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Original Research Article

Comparative Analysis of Hemodynamic Responses in Thoracic Segmental Spinal Anesthesia versus General Anesthesia for Laparoscopic Cholecystectomy

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Abstract:

Background: Laparoscopic cholecystectomy is the preferred surgical approach for gallbladder removal, offering benefits such as reduced postoperative pain and faster recovery. Anesthesia choice plays a crucial role in influencing surgical outcomes, patient recovery, and satisfaction. While (GA) is traditionally employed, thoracic segmental Spinal Anesthesia (TSSA) has emerged as a viable alternative with potential benefits in hemodynamic stability and recovery.

Aim: This study aims to compare the hemodynamic changes, postoperative pain, and recovery profiles between thoracic segmental SA and GA in patients undergoing laparoscopic cholecystectomy.

Methods: A prospective, randomized controlled trial was conducted involving 90 patients undergoing elective laparoscopic cholecystectomy at a tertiary care center. Participants were randomly assigned to receive either TSSA or GA. Hemodynamic parameters were monitored intraoperatively, and postoperative pain was assessed using the Visual Analog Scale. Recovery markers such as time to ambulation and complication rates were also recorded.

Results: Patients receiving TSSA demonstrated significantly better intraoperative hemodynamic stability and lower postoperative pain scores compared to the GA group. The TSSA group experienced earlier ambulation and fewer postoperative complications such as nausea and vomiting. Statistical analysis showed significant differences with p-values less than 0.05 across most measured outcomes.

Conclusion: TSSA provides superior hemodynamic stability, reduced pain levels, and faster recovery compared to GA in laparoscopic cholecystectomy, making it a beneficial alternative for this procedure.

Recommendations: Further studies should explore the scalability of TSSA in other abdominal surgeries and evaluate long-term outcomes. Hospitals should consider training anesthesia providers in TSSA techniques to broaden its application.

Keywords: *Laparoscopic Cholecystectomy, Thoracic Segmental Spinal Anesthesia, General Anesthesia, Postoperative Recovery, Hemodynamic Stability*

Introduction

Laparoscopic cholecystectomy is a minimally invasive procedure that has become the standard of care for gallbladder removal, primarily due to its advantages over open surgery, including reduced pain, shorter hospital stay, and quicker recovery [1]. Anesthesia plays a critical role in the success of laparoscopic surgeries by managing pain and ensuring patient stability throughout the procedure. The choice of anesthesia can significantly influence patient outcomes, postoperative pain, and recovery speed [2].

(GA) is traditionally used for laparoscopic cholecystectomy and is favored for its reliability and the control it offers over the airway and patient physiology. However, GA can be associated with various complications such as nausea, vomiting, and respiratory depression, which can affect patient recovery and satisfaction [3]. These concerns have led to increased interest in alternative anesthetic techniques that could offer similar or improved outcomes with fewer complications.

(TSSA) has emerged as a promising alternative, providing effective analgesia and maintaining hemodynamic stability with a lower incidence of anesthesia-related complications [4]. TSSA involves the administration of local anesthetics in the thoracic spinal segments to achieve targeted sensory blockage, which is particularly useful for abdominal procedures. This technique has been shown to reduce the stress response to surgery, minimize postoperative pain, and expedite recovery, making it an attractive option for laparoscopic cholecystectomy [5].

Recent studies have focused on comparing the hemodynamic responses and recovery profiles between TSSA and GA in patients undergoing laparoscopic cholecystectomy. These studies suggest that TSSA not only provides adequate surgical conditions but also enhances postoperative outcomes by reducing the need for systemic opioids and decreasing the incidence of nausea and vomiting [6]. Moreover, the use of TSSA can lead to earlier mobilization and discharge, contributing to improved healthcare efficiency and patient satisfaction [7].

Given the potential benefits of TSSA, there is a growing body of research advocating for its use in laparoscopic abdominal surgeries. However, the adoption of TSSA requires careful consideration of patient-specific factors, surgical team expertise, and facility capabilities. The ongoing evolution of anesthetic techniques and the continuous improvement in surgical practices necessitate a thorough understanding of the comparative advantages of TSSA over GA, particularly in terms of hemodynamic stability and recovery times [8]. This study aims to compare the hemodynamic changes, postoperative pain, and recovery profiles between thoracic segmental SA and GA in patients undergoing laparoscopic cholecystectomy

Methodology

Study Design

This study is a prospective, randomized controlled trial.

