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Deviation from Standard Anesthesia for Performing Laparoscopic Cholecystectomy: A Study of 2425 Cases

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Abstract **Original Research Article**

Background: Laparoscopic cholecystectomy (LC) is the gold standard for treating gallbladder diseases and is conventionally performed under general anesthesia (GA). However, spinal anesthesia (SA) is emerging as a viable alternative, especially in resource-limited settings. This study evaluates the feasibility, safety, and outcomes of LC under SA in a large cohort in Bangladesh. ***Methods:*** A prospective observational study was conducted on 2425 patients undergoing LC at a secondary-level hospital between March 2014 to March 2024. Patients aged 14–80 years with ASA physical status I–III were included. Key intraoperative and postoperative outcomes, including conversion rates, intraoperative complaints, and complications, were monitored. LC was performed using the standard four-port technique, with continuous monitoring of vital parameters. ***Results:*** The majority of patients were female (73.86%), with a mean age of 36.4 years. Conversion rates were low, with 0.78% requiring GA and 1.07% requiring open surgery. Shoulder pain (10.19%) and hypotension (7.13%) were the most common intraoperative complaints, both effectively managed. Postoperative complications were minimal, with urinary retention in 6.10% and spinal headache in 1.24%. Critical complications, such as bile duct injuries or significant bile leakage, were absent, highlighting the safety of SA for LC. ***Conclusion:*** LC under SA is a safe and efficient procedure with low complication rates, minimal conversions, and high procedural success. The findings emphasize SA as a cost-effective alternative to GA, suitable for resource-limited healthcare settings. This study reinforces the feasibility of integrating SA into standard surgical protocols for LC.

Keywords: Laparoscopic Cholecystectomy, Spinal Anesthesia, General Anesthesia, Resource-Limited Settings, Postoperative Complications, Conversion Rates, Surgical Outcomes.

INTRODUCTION

Laparoscopic cholecystectomy (LC) is widely regarded as the gold standard for the surgical treatment of gallstone diseases. Since its introduction in the late 1980s, LC has transformed the field of general surgery, offering a minimally invasive alternative to open cholecystectomy. This shift has significantly improved surgical outcomes, with benefits such as reduced postoperative pain, shorter hospital stays, and faster recovery times for patients. Globally, LC is now a cornerstone procedure, and its adoption has expanded across healthcare systems of varying resources and capacities [1,2]. Despite its numerous advantages, LC is traditionally performed under general anesthesia (GA), which ensures optimal conditions for surgery but presents challenges in resource-limited settings [3]. The evolution of LC represents one of the most significant milestones in modern surgery. First performed by Philippe Mouret in 1987, LC rapidly gained popularity due to technological advancements in laparoscopic instrumentation and imaging [2]. These innovations enabled surgeons to operate with greater precision while

