ORIGINAL ARTICLE

Outcome of Segmental Thoracic Spinal Anaesthesia in Laparoscopic Cholecystectomy

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ABSTRACT

Background: Segmental thoracic spinal anaesthesia has been used in different surgeries. This regional anaesthesia technique could be a potential alternative to general anaesthesia for laparoscopic cholecystectomy. ***Objective:*** To assess the outcome of segmental thoracic spinal anaesthesia in laparoscopic cholecystectomy. ***Methods:*** This study was conducted at surgery operation theatre in the Shaheed Suhrawardy Medical College Hospital, Dhaka, Bangladesh, from February to April, 2023. Patients aged between 18 and 40 years with ASA class I or II undergoing elective laparoscopic cholecystectomy were included. Segmental thoracic spinal anaesthesia was performed at T10 intervertebral space with injection 0.5% hyperbaric bupivacaine 1 ml (5mg) and fentanyl 0.5 ml (25 microgram). Perioperative hemodynamic changes, side effects, time of first rescue analgesic, total opioid consumption in first 24 h, patient and surgeon satisfaction score were recorded. ***Results:*** A total of 30 patients received thoracic segmental spinal anaesthesia and none of them required conversion to general anaesthesia. The mean age of the patients was 29.89 ± 8.5 years. Maximum patients 21 (70%) belongs to ASA Class I. Two patients experienced paraesthesia during insertion of spinal needle and subsided by slight withdrawal of the needle without any adverse sequelae. They were observed for a period of one month and no post procedural sequelae was found. Average duration of surgery was 48.20±9.7 minutes. There were no clinically significant hemodynamic changes during the perioperative period. Five patients (16.6%) experienced shoulder pain. The time of 1st analgesic was 3.8±1.2 hours and total dose of opioid consumption was 70.68±12.7 mg in first 24 hours. Both patients (53%) and surgeons (60%) were satisfied with this technique. ***Conclusion:*** Laparoscopic cholecystectomy can be done effectively by segmental thoracic spinal anaesthesia technique. It can be considered as an alternative to general anaesthesia but great caution is required to avoid injury to the spinal cord during needle insertion.

Keywords: Outcome, regional anaesthesia, spinal anaesthesia, laparoscopic cholecystectomy.

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INTRODUCTION

Thoracic spinal anaesthesia was first performed in Romania by Thomas Jonnesco in early 1908[1,2]. Subsequently, anaesthetists around the world have gained interest in this unconventional technique[2]. In 1932, Kirschner described the technique for segmental spinal anaesthesia[2]. In 1934 and 1935, Etherington-Wilson proposed some explanations for the block of spinal roots intratechally[3]. Afterwards, spinal anaesthesia for thoracic surgery was proposed in 1942[4].

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Thoracic segmental spinal anaesthesia has been used for patients undergoing surgery with major medical problems[5]. It has been demonstrated as a safe and effective method for various surgeries including breast and abdominal cancer surgery[5]. However, significant debate remains regarding this practice around the world. The principal concerns related to this technique are: risks of spinal cord injury, complete block due to cephalad spread of local anaesthetics, and blockade of cardio accelerator sympathetic fibers leading to haemodynamic instability[6].

In comparison to general anaesthesia or lumbar subarachnoid block, thoracic segmental spinal anaesthesia has several advantages[5-8]. General anaesthesia related complications including negative drug effects, prolong recovery, airway instrumentation, and inadequate pain control can be prevented. Furthermore, the anesthetic dose requirement during the procedure is lower, which minimally affects cardiovascular stability[5,7,8,9].

General anaesthesia is usually performed in laparoscopic cholecystectomy. Conventionally used regional anaesthesia techniques like epidural and paravertebral block are also effective. But there are some drawbacks related to these techniques which are still concerning like delayed onset, patchy sensory block and the potential of local anesthetic toxicity due to large volume of local anesthetics[5,7,8].

