Section: General Surgery

Original Research Article

TO EVALUATE EFFICACY, COST BENEFIT OF LAPAROSCOPIC CHOLECYSTECTOMY UNDER SPINAL/ EPIDURAL ANAESTHESIA: A PROSPECTIVE STUDY

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ABSTRACT

Background: Spinal anaesthesia (SA) is being increasingly explored as an alternative to general anaesthesia (GA) for laparoscopic cholecystectomy (LC). The aim is to compare the efficacy, safety, postoperative recovery, and cost-effectiveness of laparoscopic cholecystectomy performed under spinal versus general anaesthesia. Settings and Design is prospective, randomized study conducted at a tertiary care center over one years.

Materials and Methods: 244 patients with cholelithiasis were randomized into two groups: SA group (n=124) and GA group (n=120). Standard four-port LC was performed in all cases. Primary outcomes included anaesthesia time, surgery time, pneumoperitoneum duration, and cost. Secondary outcomes included intra- and postoperative complications, pain scores, and conversions. Statistical Analysis is student t-test and Chi-square test were used. $P<0.05$ considered statistically significant.

Results: Anaesthesia time was significantly lower in SA group (40.3 ± 6.1 min) vs GA group (48.6 ± 7.2 min). Surgery and pneumoperitoneum times were slightly longer in SA group (36.9 ± 5.4 min vs 34.7 ± 5.7 min; not statistically significant). In SA group, 3 cases (2.4%) were converted to GA due to discomfort and anxiety. Postoperative pain at 6 and 12 hours was significantly lower in SA group. Average hospital cost was significantly less in SA group (₹8,500 vs ₹12,000). No significant postoperative complications occurred in either group.

Conclusion: Laparoscopic cholecystectomy under spinal anaesthesia is a feasible, safe, and cost-effective alternative to general anaesthesia, particularly in resource-constrained settings.

Keywords: Laparoscopic cholecystectomy, spinal anaesthesia, general anaesthesia, postoperative pain, cost analysis

INTRODUCTION

Laparoscopic cholecystectomy (LC) has become the gold standard for treating symptomatic gallstone disease. General anaesthesia (GA) is conventionally preferred for LC, as it provides optimal control over airway, ventilation, and patient comfort during carbon dioxide pneumoperitoneum and the steep head-up position required during surgery.[1]

However, spinal anaesthesia (SA) is increasingly being explored as an alternative, even for routine laparoscopic procedures. It offers potential benefits such as reduced postoperative pain, minimal respiratory complications, early ambulation, and avoidance of airway manipulation.[2–4] Several studies have demonstrated that LC can be safely performed under SA, with comparable outcomes to GA.[5–7]

Despite these advantages, SA is not widely adopted for LC due to concerns about patient discomfort, referred shoulder pain, hemodynamic instability, and the potential need for conversion to GA during the procedure.[8–10] Additionally, limited visibility in the surgical field at low-pressure pneumoperitoneum is a common concern.[11]

In developing countries where healthcare resources are limited, SA may offer significant cost advantages over GA.[12,13] Therefore, this study aims to compare spinal and general anaesthesia for laparoscopic cholecystectomy in terms of intraoperative parameters, postoperative outcomes, patient comfort, and cost-effectiveness in a tertiary care center.

MATERIALS AND METHODS

Study Design and Setting: This was a prospective, randomized comparative study conducted at the Department of Surgery and Anaesthesia, Integral Institute of Medical Science and Research, Lucknow, India, over a period of one year from January 2024 to December 2024. The study was approved by the institutional ethical committee, and informed written consent was obtained from all participants. A total of 250 patients diagnosed with acute/chronic cholecystitis and scheduled for elective laparoscopic cholecystectomy were enrolled. 5 patients in GA group and 1 in SA group were converted to open procedures and were excluded. A total of 244 patients were then analysed. Patients with acute or chronic cholecystitis aged 18-75 years, with ASA physical status I or II, and consenting to anesthesia were included and those with severe acute cholecystitis or cholangitis, suspected or confirmed common bile duct stones, upper abdominal surgery history, spinal anesthesia constraints, severe cardiopulmonary disease, or psychiatric disorders were excluded. Patients were randomly allocated into two groups using a computer-generated randomisation sequence:

- Group GA (n=120): Received general anaesthesia
- Group SA (n=124): Received spinal anaesthesia.

The anaesthesia type was administered by different anaesthesiologists not involved in surgical or postoperative evaluation. Surgeons and outcome assessors were blinded to group allocation.

