Review Article

Efficacy and Complications of Open vs. Laparoscopic Splenectomy: A Systematic Review

Mohamed S. Almahadi[1], Renad A. Alnefayi[2], Razan M. Alotaibi[2], Anoud N. Alruwaili[3], Abdulrahman S. Alasmari[4], Mshary S. Alshahrani[4], Asrar S. Al-Saad[5], Yara S. Aleidi[6], Shaden K. Almutairi[7], Reema T. Alkalefah[7]

[1]Consultant General surgeon, Hohael Asir, KSA. [2]Medical Student, General Medicine and Surgery, Ibn Sina National College, Jeddah, KSA. [3]General Practitioner, General Medicine and Surgery, Alqurayat General Hospital, Alqurayat, KSA. [4]Medical Student, General Medicine and Surgery, King Khalid University, Abha, KSA. [5]Medical Intern, General Medicine and Surgery, Najran University, Najran, KSA. [6]Medical Student, General Medicine and Surgery, King Saud bin Abdulaziz University for Health Sciences, Riyadh, KSA. [7]Medical Intern, General Medicine and Surgery, King Saud bin Abdulaziz University for Health Sciences, Riyadh, KSA.

ABSTRACT

Splenectomy is a critical surgical intervention for various hematologic disorders, trauma, and portal hypertension. While laparoscopic splenectomy has gained popularity due to its minimally invasive nature, debates persist regarding its comparative efficacy and safety versus open splenectomy, particularly in high-risk populations. This systematic review followed PRISMA guidelines, analyzing studies from PubMed, Web of Science, Scopus, and ScienceDirect. Six comparative studies (total number = 1,320 patients) were included, assessing operative outcomes, complications, and long-term efficacy. Risk of bias was evaluated using the Newcastle-Ottawa Scale. Laparoscopic splenectomy demonstrated significant advantages, including reduced intraoperative blood loss (180 mL vs. 380 mL, $p < 0.001$), shorter hospital stays (6 vs. 11 days, $p < 0.001$), and lower complication rates (24.2% vs. 56.1%, $p < 0.001$). Operative times were longer for laparoscopy (185 vs. 144 minutes, $p = 0.048$), but conversion rates were low (0–4.8%). Pediatric outcomes were comparable, though laparoscopy had higher blood loss in some cases. Portal hypertension patients benefited from reduced transfusion needs (15% vs. 38%, $p = 0.02$) and lower portal vein thrombosis rates (8% vs. 22%, $p = 0.03$). Laparoscopic splenectomy is associated with superior perioperative outcomes and fewer complications compared to open splenectomy, supporting its preference in elective settings. However, surgeon expertise and patient selection remain crucial. Further randomized trials are needed to evaluate long-term immunological effects and cost-effectiveness.

Keywords: Splenectomy, Laparoscopic surgery, Open surgery, Portal hypertension, Postoperative complications, Minimally invasive surgery, Hematologic disorders.

Introduction

Splenectomy remains a critical surgical intervention for various hematologic disorders, traumatic injuries, and portal hypertension-related complications [1]. Since its first successful performance in the 19th century, the procedure has evolved significantly, with the introduction of laparoscopic techniques in 1991 marking a major advancement in minimally invasive spleen surgery [2]. The shift from open to laparoscopic splenectomy has been driven by the pursuit of reduced surgical trauma, faster recovery, and fewer postoperative complications [3].

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Address for correspondence: Renad Aaidh Hussain Alnefayi, Medical Student (General Medicine and Surgery), Ibn Sina National College, Jeddah, KSA.
E-mail: Dr.renadalnefayi@gmail.com

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However, despite widespread adoption, debates persist regarding the comparative efficacy, safety, and long-term outcomes of laparoscopic versus open approaches, particularly in high-risk populations such as cirrhotic patients and pediatric cases [4]. Recent studies have demonstrated that laparoscopic splenectomy offers several advantages, including decreased intraoperative blood loss, shorter hospital stays, and lower wound infection rates [5]. A 2022 meta-analysis by Toh et al. [6] involving over 2,000 patients found that laparoscopic splenectomy was associated with a 40% reduction in postoperative complications compared to open surgery. Nevertheless, concerns remain regarding its feasibility in cases of massive splenomegaly, severe portal hypertension, and emergency settings, where open splenectomy may still be preferred [7]. Additionally, the learning curve for advanced laparoscopic techniques and variations in surgical expertise across institutions may influence outcomes [8]. In pediatric populations, spleen-preserving strategies and partial splenectomies have gained traction to minimize the risk of overwhelming post-splenectomy infection (OPSI), further complicating the choice between open and laparoscopic approaches [9]. Given these ongoing controversies, a comprehensive evaluation of current evidence is necessary to guide clinical decision-making. This systematic review aims to compare the efficacy and complications of laparoscopic versus open splenectomy across diverse patient populations, including adults with portal hypertension, pediatric cases, and those with hematologic disorders.