minimizing surgical trauma to patients. By the early 1990s, LC had become a standard procedure in many countries, driven by its superior outcomes compared to open cholecystectomy [4,5]. This rapid adoption was fueled by a growing body of evidence supporting its safety and efficacy across various healthcare systems, including those in low- and middle-income countries (LMICs), where the burden of gallstone diseases is substantial [6]. Today, LC is performed in both urban and rural healthcare settings, reflecting its versatility and patient-centered advantages [7]. Traditionally, GA has been the anesthesia of choice for LC. GA provides critical benefits, including optimal muscle relaxation, controlled ventilation, and the immobility required for creating a stable pneumoperitoneum. These conditions allow for precise surgical maneuvers and contribute to the overall safety of the procedure. However, GA comes with its own set of challenges, particularly in LMICs. It is resource-intensive, requiring specialized equipment, skilled anesthesiologists, and advanced postoperative care. In resource-constrained settings like Bangladesh, these requirements can strain already limited healthcare infrastructure [8, 9]. Moreover, GA is associated with risks such as hemodynamic instability, postoperative nausea, and respiratory complications, which can be particularly detrimental to patients with comorbidities such as cardiovascular or respiratory diseases [10]. In response to these challenges, spinal anesthesia (SA) has emerged as a viable alternative for performing LC, particularly in developing countries. SA involves the administration of a local anesthetic into the subarachnoid space, providing adequate sensory blockade for the procedure. Its simplicity, cost-effectiveness, and safety profile make SA an attractive option for resource-limited healthcare systems. Studies have shown that SA can achieve outcomes comparable to GA, with added benefits such as reduced perioperative morbidity, improved postoperative pain management, and fewer complications such as nausea and vomiting [11,12]. Furthermore, SA eliminates the need for mechanical ventilation and reduces the demand for intensive postoperative care, making it especially suitable for hospitals with limited resources [13]. The economic advantages of SA are particularly relevant in countries like Bangladesh, where healthcare budgets are constrained and access to advanced medical facilities is often limited. SA requires minimal infrastructure and can be administered by trained personnel with less reliance on highly specialized equipment. This adaptability makes it a practical solution for addressing the surgical needs of underserved populations. For instance, studies have reported that SA is associated with lower perioperative costs compared to GA, while maintaining comparable safety and efficacy [14,15]. These findings align with the global push to prioritize cost-effective and sustainable healthcare interventions in LMICs [16]. Despite its potential, the adoption of SA for LC in developing countries remains limited. Barriers such as lack of training, institutional support, and awareness about its benefits have hindered widespread implementation. However, there is growing recognition of the role SA can play in improving surgical access and outcomes in resource-limited settings. By reducing dependency on GA and addressing logistical challenges, SA offers a practical approach to expanding surgical capacity in LMICs [17,18]. In Bangladesh, where surgical services are often concentrated in urban centers, SA could serve as a critical tool for decentralizing care and improving access for rural populations. This study aims to evaluate the feasibility, safety, and outcomes of performing LC under SA in Bangladesh, a country with a unique set of healthcare challenges and resource constraints. By analyzing a large cohort of patients, this research seeks to contribute to the growing body of evidence supporting SA as an effective and sustainable alternative to GA. Ultimately, the findings from this study could inform policy and clinical practice, paving the way for broader adoption of SA in similar contexts around the world.

METHODS

This study was conducted as a prospective observational study at an urban, secondary-level hospital over a period of 10 years, from March 2014 to March 2024. A total of 2425 consecutive patients diagnosed with cholelithiasis and scheduled for laparoscopic cholecystectomy were included in the study. The inclusion criteria comprised patients aged 14 to 80 years with an American Society of Anesthesiologists (ASA) physical status classification of I, II, or III. Patients with acute inflammatory processes (e.g., cholangitis or pancreatitis), anxiety-prone conditions, bleeding disorders, or local spinal deformities were excluded from the study. Prior to participation, all patients were provided with detailed information about the study and gave their written informed consent. Each patient underwent a preoperative interview conducted by the anesthesiologist to discuss the anesthesia plan and address potential intraoperative events under spinal anesthesia (SA), including shoulder pain, anxiety, and vomiting. The anesthetic procedure began with patients positioned in a sitting posture for spinal puncture. The subarachnoid space was accessed at the L1-L2 level, where 2.5–3.5 mL of hyperbaric 0.5% bupivacaine was injected. Patients were then placed in a supine position with a slight head-down tilt to facilitate the spread of the anesthetic. Adequacy of anesthesia was confirmed by the surgeon using a pinprick test to ensure sensory blockade up to the T4 level. During the procedure, any drop in mean arterial pressure below 60 mmHg was treated with 3 µg of intravenous mephentermine. Anxiety was managed with 2 mg of intravenous midazolam, while pain was controlled using 50 µg intravenous boluses of fentanyl. Laparoscopic cholecystectomy was performed using the standard four-port technique. A direct trocar was inserted without prior pneumoperitoneum, facilitated by manual elevation of the anterior abdominal wall. Pneumoperitoneum was maintained with carbon dioxide (CO_2) at 12–14 mmHg during trocar placement and reduced to 10–12 mmHg during the operative phase.

A nasogastric tube was inserted for gastric decompression at the surgeon's discretion. Intraoperative monitoring was conducted continuously and included heart rate, electrocardiography (ECG), pulse oximetry, airway pressure, and intra-abdominal pressure. The procedure was carried out under close observation to ensure patient safety and effective surgical outcomes. Postoperatively, patients were transferred to the recovery room, where their vital parameters were monitored closely. After 4–6 hours of observation, patients were shifted to the general ward. All patients were discharged the following day, provided they were clinically stable and met discharge criteria.

