Scholars Journal of Applied Medical Sciences
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Anaesthesia

Efficacy of Segmental Thoracic Spinal Anaesthesia in Laparoscopic Cholecystectomy

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DOI: 10.36347/sjams.2024.v12i02.009 | **Received:** 05.01.2024 | **Accepted:** 08.02.2024 | **Published:** 14.02.2024

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Abstract **Original Research Article**

Introduction: Segmental Thoracic Spinal Anesthesia (STSA) in Laparoscopic Cholecystectomy represents a significant advancement in the field of anesthesiology, offering a viable alternative to the traditional general anesthesia (GA) for this procedure. ***Aim of the study:*** The aim of this study was to assess the efficacy of segmental thoracic spinal anaesthesia in laparoscopic cholecystectomy. ***Methods:*** This prospective observational study, conducted at the Department of Anaesthesia, Analgesia and Intensive care medicine, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh, from June to December 2023, included 60 patients undergoing laparoscopic cholecystectomy. They were divided into two groups of 30 each: Group A received segmental thoracic spinal anesthesia, and Group B underwent surgery under general anesthesia. ***Result:*** Group A and Group B were demographically similar, with no significant differences in age, sex, BMI, ASA grading, or cholecystectomy indications. Group A had a shorter anesthesia duration (83.0 ± 25.1 min) compared to Group B with 97.8 ± 29.5 min (p=0.0407). Surgical time and intraoperative fluid volume showed no significant difference. Group A experienced more bradycardia (13.3%) and shoulder pain (16.7%), while Group B had more nausea (13.3%) and hypotension (10%). Postoperatively, Group A had a shorter hospital stay and quicker recovery. Group A reported less shoulder pain (6.7% vs. 26.7%, p=0.0395) and no nausea. VAS scores were consistently lower in Group A at all postoperative times, indicating better pain management. ***Conclusion:*** The study conclusively demonstrates that thoracic segmental spinal anesthesia offers comparable significant advantages in laparoscopic cholecystectomy with shorter durations of anesthesia, quicker postoperative recovery, and reduced postoperative pain.

Keywords: Efficacy, Segmental Thoracic Spinal Anaesthesia, and Laparoscopic Cholecystectomy.

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I INTRODUCTION

Cholecystectomy is the only definitive therapy for symptomatic stones, which is removing the stones and gall bladder, to prevent recurrence of the disease [1]. Laparoscopic cholecystectomy, a minimally invasive procedure for gallbladder removal, has become

the standard treatment for gallstone disease. Laparoscopic cholecystectomy was first introduced by Phillipe Mouret in 1987 and is now generally performed by many surgeons [2,3]. Traditionally performed under general anesthesia (GA), this surgical approach has evolved with the advent of regional anesthesia techniques, particularly segmental thoracic spinal anesthesia (STSA). The increasing preference for STSA over GA is attributed to its favorable operating conditions, faster block time, and better hemodynamic stability, making it a viable option even for patients with significant medical comorbidities [4]. The concept of STSA involves administering a local anesthetic into the thoracic subarachnoid space, targeting specific spinal segments. This technique has been shown to provide effective intraoperative analgesia, postoperative pain control, and reduced opioid requirements, thereby minimizing the side effects commonly associated with GA [5]. Moreover, STSA offers the advantage of shorter hospital stays and relatively fewer complications, which is particularly beneficial in the context of day-case surgeries [6]. Recent studies have highlighted the efficacy of STSA in laparoscopic cholecystectomy, focusing on various aspects such as patient satisfaction, pain management, and safety. A literature review by Mohsen K [7]. emphasized that STSA, compared to GA, results in shorter discharge times and greater patient satisfaction. Additionally, it was found to be associated with a lower incidence of postoperative pneumonia and atelectasis, making it preferable for patients with respiratory comorbidities. However, it is noteworthy that surgeon satisfaction was reportedly higher with GA, suggesting the need for a balanced approach in anesthesia selection [7]. Comparative studies have also been conducted to evaluate the effectiveness of different dosages of hyperbaric bupivacaine in STSA. A study comparing two dosages found no significant difference in the onset and duration of sensory and motor blocks between the groups, indicating the flexibility and adaptability of STSA in dosage selection [8]. The safety and feasibility of STSA have been extensively studied. Chandra *et al.*, conducted an observational study involving a large subset of healthy patients undergoing laparoscopic cholecystectomy under STSA. The study reported a high success rate of spinal anesthesia in the first attempt, with minimal complications and high patient satisfaction [9]. This underscores the reliability and safety of STSA in clinical practice. In addition to safety and efficacy, the economic aspect of STSA has also been explored. Kejriwal *et al.*, highlighted the economic benefits of STSA, emphasizing its cost-effectiveness compared to GA, especially in resource-limited settings [10]. This aspect is crucial in the current healthcare environment, where cost-efficiency is as important as clinical efficacy. Moreover, the application of STSA in specific clinical scenarios has been documented. For instance, Ghosh and Roy reported the successful use of STSA in a patient with Birt-Hogg-Dube syndrome undergoing laparoscopic cholecystectomy, demonstrating the technique's versatility and safety in patients where GA might pose a higher risk [11]. Segmental thoracic spinal anesthesia emerges as a promising regional anesthesia technique for laparoscopic cholecystectomy. As the healthcare industry continues to evolve towards minimally invasive procedures, the role of segmental TSA in laparoscopic cholecystectomy is likely to become increasingly significant. The current study was conducted to assess the efficacy of segmental thoracic spinal anaesthesia in laparoscopic cholecystectomy.

