



Role of Thoracic Spinal Anesthesia in Laparoscopic Cholecystectomy: A Literature Review

Khaled Mohamed Mohsen^{a++*}

^a *Burjeel Royal Hospital, Al Ain, United Arab Emirates.*

Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

The efficacy of thoracic spinal anesthesia (TSA) in laparoscopic cholecystectomy has been investigated through various studies focusing on patient satisfaction, pain management, and safety. In comparison to general anesthesia, Thoracic spinal anesthesia (TSA) in laparoscopic cholecystectomy was associated with shorter discharge times and greater patient satisfaction compared to general anesthesia. However, it should be noted that surgeon satisfaction was higher with general anesthesia. TSA demonstrated superior postoperative analgesia and hemodynamic stability compared to lumbar spinal anesthesia, making it a safe and effective alternative for laparoscopic cholecystectomy in healthy patients. Additionally, segmental thoracic spinal anesthesia was found to be associated with a lower incidence of postoperative pneumonia and atelectasis, making it a preferable choice for patients with respiratory comorbidities. Overall, thoracic spinal anesthesia showed promising outcomes, manageable intraoperative complications, and high patient satisfaction rates, making it a feasible regional anesthesia technique for laparoscopic cholecystectomy.

⁺⁺ *Anesthesia Specialist;*

^{*}*Corresponding author: E-mail: drkhaledmmohsen@gmail.com;*

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1. INTRODUCTION

Since the initial report in 2006 of laparoscopic cholecystectomy (LC) performed using “combined spinal-epidural anesthesia” on a patient with severe “chronic obstructive pulmonary disease” awaiting lung transplantation, the possibility and safety of using neuraxial anesthesia (NA), including epidural, spinal or combined techniques, in laparoscopic surgeries have been established in various studies [1-4].

Prospective randomized studies have consistently shown that spinal anesthesia (SA) when compared to general anesthesia (GA), leads to significantly lower rates of postoperative pain, nausea, and vomiting in laparoscopic cholecystectomy (LC). These findings make SA an ideal technique for elective laparoscopic surgeries performed on low-risk patients with an American Society of Anesthesiologists (ASA) score of 1 or 2. SA not only facilitates faster patient recovery but also enables early discharge, ultimately leading to reduced costs [5-9].

However, there are concerns regarding potential significant respiratory and cardiovascular changes due to raised intra-abdominal pressure caused by pneumoperitoneum during laparoscopic cholecystectomy (LC) [10]. Moreover, the use of spinal anesthesia (SA) in elective laparoscopic cholecystectomy (LC) procedures has been limited due to concerns about the sympathetic blockade and unfounded fears regarding spinal cord damage. Additionally, the frequent occurrence of intraoperative right shoulder pain has further restricted the widespread adoption of SA in LC [11].

Specifically, shoulder tip pain, which has been reported in 10-55% of cases during surgery, is widely acknowledged as a distressing factor for awake patients. Although this pain can typically be alleviated with opioid administration, it may still lead to a conversion to general anesthesia (GA) in up to 10% of cases, as observed in various studies [10]. Furthermore, the majority of studies in the literature that examine the use of spinal anesthesia (SA) in elective laparoscopic cholecystectomy (LC) have predominantly focused on lumbar puncture techniques. These studies have utilized hyperbaric or isobaric

bupivacaine as the intrathecal local anesthetic, often combined with opioids as adjuvants [12].

It is worth noting that achieving an optimal sensory block with isobaric bupivacaine often requires the patient to be placed in a Trendelenburg (head-down) position, which may have negative implications on the central nervous system, respiratory, and cardiovascular [13]. Additionally, the use of opioids as adjuvants can potentially lead to side effects such as urinary retention, vomiting, nausea, and respiratory depression [14]. Although isolated reports have described the use of thoracic puncture techniques, the lumbar approach remains the more commonly reported method in the literature [15].

Therefore, the purpose of this review is to evaluate the role of spinal anesthesia especially in thoracic region in laparoscopic cholecystectomy.

