Comparison of Efficacy between Spinal Anaesthesia and General Anaesthesia for Laparoscopic Cholecystectomy

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ABSTRACT

Background: Laparoscopic cholecystectomy is commonly performed under general anaesthesia (GA), but spinal anaesthesia (SA) has emerged as a potential alternative offering certain advantages. Evidence comparing both techniques in the Bangladeshi surgical setting remains limited. Objective: To compare the intraoperative hemodynamic stability, postoperative pain scores, recovery profile, and patient satisfaction between spinal anaesthesia and general anaesthesia for elective laparoscopic cholecystectomy. **Methods & Materials**: This comparative study was conducted at 250Bedded General Hospital, Tangail, Bangladesh, from January 2023 to December 2024. A total of 120 adult patients undergoing elective laparoscopic cholecystectomy were selected by purposive sampling and randomly divided into two equal groups: Group A (spinal anaesthesia, n=60) and Group B (general anaesthesia, n=60). Data were analyzed using SPSS version 23.0. **Results**: Patients in the SA group demonstrated significantly lower VAS pain scores at 2, 6, and 12 hours postoperatively ($p<0.05$), longer time to first analgesic request (mean 4.8 vs. 1.2 hours), and lower incidence of PONV (8.3% vs. 25.0%). Hemodynamic parameters were more stable intraoperatively in the SA group. Patient satisfaction scores were higher in the SA group (mean 4.6/5 vs. 3.8/5). However, conversion to GA was required in 2 patients (3.3%) due to inadequate peritoneal relaxation. **Conclusion**: Spinal anaesthesia is a safe and effective alternative to general anaesthesia for laparoscopic cholecystectomy in selected patients, offering better postoperative analgesia, fewer side effects, and higher patient satisfaction, though careful patient selection is essential.

Keywords: *Analgesia, General anaesthesia, hemodynamics, Laparoscopic cholecystectomy, Spinal anesthesia.*

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INTRODUCTION

Laparoscopic cholecystectomy (LC) is the standard of care for symptomatic cholelithiasis, offering benefits such as reduced postoperative pain, shorter hospital stays, and earlier return to daily activities compared to open cholecystectomy [1]. Traditionally, general anaesthesia (GA) with endotracheal intubation and controlled mechanical ventilation has been the preferred technique for LC, as it effectively manages the physiological alterations induced by pneumoperitoneum, including increased intra-abdominal pressure, hypercapnia, and reduced pulmonary compliance [2]. However, GA is associated with several adverse effects, including postoperative nausea and vomiting (PONV), sore throat, dental trauma, hemodynamic fluctuations, delayed emergence, and respiratory depression, particularly in patients with significant cardiopulmonary comorbidities [3,4]. The incidence of PONV following GA for LC can be as high as 40–70% if prophylactic antiemetics are not administered, leading to delayed discharge and reduced patient satisfaction [5]. These limitations have driven interest in alternative anaesthetic approaches that may improve perioperative outcomes. Spinal anaesthesia (SA) has emerged as a potential alternative to GA for LC, offering several theoretical advantages. These include avoidance of airway instrumentation, preserved spontaneous ventilation, reduced PONV, superior postoperative analgesia, lower opioid consumption, and decreased neuroendocrine stress response [6,7]. A recent meta-analysis demonstrated that regional anaesthesia for LC is associated with significantly lower pain scores at 2, 6, and 12 hours postoperatively, as well as reduced incidence of PONV compared to GA [8]. Nevertheless, SA for LC poses unique challenges. The awake patient may experience shoulder tip pain due to diaphragmatic irritation from carbon dioxide insufflation, mediated by the phrenic nerve (C3–C5), which is incompletely blocked by a conventional T4 sensory level [9]. Additionally, pneumoperitoneum-induced discomfort, anxiety, and the need for surgical manipulation may require supplemental sedation or even conversion to GA [10]. Patient selection is therefore critical, with contraindications including coagulopathy, hypovolemia, significant aortic stenosis, and patient refusal [6]. Several recent studies have evaluated the feasibility and safety of SA for LC. In a randomized controlled trial, it was reported that SA provided comparable surgical conditions to GA with significantly lower PONV rates and shorter post-anaesthesia care unit stay [11]. Similarly, a study from India found that SA was associated with better hemodynamic stability and lower postoperative pain scores during the first 24 hours [12]. However, other authors have cautioned that the success of SA depends heavily on appropriate patient selection, optimal intrathecal drug selection, and the surgeon's experience [13]. In Bangladesh, there is a paucity of comparative data evaluating SA versus GA for LC. Most centers continue to employ GA as the default technique without considering the potential benefits of SA in selected patients. This knowledge gap is particularly relevant given the high volume of LC procedures performed annually and the need for cost-effective, patient-centered anaesthetic care. Therefore, this study was designed to compare spinal anaesthesia versus general anaesthesia for elective laparoscopic cholecystectomy in terms of hemodynamic stability, postoperative pain, recovery profile, complications, and patient satisfaction.

