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A Comparison of General anesthesia and segmental thoracic Spinal Anesthesia regarding hemodynamic and respiratory stability for laparoscopic cholecystectomy

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ABSTRACT

Background: Laparoscopic Cholecystectomy (LC) is conventionally performed under general anaesthesia (GA), but multiple studies have found spinal anaesthesia (SA) as a safe alternative. GA may be associated with postoperative pain and nausea and vomiting (PONV) and the use of neuraxial techniques for a variety of surgical procedures resulted in a decrease in mortality, venous thromboembolism, myocardial infarction, and several other complications. Spinal anesthesia (SA) is a commonly used anaesthesia technique that has a very good safety profile.

Methods: This is a prospective study conducted in the Department of Anesthesia at Goa Medical College, Goa from June 2021 to May 2022. Ninety patients classified according to the American Society of Anesthesiology (ASA) as class I or II undergoing laparoscopic cholecystectomy, divided into two groups, 45 patients each. Written informed consent was taken from each patient before the study. Group A received conventional general anesthesia with endotracheal intubation and mechanical ventilation, and Group B received a segmental T10-T11 interspace thoracic spinal anesthesia using 1 ml of plain bupivacaine 0.5% (5 mg) in addition to 25 mcg fentanyl. In group B, drugs to manage patient anxiety or hemodynamic perturbations (bradycardia or hypotension) were given when needed.

Result: Group B, receiving segmental thoracic spinal anesthesia, was more hemodynamically stable as compared to Group A. All three hemodynamic parameters pulse rate, systolic blood pressure, and diastolic blood pressure were elevated throughout the procedure in the GA group. Bradycardia was seen in 2 and hypotension in 5 cases in the Group B group. The surgeons did not find any significant difference in the operating conditions or muscle relaxation between the two groups. Patients in both groups maintained above 97-98% SPO2. Post-operative nausea and vomiting were seen in 26.7% of cases in the GA group and in 11.1% in Group B. Post-operative analgesia were better in Group B for a duration of 6 hours, after which there was not much difference in both the groups.

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Conclusion: Segmental Thoracic Spinal anesthesia is adequate and safe for laparoscopic cholecystectomy in otherwise healthy patients and offers better postoperative pain control than general anesthesia without limiting the recovery.
Keywords: General Anesthesia, Laparoscopic Cholecystectomy, Segmental Thoracic Spinal Anesthesia

INTRODUCTION

Laparoscopic cholecystectomy (LC) has become the gold standard for the surgical treatment of symptomatic cholelithiasis and has gained worldwide acceptance [1]. It is a minimally invasive procedure with a significantly shorter hospital stay and a quicker convalescence compared with the classical open cholecystectomy [2].

LC is conventionally done under general anaesthesia (GA) and may be associated with postoperative pain and nausea and vomiting (PONV). Rodgers et al. published a meta-analysis showing that the use of neuraxial techniques for a variety of surgical procedures resulted in a decrease in mortality, venous thromboembolism, myocardial infarction, and several other complications [3]. Spinal anesthesia (SA) is a commonly used anaesthesia technique that has a very good safety profile. SA has several advantages over GA. These advantages include the patients' being awake and oriented at the end of the procedure, less postoperative pain, and the ability to ambulate earlier than patients receiving general anesthesia. Moreover, the incidences of nausea and vomiting are less with selective segmental thoracic spinal anesthesia than with general anesthesia [4].

SA is more effective than GA in blunting the neuroendocrine stress and adverse responses to surgery [5]. Some possible problems related to the technique of general anesthesia such as teeth and oral cavity damage during laryngoscopy, sore throat, and pain related to intubation and/or extubation are prevented by administering selective segmental thoracic spinal anesthesia to patients undergoing laparoscopic interventions [6]. Multiple reports have been published regarding the feasibility of SA for LC in patients fit for GA [7].

In recent years, advanced laparoscopic surgery has targeted older and high-risk patients for general anesthesia; in these patients, regional anesthesia offers several advantages with improved patient satisfaction [8]. This statement is predominantly based on the assumption that laparoscopy necessitates endotracheal intubation to prevent aspiration and respiratory distress secondary to the induction of carbon dioxide pneumoperitoneum, which is not well tolerated in a patient who is awake during the procedure [9].

These contradictions make it necessary to closely compare SA and GA in LC, to evaluate whether SA in LC is associated with better results.

MATERIALS AND METHODS

This is a prospective study conducted in the Department of Anesthesia at Goa Medical College, Goa from June 2021 to May 2022 among 90 patients.

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Inclusion Criteria: Patients of either gender and 18-60 years age group was chosen with inclusion criteria of ASA physical status classification groups I or II.