There is currently renewed attention to thoracic segmental spinal anaesthesia for several common surgeries[10,11]. This technique can be valuable for providing greater hemodynamic stability, better analgesia, with higher patient satisfaction, lesser incidence of nausea, vomiting and reduced postanaesthesia care stay[3,5-9]. Though thoracic segmental spinal anaesthesia was performed in patients with major medical problems[5], the application of this technique in healthy individual is very few. Thus this study is designed to assess the outcome of thoracic segmental spinal anaesthesia in laparoscopic cholecystectomy among healthy patients.

METHODS

This study was conducted at surgery operation theatre, in the Department of Anaesthesia, Intensive Care and Pain Medicine, Shaheed Suhrawardy Medical College and Hospital, Dhaka, Bangladesh. A total of 30 patients were included in this study who met the inclusion and exclusion criteria. Patients aged between 18 and 40 years of either sex, BMI <30 Kg/m^2 and ASA class I or II undergoing elective laparoscopic cholecystectomy were included in this study. The exclusion criteria were as follows: pregnant patient; patient with psychiatric disease, bleeding disorder and cardiovascular disease; presence of infection in the site of block; known allergy to local anesthetic; and any block failure case. After reaching to the operating room, an 18G IV cannula was inserted in a peripheral vein and infusion of balanced crystalloid solution was started. Patient's baseline vital parameters were recorded using pulse oxymeter, ECG and non-invasive blood pressure (NIBP). Patients were placed in sitting position and T10-T11 intervertebral space was identified. Under full aseptic precautions and skin infiltration with (1% lignocaine) local anesthetics, a quincke babcock spinal needle 25G was placed in mid-line/paramedian approach. Correct placement was confirmed by free flow of clear CSF. Then, small volume (1.5 ml) of local anaesthetics [1 ml of 0.5% hyperbaric bupivacaine (5 mg) and 0.5 ml of fentanyl (25 microgram)] was injected and patients were placed in supine position immediately. After that, clinical examination was done to assess the sensory and motor block along with heart rate, blood pressure, and SpO_2. The vital parameters were recorded in regular interval until the end of surgery. The level of sensory block was assessed by pinprick, and motor block was assessed by 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)[12].

When a minimum block from T4 to T12 was achieved, patients were sedated by 0.05 mg/Kg midazolam intravenously and their level of sedation was measured by Ramsay Sedation Scale (1 = Awake; agitated or restless or both; 2 = Awake; cooperative, oriented, and tranquil; 3 = Awake but responds to commands only; 4 = Asleep; brisk response to light glabellar tap or loud auditory stimulus; 5 = Asleep; sluggish response to light glabellar tap or loud auditory stimulus; 6 = Asleep; no response to glabellar tap or loud auditory stimulus)[13]. All patients were given oxygen supplementation at 5 L/min with facemask. Pneumoperitoneum was done by using carbon dioxide insufflation and a pressure

limit of not more than 12 mm Hg was allowed. Adverse effects were treated accordingly e.g hypotension with ephedrine, bradycardia with atropine and pain with fentanyl, all as intravenous boluses as required. After surgery, patients were transferred to the recovery room and from there to ward after complete regression of the block. The perioperative hemodynamic changes, adverse effects, time of first rescue analgesic, total opioid (pethidine) consumption in first 24 h, patient and surgeon satisfaction score were recorded in data sheet.

Collected data were analyzed using SPSS (Statistical Package for Social Sciences) for Windows, version 23.0. Qualitative variables were expressed as frequency and percentages. Quantitative data were expressed in mean±SD (standard deviation). The results were presented using tables and figures.