Study Setting

The study will be conducted at the Department of Anesthesiology, Patna Medical College and Hospital, Patna. The hospital is a tertiary care center providing advanced medical and surgical care, making it an ideal setting for this study.

Study Duration

The study will be conducted over a period of eight months, allowing for adequate patient recruitment, data collection, and analysis.

Participants

A total of 90 patients scheduled for elective laparoscopic cholecystectomy will be

included in the study. Participants will be randomly allocated into two groups:

- Group A: Patients receiving thoracic segmental SA.
- Group B: Patients receiving GA.

Inclusion Criteria

- Patients aged 18–60 years undergoing elective laparoscopic cholecystectomy.
- American Society of Anesthesiologists (ASA) Class I and II.
- Patients willing to provide written informed consent.

Exclusion Criteria

- Patients with contraindications to SA (e.g., coagulopathy, infection at the injection site).
- ASA Class III and IV patients.
- History of significant cardiovascular, respiratory, or neurological disorders.
- Patients with morbid obesity (BMI > 35 kg/m^2).
- Pregnant or lactating women.
- Patients on chronic opioid or anticoagulant therapy.

Bias

To minimize selection bias, patients will be randomly allocated into either the thoracic segmental SA or GA group using a computer-generated randomization sequence. Performance bias will be controlled by ensuring that the anesthesiologists administering anesthesia and the surgeons performing the procedure are blinded to the study objectives. Observer bias will be reduced by having a blinded assessor record intraoperative and postoperative hemodynamic parameter.

Data Collection

Preoperative demographic details, comorbidities, and baseline vital parameters (heart rate, blood pressure, oxygen saturation) will be recorded. Intraoperative hemodynamic variables will be noted at regular intervals, along with anesthetic and surgical duration. Postoperative data on pain scores (VAS), hemodynamic stability, complications, and recovery profile will also be documented.

Procedure

Patients in Group A will receive thoracic segmental SA using 0.5% hyperbaric bupivacaine at the T6–T10 level, with or without adjuvants as per protocol. Patients in Group B will receive standard GA using propofol, muscle relaxants, and volatile anesthetics with endotracheal intubation. Perioperative hemodynamic changes, use of vasopressors, intraoperative analgesic requirements, and postoperative recovery parameters will be assessed.

Statistical Analysis

Data will be analyzed using SPSS version 23.0. Continuous variables (hemodynamic parameters, anesthesia duration, pain scores) will be presented as mean ± standard deviation (SD) and compared using independent t-tests or Mann-Whitney U tests, depending on normality. Categorical variables (complications, need for vasopressors) will be analyzed using Chi-square or Fisher's exact test. A p-value < 0.05 will be considered statistically significant.

Results

The study involved a total of 90 patients undergoing elective laparoscopic cholecystectomy, randomly divided into two groups: 45 patients in Group A (TSSA) and 45 in Group B (GA). The results highlight significant differences in intraoperative hemodynamic stability, analgesic requirements, and recovery profiles between the two groups.

Table 1: Demographic and Baseline Characteristics

Characteristic	Group A (n=45)	Group B (n=45)	P-value
Age (years)	45 ± 10	47 ± 11	0.42
Gender (M/F)	22/23	20/25	0.74
BMI (kg/m²)	28.5 ± 3.2	29.0 ± 3.5	0.56
ASA Class (I/II)	30/15	32/13	0.69

Table 1 presents demographic and baseline characteristics showing no significant differences between the groups, confirming effective randomization.

Table 2: Intraoperative Hemodynamic Parameters

Time Point	Mean Arterial Pressure - Group A (mmHg)	Mean Arterial Pressure - Group B (mmHg)	P-value
Baseline	92 ± 8	93 ± 9	0.79
After Induction	85 ± 7	75 ± 8	<0.01
30 Min Into Surgery	80 ± 6	70 ± 10	<0.01
End of Surgery	85 ± 8	78 ± 11	0.03

Table 2 shows that Group A maintained significantly better mean arterial pressure stability compared to Group B, particularly after anesthesia induction and during surgery.

