ORIGINAL RESEARCH

A Comparative Study of Laparoscopic Cholecystectomy under Spinal Anaesthesia versus General Anaesthesia

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Received: 15December, 2012 Accepted: 22January, 2013

ABSTRACT
Aim: This prospective, randomized controlled study aimed to compare the efficacy and safety of spinal anesthesia (SA) versus general anesthesia (GA) in patients undergoing laparoscopic cholecystectomy (LC), with a focus on intraoperative hemodynamics, postoperative recovery, complication rates, and patient satisfaction.
Materials and Methods: A total of 100 patients scheduled for elective LC were randomly assigned to either the SA group (n=50) or the GA group (n=50). The primary outcomes measured were hemodynamic stability (heart rate and blood pressure), the feasibility of completing the procedure under spinal anesthesia, and the incidence of intraoperative and postoperative complications. Secondary outcomes included pain levels, time to ambulation, length of hospital stay, and patient satisfaction, which were assessed using standardized scales.
Results: The study demonstrated no significant differences in demographic characteristics between the two groups. Intraoperatively, the SA group exhibited lower mean arterial pressure and heart rate, and a higher need for vasopressor support compared to the GA group. Postoperatively, the SA group had a significantly shorter time to ambulation, reduced hospital stay, and better pain control, with fewer patients requiring rescue analgesia. However, the SA group had a higher incidence of bradycardia and shoulder pain, while the GA group reported more nausea and vomiting. Patient satisfaction scores were significantly higher in the SA group, indicating better overall comfort and recovery.
Conclusion: Spinal anesthesia for laparoscopic cholecystectomy offers several advantages over general anesthesia, including faster recovery, reduced hospital stays, and improved patient satisfaction. However, it may be associated with certain hemodynamic challenges and a higher incidence of shoulder pain. The choice of anesthesia should be tailored to individual patient factors and the clinical setting.
Keywords: Laparoscopic cholecystectomy, Spinal anesthesia, General anesthesia, Postoperative recovery, Patient satisfaction.

INTRODUCTION

Laparoscopic cholecystectomy (LC) is the gold standard procedure for the surgical management of gallbladder diseases, particularly gallstones and chronic cholecystitis. Since its introduction, LC has significantly reduced surgical morbidity, improved patient recovery, and shortened hospital stays compared to open cholecystectomy. Traditionally, LC is performed under general anesthesia (GA) to ensure optimal surgical conditions, patient comfort, and controlled ventilation. However, recent advancements in regional anesthesia techniques have led to increased interest in spinal anesthesia (SA) as an alternative approach for LC. Spinal anesthesia provides effective sensory and motor blockade, reducing intraoperative stress responses and postoperative complications. The choice between SA and GA for LC has become an area of growing research interest, as both techniques offer distinct advantages and limitations.[1]

General anesthesia remains the most widely used anesthetic technique for LC due to its ability to provide complete unconsciousness, airway control through endotracheal intubation or a laryngeal mask airway, and stable surgical conditions. It allows for controlled ventilation, which is crucial in laparoscopic surgeries that involve carbon dioxide (CO_2) insufflation to create pneumoperitoneum. However, GA is associated with certain disadvantages, such as hemodynamic fluctuations, postoperative nausea and vomiting (PONV), delayed recovery, and potential respiratory complications. The use of inhalational anesthetics and muscle relaxants may lead to prolonged recovery times and increase the risk of postoperative pain and airway-related issues. Despite these concerns, GA continues to be the preferred choice for LC due to its reliability and familiarity among anesthesiologists and surgeons.[2]

Spinal anesthesia, on the other hand, has gained attention as a feasible alternative for LC, especially in patients with contraindications to GA, such as those with respiratory diseases, cardiovascular instability, or a high risk of airway complications. SA involves the administration of a local anesthetic into the subarachnoid space, resulting in a temporary but profound sensory, motor, and autonomic blockade. One of the key benefits of SA is its ability to provide excellent intraoperative analgesia while minimizing the systemic effects associated with GA. Patients undergoing SA for LC often experience fewer hemodynamic fluctuations, reduced postoperative pain, and earlier recovery of gastrointestinal function. Additionally, SA has been associated with lower incidences of PONV, a common postoperative complaint following GA.[3]

