was conducted for a period of 6 months from July 2023 to December 2023 among pediatric patients [who underwent splenectomy (open or laparoscopic)] in general surgery department at tertiary care hospital, Andaman and Nicobars Islands.

Patient Selection

Patients included in the study were identified from the institutional database and met specific inclusion criteria. These criteria encompassed pediatric individuals aged ≤ 18 years who underwent laparoscopic splenectomy (LS) or open splenectomy (OS) as the primary surgical intervention for various splenic pathologies. The indications for splenectomy included but were not limited to hematological disorders such as hereditary spherocytosis, immune thrombocytopenia purpura (ITP), and hemoglobinopathies, as well as splenic tumors, cysts, and traumatic injuries.

The exclusion criteria encompassed patients with contraindications to laparoscopic surgery, including severe cardiopulmonary compromise, uncontrolled coagulopathy, or intra-abdominal adhesions precluding safe laparoscopic access.

Data Collection

Demographic, clinical, and operative data of 10 years (between June 2013 and May 2023) were collected from electronic medical records. Variables of interest included age, sex, underlying diagnosis necessitating splenectomy, preoperative laboratory values (hemoglobin, platelet count, white blood cell count, coagulation profile), operative details such as surgical approach (open vs laparoscopic), operative time, intraoperative complications such as bleeding, wound infection; postoperative outcomes (length of hospital stay, complications), and long-term follow-up data, such as post-splenectomy infectious complications and splenic function, were also collected where available.

Surgical Technique

LS procedures were performed according to standardized techniques, with trocar placement and meticulous dissection of the splenic vessels using minimally invasive instruments. In contrast, OS involved a traditional open approach with a subcostal incision or midline laparotomy. Perioperative management protocols, including anesthesia techniques and postoperative care, were similar between groups.

Perioperative Management

Preoperative vaccination against encapsulated organisms was administered as per institutional protocols. Prophylactic antibiotics were administered perioperatively. Postoperative pain management consisted of multimodal analgesia, including intravenous opioids and nonsteroidal anti-inflammatory drugs. Patients were monitored for signs of post-splenectomy sepsis and received appropriate antibiotic therapy.

Outcome Measures

Primary outcome measures included intraoperative and postoperative complications, operative time, and length of hospital stay. Secondary outcomes encompassed the need for blood transfusion, post-splenectomy infectious complications, and long-term outcomes such as splenic function and immunological status.

Statistical Analysis

Statistical software, SPSS version 20.0, was utilized for data analysis, and all statistical tests were two-tailed. Descriptive statistics were used to summarize demographic characteristics, clinical variables, and outcome measures for both groups. Continuous variables, such as patient age and operative time, were presented as means with standard deviations. Categorical variables, including sex and underlying diagnosis, were expressed as frequencies and percentages. To assess differences between LS and OS groups, comparative analyses were performed using appropriate statistical tests [Continuous variables were analyzed using independent t-tests. Chi-square tests for categorical variables]. Significance was set at $p < 0.05$.

Ethical Considerations

This study was conducted in accordance with the principles of the Declaration of Helsinki and approved by the Institutional Review Board. Informed consent was obtained from all patients or their legal guardians prior to surgery.

RESULTS

In our study, a total of 82 study participants were found eligible, 41 study participants in each laparoscopic and open splenectomy group. Our analysis revealed no statistically significant disparities between the two cohorts in terms of age (LS: 9.5 ± 3.2 years vs. OS: 9.8 ± 3.5 years, p = 0.686), sex distribution (p = 0.651), or underlying diagnoses, including hereditary spherocytosis (LS: 36.6% vs. OS: 31.7%, p = 0.883) and immune thrombocytopenia purpura (ITP) (LS: 43.9% vs. OS: 48.8%, p = 0.742). Furthermore, there were no significant discrepancies observed in preoperative hematological parameters, encompassing hemoglobin concentration (LS: 9.8 ± 1.5 g/dL vs. OS: 9.7 ± 1.3 g/dL, p = 0.747), platelet count (LS: 100.9 ± 20.3 x10^3/µL vs. OS: 98.6 ± 22.4 x10^3/µL, p = 0.627), and white blood cell count (LS: 8.5 ± 2.0 x10^3/µL vs. OS: 8.2 ± 1.8 x10^3/µL, p = 0.477). [Table1]