2. EFFICACY OF THORACIC SPINAL ANESTHESIA FOR LAPAROSCOPIC CHOLECYSTECTOMY

2.1 Patient Satisfaction with Thoracic Spinal Anesthesia in Laparoscopic Cholecystectomy

Patient satisfaction with thoracic spinal anesthesia in laparoscopic cholecystectomy can vary depending on individual experiences and preferences. Various studies have investigated patient satisfaction levels regarding thoracic spinal anesthesia in laparoscopic cholecystectomy.

For example, a study compared patient satisfaction, surgeon satisfaction, and discharge time, between two groups of healthy patients undergoing LC [3]. One group received general anesthesia, while the other group underwent segmental TSA. The findings revealed that patients who received segmental TSA had a shorter discharge time and reported higher levels of satisfaction. However, in terms of surgeon satisfaction, the general anesthesia group scored higher. These results indicate that segmental TSA can be successfully and effectively utilized for LC in healthy patients when administered by experienced anesthetists [1].

In a study conducted by Kumbhare et al., they examined 90 patients who underwent laparoscopic cholecystectomy. The patients were divided into three equal groups to compare the use of general anesthesia (GA), thoracic spinal anesthesia (TSA), and lumbar spinal anesthesia (LSA) for the procedure [16]. In their study, the researchers utilized different medications for the lumbar and thoracic levels in their respective anesthesia groups. In the lumbar level group, the patients were administered hyperbaric bupivacaine 15 mg and fentanyl 25 mcg at the L2/L3 level [2]. In contrast, the thoracic level group received hyperbaric “bupivacaine 7.5 mg” and “fentanyl 25 mcg” at the T10/T11 level. The general anesthesia (GA) group underwent tracheal intubation with the help of standard medications. Various parameters were assessed during the surgery, including additional analgesic requirements, intraoperative vital signs, adverse effects during the postoperative recovery period, and satisfaction levels reported by both the patient and surgeon. The results of the study provided evidence that both lumbar and thoracic regional anesthesia approaches are safe and viable alternatives to general anesthesia (GA) for laparoscopic cholecystectomy in patients without any underlying health conditions. Postoperative analgesia was found to be superior in the regional anesthesia groups in comparison with the GA group. Segmental thoracic spinal anesthesia demonstrated better hemodynamic stability, reduced need for vasopressors, and potential for early ambulation and discharge when compared to lumbar spinal anesthesia. The researchers also noted that patients expressed higher satisfaction levels with thoracic spinal anesthesia. This makes it a highly favorable option for outpatient surgical procedures.

In a research conducted by Paliwal et al., they compared segmental spinal anesthesia with general anesthesia (GA) for “laparoscopic cholecystectomy” in 60 patients. The research demonstrated that spinal anesthesia can be a more favorable option, especially for patients with “respiratory comorbidities”, as it was linked to a reduced occurrence of postoperative pneumonia and atelectasis [17].

In another study, Ellakany et al. conducted a randomized controlled trial involving sixty patients who underwent “open surgeries for abdominal malignancies”. They compared the utilization of segmental TSA with GA. The study findings indicated that segmental thoracic spinal anesthesia was a viable option for high-risk

patients, as it resulted in increased patient satisfaction, shorter recovery time, reduced hospital stay, and lower incidences of vomiting and nausea [18]. Consistent with these findings, the present study revealed that 94% of the patients expressed a high level of satisfaction with the anesthesia technique employed after their surgery.

A study was conducted to assess the effectiveness of thoracic spinal anesthesia in patients scheduled for laparoscopic cholecystectomy [19]. According to this research, in a total of 2,074 patients, spinal anesthesia was successfully administered, with 92% of patients achieving success in a single attempt. The occurrence of paresthesia during needle insertion was observed in 5.8% of patients. Some patients experienced hypotension (18%), bradycardia (13%), and nausea (10%), while shoulder tip pain was reported by only 6 percent of patients. The most of the patients 94 percent expressed a high level of satisfaction with the procedure. No adverse events were reported during the postoperative period. The findings of this study suggest that TSA is a viable regional anesthesia method for healthy individuals who are undergoing laparoscopic cholecystectomy. The incidence of intraoperative complications was found to be manageable, and there was no evidence of neurological complications. This technique provides the benefit of minimizing postoperative complications, maintaining stable hemodynamics, and ensuring a satisfactory level of patient satisfaction.