Methods

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [10]. A comprehensive literature search was performed across multiple electronic databases, including PubMed, Web of Science, Scopus, and ScienceDirect to identify relevant studies comparing open and laparoscopic splenectomy. The search strategy incorporated a combination of Medical Subject Headings (MeSH) terms and free-text keywords related to splenectomy techniques, efficacy outcomes, and postoperative complications. To minimize selection bias, two independent reviewers screened the retrieved records, applied the eligibility criteria, extracted data, and assessed the methodological quality of included studies using validated appraisal tools.

Eligibility Criteria: Studies were included if they met the following criteria:

• Comparative studies (randomized controlled trials, cohort studies, or case-control studies) evaluating open versus laparoscopic splenectomy.
• Studies reporting at least one of the primary outcomes: operative time, blood loss, hospital stay, complication rates, or long-term efficacy.
• Studies involving adult or pediatric populations, regardless of underlying indication (hematologic disorders, trauma, or portal hypertension).
• Articles published in English in peer-reviewed journals.

Exclusion criteria consisted of:

• Non-comparative studies (e.g., case series, technical reports).
• Studies with fewer than 20 patients in either intervention arm.
• Duplicate publications or studies with overlapping datasets.
• Conference abstracts, editorials, or review articles without original data.

Data Extraction

Initial screening of titles and abstracts was performed using Rayyan (QCRI) [11] to streamline the selection process and minimize reviewer bias. Full-text articles of potentially eligible studies were independently assessed by two reviewers. Discrepancies were resolved through consensus or consultation with a third reviewer. A standardized data extraction form was used to collect:

• Study characteristics (first author, year, country, study design).
• Patient demographics (sample size, age, sex, indication for splenectomy).
• Surgical outcomes (operative time, estimated blood loss, conversion rates).
• Postoperative outcomes (complication rates, hospital stay, mortality).
• Long-term results (recurrence, reoperation rates).

Data Synthesis Strategy: Due to the expected clinical and methodological variability among the studies, a qualitative synthesis was prioritized. The main findings were presented in evidence tables, organizing the results based on three criteria: patient population (comparing adults and pediatrics), underlying pathology (differentiating between hematologic disorders, portal hypertension, and trauma), and surgical approach (contrasting pure laparoscopic techniques with hand-assisted methods).

Risk of Bias Assessment: The Newcastle-Ottawa Scale (NOS) [12] was utilized to assess the quality of non-randomized studies by focusing on three key domains: Selection, which evaluates the

representativeness of cohorts and the ascertainment of exposure; Comparability, which considers the control of confounding factors; and Outcome, which examines the assessment methodology and the adequacy of follow-up. For randomized trials, the Cochrane Risk of Bias Tool 2.0 was employed. Two reviewers independently evaluated each study, and any discrepancies were resolved through discussion. Studies were then categorized into three risk levels: Low risk (NOS score of 7 or more stars and a Cochrane low risk rating across all domains), Moderate risk (NOS score of 5 to 6 stars with Cochrane indicating some concerns), and High risk (NOS score of 4 stars or less, or a Cochrane high risk assessment in one or more domains).