Our analysis revealed significant differences in operative time and blood loss between the two groups, with LS demonstrating a shorter operative time (LS: 122.4 ± 33.6 minutes vs. OS: 145.7 ± 44.3 minutes, p = 0.009) and lower blood loss (LS: 192.8 ± 90.8 mL vs. OS: 288.3 ± 118.6 mL, p = 0.011). Additionally, while the conversion to open surgery was not applicable in the LS group, intraoperative complications were comparable between LS and OS (LS: 9.8% vs. OS: 12.2%, p = 0.728), with similar rates of bleeding (LS: 4.9% vs. OS: 7.3%, p = 0.644) and visceral injury (LS: 2.4% vs. OS: 4.9%, p = 0.556). One case of port site hernia was reported in the LS group. [Table 2]

Our analysis revealed no significant differences in overall complications between the two groups (LS: 14.6% vs. OS: 19.5%, p = 0.557), with similar rates of bleeding (LS: 7.3% vs. OS: 9.8%, p = 0.692), surgical site infection (LS: 4.9% vs. OS: 7.3%, p = 0.644), and pneumonia (LS: 2.4% vs. OS: 4.9%, p = 0.556). None of the patients developed sepsis in either group. Similarly, the need for postoperative transfusion was comparable between LS and OS (LS: 12.2% vs. OS: 14.6%, p = 0.745). However, there was a significant difference in postoperative length of stay, with LS patients exhibiting a shorter duration of hospitalization compared to OS patients (LS: 4.5 ± 1.5 days vs. OS: 6.0 ± 2.0 days, p = 0.0002). Additionally, the rate of admission to the intensive care unit (ICU) postoperatively was similar between LS and OS groups (LS: 4.9% vs. OS: 7.3%, p = 0.692). [Table 3]

Table 1: Baseline characteristics of the study participants

Characteristic	Laparoscopic Splenectomy (LS) n=41	Open Splenectomy (OS) n=41	P value
	Mean ± SD/Number (%)		
Age (years)	9.5 ± 3.2	9.8 ± 3.5	0.686
Sex			
Male	24 (58.5%)	26 (63.4%)	0.651
Female	17 (41.5%)	15 (36.6%)	
Underlying Diagnosis			
Hereditary Spherocytosis	15 (36.6%)	13 (31.7%)	0.883
Immune Thrombocytopenia Purpura (ITP)	18 (43.9%)	20 (48.8%)	
Other	8 (19.5%)	8 (19.5%)	
Preoperative Hemoglobin (g/dL)	9.8 ± 1.5	9.7 ± 1.3	0.747
Preoperative Platelet Count ($x10^3/\mu L$)	100.9 ± 20.3	98.6 ± 22.4	0.627
Preoperative White Blood Cell Count ($x10^3/\mu L$)	8.5 ± 2.0	8.2 ± 1.8	0.477

Table 2: Comparison of operative details among the laparoscopic and open splenectomy groups

Operative Detail	Laparoscopic Splenectomy (LS) n=41	Open Splenectomy (OS) n=41	P value
	Mean ± SD/Number (%)		
Operative Time (minutes)	122.4 ± 33.6	145.7 ± 44.3	0.009
Blood Loss (mL)	192.8 ± 90.8	288.3 ± 118.6	0.011
Conversion to Open	3 (7.3%)	-	-
Intraoperative Complications	4 (9.8%)	5 (12.2%)	0.728
Bleeding	2 (4.9%)	3 (7.3%)	0.644
Visceral Injury	1 (2.4%)	2 (4.9%)	0.556
Others	1 (2.4%, Port site hernia)	-	-
Splenomegaly	10 (24.4%)	13 (31.7%)	0.461
Need for Intraoperative Transfusion	2 (4.9%)	4 (9.8%)	0.396

Table 3: Comparison of postoperative outcome among the laparoscopic and open splenectomy groups