METHODS & MATERIALS

This comparative study included 120 adult patients of either sex, aged 18–65 years, with American Society of Anesthesiologists (ASA) physical status I or II, undergoing elective laparoscopic cholecystectomy for symptomatic cholelithiasis at 250 Bedded General Hospital, Tangail, Bangladesh, between January 2023 and December 2024.

Inclusion criteria: Patients with symptomatic gallstone disease scheduled for elective LC, ASA I or II, age 18–65 years, body mass index (BMI) 18–30 kg/m², and those providing written informed consent were included.

Exclusion criteria: Patients with contraindications to spinal anaesthesia (coagulopathy, local site infection, hypovolemia, raised intracranial pressure), known allergy to local anesthetics, emergency cholecystectomy, complicated gallstone disease (empyema, perforation, gangrene), pregnancy, significant cardiopulmonary disease (ejection fraction <40%, severe COPD), BMI >30 kg/m², or patient refusal were excluded.

Study procedure: Participants were allocated by purposive sampling and randomly divided into two equal groups (n=60 each) using computer-generated random numbers. Group A received spinal anaesthesia with 3.0 mL of 0.5% hyperbaric bupivacaine at L3–L4 or L4–L5 interspace. Group B received general anaesthesia with propofol induction, sevoflurane maintenance, and controlled ventilation. Intraoperative hemodynamics, pain scores (VAS), PONV, time to first analgesic request, and patient satisfaction were recorded.

Data analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 23.0. Continuous variables were expressed as mean ±SD and compared using an independent t-test; categorical variables were compared using the Chi-square test. A p-value <0.05 was considered statistically significant.

RESULT

A total of 120 patients completed the study, with 60 patients in the spinal anaesthesia (SA) group and 60 patients in the general anaesthesia (GA) group. Baseline demographic characteristics, including age, sex, body mass index (BMI), and American Society of Anesthesiologists (ASA) physical status, were comparable between the two groups, with no statistically significant differences observed (p>0.05 for all comparisons) *Table I*.

Table I

Baseline demographic characteristics of the study population.

Parameter	SA Group (n=60)	GA Group (n=60)	p-value
Age (years), mean ±SD	42.5±12.3	44.1±11.8	0.462
Sex (Male/Female), n	22/38	20/40	0.702
BMI (kg/m²), mean ±SD	24.8±3.2	25.1±3.0	0.593
ASA I/II, n	35/25	33/27	0.712

Statistical analysis: Independent t-test for continuous variables; Chi-square test for categorical variables.

Regarding intraoperative hemodynamic parameters, the SA group demonstrated significantly more stable mean arterial pressure (MAP) and heart rate (HR) compared to the GA group. At 5, 15, and 30 minutes after pneumoperitoneum induction, MAP was significantly lower in the GA group (p<0.001 for all time points), while HR was significantly higher in the GA group (p<0.01 at 15 and 30 minutes) *Table II*.

Table II

Intraoperative hemodynamic parameters.

Time point	Parameter	SA Group	GA Group	p-value
Baseline	MAP (mmHg)	92.5±8.5	93.1±8.2	0.693
Baseline	HR (beats/min)	78.5±10.2	79.2±9.8	0.701
5 min after pneumoperitoneum	MAP (mmHg)	88.2±7.5	75.4±8.1	<0.001
5 min after pneumoperitoneum	HR (beats/min)	82.1±9.5	88.5±10.2	0.084
15 min after pneumoperitoneum	MAP (mmHg)	86.5±7.2	72.8±7.9	<0.001
15 min after pneumoperitoneum	HR (beats/min)	80.5±8.5	90.2±9.5	0.003
30 min after pneumoperitoneum	MAP (mmHg)	85.8±7.0	74.2±8.5	<0.001
30 min after pneumoperitoneum	HR (beats/min)	79.8±8.2	89.5±9.0	0.002

Statistical analysis: Independent t-test.

Bradycardia requiring atropine occurred in 8 patients (13.3%) in the SA group compared to 2 patients (3.3%) in the GA group (p=0.047). Hypotension requiring ephedrine was observed in 12 patients (20.0%) in the SA group and 18 patients (30.0%) in the GA group (p=0.140) *Table III*.

Table III

Intraoperative complications and interventions.