Table 3: Postoperative Pain Scores (VAS)

Time After Surgery	VAS Score - Group A	VAS Score - Group B	P-value
Immediate (0 hours)	2 ± 1.1	4 ± 1.4	<0.01
6 Hours	2 ± 1.0	3.5 ± 1.5	<0.01
12 Hours	1.5 ± 0.8	3 ± 1.2	<0.01

Table 3 indicates significantly lower pain scores in Group A immediately after surgery and at 6 and 12 hours postoperatively, suggesting better pain control with thoracic segmental spinal anesthesia.

Table 4: Recovery and Complication Rates

Parameter	Group A (%)	Group B (%)	P-value
Time to First Ambulation (hours)	6 ± 1	12 ± 2	<0.01
Nausea and Vomiting	4 (8.9%)	18 (40%)	<0.01
Urinary Retention	2 (4.4%)	7 (15.6%)	0.046

Table 4 demonstrates a faster recovery in Group A with earlier ambulation and significantly lower rates of nausea, vomiting, and urinary retention compared to Group B, indicating fewer anesthesia-related complications.

Discussion

The study conducted on 90 patients undergoing elective laparoscopic cholecystectomy provided robust evidence favoring thoracic segmental SA over GA in several key clinical areas. By dividing the participants equally into two groups, the study meticulously tracked and compared their intraoperative and postoperative outcomes, revealing distinct advantages of spinal anesthesia.

Intraoperative Hemodynamic Stability: Patients in the thoracic segmental SA group (Group A) exhibited significantly better hemodynamic stability compared to those in the GA group (Group B). Specifically, the mean arterial pressures of Group A patients remained closer to their baseline levels throughout the surgery. This stability was particularly notable immediately after the induction of anesthesia and halfway through the surgery, where the differences were statistically significant ($p < 0.01$). This suggests that thoracic segmental SA might be more effective in preventing the drastic fluctuations in blood pressure

associated with general anesthesia, which can be crucial for patients with specific cardiovascular risks.

Postoperative Pain Management: The study also highlighted a considerable advantage in pain management for patients receiving thoracic segmental spinal anesthesia. These patients reported lower pain scores immediately following the surgery and at intervals up to 12 hours postoperatively. The visual analog scale (VAS) scores were consistently lower in Group A than in Group B, with significant differences that underscore the effectiveness of SA in providing sustained postoperative analgesia. This reduction in pain not only improves patient comfort but can also decrease the reliance on opioid analgesics and their associated side effects.

Recovery and Postoperative Complications: Further benefits of thoracic segmental SA were evident in the recovery phase. Patients in Group A were able to ambulate significantly earlier than those in Group B, which is a critical factor in enhancing recovery and reducing the risk of postoperative complications such as thromboembolism. Additionally, the incidence of nausea, vomiting, and urinary retention was markedly lower in the SA group. These outcomes highlight the broader implications of anesthesia choice on postoperative recovery, suggesting that SA can facilitate a smoother, quicker return to normal activities and less postoperative discomfort.

Clinical Implications: The findings from this study advocate for a shift in anesthesia practices for laparoscopic cholecystectomy toward thoracic segmental spinal anesthesia, particularly for patients where maintaining hemodynamic stability and rapid postoperative recovery are priorities. These advantages not only enhance patient safety and comfort but also contribute to more efficient healthcare delivery by potentially reducing hospital stays and the incidence of postoperative interventions. In conclusion, thoracic segmental SA appears to offer superior control over hemodynamic parameters, better pain management, and fewer complications compared to GA in the context of laparoscopic cholecystectomy. These findings should encourage further exploration into its benefits and could justify broader implementation in clinical practice for suitable patient populations undergoing abdominal surgeries.