RESULTS

A total of 30 patients, scheduled for elective laparoscopic cholecystectomy received thoracic segmental spinal anaesthesia. This technique was successful in all patients and none required conversion to general anaesthesia. The mean age of the patients was 29.89 ± 8.5 years. Male to female ratio was 1:4. Maximum patient 21(70%) were in ASA Class I. The mean BMI was 26.56±2.14 Kg/m^2 (Table 1). An effective sensory block was developed (T4-T12) in all patients. Only 12 patients developed partial motor block of the lower limb (seven had grade 1 and five had grade 2 block according to modified Bromage scale). Two patients experienced paraesthesia in the right leg but it was too brief and subsided by slight withdrawal of the spinal needle. The mean sedation score was 2.4±0.6 according to Ramsay Sedation Scale. Average duration of surgery was 48.20±9.7 minutes. The changes of heart rate and blood pressure (MAP) over time were shown in figure 1 and figure 2, respectively. There was no clinically significant variations except for those who developed hypotension and bradycardia. The SpO2 was maintained between 96 to 99%. The hemodynamics were normal in most of the patients. Only 3(10%) patients developed hypotension and 2(6.6%) developed bradycardia. Five patients experienced mild to moderate shoulder pain which was managed accordingly and one complained of mild itching requiring no treatment. None of the participants complained of nausea/vomiting and respiratory distress. Table 2 shows the frequency of unwanted effects. The time of 1st dose of analgesic and total opioid consumption were presented in figure III. The mean time for 1st dose of analgesic was 3.8±1.2 hours and total opioid consumption was 70.68±12.7 mg in first 24 hours. Most of the surgeons were satisfied with this anesthesia technique. The majority of the patients were satisfied with this technique and were comfortable during surgery (Table 3).

Table 1: Distribution of the patients by demographic characteristics (n=30)

Variables	Value
Age in years	29.89±8.5
Gender	
Male	6 (20%)
Female	24 (80%)
BMI (kg/m^2)	26.56±2.14
ASA status	
Class I	21 (70%)
Class II	9 (30%)

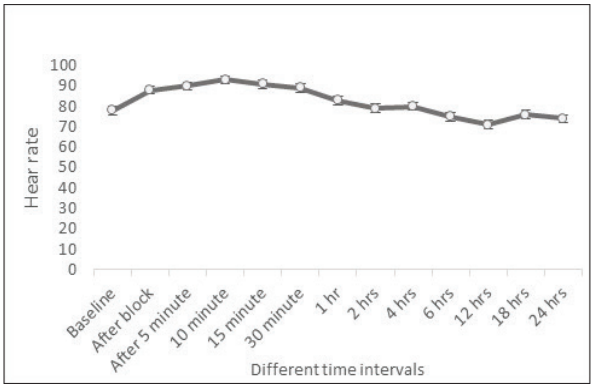

Figure 1: Heart rate changes over time

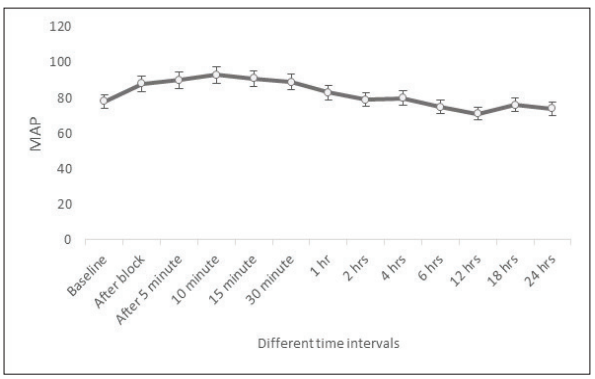

Figure 2: Blood pressure (MAP) changes over time

Table 2: Frequency of unwanted effects

Unwanted Effects	Frequency (%)
Nausea/Vomiting	-
Hypotension	3 (10%)
Bradycardia	2 (6.6%)
Itching	1 (3.3%)
Shoulder pain	5 (16.6%)
Respiratory distress	0 (0.0%)