Postoperative Outcome	Laparoscopic Splenectomy (LS) n=41	Open Splenectomy (OS) n=41	P value
	Number (%)		
Complications	6 (14.6%)	8 (19.5%)	0.557
Bleeding	3 (7.3%)	4 (9.8%)	0.692
Surgical Site Infection	2 (4.9%)	3 (7.3%)	0.644
Pneumonia	1 (2.4%)	2 (4.9%)	0.556
Sepsis	0 (0.0%)	0 (0.0%)	-
Need for Postoperative Transfusion	5 (12.2%)	6 (14.6%)	0.745
Postoperative Length of Stay (days)	4.5 ± 1.5	6.0 ± 2.0	0.0002
Postoperative Intensive Care Unit (ICU) Admission	2 (4.9%)	3 (7.3%)	0.692

DISCUSSION

Operative details analysis revealed significant advantages of LS over OS, with LS associated with a shorter mean operative time (LS: 122.4 ± 33.6 minutes vs. OS: 145.7 ± 44.3 minutes, p = 0.009) and reduced blood loss (LS: 192.8 ± 90.8 mL vs. OS: 288.3 ± 118.6 mL, p = 0.011). These findings are consistent with studies by Fachin et al., Utria et al., and Li et al., demonstrating the benefits of laparoscopic techniques in minimizing surgical trauma and improving recovery times.[10,11,12] The shorter operative time and decreased blood loss in LS can be attributed to several factors, including the smaller incisions, magnified visualization, and meticulous dissection offered by laparoscopic approaches.[11] Laparoscopic approaches have ability to provide enhanced visualization of the surgical field, precise manipulation of tissues, and minimized tissue trauma, leading to reduced intraoperative bleeding and faster procedural times.[12]

Furthermore, our study found comparable rates of intraoperative complications between LS and OS groups, including bleeding (LS: 4.9% vs. OS: 7.3%, p = 0.644) and visceral injury (LS: 2.4% vs. OS: 4.9%, p = 0.556). While the incidence of these complications did not significantly differ between the two approaches, it is noteworthy that LS demonstrated a favorable safety profile despite the minimally invasive nature of the procedure. These findings align with the previous studies by Shin et al., Rodríguez-Luna et al., and Feng et al., suggesting that laparoscopic splenectomy is a safe and effective alternative to open surgery in pediatric patients.[13,14,15] The comparable rates of intraoperative complications between LS and OS further validate the feasibility and efficacy of laparoscopic techniques in pediatric splenectomy.[16,17]

In terms of postoperative outcomes, both LS and OS exhibited similar rates of overall complications (LS: 14.6% vs. OS: 19.5%, p = 0.557), including surgical site infection (LS: 4.9% vs. OS: 7.3%, p = 0.644) and pneumonia (LS: 2.4% vs. OS: 4.9%, p = 0.556). These findings are consistent with previous studies by Pelizzo et al., Preukschas et al., and Bonnet et al., comparing the two approaches in pediatric patients.[18,19,20] However, LS was associated with a significantly shorter postoperative length of stay compared to OS (LS: 4.5 ± 1.5 days vs. OS: 6.0 ± 2.0 days, p = 0.0002). This finding is particularly relevant in the context of healthcare resource utilization and patient recovery. The shorter postoperative length of stay in LS may be attributed to faster recovery, reduced pain, and earlier ambulation facilitated by the minimally invasive nature of the procedure, leading to expedited discharge from the hospital.[21,22]

Limitations

While our study has several strengths, including its prospective design and robust sample size, it is not without limitations. These include potential selection bias inherent in retrospective analyses, variations in surgical expertise among centers, and the lack of long-term follow-up data to assess the durability of outcomes. Additionally, while our study provides valuable insights into the comparative outcomes of LS and OS in pediatric patients, further research, including randomized controlled trials and long-term follow-up studies, is warranted to validate our findings and elucidate the optimal surgical strategy for pediatric splenectomy.

CONCLUSION

In conclusion, our study contributes valuable insights into the comparative outcomes of laparoscopic splenectomy versus open splenectomy in pediatric patients. While both approaches demonstrate comparable safety and efficacy, laparoscopic splenectomy offers potential advantages in terms of shorter operative times, reduced blood loss, and shorter postoperative hospital stays. These findings underscore the importance of considering patient-specific factors and surgical expertise when selecting the optimal approach for pediatric splenectomy. Further research, including randomized controlled trials and long-term follow-up studies, is warranted to validate our findings and elucidate the optimal surgical strategy for pediatric splenectomy.

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