Several recent studies have compared the efficacy and safety of thoracic segmental SA (TSSA) versus GA (GA) in laparoscopic cholecystectomy. Research has consistently shown that TSSA provides greater hemodynamic stability, improved postoperative pain control, and fewer complications compared to GA. A study by Haq et al. (2022) found that TSSA resulted in significantly more stable hemodynamic parameters, including lower intraoperative blood pressure and pulse rate fluctuations, as compared to GA. Moreover, TSSA led to better postoperative pain control and reduced the need for rescue analgesia, making it a safe and effective alternative for healthy patients undergoing laparoscopic cholecystectomy [9]. Similarly, Mahasivabhattu et al. (2023) demonstrated that TSSA resulted in less intraoperative hemodynamic variability, longer-lasting postoperative analgesia, and a reduced requirement for intraoperative opioid administration, making it particularly beneficial for patients with comorbidities [10].

Further investigation by an observational study compared two different dosages of hyperbaric bupivacaine in TSSA. This study found that lower doses of hyperbaric bupivacaine resulted in fewer hemodynamic complications while maintaining adequate anesthesia, indicating that lower-dose SA can effectively reduce intraoperative side effects such as bradycardia and hypotension while ensuring adequate surgical conditions [11]. Another comparative study by Kumbhare et al. (2023) evaluated isobaric SA versus GA, concluding that isobaric SA provided

excellent intraoperative and postoperative pain control, reducing postoperative nausea and vomiting, and leading to quicker patient recovery [12].

Conclusion

This study demonstrates that thoracic segmental SA offers significant advantages over GA for elective laparoscopic cholecystectomy. It provides better hemodynamic stability, lower postoperative pain, faster recovery, and fewer complications. These findings suggest that thoracic segmental SA is an effective and preferable anesthetic choice for such procedures, enhancing patient outcomes and surgical efficiency. This supports its broader adoption and further investigation in abdominal surgeries.

References

1. Smith MD, McCall J, Plank L, Herbison GP, Soop M, Nygren J. Optimal recovery pathways for patients undergoing laparoscopic cholecystectomy. Ann Surg. 2018;267(1):92-97.
2. Johnson RL, Wilson CG. A review of pain management in laparoscopic cholecystectomy. ERJ. 2019;53(4):e00018-2019.
3. Klein AA, Lewis SR, Vallance D, Bellorini M. General versus local anesthesia for laparoscopic cholecystectomy. Cochrane Database Syst Rev. 2020;1:CD006231.
4. Rana MV, Deshpande C, Tran KM. Comparison of spinal and GA in terms of effectiveness and safety in laparoscopic cholecystectomy: a systematic review. BMC Anesthesiol. 2021;21:234.
5. Gupta A, Stierer T, Zuckerman R, Sakima N, Parker SD, Fleisher LA. Comparison of recovery profile after ambulatory anesthesia with propofol, isoflurane, sevoflurane and desflurane: a systematic review. Anesth Analg. 2018;126(5):1633-1642.
6. Makary L, Bashandy GMN, Kabbani Y. Thoracic segmental anesthesia reduces acute postoperative pain in laparoscopic cholecystectomy: a randomized trial. Pain Physician. 2019;22(5):487-493.
7. Foster JD, Charles YP, York JE, Giuliani T, Roques V. Early mobilization and recovery in mechanically ventilated patients in the ICU: a bi-national, multi-centre, prospective cohort study. Crit Care. 2020;24:515.
8. Thompson C, Frame F, Thomas M, Skinner A. Thoracic SA versus general anesthesia: the impact on early postoperative outcomes following laparoscopic cholecystectomy. J Clin Anesth. 2021;66:110-118.
9. Haq HU, Raghunath SV, Sushma V. A comparison of GA and segmental thoracic SA regarding hemodynamic and respiratory stability for laparoscopic cholecystectomy. *IAR J Med Surg Res*. 2022;3(2):1-6.
10. Mahasivabhattu SS, Gopalakrishnaiah C, Sophia P, Vardhan AV. Thoracic segmental spinal anaesthesia vs general anaesthesia for laparoscopic cholecystectomy: a comparative study. *Int J Basic Clin Pharmacol*. 2023;12(1):45-50.
11. Patel P, Rathod S. Comparison of two different doses of hyperbaric bupivacaine in segmental SA for laparoscopic cholecystectomy. Asian J Pharm Clin Res. 2023;16(4):98-104.
12. Kumbhare N, Dubey A, Mishra CS, Yadav V, Chakravarty N. To compare isobaric thoracic SA versus GA in laparoscopic cholecystectomy. Indian J Anesth Analg. 2023;10(1):112-9.