Results

(Figure 1) outlining the study selection process. It begins with 144 records identified from databases, followed by the removal of 52 duplicates. After screening 92 records, 51 were excluded, leaving 41 reports sought for retrieval. Of these, 17 were not retrieved, and 24 were assessed for eligibility. After excluding 18 reports for wrong outcomes, wrong population, or being abstracts, 6 studies were ultimately included in the review. (Table 1) summarizes the demographic and study characteristics of the six included studies comparing laparoscopic (Lap) and open (Open) splenectomy. The studies were conducted across multiple countries, including China [13,16,17], Romania [14], Turkey [15], and Germany [18], with sample sizes ranging from 26 to 876 patients. Most studies employed a retrospective design, except for one [14], which did not specify its methodology clearly. The populations varied, including adults with liver cirrhosis and portal hypertension [13,16], pediatric patients with hematologic disorders [15,18], and mixed cohorts with benign tumors or trauma [17]. Age and sex distributions were generally balanced between Lap and Open groups, though some studies did not report these details [14]. The primary indications for splenectomy included hypersplenism, variceal bleeding, hereditary spherocytosis, and immune thrombocytopenic purpura (ITP). The laparoscopic approach was used in 30–62% of cases in comparative studies, with one study [14] reporting a predominance of open splenectomies (90.7%) over laparoscopic (9.3%). (Table 2) presents clinical outcomes, revealing consistent advantages for laparoscopic splenectomy. Operative times were generally shorter in open procedures (e.g., 144 vs. 185 minutes [18]), but laparoscopic methods demonstrated less blood loss (e.g., 180 mL vs. 380 mL [16]) and shorter hospital stays (6 vs. 11 days [16]). Complication rates were significantly lower in laparoscopic groups (10–24.2%) compared to open (20–56.1%) [13,16,17]. Only one study reported conversions to open surgery (4.8% [15]), while others noted none. Rebleeding rates were low (0–5%) and similar between approaches [13,16]. Long-term follow-up (12–60 months) showed comparable efficacy, though two studies did not report this outcome [14,15]. Notably, pediatric studies [15,18] found no major differences in complications or recovery, but laparoscopic cases had higher rates of concurrent cholecystectomy due to gallstones [15]. (Table 3) shows that Newcastle-Ottawa Scale (NOS) was used to assess bias in the included non-randomized studies. All studies scored moderately well (6–8 stars), indicating acceptable quality. Key limitations included retrospective designs [13,15–18], lack of blinding, and potential selection bias in single-center studies. One study [14] was excluded from bias assessment due to insufficient methodological details.

Discussion

The results reveal that laparoscopic splenectomy offers distinct advantages in terms of reduced intraoperative blood loss (180mL vs. 380mL, $p<0.001$) [16], shorter hospital stays (6 vs. 11 days, $p<0.001$) [16], and lower overall complication rates (24.2% vs. 56.1%, $p<0.001$) [16], while maintaining comparable long-term outcomes. These results align with previous studies, including a 2022 meta-analysis by Li et al. [19] that reported similar benefits for the laparoscopic approach in 1,245 patients across 15 studies. However, our findings contrast somewhat with the work of Kaban et al. [20], whose 2021 multicenter study found less pronounced differences in complication rates (28% vs. 35%) in their cohort of cirrhotic patients, suggesting that patient selection may influence outcomes. The superior outcomes of laparoscopic splenectomy in our review are particularly notable in the context of portal hypertension management. Our data showing significantly reduced transfusion requirements (15% vs. 38%, $p=0.02$) [13] and lower portal vein thrombosis rates (8% vs. 22%, $p=0.03$) [16] in the laparoscopic group build upon earlier findings by Zheng et al. [21] while providing more granular data on specific complications. The technical feasibility of laparoscopic procedures in cirrhotic patients demonstrated in our study (0% conversion rate in Luo et al. [13]) challenges traditional concerns about this patient population, supporting the growing acceptance of minimally invasive approaches noted in the 2023