II OBJECTIVES

To assess the efficacy of segmental thoracic spinal anaesthesia in laparoscopic cholecystectomy.

III METHODOLOGY & MATERIALS

This prospective observational study was conducted in Department of Anaesthesia, Analgesia and Intensive care medicine, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, during the period from June 2023 to December 2023. Total 60 patients who underwent laparoscopic cholecystectomy were included in this study. The patients were divided into two groups, each containing 30 patients, where patients of group A were operated under segmental thoracic spinal anaesthesia and patients of group B were operated under general anaesthesia. Consent of the patients and guardians were taken before collecting data. After collection of data, all data were checked and cleaned. After cleaning, the data were entered into computer and statistical analysis of the results being obtained by using windows-based computer software devised with Statistical Packages for Social Sciences version 22. After compilation, data were presented in the form of tables, figures and charts, as necessary. Numerical variables were expressed as mean and standard deviation, whereas categorical variables were count with percentage. P value ≤0.05 was considered statistically significant.

Inclusion Criteria:

- Patients undergoing laparoscopic cholecystectomy
- Patients aged between 20-70

Exclusion Criteria:

- Patients having other chronic disease
- Patients transferred to another hospital
- Patients who did not give consent

IV RESULT

Table I demonstrates the demographic characteristics of the study groups. The demographic characteristics of both groups were closely matched. The average age was 42.6 years (±13.5) in Group A and 45.2 years (±11.7) in Group B, with the age range spanning from 20 to 70 years in both groups. The gender distribution was also similar, with Group A comprising 36.7% males and 63.3% females, and Group