2.2 Pain Management with Thoracic Spinal Anesthesia in Laparoscopic Cholecystectomy

Pain management with thoracic spinal anesthesia (TSA) in laparoscopic cholecystectomy has shown significant advantages over general anesthesia, leading to improved postoperative outcomes. For example, a prospective randomized controlled trial was carried out on a group of patients who were scheduled for elective laparoscopic cholecystectomy (LC). The study revealed several advantages of spinal anesthesia (SA) compared to GA in terms of managing pain and preventing postoperative nausea and vomiting (PONV). These benefits resulted in a smoother postoperative experience, faster patient recovery, and the potential for discharge on the same day of surgery. This study further supports the idea of LC as a routine ambulatory

procedure, which can help reduce overall healthcare waiting lists and costs, as supported by recent evidence [20].

Several studies have investigated the use of "lumbar spinal anesthesia" (SA) with opioids, "hyperbaric bupivacaine" and isobaric in elective LC. These studies have consistently shown that this method is superior to GA in terms of managing vomiting, nausea, and pain during the perioperative period. However, one common issue encountered is the occurrence of right shoulder pain during surgery, which can sometimes lead to a switch to GA. This case series presents a new approach called segmental TSA with hypobaric ropivacaine, which eliminates the use of opioids. The main benefit of this approach is its effectiveness in reducing shoulder pain [21].

In this series, the average age of the patients was 75.7 years, with a standard deviation of 17.5 years. STSA was successfully performed on all patients without any complications or the need to switch to general anesthesia. The average duration of surgery and spinal anesthesia (SA) was 37.5 minutes (± 8.7) and 145.2 minutes (± 21.8), respectively. None of the patients reported shoulder or abdominal pain or experienced nausea during the surgery. Only four patients required vasopressor drugs, and two patients needed intravenous sedatives. In the postoperative period, the average pain score on the visual analog scale (VAS) was 3 (± 2), and within the first 12 hours after surgery, it increased to 4 (± 2). The median "length of hospital stay" ranged from 1 to 3 days, with an average of 2 days according to the findings of this study, hypobaric opioid-free STSA (Sub-Tenon's space anesthesia) shows promising outcomes as a successful method for "laparoscopic surgeries", with minimal to no incidence of shoulder pain. Nevertheless, larger "prospective studies" are required to verify and authenticate these findings.

A study examining the effectiveness of thoracic spinal anesthesia in laparoscopic cholecystectomy (LC) revealed that complications were uncommon and easily managed, with all cases rated as either grade 0 or grade 1 [22]. Of particular interest was the unexpectedly low occurrence and ease of treatment for shoulder tip pain, a common issue following laparoscopic surgery. During the operation, shoulder tip pain occurred in 25% of patients, while the postoperative incidence was 10%. The former percentage aligns with findings from a previous study on laparoscopic surgery

under the epidural block, contrasting with the higher incidence (30-50%) reported after laparoscopic surgery under general anesthesia [23].

A study was designed to assess the effectiveness and feasibility of utilizing thoracic epidural anesthesia for laparoscopic cholecystectomy [24]. According to this research, thoracic epidural anesthesia proved to be successful in the majority of laparoscopic cholecystectomy cases, with only two patients requiring conversion to general anesthesia. Throughout the procedure, the patient's hemodynamic parameters and respiratory efficiency remained within normal ranges. Vasopressor treatment was necessary for only four patients to manage hypotension and shoulder pain was experienced by 15 patients, effectively alleviated with small doses of ketamine. Midazolam was administered to 11 patients to address anxiety. The average surgical time was 56.8 ± 51.6 minutes. The 24-hour postoperative epidural infusion provided effective analgesia while minimally affecting bowel and bladder function. Only three patients experienced postoperative vomiting. Both surgeons and patients expressed satisfaction with the outcomes of the procedure. The use of thoracic epidural anesthesia with 0.75% ropivacaine and fentanyl for elective laparoscopic cholecystectomy has proven to be effective. It successfully maintains ventilation and keeps hemodynamic changes within normal physiological ranges, even during pneumoperitoneum. Additionally, this approach has minimal side effects that can be easily managed.