Anaesthetic Technique

General Anaesthesia (GA) group: Induction with propofol (2–2.5 mg/kg), fentanyl (2 mcg/kg), and rocuronium (0.6 mg/kg). Maintenance with isoflurane/sevoflurane in oxygen and nitrous oxide. Ventilation adjusted to maintain normocapnia. Reversal was done with neostigmine and glycopyrrolate at the end of surgery.

Spinal Anaesthesia (SA) group: Spinal block performed in the L3-L4 interspace using 2.5–3.5 ml of 0.5% hyperbaric bupivacaine. Patients were positioned in 10–15° head-down tilt to achieve T4 level sensory block. Hypotension was managed with intravenous fluids and vasopressors (mephentermine). Midazolam and fentanyl were administered intravenously if intraoperative discomfort or anxiety occurred.

Surgical Technique: All patients underwent a standard four-port laparoscopic cholecystectomy using CO_2 pneumoperitoneum maintained at 8–10 mmHg pressure. Low-pressure pneumoperitoneum was used in both groups to maintain comparability. Surgery was conducted by the same team of experienced laparoscopic surgeons.

Outcome Measures

Primary outcome measures included:

- Anaesthesia time
- Pneumoperitoneum time
- Total surgery duration
- Total hospital cost

Secondary outcome measures included:

- Conversion to GA (in SA group)
- Intraoperative events (shoulder pain, anxiety, hypotension, nausea/vomiting)
- Postoperative complications
- Postoperative pain scores using the Visual Analogue Scale (VAS) at 6, 12, and 24 hours

Cost Analysis

Direct hospital cost was calculated based on standard hospital billing records, including anaesthesia, surgical fees, medications, and length of hospital stay. Average cost was calculated in both groups.

Statistical Analysis

Data were analysed using SPSS v26.0. Continuous variables were expressed as mean ± standard deviation and compared using the Student's t-test. Categorical variables were compared using the Chi-square or Fisher's exact test. A p value <0.05 was considered statistically significant.

RESULTS

A total of 244 patients were enrolled and analyzed, with 120 in the General Anaesthesia (GA) group and 124 in the Spinal Anaesthesia (SA) group. The demographic profiles of both groups were comparable.

Table 1: Demographic Characteristics

Characteristic	GA Group (n=120)	SA Group (n=124)
Age (mean ± SD)	45.8 ± 11.7	44.5 ± 12.3
Gender (F/M)	80/40	85/39

There was no significant difference in age or gender distribution between the two groups.

Table 2: Intraoperative Parameters

Parameter	GA Group (mean ± SD)	SA Group (mean ± SD)	p-value
Anaesthesia Time (min)	48.6 ± 7.2	40.3 ± 6.1	<0.001
Pneumoperitoneum Time (min)	34.7 ± 5.7	36.9 ± 5.4	0.08
Surgery Duration (min)	35.2 ± 6.4	37.4 ± 5.8	0.06

Anaesthesia time was significantly shorter in the SA group ($p<0.001$). Pneumoperitoneum and surgery times were slightly longer in SA group, but the differences were not statistically significant.

Intraoperative Events and Conversions: In the SA group, 3 patients (2.4%) required conversion to GA due to anxiety (1 case), unrelieved shoulder pain (1 case), and hypotension with vomiting (1 case). Minor intraoperative events were more common in the SA group but were manageable.

Table 3: Intraoperative Events in SA Group (n=124)

Event	No. of Cases
Referred Shoulder Pain	9
Hypotension	5
Anxiety	4
Nausea/Vomiting	3
Conversion to GA	3

Table 4: Postoperative Complications

Complication	GA Group (n=120)	SA Group (n=124)
Pain abdomen (extra analgesia)	16 (13.3%)	4 (3.2%)
Nausea/Vomiting	8 (6.7%)	2 (1.6%)
Urinary Retention	1 (0.8%)	3 (2.4%)
Post-Dural Puncture Headache	0	2 (1.6%)
Sore Throat	5 (4.2%)	0

Postoperative pain and nausea/vomiting were more frequent in the GA group. Minor complications like headache and urinary retention were slightly more in the SA group.

Pain Scores: Pain was assessed using the Visual Analogue Scale (VAS). Pain scores were significantly lower in the SA group at 6 and 12 hours.

Table 5: VAS Pain Scores (Median [Range])

Time Post-op	GA Group	SA Group	p-value
6 hours	4 (2–7)	1 (0–4)	<0.001
12 hours	2 (1–5)	1 (0–3)	0.01
24 hours	1 (0–3)	1 (0–2)	0.42

Cost Analysis: Average cost for patients in the SA group was ₹8,500 compared to ₹12,000 in the GA group. The difference was statistically significant ($p<0.001$), reflecting lower use of drugs and equipment in the SA group.