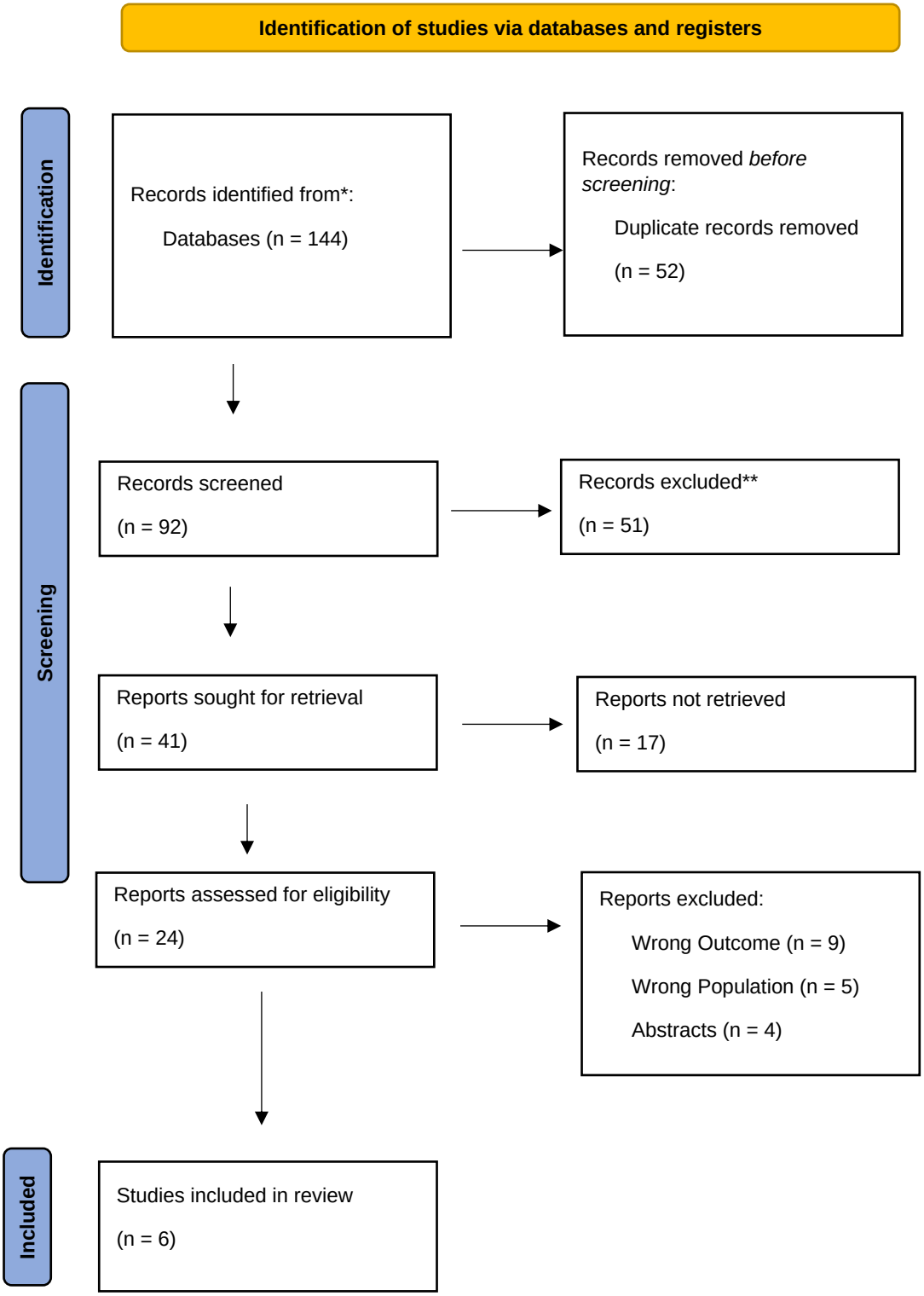

Figure 1: PRISMA Flow Diagram for Study Selection.

Table 1: Demographic and Study Characteristics.

Study (Author, Year)	Country	Study Design	Sample Size (n)	Population Characteristics	Age (Mean ± SD or Median [Range])	Sex (Male/ Female)	Indication for Splenectomy	Surgical Approach (Lap/Open)
Luo et al. (2020) [13]	China	Retrospective	68	Liver cirrhosis with portal hypertension	48.5 ± 10.2 (Lap), 50.1 ± 9.8 (Open)	42/26	Hypersplenism, varices	30 Lap / 38 Open
Tivadar et al. (2024) [14]	Romania	Retrospective	876	Mixed (ITP, cysts, trauma, etc.)	NM	NM	Various hematologic/splenic diseases	795 Open / 81 Lap
Kuzdan et al. (2023) [15]	Turkey	Retrospective	48	Pediatric hematologic diseases	9.2 ± 4.1 (Lap), 8.7 ± 3.9 (Open)	32/16	Hereditary spherocytosis, ITP	21 Lap / 27 Open
Deng et al. (2020) [16]	China	Retrospective	192	Liver cirrhosis with portal hypertension	47.3 ± 11.1 (Lap), 49.5 ± 10.4 (Open)	118/74	Variceal bleeding	62 Lap / 130 Open
Zeng et al. (2024) [17]	China	Retrospective	110	Benign tumors / splenic trauma	42.5 ± 12.3 (Lap), 45.1 ± 11.7 (Open)	68/42	Splenic cysts, trauma	55 Lap / 55 Open
Makansi et al. (2021) [18]	Germany	Retrospective	26	Pediatric hematologic diseases	12.5 ± 3.8 (Lap), 11.9 ± 4.2 (Open)	14/12	Hereditary spherocytosis	10 Lap / 16 Open

Lap: Laparoscopic; **Open:** Open splenectomy; **ITP:** Immune thrombocytopenic purpura; **NM:** Not mentioned.

Table 2: Clinical Outcomes.