Exclusion criteria: Body mass index above 35 kg/m2, acute cholecystitis, pancreatitis or cholangitis, previous open surgery in the upper abdomen, contraindication for pneumoperitoneum, and the presence of any condition contra-indicating elective surgery or segmental thoracic spinal anesthesia.

Patients were randomized by sealed envelopes to receive either General Anesthesia (Group A) or Spinal anesthesia (Group B). Patient's preoperative evaluation and preparation were standardized. All patients, who were in the spinal anesthesia group, were informed about spinal anesthesia in detail and any anxiety, discomfort, or pain during surgery would be dealt with intravenous medication. The patients were also informed about the probability of conversion to general anesthesia if needed. On the night before surgery, all patients received 150 mg ranitidine and 10 mg metoclopramide. The patient was asked to remain nil per oral 8 hours before surgery.

Both anesthesia and surgery were performed in all cases by the same anesthesia and surgery team. On patients' arrival in the operating room, after establishing noninvasive monitoring (electrocardiogram, arterial blood pressure, and pulse oximetry), 500 ml of Ringer Lactate solution was commenced intravenously for preloading. All patients were intravenously administered 1 mg of midazolam hydrochloride, 1 mg of granisetron hydrochloride, and 8 mg of dexamethasone before the induction of anesthesia. The nasogastric tube was inserted only on the surgeon's demand to decompress the stomach and avoid vomiting and aspiration.

After obtaining baseline vital signs, oxygen at 5 l/min was commenced through a face mask. Patients were planned to give segmental thoracic spinal anesthesia in a sitting position and under an aseptic technique Thoracic segmental spinal anesthesia was given at the T10th -11th thoracic interspace using 25 gauge needle by paramedian approach. The space was identified. A 25 gauge pencil point spinal needle was inserted and once flow of clear CSF began 1 ml of plain bupivacaine 0.5%, i.e., 5 mg in addition to 25 mcg fentanyl was injected, the patient was turned to the supine position for the operation, and oxygen was started at 5 L/min.

Hemodynamic parameters were recorded every 2 min for 10 min then every 5 min thereafter. The sensory loss was confirmed by pinprick determining its upper and lower level. Motor block was confirmed by using a modified Bromage scale: 0, able to lift extended legs; 1, just able to flex knees, full ankle movement; 2, no knee movement, some ankle movement; 3, complete paralysis. Sensory and motor block were recorded just before the start of surgery and after the completion of surgery. The surgeon was allowed to start his incision once the block was considered adequate (T4–T12 sensory block). Intravenous drugs were given to control patient anxiety, hypotension, and bradycardia (i.e., 1 mg midazolam increments for anxiety, 5 mg increments of ephedrine for hypotension, or 0.6 mg atropine for bradycardia).

In patients randomized to receive general anesthesia, anesthesia was induced with propofol (2–3 mg/kg), fentanyl citrate (2 mcg/kg), and atracurium besylate (0.5 mg/kg). Balanced anesthesia was continued with sevoflurane, 1–2%. After intubation of the trachea, the lungs were ventilated with 50% oxygen in the air using a semiclosed circle system. Ventilation was controlled with a

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tidal volume of 6–8 ml/kg, and the ventilatory rate was adjusted to maintain a PaCO2 value of 35–40 mmHg. Residual neuromuscular block was antagonized with 2.5 mg of neostigmine and 1 mg of atropine sulfate at the end of surgery.

All patients were monitored by electrocardiogram, heart rate, arterial blood pressure, respiratory rate, and pulse oximetry and were recorded at 5-min intervals. Laparoscopic cholecystectomy was performed by using the same technical principles for both Groups, with the standard 4-trocar techniques. Pneumoperitoneum was established by using the open technique with carbon dioxide at a maximum intra-abdominal pressure of 10-12 mmHg, instead of the usual 14 mmHg. To minimize the incidence of shoulder pain, 10 ml of Sensorcaine 0.25 % was spread under the right diaphragmatic cupula using a cannula. Another modification of the technique i.e., head up and left tilt to minimize diaphragmatic irritation.

Operative time in both groups as well as any intraoperative adverse effects like bradycardia, hypotension, nausea, vomiting, headache, and abdominal discomfort were recorded. Drug consumption and fluid intake were also recorded.

Patients who received thoracic spinal anesthesia (group B) and requested sedation were given an intraoperative increment of IV midazolam 1–2 mg. 25 mcg of Fentanyl was given intravenously for analgesia on an as-needed basis.

All patients were transferred to the postanesthesia care unit (PACU). Discharge time was recorded as the time from admission to PACU until the patient met all discharge criteria from it. These included mental alertness, stable vital signs, absence of nausea, control of pain, ability to ambulate, and (for regional techniques) voiding.