The collective findings from these studies consistently revealed that pain occurrence with thoracic spinal anesthesia was either negligible or reported as low. However, in some cases where pain was observed, it was effectively managed and did not pose significant challenges.

2.3 Safety of Thoracic Spinal Anesthesia for Laparoscopic Cholecystectomy

Anesthesiologists often worry about the potential risk of damaging the spinal cord during a thoracic puncture. However, MRI studies have revealed that the spinal cord is positioned anteriorly within the "thecal sac" in the thoracic segment [30,31]. This anatomical arrangement ensures a safe distance exists at the thoracic level, preventing

the spinal needle from coming into contact with the neural tissues.

Imbelloni and Gouveia conducted a study involving 50 patients, utilizing MR imaging to examine the thoracic spinal canal. Their findings clarified that even in cases of “accidental perforation” of the “thoracic dura mater”, spinal cord injury was absent [25]. In their observations, they noted specific measurements for the space between the protective membrane (dura mater) and the spinal cord. At the T2 level, the distance measured “5.19 mm, at T5 it measured 7.75 mm, and at T10 it measured 5.88 mm”. The magnetic resonance (MR) imaging provided additional confirmation that the spinal cord and the bundle of nerves called the cauda equina are positioned closer to the back of the protective membrane (dura mater) in the lower back (lumbar) region, whereas they are located towards the front in the middle back (thoracic) region of the spinal cord. Using these anatomical references, it was established that there exists a sufficient distance to safely advance the needle without contacting the spinal cord, even in situations where “accidental perforation” of the protective membrane (“dura mater”) occurs during SA. Imbelloni and Gouveia previously reported an approximate incidence of 13.6% for paresthesia during attempts to insert a needle into the lower back (lumbar) region for spinal anesthesia.

The introduction of a new era in thoracic spinal anesthesia (TSA) was marked by noteworthy research contributed by “Van Zundert et al”. In their report, they successfully performed a Laparoscopic Cholecystectomy using the thoracic CSE (Combined Spinal-Epidural) technique, administering a local anesthetic without encountering any adverse events [26]. The patient in this case had a history of chronic smoking and suffered from severely compromised respiratory function, specifically “chronic obstructive pulmonary disease” with severe emphysema and “homozygote α -1-antitrypsin deficiency”. This patient was oxygen-dependent and had significantly limited functional capacity, experiencing dyspnea even during mild exertion.

Besides the case report, “Van Zundert et al”. conducted a study with 20 patients, implementing a very similar anesthesia technique. Their results indicated that STSA can be effectively employed for laparoscopic surgeries in additional healthy subjects [27]. These collective findings shed light on the potential application and effectiveness of thoracic spinal anesthesia in various patient

populations, offering promising prospects for laparoscopic procedures.

For a considerable period, segmental thoracic spinal anesthesia (TSA) has been regarded as a controversial technique. Anesthesiologists have harbored concerns regarding potential hemodynamic stability and spinal cord damage, primarily due to the thoracic cardioacceleratory fibers (T2-T6) obstruction and the weakening of abdominal and thoracic muscles that assist in respiration [28].

Kiran and Sweta conducted a case study involving a patient with Byssinosis who underwent nephrectomy under Thoracic Epidural Anesthesia (TEA). They mentioned that concerns regarding TEA's impact on ventilation are minimal due to the administration of a low dose of the medication, which preserves the patient's ability to cough. Additionally, the diaphragm's functionality remains intact as it receives innervation from the cervical levels (C3, 4, 5) [29].

These findings offer promising prospects for the use of TSA in a variety of patient populations, providing a safe and effective alternative for laparoscopic procedures.

3. CONCLUSION

In conclusion, thoracic spinal anesthesia (TSA) has been found to be an effective and safe option for laparoscopic cholecystectomy, with high patient satisfaction and superior pain management compared to general anesthesia. TSA offers advantages such as shorter discharge times, reduced postoperative complications, and minimal shoulder pain incidence. The anatomical positioning of the spinal cord in the thoracic region ensures a safe distance during needle insertion, mitigating the risk of neural tissue damage. Overall, TSA shows promise as a viable regional anesthesia technique, warranting further research and exploration in different patient populations and surgical procedures.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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