Comparative Study of Segmental Thoracic Spinal Versus Thoracic Epidural Anesthesia for Laparoscopic Cholecystectomy

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ABSTRACT

Background: Laparoscopic cholecystectomy the standard surgery for gallstone disease have been successfully performed under regional anesthetic techniques. In our study we compared thoracic epidural anesthesia versus segmental thoracic spinal anesthesia in healthy patients regarding safety, efficacy and complication. Aim and objective: This study was designed to compare and evaluate safety, efficacy, benefits and complications of conducting laparoscopic cholecystectomy under segmental thoracic spinal versus thoracic epidural anesthesia. Method: Seventy ASA I or II patients undergoing laparoscopic cholecystectomy were randomized into two groups, one group received segmental thoracic spinal anesthesia (TSA) T8-T9 level using 7.5 mg isobaric bupivacaine 0.5% and 25 μg fentanyl with total volume 2ml, other group received thoracic epidural anesthesia (TEA) T8-T9 10 ml of 0.5% isobaric bupivacaine and 25μg fentanyl. Results: Segmental thoracic spinal technique was less technical difficulty (p value 0.017), less shoulder pain (p value 0.017) more abdominal relaxation (p value 0.015) than epidural technique (two cases were converted to general anesthesia in epidural group and one patient in spinal group due to uncontrollable patient discomfort. The two blocks were effective for surgery with better patient and surgical satisfaction in spinal group. Conclusion: Both segmental thoracic spinal and thoracic epidural anesthesia were safe and effective anesthetic technique for laparoscopic cholecystectomy with less technical difficulty and better abdominal relaxation in spinal group.

Keywords: regional, thoracic spinal; epidural; bupivacaine, laparoscopic cholecystectomy

1. INTRODUCTION

Laparoscopic cholecystectomy is usually performed under general anesthesia to avoid aspiration and respiratory complications secondary to the induction of pneumoperitoneum [1]. However, many LC have been performed successfully under regional anesthetic techniques [2]. Patients under regional anesthesia can be oriented with less postoperative pain, nausea and vomiting. For the successful completion of LC under regional anesthesia, neuraxial blockade must be performed to cover T4 level or above [3]. Spinal anesthesia is suitable for the minimally invasive laparoscopic surgery it has been demonstrated the safety of the segmental thoracic spinal anesthesia at T10 by using the combined spinal-epidural technique [4]. Also,
it is possible to perform laparoscopic surgery of gastrointestinal tract using epidural anesthesia [5]. Segmental thoracic epidural anesthesia in LC offers some benefits over lumbar spinal anesthesia. In addition, the level of anesthesia achieved by lumbar spinal due to pooling of drug in the sacral region by lumbar lordosis. In addition, the block level above T4 achieved by spinal anesthesia, which is desirable for LC, may cause significant cardiac depression [6]. There is no study comparing between thoracic epidural anesthesia and segmental thoracic spinal, our study was designed to compare and evaluate safety, efficacy and complication of conducting laparoscopic cholecystectomy under segmental thoracic spinal versus thoracic epidural anesthesia.