One of the primary challenges of performing LC under SA is the physiological response to pneumoperitoneum. The creation of pneumoperitoneum increases intra-abdominal pressure, which can cause discomfort, diaphragmatic irritation, and respiratory changes in patients under SA. Unlike GA, where controlled ventilation can compensate for these effects, patients under SA must rely on spontaneous breathing, which may be compromised by pneumoperitoneum-induced diaphragmatic splinting. Surgeons and anesthesiologists must carefully manage intraoperative conditions by adjusting the insufflation pressure and providing sedation if necessary to improve patient comfort.[4]

Another potential concern with SA is the risk of hemodynamic instability due to sympathetic blockade, leading to hypotension and bradycardia. However, with proper preloading, vasopressor support, and careful monitoring, these effects can be effectively managed. Despite these challenges, SA offers significant benefits, particularly in terms of faster postoperative recovery. Studies have shown that patients receiving SA for LC have shorter hospital stays, earlier ambulation, and reduced postoperative analgesic requirements compared to those under GA. Faster recovery times contribute to decreased hospital costs and improved patient satisfaction.[4]

Patient preference and comfort also play a crucial role in the choice between SA and GA. While GA ensures complete unconsciousness, eliminating intraoperative awareness or discomfort, some patients may prefer SA due to the avoidance of airway instrumentation and the reduced risk of GA-related complications. Moreover, SA allows for immediate postoperative mobility, which is beneficial in preventing deep vein thrombosis and other immobility-related complications. However, some patients may experience discomfort or anxiety due to being awake during surgery, which may necessitate mild sedation.

The feasibility and safety of LC under SA have been widely studied, and many researchers have reported positive outcomes with proper patient selection and technique modification. Despite its benefits, SA is not suitable for all patients, and careful preoperative evaluation is essential to determine the best anesthetic approach. Factors such as patient comorbidities, surgeon experience, and expected surgical difficulty must be considered when deciding between SA and GA.[5]

Both spinal anesthesia and general anesthesia offer unique advantages and challenges for laparoscopic cholecystectomy. While GA remains the conventional and widely practiced approach, SA has emerged as a viable alternative that provides effective analgesia, reduced postoperative complications, and faster recovery. The choice between SA and GA should be individualized, taking into account patient-specific factors, surgical requirements, and anesthetic expertise.

AIM & OBJECTIVES

This prospective, randomized controlled study aimed to compare the efficacy and safety of spinal anesthesia (SA) versus general anesthesia (GA) in patients undergoing laparoscopic cholecystectomy (LC), with a focus on intraoperative hemodynamics, postoperative recovery, complication rates, and patient satisfaction.

MATERIALS AND METHODS

This study was designed as a prospective, randomized controlled trial comparing laparoscopic cholecystectomy (LC) performed under spinal anesthesia (SA) versus general anesthesia (GA). The study was conducted Department of General Surgery, Saraswathi Institute of Medical Sciences, Hapur,Uttar Pradesh, India in collaboration with Department of Biochemistry, Shri Ram MurtiSmark Institute of Medical Sciences, Bareilly, Uttar Pradesh, India, following approval from the Institutional Ethics Committee (IEC). Written informed consent was obtained from all participants before enrollment. A total of 100 patients scheduled for elective laparoscopic cholecystectomy were included in the study. The Study duration was fromMarch 2010 to November 2012.

Patients were randomly assigned into two equal groups:

- **Group SA (n = 50):** Patients undergoing LC under spinal anesthesia
- **Group GA (n = 50):** Patients undergoing LC under general anesthesia

Inclusion Criteria:

- Patients aged 18–65 years
- American Society of Anesthesiologists (ASA) physical status I or II
- Indication for elective laparoscopic cholecystectomy (e.g., symptomatic gallstone disease, chronic cholecystitis)

Exclusion Criteria:

- ASA III or higher
- Contraindications to spinal anesthesia (e.g., coagulopathy, severe spinal deformity, local infection at the puncture site)
- History of severe cardiovascular or respiratory disorders
- Pregnancy
- Patient refusal

Biochemical tests are typically performed to assess:

Liver Function Tests (LFTs):

- Alanine Aminotransferase (ALT/SGPT): To detect liver cell injury.
- Aspartate Aminotransferase (AST/SGOT): Also indicates liver and heart health.
- Alkaline Phosphatase (ALP): Measures bile duct health.
- Total and Direct Bilirubin: Evaluates bile flow and liver function.

Inflammatory Markers:

- C-Reactive Protein (CRP): Indicates systemic inflammation.
- White Blood Cell (WBC) Count: Monitors immune response and infection.