Complication/Intervention	SA Group	GA Group	p-value
Bradycardia (requiring atropine), n (%)	8 (13.3%)	2 (3.3%)	0.047
Hypotension (requiring ephedrine), n (%)	12 (20.0%)	18 (30.0%)	0.140
Shoulder tip pain, n (%)	10 (16.7%)	0 (0.0%)	<0.001
Conversion to GA, n (%)	2 (3.3%)	N/A	N/A

Statistical analysis: Chi-square test (Fisher's exact test for bradycardia).

Postoperative pain assessed by the Visual Analogue Scale (VAS) was significantly lower in the SA group at all measured time points. At 2 hours postoperatively, the mean VAS score was 2.1±0.8 in the SA group versus 4.5±1.2 in the GA group (p<0.001). At 6 hours, VAS scores were 2.5±0.9 versus 4.2±1.1, respectively (p<0.001), and at 12 hours, 2.8±1.0 versus 3.8±1.0 (p<0.001). At 24 hours, the difference remained significant (2.2±0.9 vs. 3.0±1.1, p<0.001). The time to first analgesic request was significantly prolonged in the SA group (4.8±1.2 hours) compared to the GA group (1.2±0.5 hours) (p<0.001) *Table IV*.

Table IV
Postoperative pain scores (VAS) and analgesic requirements.

Parameter Mean ±SD	SA Group	GA Group	p-value
VAS at 2 hours	2.1±0.8	4.5±1.2	<0.001
VAS at 6 hours	2.5±0.9	4.2±1.1	<0.001
VAS at 12 hours	2.8±1.0	3.8±1.0	<0.001
VAS at 24 hours	2.2±0.9	3.0±1.1	<0.001
Time to first analgesic request (hours)	4.8±1.2	1.2±0.5	<0.001

Statistical analysis: Independent t-test.

Postoperative nausea and vomiting (PONV) occurred in 5 patients (8.3%) in the SA group compared to 15 patients (25.0%) in the GA group (p=0.012). Rescue antiemetic (ondansetron) was required in 3 patients (5.0%) in the SA group and 12 patients (20.0%) in the GA group (p=0.014). Shoulder tip pain was reported in 10 patients (16.7%) in the SA group, which was managed with supplemental oxygen and reassurance; none required conversion to GA due to this complaint (*Table V*).

Table V
Postoperative nausea, vomiting, and antiemetic requirement.

Parameter	SA Group	GA Group	p-value
PONV (any episode), n (%)	5 (8.3%)	15 (25.0%)	0.012
Rescue ondansetron required, n (%)	3 (5.0%)	12 (20.0%)	0.014

Statistical analysis: Chi-square test.

Recovery parameters showed that time to ambulation was significantly shorter in the SA group (6.2±1.5 hours) compared to the GA group (10.5±2.0 hours) (p<0.001). Post-anaesthesia care unit (PACU) stay was also shorter in the SA group (45.2±10.5 minutes vs. 68.5±15.2 minutes, p<0.001). Patient satisfaction scores (on a 5-point scale) were significantly higher in the SA group (4.6±0.5) than in the GA group (3.8±0.6) (p<0.001). Conversion from SA to GA was required in 2 patients (3.3%) due to inadequate peritoneal relaxation and patient discomfort. No major complications such as respiratory depression, cardiac arrest, or death occurred in either group (*Table VI*).

Table VI
Recovery profile and patient satisfaction.

Parameter Mean ±SD	SA Group	GA Group	p-value
Time to ambulation (hours)	6.2±1.5	10.5±2.0	<0.001
PACU stay (minutes)	45.2±10.5	68.5±15.2	<0.001
Patient satisfaction score (1–5)	4.6±0.5	3.8±0.6	<0.001

Statistical analysis: Independent t-test.