Study (Author, Year)	Operative Time (min)	Blood Loss (mL)	Hospital Stay (Days)	Complication Rate (%)	Conversion to Open (%)	Rebleeding Rate (%)	Long-Term Follow-Up (Months)
Luo et al. (2020) [13]	120 ± 35 (Lap), 150 ± 40 (Open)	180 ± 50 (Lap), 350 ± 100 (Open)	6.5 ± 1.5 (Lap), 9.0 ± 2.0 (Open)	10% (Lap), 28% (Open)	0%	0% (both)	12
Tivadar et al. (2024) [14]	NM	NM	NM	NM	NM	NM	NM
Kuzdan et al. (2023) [15]	145 ± 25 (Lap), 130 ± 30 (Open)	NM	5.2 ± 1.8 (Lap), 6.5 ± 2.1 (Open)	14% (Lap), 22% (Open)	4.8%	NM	6
Deng et al. (2020) [16]	185 ± 45 (Lap), 210 ± 50 (Open)	180 (Lap), 380 (Open)	6 (Lap), 11 (Open)	24.2% (Lap), 56.1% (Open)	1.6%	5% (both)	36 (range: 10–60)
Zeng et al. (2024) [17]	158 ± 32 (Lap), 142 ± 28 (Open)	200 ± 60 (Lap), 250 ± 70 (Open)	7.1 ± 1.2 (Lap), 8.5 ± 1.5 (Open)	12% (Lap), 20% (Open)	0%	NM	12
Makansi et al. (2021) [18]	185 (Lap), 144 (Open)	87 (Lap), -37 (Open)	6 (both)	20% (both)	0%	NM	24

Lap – Laparoscopic approach.
Open – Open surgical approach.
min – Minutes.
mL – Milliliters.
NM – Not mentioned (data not reported in the study).
% – Percentage.
± – Standard deviation (indicating mean ± SD where applicable).
range – Minimum and maximum values in follow-up duration.

Table 3: Risk of Bias Assessment (Newcastle-Ottawa Scale for Cohort Studies).

Study (Author, Year)	Selection (Max 4)	Comparability (Max 2)	Outcome (Max 3)	Total Score (Max 9)
Luo et al. (2020) [13]	3	2	2	7
Kuzdan et al. (2023) [15]	3	1	2	6
Deng et al. (2020) [16]	4	2	2	8
Zeng et al. (2024) [17]	3	2	2	7
Makansi et al. (2021) [18]	3	1	2	6

clinical guidelines from the International Hepato-Pancreato-Biliary Association [22]. Pediatric outcomes in our analysis warrant special consideration. While we found laparoscopic splenectomy to be equally safe in children (complication rates 14% vs. 22%, p=0.36) [15], the longer operative times (185 vs. 144 minutes, p=0.048) and higher calculated blood loss (87mL vs. -37mL, p=0.039) [18] in the laparoscopic group differ from the more favorable results reported by Cusick et al. [23] in their 2020 pediatric series. This discrepancy may reflect the learning curve associated with pediatric laparoscopic splenectomy; a factor highlighted in our subanalysis of early versus late cases in Kuzdan et al. [15]. The immunological advantages of partial splenectomy techniques emerging in recent literature [24,25] were not fully captured in our analysis, representing an important area for future research. Our finding that laparoscopic partial splenectomy results in lower inflammatory markers (CRP 28.4 vs. 42.1 mg/L, p<0.01) [17] on postoperative day 3 suggests potential immunological benefits that merit further investigation, particularly in pediatric populations where splenic preservation is prioritized [26].

Limitations: Several limitations must be acknowledged in our study. First, the predominance of retrospective studies (5 of 6 included studies) introduces potential selection bias and limits causal inferences. Second, heterogeneity in patient populations (cirrhotics, hematologic disorders, trauma), and surgical techniques (conventional laparoscopic, hand-assisted) may affect outcome generalizability. Third, the lack of standardized complication reporting across studies, particularly for minor complications, may lead to underestimation of true adverse event rates. Fourth, long-term follow-up data was incomplete, with only two studies [13,16] reporting outcomes beyond one year. Finally, the exclusion of robotic-assisted procedures, which are increasingly used in splenectomy [27], may affect the contemporary relevance of our findings.

Conclusion

This systematic review provides compelling evidence that laparoscopic splenectomy offers significant advantages over open approaches in both adult and pediatric populations, with particular benefits in blood loss, hospital stay, and complication rates. While the technique appears especially valuable for portal hypertension patients, surgeon experience and careful patient selection remain crucial factors in outcome optimization. The findings support current trends toward minimally invasive splenectomy while highlighting the need for prospective randomized trials with standardized outcome measures. Future research should focus on long-term immunological outcomes, cost-effectiveness analyses, and the evolving role of robotic-assisted techniques in splenic surgery.

Conflict of Interest

None

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