Renal Function Tests (RFTs):

- Blood Urea Nitrogen (BUN) and Creatinine: Evaluate kidney function.

Stress and Metabolic Response Markers:

- Blood Glucose: To assess stress-induced hyperglycemia.
- Cortisol: Reflects the body's stress response (optional in some studies).

Arterial Blood Gases (ABG):

- To check oxygenation, carbon dioxide levels, and acid-base balance, particularly important in GA.

Randomization and Blinding

Patients were randomly allocated to either group using a computer-generated randomization table. The anesthesiologist administering anesthesia was aware of the group allocation, while the surgeon and the outcome assessor were blinded to the anesthetic technique.

Anesthetic Techniques

Spinal Anesthesia (SA) Protocol

Patients in the spinal anesthesia group received preloading with 500 mL of Ringer's lactate solution to minimize the risk of hypotension. Spinal anesthesia was administered under strict aseptic conditions at the L3-L4 or L4-L5 interspace using a 25G Quincke needle. A 3 mL dose of 0.5% hyperbaric bupivacaine combined with 25 µg fentanyl was injected into the subarachnoid space to achieve adequate sensory and motor blockade. Oxygen supplementation was provided at a rate of 3-5 L/min via a nasal cannula to ensure optimal oxygenation. Hemodynamic parameters, including heart rate and blood pressure, were continuously monitored throughout the procedure. Hypotension, if encountered, was managed with intravenous fluids and vasopressor agents as needed. In cases of severe patient discomfort or anesthesia failure, a planned conversion to general anesthesia was implemented to ensure procedural safety and patient comfort.

General Anesthesia (GA) Protocol

For patients in the general anesthesia group, standard premedication was administered, which included intravenous midazolam at a dose of 0.02 mg/kg and fentanyl at 2 µg/kg to provide anxiolysis and analgesia. Anesthesia induction was achieved using intravenous propofol at 2 mg/kg, followed by rocuronium at 0.6 mg/kg to facilitate endotracheal intubation. Anesthesia was maintained with sevoflurane in an oxygen-air mixture, with additional doses of fentanyl and rocuronium administered as required to ensure adequate analgesia and muscle relaxation. At the end of the procedure, neuromuscular blockade was reversed using neostigmine at 0.05 mg/kg and glycopyrrolate at 0.01 mg/kg to restore spontaneous respiration and muscle function before extubation.

Surgical Procedure

All laparoscopic cholecystectomy procedures were performed by an experienced team of laparoscopic surgeons following a standardized four-port technique. Pneumoperitoneum was created by insufflating CO_2, with intra-abdominal pressure maintained between 10-12 mmHg to facilitate optimal visualization and manipulation. The gallbladder was dissected using conventional laparoscopic instruments, and after securing the cystic duct and artery with clips, it was carefully removed through the umbilical port. The procedure was completed with thorough hemostasis, followed by desufflation of the abdominal cavity and closure of the trocar sites.

Outcome Measures

The primary outcomes of the study included hemodynamic stability, assessed by monitoring heart rate and blood pressure variations throughout the procedure, and the feasibility of completing laparoscopic cholecystectomy under spinal anesthesia without the need for conversion to general anesthesia.Secondary outcomes included intraoperative and postoperative pain levels measured using the Visual Analog Scale (VAS). The incidence of intraoperative complications, such as bradycardia, hypotension, nausea, vomiting, and shoulder pain, was also recorded. Additionally, postoperative recovery parameters, including the time to ambulation, length of hospital stay, and the requirement for rescue analgesia, were evaluated. Lastly, patient satisfaction scores were assessed to determine overall acceptance and comfort associated with each anesthesia technique.

STATISTICAL ANALYSIS

Data were analyzed using SPSS version 25.0. Continuous variables were presented as mean ± standard deviation (SD) and compared using the Student's t-test or Mann-Whitney U test, as appropriate. Categorical variables were expressed as frequencies and percentages and analyzed using the chi-square test or Fisher's exact test. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Demographic and Baseline Characteristics

Characteristic	SA Group (n=50)	GA Group (n=50)	p-value
Age (years, mean ± SD)	42.6 ± 10.8	41.8 ± 11.2	0.72
Gender (M/F)	18/32	20/30	0.68
ASA I/II	28/22	26/24	0.70
BMI (kg/m², mean ± SD)	26.4 ± 3.2	26.8 ± 3.1	0.55
Indication for LC (Gallstones/Chronic Cholecystitis)	35/15	38/12	0.57