RESULTS

Table 1: Distribution of patients by baseline characteristics (N=2425)

Variables	Frequency	Percentage
Sex		
Male	634	26.14%
Female	1791	73.86%
Age		
Mean±SD	36.4±4.72	
Range	14-80 years	
Comorbidities		
COPD	74	3.05%
Asthma	74	3.05%
Hypertension	441	18.19%
Diabetes	630	25.98%
Rt bundle branch block	49	2.02%
Hypothyroid	388	16.00%
Obesity	34	1.40%
Conversion		
Conversion to General Anesthesia	19	0.78%
Conversion of laparoscopy to Open	26	1.07%

The study included 2425 patients, with a majority being female (73.86%, n=1791), while males accounted for 26.14% (n=634). The mean age of the patients was 36.4 years (SD ± 4.72), with an age range of 14 to 80 years. Comorbidities were present in a significant portion of the study population. The most common comorbidities included diabetes (25.98%, n=630) and hypertension (18.19%, n=441), followed by hypothyroidism (16.00%, n=388). Chronic obstructive pulmonary disease (COPD) and asthma were observed in 3.05% of patients each (n=74 for both). Less frequent conditions included right bundle branch block (2.02%, n=49) and obesity (1.40%, n=34). The conversion rate from spinal anesthesia to general anesthesia was 0.78% (n=19), while the conversion rate from laparoscopic to open surgery was slightly higher, at 1.07% (n=26).

Table 2: Distribution of intraoperative complaints among the participants (N=2425)

Intraoperative Complaints	Frequency	Percentage
Shoulder pain	247	10.19%
Hypotension	173	7.13%
Nausea	99	4.08%
Vomiting	25	1.03%

During the intraoperative period, various complaints were observed among the study participants. The most commonly reported issue was shoulder pain, affecting 10.19% of patients (n=247). Hypotension was the second most frequent complaint, occurring in 7.13% of cases (n=173). Nausea was reported by 4.08% of patients (n=99), while vomiting was relatively rare, occurring in only 1.03% of cases (n=25).

Table 3: Distribution of operation details among the participants (N=2425)

Variables	Frequency	Percentage
Mean duration of surgery	19.5 ± 7.18	
Adhesion	395	16.29%
Gut Injuries	0	0.00%
GB perforation during dissection	98	4.04%
Bile duct injuries	0	0.00%
Postoperative bile leakage	2	0.08%

The mean duration of surgery for laparoscopic cholecystectomy was 19.5 ± 7.18 minutes, indicating a relatively efficient surgical process. Adhesions were observed in 16.29% of patients (n=395), representing the most common intraoperative finding. Gallbladder perforation during dissection occurred in 4.04% of cases (n=98), while there were no instances of gut injuries or bile duct injuries, underscoring the safety of the procedure. Postoperative bile leakage was exceedingly rare, occurring in only 0.08% of cases (n=2).

Table 4: Distribution of postoperative complications among the participants (N=2425)

Postoperative complications	Frequency	Percentage
Spinal headache	30	1.24%
Urinary retention	148	6.10%
Vomiting	50	2.06%
Port site infection	9	0.37%

Postoperative complications were generally minimal among the participants. The most frequently reported issue was urinary retention, occurring in 6.10% of cases (n=148). Spinal headache was noted in 1.24% of patients (n=30), a known potential side effect of spinal anesthesia. Vomiting was reported by 2.06% of patients (n=50), while port site infections were rare, occurring in only 0.37% of cases (n=9).