Postoperative pain was assessed at relaxed conditions by using the visual analog scale after surgery, 4, 8, 12, and 24 h after the completion of the procedure. Other postoperative events related either to surgical or (especially) anesthesia procedures, such as abdominal discomfort, nausea, vomiting, shoulder pain, urine retention, pruritus, headache, and other neurologic sequelae, were also recorded.

Statistical analysis

The results obtained in the study were presented in a tabulated manner. Statistical analysis was done by sample “t” test. ANOVA and Chi-square test was performed for nonparametric values and corresponding P values were computed using SPSS for windows (statistical presenting system software version 25). $P < 0.05$ was considered statistically significant. 90 patients undergoing elective laparoscopic cholecystectomy over 1 year were randomly divided into two groups.

RESULT

Group A (n = 45) underwent the procedure under GA and Group B (n = 45) underwent the procedure under thoracic segmental spinal Anesthesia.

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Table 1: Distribution of Age distribution

Age group (years)	Group A n (%)	Group B n (%)
<30	18 (40)	20 (44.5)
31-45	14 (31.1)	15 (33.3)
45 and above	13 (28.9)	10 (22.2)
Total	45 (100)	45 (100)

Table 2: Gender Distribution

Gender	Group A n (%)	Group B n (%)	p-value
Male	14 (31.1)	15 (33.3)	0.764
Female	31 (68.8)	30 (66.6)	
Total	45 (100)	45 (100)	

Gender profiles were compared between the two groups of patients using the Chi-square test, and no significant difference was found (Table 2).

Table 3: Weight distribution

GROUP	Weight (kg) Mean±SD
GROUP A	70.65±7.23
GROUP B	69.81±7.33

Using 2 independent sample t-tests $P > 0.05$, therefore, there was no significant difference between the two groups concerning weight (kg) (Table 3).

Table 4: Changes in PR in two groups

Time interval (min)	Mean±SD		P value
	Group A (PR)	Group B (PR)	
Pre-operative (PI	82.7±11.3	76.8±10.3	0.02
1	107.9±12.7	79.9±12.5	<0.0001
2	105.7±12.3	78.0±9.2	<0.0001
3	106.3±11.1	75.7±9.1	<0.0001
4	105.6±10.0	74.4±8.9	<0.0001
5	103.6±11.6	76.6±9.2	<0.0001
At pneumo (PP)	116.9±13.6	83.6±6.9	<0.0001
15	114.6±9.5	77.2±12.6	<0.0001
30	107.10±12.5	73.5±12.3	<0.0001
45	107.2±13.8	73.9±8.3	<0.0001
60	102.9±7.8	74.9±8.7	<0.0001

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Values were relatively lower in Group B and the difference was found to be statistically significant ($P < 0.05$) (Table 4).

Intra-operative comparison of mean pulse rate (PR) in Group A and Group B. Group B shows less tachycardia. The values at fixed intervals in both Groups as shown in the observation table were observed. These values were compared using 2 independent sample t-tests. We found that there was a significant difference in PR values at the post-anesthesia intervals mentioned.

Table 5: Changes in SBP in two groups

Time interval (min)	Mean±SD		P value
	Group A (PR)	Group B (PR)	
Pre-operative (PI	123.9±11.9	123.5±9.5	0.91
1	146.3±10.8	121.7±9.1	<0.0001
2	145.4±12.3	116.4±9.8	<0.0001
3	143.6±12.6	110.7±8.9	<0.0001
4	142.9±10.6	106.0±8.2	<0.0001
5	142.5±11.6	103.3±8.8	<0.0001
At pneumo (PP)	153.6±10.1	121.9±11.1	<0.0001
15	144.5±9.8	116.9±110.8	<0.0001
30	136.5±7.9	113.8±9.2	<0.0001
45	131.8±8.5	108.9±9.5	<0.0001
60	146.9±6.7	115.5±10.2	<0.0001

Compared using 2 independent sample t-tests. We found that there was no statistically significant difference between Groups A and B concerning SBP values at baseline. However, there was a significant difference in SBP values after anesthesia at mentioned intervals between the two groups. Values were relatively lower in Group B, and the difference was found to be statistically significant ($P < 0.05$) (Table 5).

Table 6: Changes in DBP in two groups

Time interval (min)	Mean±SD		P value
	Group A (PR)	Group B (PR)	
Pre-operative (PI	76.9±9.1	81.0±5.5	0.01
1	91.9±9.4	75.3±6.4	<0.0001
2	90.3±9.2	74.6±6.6	<0.0001
3	89.0±9.3	70.0±6.4	<0.0001
4	89.6±9.6	65.6±6.2	<0.0001
5	87.8±7.9	63.4±5.4	<0.0001
At pneumo (PP)	99.6±9.5	78.9±6.4	<0.0001
15	91.0±12.4	75.0±6.4	<0.0001
30	85.4±8.8	75.2±6.5	<0.0001
45	81.0±6.4	76.4±6.2	<0.0001
60	90.0±6.5	76.6±6.6	<0.0001

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Recorded the values at fixed intervals in both the Groups as shown in the observation table. These values were compared using 2 independent sample t-tests. We found that there was no significant difference between Groups A and B concerning DBP values at baseline ($P > 0.05$). However, there was a significant difference in DBP values in post-anesthesia at mentioned intervals between the two groups. Values were relatively lower in Group B, and the difference was found to be statistically significant ($P < 0.05$) (Table 6).