Table 1 shows that the demographic and baseline characteristics of the study population were comparable between the spinal anesthesia (SA) and general anesthesia (GA) groups, ensuring homogeneity between both groups. The mean age of patients in the SA group was 42.6 ± 10.8 years, while in the GA group, it was 41.8 ± 11.2 years (p=0.72), indicating no statistically significant difference. The gender distribution was also similar, with a male-to-female ratio of 18:32 in the SA group and 20:30 in the GA group (p=0.68). The ASA physical status classification was predominantly ASA I in both groups, with no significant difference (p=0.70). The mean BMI was slightly higher in the GA group (26.8 ± 3.1) than in the SA group (26.4 ±

3.2), but this difference was not statistically significant (p=0.55). The primary indications for laparoscopic cholecystectomy were gallstones and chronic cholecystitis, with a nearly equal distribution between the two groups (p=0.57). These findings suggest that the randomization process was effective, and there were no confounding baseline differences that could affect the results.

Table 2: Intraoperative Parameters

Parameter	SA Group (n=50)	GA Group (n=50)	p-value
Duration of Surgery (min)	47.8 ± 10.5	45.6 ± 9.8	0.32
Mean Arterial Pressure (mmHg)	78.5 ± 7.2	84.3 ± 6.5	0.01*
Heart Rate (beats/min)	68.2 ± 8.1	75.4 ± 7.8	0.02*
Need for Vasopressor Use (%)	10 (20%)	3 (6%)	0.03*
Conversion to GA (%)	3 (6%)	N/A	-

Table 2 shows that the intraoperative parameters revealed some notable differences between the two anesthesia techniques. The mean duration of surgery was slightly longer in the SA group (47.8 ± 10.5 minutes) than in the GA group (45.6 ± 9.8 minutes), but this difference was not statistically significant (p=0.32), indicating that anesthesia type did not impact the surgical duration. A significant difference was observed in mean arterial pressure (MAP), which was lower in the SA group (78.5 ± 7.2 mmHg) compared to the GA group (84.3 ± 6.5 mmHg) (p=0.01). This is likely due to the sympathetic blockade associated with spinal anesthesia, leading to vasodilation and hypotension. Similarly, the mean heart rate was significantly lower in the SA group (68.2 ± 8.1 bpm) compared to the GA group (75.4 ± 7.8 bpm) (p=0.02), further supporting the hemodynamic effects of spinal anesthesia. Additionally, the need for vasopressor support was significantly higher in the SA group (20%) compared to the GA group (6%) (p=0.03), reinforcing the tendency for hemodynamic instability under spinal anesthesia. Notably, 3 patients (6%) in the SA group required conversion to general anesthesia due to discomfort or inadequate anesthesia, though the majority of patients were able to complete the procedure under spinal anesthesia.

Table 3: Postoperative Recovery Parameters

Parameter	SA Group (n=50)	GA Group (n=50)	p-value
Time to Ambulation (hours)	4.2 ± 1.5	7.8 ± 2.2	<0.001*
Hospital Stay (days)	1.6 ± 0.5	2.4 ± 0.6	<0.001*
Time to First Analgesic (hrs)	5.6 ± 1.8	3.2 ± 1.2	0.02*
Need for Rescue Analgesia (%)	12 (24%)	25 (50%)	0.01*

Table 3 shows that the Postoperative recovery outcomes favored spinal anesthesia in multiple aspects. The time to ambulation was significantly shorter in the SA group (4.2 ± 1.5 hours) compared to the GA group (7.8 ± 2.2 hours) (p<0.001), indicating faster postoperative mobilization. This is a crucial advantage of spinal anesthesia, as early ambulation is associated with reduced complications such as deep vein thrombosis and improved overall recovery. Hospital stay was also significantly shorter in the SA group (1.6 ± 0.5 days) compared to the GA group (2.4 ± 0.6 days) (p<0.001), suggesting that spinal anesthesia may contribute to faster discharge and reduced healthcare costs. Pain management also differed between the two groups. The time to the first analgesic requirement was significantly longer in the SA group (5.6 ± 1.8 hours) than in the GA group (3.2 ± 1.2 hours) (p=0.02), indicating better immediate postoperative pain control with spinal anesthesia. Additionally, the need for rescue analgesia was lower in the SA group (24%) compared to the GA group (50%) (p=0.01), reinforcing the analgesic benefits of spinal anesthesia.