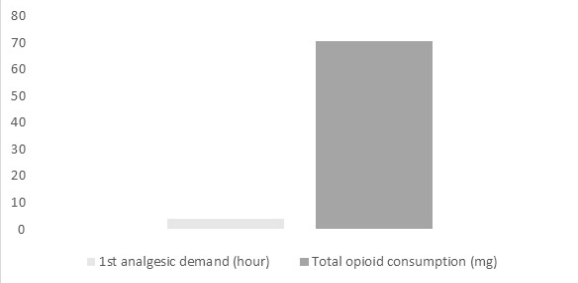

Figure 3: Time of 1st dose of analgesic and total dose of opioid consumption

Table 3: Satisfaction of both patient and surgeon

Satisfaction level	Patient (n=30)	Surgeon (n=30)
Very satisfied	16 (53%)	18 (60%)
Average satisfaction	12 (40%)	10 (33%)
Dissatisfied	2 (7%)	2 (7%)

DISCUSSION

Regional anaesthesia offers several advantages over general anaesthesia including avoidance of airway instrumentation, attenuation of the surgical stress response, provides excellent postoperative analgesia, reduction in PONV and earlier mobilization[5-9]. Apart from different regional techniques, thoracic segmental spinal anaesthesia has been studied less in healthy individual. Ellakany[7], van Zundert et al.[12] and Heisnam et al.[14] have provided some evidence that segmental spinal anaesthesia can be used for laparoscopic cholecystectomy. This study shows that sufficient segmental block can be achieved by thoracic spinal anaesthesia to perform laparoscopic cholecystectomy in ASA I and II patients.

The most important issue related to thoracic spinal anaesthesia is the risk of spinal cord injury. But MRI (Magnetic Resonance Imaging) of thoracic region revealed that the distance between the duramater and spinal cord was 5.19 mm at T2, 7.75 mm at T5, and 5.88 mm at T10[15]. This indicates that spinal cord lies anteriorly in the thoracic region. Thus intrathecal injection can be performed in the thoracic region without traumatizing the spinal cord. In our study, anaesthesia was performed at T10-T11 intervertebral space (T10th interspace). The 10th interspace was also chosen in other studies as it lies in the center of the surgical field[7,12,14].

In most of the studies, thoracic spinal anaesthesia was performed by CSE technique and isobaric bupivacaine was used as spinal anaesthetic[6,7,12]. Heisnam et al.[14] used a separate technique including placing epidural catheter through epidural needle first and then performed segmental spinal with hyperbaric bupivacaine at T10-T11 interspace. In our study, we have used 0.5% hyperbaric bupivacaine with fentanyl for intrathecal injection only without CSE system. The density is more in heavy bupivacaine than isobaric or plain bupivacaine. This difference in densities is believed to affect their diffusion patterns and distribution after injection into the CSF in the subarachnoid space[16]. Several studys have shown that heavy bupivacaine appears to cause more predictable sensory blockade and is associated with lower failure rate compared to plain bupivacaine[17].

Another concern of thoracic spinal block is the possibility of high spinal from cephalad spread of local anesthetic and effect on ventilatory mechanism because there is a possibility of inadequate ventilation due to extensive thoracic nerve block[12,14]. In our study, ventilatory parameters were well preserved and peripheral oxygen saturation (SpO2) was maintained around 96-99%. It may be due to the fact that the diaphragm which is the main inspiratory muscle is unaffected. Normally expiration is a passive phenomenon but forceful expiration and coughing may be affected under this technique[14]. The muscles of the anterior abdominal wall is responsible for forceful expiration which are innervated by the thoracic nerves[18]. Large dose and/or volume of local anesthetics can produce disastrous effects and it can be minimized by using adequate dose of local anesthetics[8]. To minimize the risk, we have used lower dose and/or volume of local anaesthetics (1.5 ml) in our study.

In most of the published literature, they have used sedation to relieve anxiety and discomfort as per

need[10,12,14]. Because moderate level of anxiety is present in the patients who underwent elective surgery under spinal anaesthesia[19]. Midazolam is a useful sedative agent for spinal anaesthesia with no clinically adverse cardiovascular or respiratory effects[20]. In our study, we have used minimal sedation for all patients with midazolam. According to Ramsay Sedation Scale, the mean sedation score was 2.6 ± 0.5 and most patient remained awake but relaxed, able to interact.