2. METHODS

This study was conducted in Beni Suef university hospital, after approval from the local ethical committee and a written informed consent for any one of the two techniques of anesthesia was obtained from all patients and informed about the probability of conversion to general anesthesia if needed. 70 patients ASA I & II male or female patient aged 18–60 years. Exclusion criteria included patient refusal, acute cholecystitis, pancreatitis or cholangitis, prior laparotomy for upper abdominal surgery, any contraindication for spinal or epidural anesthesia, body mass index >35 kg m-2, chronic obstructive pulmonary disease. Thus, 70 subjects were randomized into two equal groups to undergo laparoscopic cholecystectomy with low-pressure CO2pneumoperitoneum under segmental thoracic spinal anesthesia (TSA group) or thoracic epidural anesthesia (TEA group) using the opaque sealed-envelope technique. Sealed and numbered envelopes were placed in the operating room and opened only after the arrival of the patient. All patients were monitored with noninvasive blood pressure, oxygen saturation, and Electrocardiogram (ECG) using bed side monitor and preoperative reading was obtained. An 18-G catheter was inserted in the left hand for hydration and administration of drugs. Initially, 500 mL of Ringer's lactate, cephalosporin 2 g, ranitidine 50 mg and metoclopramide 10 mg, ondansetron 8 mg IV before the blockade fentanyl (50μg) and midazolam (2 mg) Was administered before the puncture. In TSA group with the patient in sitting position, after establishing aseptic conditions skin wheal was raised at the level of the chosen interspace with local anesthetic (lidocaine 1%) using combined spinal epidural system a 18-G epidural needle was inserted at T8/T9 interspace till the epidural space was reached then a small 27-gauge spinal needle was inserted to reach the subarachnoid space and 7.5 mg isobaric bupivacaine 0.5% and 25 μg fentanyl was injected with total volume 2ml patients were placed in the supine position . sensory loss was tested by pinprick test, which reached the level of T4 after which the surgical procedure was start. In thoracic epidural group (TEA) the patient was placed in the sitting position, Under all aseptic and antiseptic precautions, skin wheal was raised at the level of the chosen interspace with local anesthetic (lidocaine 1%) using a small (25-gauge) needle, the epidural space was identified using 16-gauge Tuohy needle and loss of resistance technique, in the T8-T9 interspace or one space above or below this interspace when it was not possible in this space. The epidural catheter was secured about 3 cm cephalad beyond the needle tip. The patient was then be placed in the supine position and 3 ml of 2% lidocaine with adrenaline (1:200000) was given as a test dose followed by 10 ml of 0.5% bupivacaine and 25μ fentanyl which was given via the epidural catheter. There after incremental doses of 3 ml of 0.5% bupivacaine was given till the desired level of block (T4) was reached. The upper and lower levels of sensory and motor block were assessed by a pinprick test and the Bromage scale and recorded every 5 minutes until the start of surgery and every 15 minutes postoperatively (table 1).

<table>
<thead>
<tr>
<th>grade</th>
<th>degree of block</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>able to lift extended leg</td>
</tr>
<tr>
<td>1</td>
<td>just able to flex knees full ankle movement</td>
</tr>
<tr>
<td>2</td>
<td>no knee movement, some ankle movement</td>
</tr>
<tr>
<td>3</td>
<td>complete paralysis</td>
</tr>
</tbody>
</table>

During surgery, heart rate, arterial blood pressure, pulse oximetry, were continuously monitored. All data were recorded at 5-minute intervals. Anxiety was treated with midazolam 1mg I.V, pain with fentanyl 50 μg I.V (If the patient still complaining of shoulder pain after the administration of lidocaine), hypotension (20% drop in baseline mean blood pressure) with i.v. ephedrine 5 mg increments, and bradycardia (HR<50 bpm with atropine 0.5 mg, all given as intravenous boluses as required. The following criteria were established for conversion of the spinal technique to general anesthesia: any organ lesion with difficulty to control bleeding, or patient dissatisfaction with regional technique at any time during the procedure.

Laparoscopic cholecystectomy performed in all patients by using the same technical principles for the two groups, with the standard 4-trocar technique with two modification, i.e., pneumoperitoneum was induced with CO2, up to a maximal pressure of 10 mmHg in all patients. During surgery, hemodynamic changes, as well as all intraoperative events especially those related to the type of regional anesthesia such as shoulder or abdominal pain, headache, nausea, vomiting, and discomfort were recorded, the length of surgery, surgeon evaluation of the quality of anesthesia, the need of supplementary sedation, time of pneumoperitoneum and at the end of surgery, we evaluated the ability of the patient to move unaided. Postoperatively, all patients were given i.v. analgesia (diclofenac 75 mg every 12 h and paracetamol 500 mg every 6 h). Postoperative pain was assessed in the two groups using a visual analog scale at 2, 4, 6 and 12 hours, postoperatively. Other postoperative events related to either the surgical or anesthetic procedure, i.e., discomfort, nausea and vomiting, shoulder pain, urinary retention, pruritus, headache, or other neurologic sequelae, had been recorded. The length of hospitalization also recorded and at the time of discharge patients had been questioned about their satisfaction (degree of satisfaction with the anesthetic technique (Table 2). Also simplified questionnaire form developed for surgeons to evaluate comments about the operation (Table 3).