B having 40% males and 60% females. The mean Body Mass Index (BMI) was 27.6 (±3.8) in Group A and 28.2 (±4.7) in Group B. Regarding the American Society of Anesthesiologists (ASA) grading, Group A had 70% of patients as ASA I and 30% as ASA II, while in Group B, 63.3% were ASA I and 36.7% were ASA II. The indications for cholecystectomy were also comparable between the two groups, with gallstones being the most common reason, followed by cholecystitis and gallbladder masses/polyps. The statistical analysis showed no significant differences between the two groups in terms of age, sex, BMI, ASA grading, and indications for cholecystectomy. Table II shows the comparison of intraoperative outcome between the study groups. The duration of anesthesia was shorter in Group A with a mean of 83.0 minutes (±25.1) compared to 97.8 minutes (±29.5) in Group B, and this difference was statistically significant (p-value = 0.0407). The mean surgical time was also slightly shorter in Group A at 68.4 minutes (±23.5) versus 77.2 minutes (±26.4) in Group B, but this difference was not statistically significant (p-value = 0.1806). Regarding intraoperative fluid volume, Group A required an average of 1160 mL (±114.7), while Group B required 1216 mL (±120.6), with no significant difference between the groups (p-value = 0.0705). In terms of intraoperative complications, Group A experienced a higher incidence of bradycardia (13.3%) and shoulder pain (16.7%) compared to Group B (3.3% for both complications). However, Group B had higher instances of nausea and vomiting (13.3%) and hypotension (10%) compared to Group A (3.3% for both). Respiratory problems were only observed in Group B (6.7%). None of these differences in complications were statistically significant. Table III presents the comparison of post-operative outcome between the study groups. The average hospital stay for Group A was significantly shorter, with a mean of 15 days (±8.3), compared to 26 days (±11.4) for Group B, and this difference was highly significant (p-value = 0.0001). Additionally, the time to full recovery was markedly quicker in Group A, with an average of 3.1 hours (±1.3), as opposed to 5.9 hours (±1.5) in Group B, again showing a highly significant difference (p-value < 0.0001). In terms of post-operative adverse effects, Group A experienced less shoulder pain (6.7%) compared to Group B (26.7%), with this difference being statistically significant (p-value = 0.0395). Nausea and vomiting were not reported in Group A but were present in 13.3% of Group B, which was also a significant difference (p-value = 0.0404). Pruritus was slightly more common in Group A (10%) compared to Group B (3.3%), but this was not statistically significant (p-value = 0.3017). A notable difference was observed in unaided ambulation at the end of the procedure, with 83.3% of patients in Group A able to ambulate unaided, compared to none in Group B, showing a highly significant difference (p-value < 0.0001). Table IV comprises the comparison of Visual Analog Scale (VAS) score in different times after surgery between the study groups. The VAS scores at different times post-operation showed a consistent pattern favoring Group A for lower pain levels. Three hours after the operation, the mean VAS score in Group A was 1.2 (±0.9), significantly lower than the 2.1 (±1.1) in Group B (p-value = 0.0010). Six hours post-operation, this trend continued with Group A having a mean score of 1.5 (±1.1) compared to 2.9 (±1.9) in Group B (p-value = 0.0009). Twelve hours after the operation, Group A's mean VAS score was 1.7 (±1.2), which was significantly lower than Group B's score of 3.5 (±1.8) (p-value < 0.0001). Finally, 24 hours post-operation, Group A maintained a lower mean pain score of 0.9 (±0.7) compared to 2.0 (±1.2) in Group B (p-value = 0.0001).

Table-I: Demographic characteristics of the study groups. (N=60)

Characteristics	Group-A (n=30)	Group-B (n=30)	p-value
Age (Years)			
Mean ± SD	42.6 ±13.5	45.2 ± 11.7	0.4286^{ns}
Range	20-70	20-70	
Sex			
Male	11 (36.7%)	12 (40%)	0.7944^{ns}
Female	19 (63.3%)	18 (60%	
BMI			
Mean ± SD	27.6 ±3.8	28.2 ±4.7	0.5887^{ns}
ASA grading			
I	21 (70%)	19 (63.3%)	0.5852^{ns}
II	9 (30%)	11 (36.7%)	
Indications of cholecystectomy			
Gallstones	22 (73.3%)	23 (76.7%)	0.7630^{ns}
Cholecystitis	6 (20%)	4 (13.3%)	0.4897^{ns}
Gallbladder masses/polyps	2 (6.7%)	3 (10%)	0.6469^{ns}

*Data was analyzed using unpaired t-test and expressed as Mean ± SD

**Data was analyzed using Fisher exact test and expressed as frequency

n = Number of subjects, ns = Non-significant

P value ≤0.05 was considered statistically significant; ASA= American Society of Anesthesiologists

Table-II: Comparison of intraoperative outcome between the study groups. (N=60)

Intraoperative outcomes	Group-A (n=30)	Group-B (n=30)	p-value
Duration of anesthesia (min)			
Mean ± SD	83.0 ± 25.1	97.8 ± 29.5	0.0407[s]
Surgical time (min)			
Mean ± SD	68.4 ±23.5	77.2 ±26.4	0.1806[ns]
Intraoperative fluid volume (mL)			
Mean ± SD	1160 ± 114.7	1216 ± 120.6	0.0705[ns]
Intraoperative complications			
Bradycardia	4 (13.3%)	1 (3.3%)	0.1639[ns]
Shoulder pain	5 (16.7%)	1 (3.3%)	0.0863[ns]
Nausea and vomiting	1 (3.3%)	4 (13.3%)	0.1639[ns]
Hypotension	1 (3.3%)	3 (10%)	0.3017[ns]
Respiratory Problems	0	2 (6.7%)	0.1527[ns]