Paresthesia is not uncommon during spinal anaesthesia. But it will have greater significance when the needle is inserted in the thoracic region. In our study, two patients experienced paresthesia during insertion of the spinal needle, symptoms responded to needle withdrawal and did not lead to any postoperative sequelae. We have also observed the patients for one month to exclude any post procedural sequelae. Imbelloni et al.[21] observed that the incidence of paresthesia during low thoracic spinal anaesthesia was 6.6% and it was not associated with any permanent neurologic deficit. The frequencies of paresthesia were more for pencil point needle (8.67%) than cut point needle (4.67%)[21]. Minor degree of lower limb motor block developed before the start of surgery in 12 patients and subsequently resolved at the end of the operation. Minimal physical spread of local anaesthetics to the lumbosacral nerve roots may cause motor block[12]. Other studies also showed mild to moderate degree of motor block after thoracic spinal anaesthesia[7,12,14].

The haemodynamic changes were minimal throughout the intraoperative period. It may be due to the fact that all the patients were belong to ASA I and II, and adequately preloaded. Only 3 patients developed hypotension which was managed by injection ephedrine and 2 patients experienced bradycardia which didn't require any treatment. It is not uncommon to develop pruritus after administration of opioids in intrathecal or epidural route. We have found that 1(3.3%) patient developed mild degree of itching/pruritus requiring no treatment. This was also reported in other studies[7,12,14]. Five patients (16.6%) described some shoulder pain and discomfort, similar to findings reported in previous studies[7]. This is not uncommon after laparoscopic surgery and can be occurred perioperatively in 25% of patients, and postoperatively in 10%[22]. Sarli et al.[23] reported that the incidence of shoulder pain was 30–50% after laparoscopic surgery done under general anaesthesia.

In our study, the incidence of all side-effects were low and easily managed. Ellakany reported the incidence of hypotension and bradycardia in thoracic segmental spinal anaesthesia for which patients received ephedrine and atropine[7]. Critchley et al.[24] reported the elevation of mean arterial pressure (MAP) after gas insufflation during general anaesthesia. We have found minimal changes in MAP after insufflation of gas. None of our patient experienced respiratory distress during abdominal insufflation, may be due to the use of the horizontal position and low gas pressure. Minimal hemodynamic changes were also reported by Gupta et al.[25] during laparoscopic cholecystectomy under thoracic epidural anaesthesia. van Zundert et al.[7] and Heisnam et al.[14] also observed minimal side effects in segmental thoracic spinal anaesthesia for laparoscopic cholecystectomy.

Effective pain control in the postoperative period is very important for better outcome and early hospital discharge[26]. In our study, the duration of analgesia was longer. This is due to the residual analgesic effect of local anesthetic and fentanyl in subarachnoid space. We have found higher satisfaction score in both patient and surgeon. Ellakany[7] and Heisnam et al.[14] reported higher satisfaction score in laparoscopic cholecystectomy under segmental thoracic spinal anaesthesia. Ullah et al.[27] have found better satisfaction in patients undergoing breast surgery under segmental thoracic spinal anaesthesia.

CONCLUSION

This study demonstrates that laparoscopic cholecystectomy could be done successfully and effectively under segmental thoracic spinal anesthesia in healthy patients. The minimal cardiovascular changes and low incidence of side effects could make this technique an alternative to general anesthesia. It could be an option to expand the horizon of regional anesthesia in a new way. However, this technique requires great caution to avoid injury to the spinal cord and more studies are needed to recommend this technique to be used routinely for laparoscopic cholecystectomy.

Conflicts of interest: None declared.

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Ethical clearance: This study was approved by the Ethics Review Committee, Shaheed Suhrawardy

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Author's contribution: Study design: MMK, SA, MSI; Data collection, compilation and analysis: MMK, MRA; Writing, editing and submitting manuscript: MMK, SA, MRA, MSI, MA

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