### Table 2: patient satisfaction questionnaire

<table>
<thead>
<tr>
<th>How comfortable were you during the operation?</th>
<th>Comfortable</th>
<th>Not so comfortable</th>
<th>Uncomfortable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are you happy with the procedure?</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Would you advise the same procedure to your known?</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

### Table 3: surgeon satisfaction questionnaire

<table>
<thead>
<tr>
<th>How was the abdominal relaxation?</th>
<th>Adequate</th>
<th>Moderate</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Was there any technical difficulty related to the anaesthetic technique?</td>
<td>A lot</td>
<td>Minimal</td>
<td>None</td>
</tr>
</tbody>
</table>

### 3. RESULTS

#### Statistical methods

All statistical calculations were done by using computer programs Microsoft Excel & SPSS statistical programs. Data described in terms of mean standard deviation (SD), and range. Descriptive statistics was done for quantitative data as minimum & maximum of the range as well as mean ± SD (standard deviation) for quantitative parametric data. Correlation coefficients were calculated using Pearson correlation analysis. p values less than 0.05 was considered statistically significant. Inferential analyses were done for quantitative variables using unpaired t-test in cases of two dependent groups with parametric data for comparing categorical data Chi Square test (X2) was performed. The Mann–Whitney test was used to compare two unrelated samples, p values less than 0.05 was considered statistically significant. The comparison between the two groups as regarding demographic data (age, sex, BMI, ASA, OP time) was not significant, so the groups are similar regarding demographic data as shown in (Table 4).

#### Table 4: Comparison between Epidural and Spinal group as regarding demographic data.

<table>
<thead>
<tr>
<th></th>
<th>Epidural group (n=33)</th>
<th>Spinal group (n=34)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Year)</td>
<td>26-65 (42.2±9.7)</td>
<td>24-65 (39.3±9.0)</td>
<td>0.197</td>
</tr>
<tr>
<td>BMI</td>
<td>27-32 (29.9±1.4)</td>
<td>27-32 (30.0±1.5)</td>
<td>0.623</td>
</tr>
<tr>
<td>OP time</td>
<td>60-90 (82.3±7.9)</td>
<td>60-90 (84.4±7.5)</td>
<td>0.247</td>
</tr>
<tr>
<td>Sex (m/f)</td>
<td>5(15.2%)/28(84.8%)</td>
<td>7(20.6%)/27(79.4%)</td>
<td>0.571</td>
</tr>
<tr>
<td>ASA (I/II)</td>
<td>30(90.9%)/3(9.1%)</td>
<td>30(88.2%)/4(11.8%)</td>
<td>0.998</td>
</tr>
</tbody>
</table>

Data represented as range– mean ± SD

As regarding hemodynamic changes, heart rate, mean arterial blood pressure showed significant changes at the thirty or the thirty-five-minute due abdominal insufflation with CO2. SpO2 did not show significant changes in any of the two groups. There were adequate sensory level (T2-T4) achieved in both groups with no differences between the two groups according the degree of block recorded by the sensory level and bromage scale too. There were no statistically significant differences between the two groups in intraoperative drugs given for hypotension (ephedrine), bradycardia (atropine), midazolam and fentanyl given.
for anxiety and shoulder pain as shown in (Figure 1 a and b).

Intra operative adverse effect like nausea, vomiting, headache, abdominal pain did not show differences between the two groups except shoulder pain which was significantly high (p value 0.039) in epidural group (15 cases) than spinal (7cases) group. By asking the patient at the end of surgery about their opinion in the anesthetic technique we found that most of the patients were comfortable and satisfied with this anesthetic technique. About surgeon satisfaction: abdominal relaxation was significantly adequate in spinal group than epidural group (p value 0.015) as shown in (Figure 2).

Also in comparison with the spinal group minimal technically difficulty was significantly higher in epidural group p value 0.015 (3 cases in epidural group with a lot of difficulty two of them were converted to GA and 2 cases in spinal group one of them was converted to GA due to uncontrollable patient discomfort and lot of patient movement) but most of both groups did not show much technical difficulty as shown in [Table 5] There were no significant differences between the two groups as regarding post-operative adverse effects and post anesthesia care unit. Post-operative visual analogue scale for post-operative pain show no significant differences between the two groups but prolonged analgesia in TSA group.