Table 4: Intraoperative and Postoperative Complications

Complication	SA Group (n=50)	GA Group (n=50)	p-value
Bradycardia (%)	8 (16%)	2 (4%)	0.04*
Hypotension (%)	12 (24%)	5 (10%)	0.03*

Nausea/Vomiting (%)	6 (12%)	14 (28%)	0.02*
Shoulder Pain (%)	18 (36%)	5 (10%)	<0.001*

Figure I: Intraoperative and postoperative complications

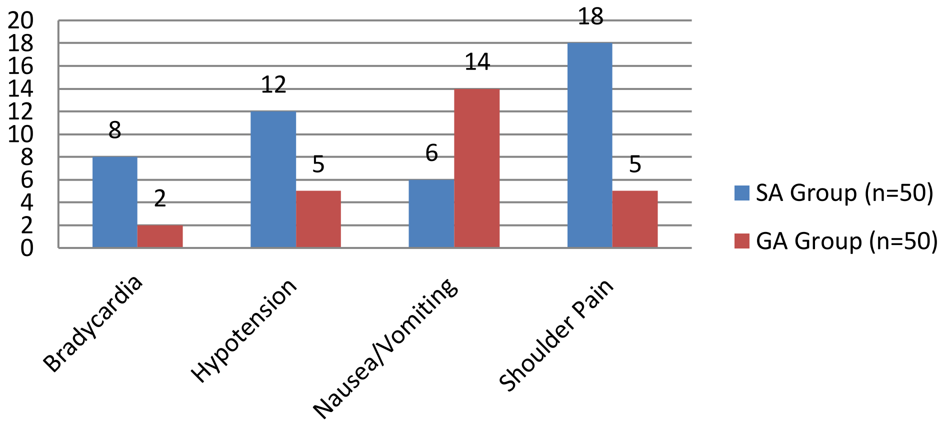

Table 4 and figure I, shows that the complication profile varied between the two groups, reflecting the physiological effects of each anesthetic technique. Bradycardia was significantly more common in the SA group (16%) than in the GA group (4%) (p=0.04), likely due to the sympathetic blockade effect of spinal anesthesia. Similarly, hypotension was more frequent in the SA group (24%) compared to the GA group (10%) (p=0.03), further emphasizing the hemodynamic challenges associated with spinal anesthesia. Conversely, nausea and vomiting were more prevalent in the GA group (28%) compared to the SA group (12%) (p=0.02). This aligns with the known association between general anesthesia and postoperative nausea and vomiting (PONV), likely due to inhalational agents and opioid use. Shoulder pain, a common discomfort associated with laparoscopic procedures due to diaphragmatic irritation from CO_2 insufflation, was significantly more frequent in the SA group (36%) compared to the GA group (10%) (p<0.001). This could be attributed to preserved diaphragmatic sensation in some patients under spinal anesthesia, whereas general anesthesia provides complete sensory blockade.

Table 5: Patient Satisfaction Scores

Satisfaction Parameter	SA Group (n=50)	GA Group (n=50)	p-value
Overall Satisfaction Score (1-10)	8.6 ± 1.2	7.4 ± 1.5	0.01*
Willingness to Choose Again (%)	42 (84%)	30 (60%)	0.02*
Postoperative Comfort (VAS 1-10)	7.8 ± 1.5	6.5 ± 1.8	0.03*

Table 5 shows that the patient satisfaction was assessed using multiple parameters, all of which favored spinal anesthesia. The overall satisfaction score was significantly higher in the SA group (8.6 ± 1.2) than in the GA group (7.4 ± 1.5) (p=0.01), suggesting that patients found the experience more favorable with spinal anesthesia. Willingness to choose the same anesthesia technique for future surgeries was also significantly higher in the SA group (84%) compared to the GA group (60%) (p=0.02), reinforcing the acceptability of spinal anesthesia among patients. Postoperative comfort, measured on a Visual Analog Scale (VAS), was also significantly better in the SA group (7.8 ± 1.5) compared to the GA group (6.5 ± 1.8) (p=0.03), further highlighting the benefits of spinal anesthesia in terms of reduced pain and better overall recovery experience.