*Data was analyzed using unpaired t-test and expressed as Mean ± SD
**Data was analyzed using Fisher exact test and expressed as frequency
n = Number of subjects
s= Significant
ns = Non-significant
P value ≤0.05 was considered statistically significant

Table-III: Comparison of post-operative outcome between the study groups. (N=60)

Post-operative outcome	Group-A (n=30)	Group-B (n=30)	p-value
Hospital stay (Days)			
Mean ± SD	15 ± 8.3	26 ± 11.4	0.0001[s]
Time of full recovery (Hour)			
Mean ± SD	3.1 ± 1.3	5.9 ± 1.5	< 0.0001[s]
Adverse effects			
Shoulder pain	2 (6.7%)	8 (26.7%)	0.0395[s]
Nausea and vomiting	0	4 (13.3%)	0.0404[s]
Pruritus	3 (10%)	1 (3.3%)	0.3017[ns]
Unaided ambulation at the end of procedure			
Yes	25 (83.3%)	0	< 0.0001[s]

*Data was analyzed using unpaired t-test and expressed as Mean ± SD
**Data was analyzed using Fisher exact test and expressed as frequency
n = Number of subjects
s= Significant
ns = Non-significant
P value ≤0.05 was considered statistically significant

Table-IV: Comparison of Visual Analog Scale (VAS) score in different times after surgery between the study groups. (N=60)

VAS score	Group-A (n=30)	Group-B (n=30)	p-value
3 hours after operation	1.2 ± 0.9	2.1 ± 1.1	0.0010[s]
6 hours after operation	1.5 ± 1.1	2.9 ± 1.9	0.0009[s]
12 hours after operation	1.7 ± 1.2	3.5 ± 1.8	< 0.0001[s]
24 hours after operation	0.9 ± 0.7	2.0 ± 1.2	0.0001[s]

Data was analyzed using unpaired t-test and expressed as Mean ± SD
n = Number of subjects
s = Significant
P value ≤0.05 was considered statistically significant

V DISCUSSION

This prospective observational study was conducted in Department of Anaesthesia, Analgesia and Intensive care medicine, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, during the period from June 2023 to December 2023 to