Table 7: Post-operative nausea and vomiting

PONV	**n (%)**	
	Group A	Group B
Yes	12 (26.7)	05 (11.1)
No	33 (73.3)	40 (88.9)

Group A had 26.7% of patients with PONV as compared to 11.1% in Group B. However, the incidence was not statistically significant (Table 7).

Table 8: Mean pain score (VAS) in two groups

Time interval (h)	**Mean±SD**		**P value**
	Group A	**Group B**	
1	9.3±0.9	0.2±0.5	0.01
2	7.8±0.9	4.0±0.9	0.0001
3	6.9±3.7	6.7±2.2	0.65
4	7.5±2.8	6.8±2.0	0.09
5	6.9±2.0	6.3±2.9	0.09

Recorded the values at fixed intervals in both the Groups as shown in the observation table. These values were compared using 2 independent sample t-tests. There was a significant difference between the two groups concerning VAS values during the postoperative period until 6-h. Values were lower in Group B, and the difference was found to be statistically significant ($P < 0.05$). We also found that there was no statistically significant difference between Groups A and B concerning VAS pain score post-operative 9 and 12 h ($P > 0.05$) (Table 8).

DISCUSSION

The present study has not only confirmed the feasibility of safely performing laparoscopic cholecystectomy under segmental thoracic spinal anesthesia as the sole anesthetic procedure but also shown the superiority of segmental thoracic spinal anesthesia in terms of better postoperative pain control as compared to general anesthesia. Pain assessed throughout any time in the postoperative period during the patient's hospital stay was significantly lesser in the segmental thoracic spinal group as compared to the general anaesthesia group [10]. Pain relief, an important component for a rapid and smooth recovery, was seen in segmental thoracic spinal anesthesia group.

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Intraoperatively, two things were noted – hypotension and pain/discomfort in the right shoulder in the segmental thoracic spinal group. Hypotension is due to sympathetic blockade and the mechanical effect of pneumoperitoneum, while pain and discomfort over the right shoulder can be attributed to diaphragmatic irritation from pneumoperitoneum with carbon dioxide. [11] Most of this was managed without drugs, i.e., reassurance to the patient, massage of the right shoulder, keeping the intra-abdominal pressure to 12 mm Hg, avoiding excessive tilting of the table, and thereby minimizing diaphragmatic irritation. [12] In our study, diaphragmatic irritation was much less as installation of Inj. Sensorcain (0.25%) 10 ml intraperitonially was done before starting of operative procedure. Especially with the segmental thoracic spinal group, as spinal anesthesia causes a high level of the motor, sensory and sympathetic blockade and thereby good abdominal muscle relaxation as compared to general anesthesia was obtained.

In group A, the initial increase in pulse rate and BP after peritoneal insufflations are due to both mechanical and neurohumoral effects [13]. The return of pulse rate and BP to normal baseline was gradual. In group B, there was little variation in pulse and BP after peritoneal insufflation as segmental thoracic spinal anesthesia tends to decrease the pulse and BP, while the neurohumoral and mechanical effects of pneumoperitoneum tend to increase them. After several minutes, the neurohumoral and mechanical effects are compensated so that there is a slight decrease in the pulse rate and BP. The decrease in pulse rate and BP in group B as compared to group A can be explained as due to a decrease in pain caused by the residual analgesic effect of local anesthesia in subarachnoid space.

Nausea and vomiting are particularly troublesome after laparoscopic surgery; over 50% of patients required antiemetics, so prophylactic antiemetics had been given routinely. Regarding the postoperative complications, nausea, vomiting, and dizziness were more common with general anesthesia due to intubation of the trachea and intravenous drugs.
As segmental thoracic spinal anesthesia is a regional block, there is less procedure-related cost and hospital stay because of less postoperative pain and complications.

CONCLUSION

Segmental thoracic spinal anesthesia had a shorter discharge time and better satisfaction when compared to patients who received general anesthesia, surgeon satisfaction was higher for the general anesthesia group than thoracic spinal anesthesia group, and thoracic spinal anesthesia can be used successfully and effectively for laparoscopic cholecystectomy in healthy patients by experienced anesthetists.

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