DISCUSSION

The demographic and baseline characteristics in this study were comparable between the SA and GA groups, ensuring homogeneity in patient selection. The mean age of patients was similar in both groups (42.6 ± 10.8 years vs. 41.8 ± 11.2 years, p=0.72), with no significant differences in gender distribution, ASA classification, BMI, or surgical indications. These findings are consistent with those reported by Tzovaras et al. (2008), who found no significant demographic variations between SA and GA groups undergoing laparoscopic cholecystectomy.[4] Similarly, Sinha et al. (2005) also demonstrated the effectiveness of randomization in studies comparing different anesthesia techniques, confirming that baseline characteristics do not influence surgical outcomes when proper patient selection is ensured.[5]

Intraoperative parameters revealed notable differences between SA and GA. The mean duration of surgery in this study was slightly longer in the SA group (47.8 ± 10.5 minutes vs. 45.6 ± 9.8 minutes, p=0.32), though the difference was not statistically significant. This is in agreement with studies by Mertens et al. (2007) and Hamad et al. (2006), which found that SA does not significantly impact surgical duration in laparoscopic procedures.[6,7]

However, a significant reduction in mean arterial pressure (78.5 ± 7.2 mmHg vs. 84.3 ± 6.5 mmHg, p=0.01) and heart rate (68.2 ± 8.1 bpm vs. 75.4 ± 7.8 bpm, p=0.02) was observed in the SA group, likely due to sympathetic blockade. These hemodynamic changes were also reported by Tzovaras et al. (2008) and Pavithran et al. (2004), who highlighted the increased risk of hypotension and bradycardia with SA.[4,8] Furthermore, the need for vasopressor support was significantly higher in the SA group (20% vs. 6%, p=0.03), consistent with the findings of Ke RW et al. (2002), who emphasized the importance of vigilant intraoperative hemodynamic monitoring in SA patients.[9]

Postoperative recovery outcomes in this study favored spinal anesthesia. Time to ambulation was significantly shorter in the SA group (4.2 ± 1.5 hours vs. 7.8 ± 2.2 hours, p<0.001), and hospital stay was reduced (1.6 ± 0.5 days vs. 2.4 ± 0.6 days, p<0.001). These findings align with studies by Fredman et al. (1999) and Imbelloni et al. (2010), which reported that SA facilitates earlier mobilization and faster hospital discharge. Additionally, the time to first analgesic requirement was longer in the SA group (5.6 ± 1.8 hours vs. 3.2 ± 1.2 hours, p=0.02), and the need for rescue analgesia was lower (24% vs. 50%, p=0.01), indicating superior postoperative pain control.[10,11] This is consistent with the findings of Joris et al. (2001), who demonstrated that SA provides prolonged analgesia and reduces opioid consumption, contributing to better pain management.[12]

Intraoperative and postoperative complications varied significantly. Bradycardia (16% vs. 4%, p=0.04) and hypotension (24% vs. 10%, p=0.03) were more frequent in the SA group, reinforcing findings from Hamad et al. (2006), who reported similar adverse effects due to sympathetic blockade.[7] Conversely, postoperative nausea and vomiting (PONV) were significantly higher in the GA group (28% vs. 12%, p=0.02), which aligns with the study by Sharrock et al. (1996), attributing higher PONV rates to inhalational anesthetics and opioid use in GA.[13] However, shoulder pain was more prevalent in the SA group (36% vs. 10%, p<0.001), possibly due to diaphragmatic irritation from CO_2 insufflation, as previously reported by Ke RW et al. (2002).[9]

Patient satisfaction scores were higher in the SA group in this study. The overall satisfaction score was significantly greater (8.6 ± 1.2 vs. 7.4 ± 1.5, p=0.01), and more SA patients expressed willingness to choose the same anesthesia technique again (84% vs. 60%, p=0.02). Postoperative comfort, as measured by VAS, was also significantly better in the SA group (7.8 ± 1.5 vs. 6.5 ± 1.8, p=0.03). These findings are consistent with Pavithran et al. (2004), who demonstrated that spinal anesthesia results in greater patient satisfaction due to reduced postoperative pain, lower PONV rates, and faster recovery.[8]

LIMITATIONS OF THE STUDY

- Small Sample Size
- Short Follow-Up Duration

CONCLUSION

In conclusion, spinal anesthesia (SA) for laparoscopic cholecystectomy offers several advantages, including faster postoperative recovery, reduced hospital stays, and improved patient satisfaction compared to general anesthesia (GA). While both techniques provide effective anesthesia, SA is associated with fewer postoperative complications such as nausea and vomiting, although it may pose challenges related to hemodynamic stability and diaphragmatic irritation. The choice between SA and GA should be individualized based on patient characteristics, surgical factors, and anesthesiologist expertise.

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