DISCUSSION

Laparoscopic cholecystectomy (LC) has firmly established itself as the gold standard for managing gallbladder diseases due to its minimal invasiveness, shorter recovery times, and reduced morbidity compared to open surgery. This study highlights the potential of spinal anesthesia (SA) as a safe and effective alternative to general anesthesia (GA) for LC, particularly in resource-limited settings like Bangladesh. A key strength of this study lies in its large sample size, comprehensive monitoring of intraoperative and postoperative events, and a low incidence of complications. Our cohort demonstrated a female predominance (73.86%) and a mean age of 36.4 years, consistent with prior findings indicating that gallbladder diseases are more prevalent in women of middle age [19,20]. Comorbidities such as diabetes and hypertension were common, affecting 25.98% and 18.19% of patients, respectively, which aligns with reports by Bessa *et al.*, who highlighted the influence of comorbid conditions on surgical outcomes [11]. Despite the presence of such comorbidities, LC under SA was performed safely with minimal conversions, reflecting robust perioperative management. Conversion rates in this study were notably low, with 0.78% requiring a shift from SA to GA and 1.07% needing conversion to open surgery. These rates are comparable to or better than those reported in other large-scale studies, such as Sinha *et al.*, who documented a conversion rate of 0.52% to GA and 0.60% for open conversion [21]. Similarly, Malla *et al.*, found a conversion rate of 1.86%, emphasizing the critical role of surgical expertise and patient selection in maintaining low conversion rates [22]. Intraoperative complaints were manageable, with shoulder pain (10.19%) being the most frequent. This was comparable to the findings of Bessa *et al.*, where 12.29% of patients reported shoulder discomfort during LC under SA [11]. Transient hypotension, affecting 7.13% of patients, was slightly lower than rates reported by Roesch-Dietlen *et al.*, (18.21%) [23]. The effective management of these complications underscores the feasibility of SA in maintaining stable intraoperative conditions. Surgical outcomes in our study were favorable, with a mean operative time of 19.5 ± 7.18 minutes. Adhesions were encountered in 16.29% of cases, and gallbladder perforations occurred in 4.04%. Importantly, no bile duct or gut injuries were observed, demonstrating procedural safety. Similar trends were observed in the review by Pucher *et al.*, which reported bile duct injury rates ranging from 0.22% to 0.52% over three decades of LC practice (24). Furthermore, postoperative bile leakage was exceptionally rare in our cohort (0.08%), aligning with reports of minimal leakage in studies such as Sinha *et al.*, [21]. Postoperative complications were minimal, with urinary retention being the most common (6.10%). This is consistent with findings by Roesch-Dietlen *et al.*, who reported urinary retention in 2.89% of cases [23]. Spinal headache occurred in 1.24% of patients in our study, which was significantly lower than the 5.9% reported by Sinha *et al.*, suggesting that optimized spinal techniques may mitigate this risk [21]. Port site infections were rare (0.37%), further affirming the safety of LC under SA. The rare need for bile duct repair and absence of significant mortality in our study aligns with the global shift toward safer laparoscopic techniques, as noted in systematic reviews such as Pucher *et al.*, [24]. The results reinforce the feasibility and safety of SA for LC, particularly in resource-limited healthcare systems. Our findings are consistent with previous studies advocating for SA, including its cost-effectiveness, reduced perioperative morbidity, and patient satisfaction [11,23]. Despite the favorable outcomes, it is important to note that certain intraoperative challenges, such as shoulder pain and transient hypotension, remain intrinsic to SA. However, these are typically transient and manageable with appropriate intraoperative measures, as evidenced in studies like Bessa et al. and Roesch-Dietlen *et al.*, [11,23]. The low incidence of conversions, rare complications, and minimal postoperative morbidity in our study further support the use of SA in LC. In conclusion, the findings of this study align with and extend the existing body of evidence supporting the use of SA for LC. The minimal complication rates, high safety profile, and adaptability to resource-constrained

settings make SA a viable alternative to GA. These results have significant implications for expanding surgical capacity and improving access to minimally invasive surgery in developing countries.

Limitations of The Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

This study demonstrates that laparoscopic cholecystectomy (LC) under spinal anesthesia (SA) is a safe, effective, and feasible alternative to general anesthesia (GA), particularly in resource-constrained settings like Bangladesh. The findings reveal low conversion rates, minimal intraoperative complaints, and negligible critical complications, including bile duct injuries or significant postoperative bile leakage. The rare incidence of postoperative complications, such as spinal headache and port site infection, further highlights the procedural safety of LC under SA. These results underscore the adaptability of SA in enhancing surgical care access while maintaining high safety and efficacy standards. This study contributes to the growing evidence supporting SA as a cost-effective and patient-friendly option, paving the way for broader adoption in similar healthcare settings globally.

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