Table 6: Cost Analysis

Group	Average Cost (INR)	p-value
GA	₹ 12,000	<0.001
SA	₹ 8,500	—

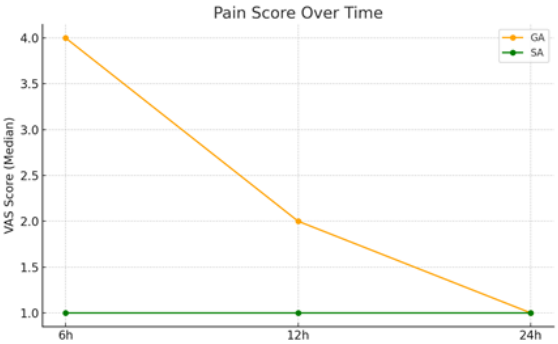

Figure 1: Line graph showing declining VAS pain scores over 24 hours for both groups.

DISCUSSION

This prospective study compared the outcomes of laparoscopic cholecystectomy (LC) performed under spinal anaesthesia (SA) versus general anaesthesia (GA) in 244 patients. The findings demonstrate that SA is a feasible, effective, and economically advantageous alternative to GA in selected patients. Notably, the SA group exhibited a low conversion rate to GA (2.4%), lower postoperative pain scores, fewer complications, and significantly reduced hospital costs.

The reduced postoperative pain observed in the SA group is consistent with previous studies by Imbelloni et al,[4] and Aydogan et al,[9] who

emphasized the role of SA in improving perioperative pain control, particularly when combined with low-pressure pneumoperitoneum. Moreover, Gupta et al,[12] and Khurana et al,[13] reported similar reductions in analgesic requirements with SA, underscoring its role in enhanced postoperative comfort and opioid-sparing benefits.

The incidence of postoperative nausea and vomiting (PONV) was also significantly lower in the SA group, aligning with the observations made by Kim et al,[5] Hasaniya et al,[8] and Aydogan et al.[9] This reduction in PONV not only contributes to improved patient satisfaction but also facilitates early oral intake and ambulation, thereby accelerating recovery.

While GA continues to be the preferred anaesthetic modality in patients with significant comorbidities due to its superior control over airway and ventilation, as supported by the findings of Joris et al,[6] our study reaffirms that SA is a safe option for patients with low anaesthetic risk. Additionally, the haemodynamic stability and controlled intra-abdominal pressure achievable under SA, as demonstrated in the study by van Zundert et al,[2] enhance its intraoperative safety profile.

Cost-effectiveness remains a critical factor in resource-limited healthcare settings. The significantly lower average hospital cost in the SA group, as demonstrated in our study, supports the findings of Gupta and Singh,[12] who emphasized the economic benefits of SA in laparoscopic procedures conducted in rural India. This cost reduction is attributable to the decreased use of anaesthetic agents, airway devices, and shorter recovery times.

Our findings also differ from those of Minai and Khan,[10] and El-Labban et al,[15] who reported no significant difference in recovery times between SA and GA. The discrepancy may be attributed to differences in patient selection criteria, as our study predominantly included healthy adults with low surgical risk. In contrast, studies such as those by Joris et al,[6] and Mann et al,[16] included elderly or comorbid populations, which could affect the generalizability of recovery outcomes.

Furthermore, concerns about the suitability of SA in longer procedures, as raised by Mann et al,[16] were not substantiated in our study. We observed no significant difference in total surgical time between the two groups, indicating that with proper anaesthetic technique and intraoperative monitoring, SA can be effectively used even in procedures of longer duration.

In summary, our study supports the growing body of evidence advocating for the use of spinal anaesthesia in laparoscopic cholecystectomy. It provides comparable surgical outcomes to general anaesthesia, with the added benefits of reduced pain, lower complication rates, faster recovery, and substantial cost savings. However, patient selection remains key, and SA should be employed in appropriately screened individuals to ensure optimal outcomes.

CONCLUSION

In conclusion, our study suggests that spinal anaesthesia can be a viable alternative to general anaesthesia for laparoscopic cholecystectomy, offering advantages in recovery time and postoperative complications. This is consistent with studies by vanZunder et al., TiwariS et al., Imbelloni et al. and mentioned in the introduction.[2-4] However, as with the findings of Kim MH et al[5] further prospective, randomized controlled trials are needed to validate these results and refine the selection criteria for spinal anaesthesia, particularly in complex or high-risk patients.

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