assess the efficacy of segmental thoracic spinal anaesthesia in laparoscopic cholecystectomy. For this, the outcomes of segmental thoracic spinal anaesthesia were compared with general anesthesia where group A indicates patients operated under thoracic segmental spinal anesthesia and group B indicates patients operated under general anesthesia. The demographic characteristics of the two groups were closely matched, ensuring a balanced comparison. The average age in Group A was 42.6 years (±13.5) and in Group B was 45.2 years (±11.7), with both groups ranging from 20 to 70 years. The gender distribution was similar, with 36.7% males and 63.3% females in Group A, and 40% males and 60% females in Group B. The mean Body Mass Index (BMI) was 27.6 (±3.8) in Group A and 28.2 (±4.7) in Group B. Regarding the American Society of Anesthesiologists (ASA) grading, 70% of patients in Group A were ASA I and 30% were ASA II, compared to 63.3% ASA I and 36.7% ASA II in Group B. The indications for cholecystectomy were comparable, with gallstones being the most common reason, followed by cholecystitis and gallbladder masses/polyps. These demographic findings are in line with other studies [12-13]. In the study of Paliwal NW *et al.,* [13], the most common cause of cholecystectomy in both the groups was found to be cholelithiasis (81.66%) followed by cholecystitis (11.66%) and neoplastic diseases (5%). Intraoperatively, the duration of anesthesia was significantly shorter in Group A (83.0 ± 25.1 minutes) compared to Group B (97.8 ± 29.5 minutes), aligning with findings by Mahasivabhattu SS *et al.,* [14], who reported similar reductions in anesthesia duration with regional anesthesia techniques. The mean surgical time was also slightly shorter in Group A (68.4 ± 23.5 minutes) versus Group B (77.2 ± 26.4 minutes), but this difference was not statistically significant (p-value = 0.1806). The intraoperative fluid volume showed no significant difference between the groups (Group A: 1160 ± 114.7 mL, Group B: 1216 ± 120.6 mL), which is consistent with the findings of Bessa *et al.,* [15], indicating that both anesthesia techniques are comparable in terms of intraoperative fluid management. The incidence of intraoperative complications like bradycardia (Group A: 13.3%, Group B: 3.3%) and shoulder pain (Group A: 16.7%, Group B: 3.3%) was higher in Group A, while nausea (Group A: 3.3%, Group B: 13.3%), vomiting, and hypotension (Group A: 3.3%, Group B: 10%) were more common in Group B. These findings are in line with the study by Mahasivabhattu SS *et al.,* [14] and Yousef GT *et al.,* [16], which highlighted the differential side-effect profiles of spinal and general anesthesia. The absence of significant respiratory problems in Group A supports the notion that segmental spinal anesthesia might be advantageous for patients with specific respiratory risks. Postoperatively, the shorter hospital stay in Group A (15 ± 8.3 days) compared to Group B (26 ± 11.4 days) and quicker full recovery (Group A: 3.1 ± 1.3 hours, Group B: 5.9 ± 1.5 hours) are noteworthy. These findings echo the research by Yousef GT *et al.,* [16], who found that regional anesthesia could expedite postoperative recovery. The significantly lower incidence of shoulder pain in Group A (6.7%) compared to Group B (26.7%) and nausea and vomiting (Group A: 0%, Group B: 13.3%) further underscores the benefits of segmental spinal anesthesia, as these are common complaints following laparoscopic surgeries under general anesthesia, as discussed by Yousef GT *et al.,* [16]. The ability for unaided ambulation at the end of the procedure was remarkably higher in Group A (83.3%) compared to Group B (0%), a finding that is supported by the work of Ellakany M *et al.,* [17], emphasizing the enhanced postoperative mobility associated with spinal anesthesia. This aspect is particularly important in the context of fast-track surgery and enhanced recovery after surgery (ERAS) protocols, as highlighted by Ljungqvist *et al.,* [18]. The Visual Analog Scale (VAS) scores consistently favored Group A at all postoperative time points, indicating better pain management. Three hours after the operation, the mean VAS score in Group A was 1.2 (±0.9), significantly lower than the 2.1 (±1.1) in Group B (p-value = 0.0010). Six hours post-operation, this trend continued with Group A having a mean score of 1.5 (±1.1) compared to 2.9 (±1.9) in Group B (p-value = 0.0009). Twelve hours after the operation, Group A's mean VAS score was 1.7 (±1.2), which was significantly lower than Group B's score of 3.5 (±1.8) (p-value < 0.0001). Finally, 24 hours post-operation, Group A maintained a lower mean pain score of 0.9 (±0.7) compared to 2.0 (±1.2) in Group B (p-value = 0.0001). These findings are similar to the studies conducted by Paliwal NW *et al.,* [13] and Ellakany M *et al.,* [17]. This study provides compelling evidence that segmental thoracic spinal anesthesia offers several advantages over general anesthesia in laparoscopic cholecystectomy, including shorter anesthesia duration, faster postoperative recovery, reduced postoperative pain, and fewer incidences of certain complications. These findings are significant in the context of optimizing patient outcomes and align with the growing body of literature advocating for the selective use of regional anesthesia techniques in abdominal surgeries. Future research could focus on long-term outcomes and patient satisfaction to further validate these findings.

Limitations of the study

In our study, there was small sample size. Study population was selected from one center in Dhaka city, so may not represent wider population. The study was conducted at a short period of time.

VII CONCLUSION AND RECOMMENDATIONS

The study conclusively demonstrates that thoracic segmental spinal anesthesia offers comparable significant advantages in laparoscopic cholecystectomy. Patients operated under thoracic segmental spinal anesthesia experiences shorter durations of anesthesia, quicker postoperative recovery, and reduced postoperative pain. Additionally, a significantly shorter

hospital stay and a higher rate of unaided ambulation post-surgery were found. Despite a higher incidence of certain intraoperative complications like bradycardia and shoulder pain in patients operated under thoracic segmental spinal anesthesia, these were outweighed by the overall benefits, suggesting that thoracic segmental spinal anesthesia could be a preferable option for laparoscopic cholecystectomy. Further study with larger sample size and longer study duration is recommended for better understanding the efficacy of segmental thoracic spinal anaesthesia in laparoscopic cholecystectomy. Comparison with other anesthetic approaches may also be done.

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