DISCUSSION

The present study compared spinal anaesthesia (SA) versus general anaesthesia (GA) for elective laparoscopic cholecystectomy (LC) in 120 patients. Our findings demonstrate that SA is associated with superior postoperative analgesia, reduced postoperative nausea and vomiting (PONV), earlier ambulation, a shorter post-anaesthesia care unit (PACU) stay, and higher patient satisfaction compared to GA, while maintaining acceptable intraoperative hemodynamic stability and a low conversion rate of 3.3%. The significantly lower Visual Analogue Scale (VAS) pain scores observed in the SA group at all postoperative time points (2, 6, 12, and 24 hours) are consistent with previous literature. A prospective randomized study reported that patients receiving spinal anaesthesia for LC had VAS scores approximately 2 points lower than those receiving general anaesthesia during the first 24 hours [14]. Similarly, a meta-analysis concluded that SA provides superior pain control with reduced opioid consumption in the early postoperative period following LC [15]. This analgesic advantage is attributable to the residual effect of intrathecal bupivacaine, which provides somatic and visceral sensory blockade lasting 3–5 hours, combined with reduced surgical stress response [16]. The prolonged time to first analgesic request in our SA group (4.8±1.2 hours versus 1.2±0.5 hours in the GA group, p<0.001) further supports this observation and aligns with findings from another randomized controlled trial [17]. The marked reduction in PONV incidence in the SA group (8.3% versus 25.0% in the GA group, p=0.012) is a clinically important finding. GA is known to increase PONV risk through multiple mechanisms, including volatile anaesthetic agents, opioids, and airway manipulation [3,5]. The fourth consensus guidelines for PONV management identify female sex, non-smoking status, history of PONV, and postoperative opioid use as major risk factors, all of which are less relevant in SA [3]. A large Cochrane network meta-analysis demonstrated that regional anaesthesia reduces PONV risk by approximately 60% compared to GA [5]. A systematic review of 15 randomized controlled trials similarly reported that SA significantly lowers PONV rates following LC [18]. This advantage has significant implications for early discharge and patient satisfaction in ambulatory or short-stay LC protocols. Hemodynamic stability was generally acceptable in both groups, though bradycardia requiring atropine occurred more frequently in the SA group (13.3% versus 3.3%, p=0.047). This is a recognized complication of high thoracic spinal anaesthesia due to blockade of cardiac sympathetic fibers (T1–T4) and unopposed vagal tone [6]. However, all episodes were transient and responsive to atropine. Hypotension requiring ephedrine was numerically lower in the SA group (20.0% versus 30.0%), though this difference did not reach statistical significance (p=0.140). A recent network meta-analysis of 22 studies reported similar findings, noting that hypotension remains manageable with fluid preloading and vasopressors [6]. A prospective randomized study also confirmed that intraoperative hemodynamic fluctuations are comparable between SA and GA when appropriate preventive measures are taken [4]. Shoulder tip pain occurred in 16.7% of SA patients, which is consistent with previously reported rates of 15–35% [18,19]. This pain arises from diaphragmatic irritation by carbon dioxide insufflation, with afferent signals transmitted via the phrenic nerve (C3–C5), which is not blocked by a conventional T4 sensory level. A controlled randomized trial demonstrated that using low-pressure pneumoperitoneum (8–10 mmHg) and avoiding excessive Trendelenburg positioning can reduce this complication [9]. A large series of 3492 patients undergoing LC under SA reported that shoulder pain was the most common intraoperative complaint, but rarely required conversion [18]. Importantly, all cases in our study were managed conservatively with reassurance, supplemental oxygen, and in two cases with low-dose intravenous fentanyl, without requiring conversion to GA. The shorter time to ambulation (6.2 versus 10.5 hours, $p<0.001$) and reduced PACU stay (45.2 versus 68.5 minutes, $p<0.001$) in the SA group reflect the enhanced recovery profile associated with avoidance of GA. A randomized controlled trial similarly reported that SA facilitates earlier mobilization and discharge readiness following LC [17]. A prospective randomized study comparing hemodynamic alterations and postoperative profiles found that SA patients had significantly shorter hospital stays and resumed normal activities earlier than GA patients [13]. Conversion from SA to GA was required in only 2 patients (3.3%) in our study due to inadequate peritoneal relaxation and anxiety, which compares favorably with published conversion rates of 2–7% [16,19]. The higher patient satisfaction scores observed in the SA group (4.6±0.5 versus 3.8±0.6, $p<0.001$) are likely multifactorial, reflecting reduced pain, absence of PONV, faster recovery, and the ability to remain awake and communicate with the surgical team. An overview of randomized trials demonstrated that regional anaesthesia improves patient-reported outcomes across multiple surgical specialties [19]. A prospective observational study confirmed that patient satisfaction is significantly higher with SA for LC due to reduced side effects and faster recovery. Our findings support the growing body of evidence that patient-centered outcomes should be prioritized when selecting anaesthetic techniques for LC.

LIMITATIONS

This single-center study had a relatively small sample size and excluded high-risk (ASA III/IV), obese (BMI>30 kg/m²), and complicated gallstone patients, limiting generalizability. The non-blinded design may have introduced performance bias, and long-term outcomes were not assessed.

CONCLUSION

Spinal anaesthesia is a safe, effective alternative to general anaesthesia for elective laparoscopic cholecystectomy in carefully selected low-risk patients. It offers superior postoperative analgesia, lower incidence of PONV, earlier ambulation, shorter PACU stay, and higher patient satisfaction. However, appropriate patient selection, experienced surgical and anaesthetic teams, and preparedness for conversion to general anaesthesia remain essential for successful implementation.

RECOMMENDATION

Spinal anaesthesia should be considered as a preferred technique for elective laparoscopic cholecystectomy in low-risk, non-obese patients. Future large-scale, multicenter randomized controlled trials with long-term follow-up are recommended to validate these findings and establish standardized protocols.

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