4. DISCUSSION

Laparoscopic surgery is usually performed under general anesthesia, but regional anesthesia offers superior analgesia, decreased risk for postoperative deep venous thrombosis and acute postoperative confusion compared with general anesthesia [8]. So, there is significant and increased interest in the use of regional anesthesia for many surgeries. Our study was
designed to compare and evaluate safety, efficacy, patient satisfaction, surgeon satisfaction and complication of conducting LC under segmental thoracic spinal versus thoracic epidural anesthesia. The risk of spinal cord injury was probably the most serious complication when performing thoracic spinal block or epidural block so anesthesiologists were afraid to perform spinal anesthesia above the termination of the spinal cord. But the results from MRI studies indicate that the spinal cord lies anteriorly within its thecal sac in the thoracic curve and the following measures were found: 5.19 mm in T2, 7.75 mm in T5 and 5.88 mm in T10, this let us say, sufficient distance to permit the careful advancement of a needle (accidentally or intentionally) without reaching the cord and administer anesthetic for a segmental spinal anesthesia. This anatomical explanation was proposed for the absence of spinal cord injury during an accidental perforation during attempted thoracic epidural [9]. We studied 70 patients aged 18-60 years old, ASA I-II undergoing LC. 35 patients had thoracic epidural and 35 patients had segmental spinal anesthesia, one patient excluded from the study in spinal group and two patients in epidural group due to much technical difficulty as the surgeon claimed and uncontrollable patient discomfort. After conducting neuraxial block patients monitored for hemodynamic changes, shoulder pain, abdominal discomfort, nausea, vomiting, headache, abdominal relaxation and technical difficulty. This study showed that hemodynamic changes was not significant between the two groups, bradycardia occurred in 3 patient in epidural group and in 6 patients in spinal group, hypotension occurred in 5 patients in epidural group and in 10 patients in spinal group these hemodynamic changes managed successfully as usual by atropine for bradycardia (HR<50bpm) and ephedrine for hypotension (MBP<20% of baseline) and none of them needed conversion to general anesthesia or intubation. Ellakany MH study of 40 patients divided into 2 equal groups about LC under thoracic spinal anesthesia versus general anesthesia showed that The intra-operative cardiovascular changes in the thoracic spinal group were significant when compared with the general anesthesia group, and were higher than our study as hypotension, and bradycardia were encountered in 8 patients, while in general anesthesia group no patient developed hypotension or bradycardia [10]. AAA Mahmoud, et al feasibility study on 25 patients about The novel use of spinal anesthesia at the mid-thoracic level for breast surgery also found that segmental thoracic spinal anesthesia at T5 level in healthy patients undergoing breast surgery can be used successfully with minimal hemodynamic instability [11]. In 2011 Gupta A, et al studied thoracic epidural anesthesia on 48 patient with 0.75% ropivacaine and fentanyl for elective LC, hemodynamic parameters and respiratory efficiency were maintained within physiological limits. Only 4 patients required treatment for hypotension with vasopressor [12]. Referred shoulder pain was a statistically significant intraoperative problem. Minai et al. attributed high incidence of shoulder pain to the physical and chemical stimulation of the diaphragm by carbon dioxide pneumoperitoneum [13]. Our study showed that Shoulder pain was greater to some extent in epidural group than spinal group (15 patients in epidural group and 7 patients in spinal group) and all had been managed by reassurance of the patient and IV fentanyl, abdominal discomfort occurred in 4 patients in epidural group and 1 patient in spinal group and managed by supplementary dose of IV fentanyl. Intraoperative nausea occurred also in 5 patients in epidural group and 4 patients in spinal group and vomiting 1 patient in epidural group and 2 patients in spinal group. all cases who developed nausea or vomiting were related to patient who developed hypotension and they did not affect the progress of surgery, we tried to decrease incidence of nausea and vomiting by pre-medication with ondansetron and metoclopramide. One patient of two who excluded from the study in the thoracic epidural group was due to severe shoulder pain and discomfort. Also, Nandita Mehta, et al published A feasibility study for thoracic combined spinal epidural anesthesia for LC and found occurrence of shoulder pain was the main drawback for using regional anesthesia in LC where 10 patients (33%) of total 30 who received 2 ml of isobaric levobupivacaine 0.5% with 25 μg of fentanyl given intrathecally complained of shoulder pain. Conversion to GA was done in 1 patient due to severe shoulder pain and anxiety otherwise had been managed effectively with small doses of opioid analgesics. Hypotension occurred in 11 patients (36%) and bradycardia occurred in 6 patients (20%) which was managed in all with a single dose of atropine [14]. Similarly, Van Zundert et al. study on 20 patient undergoing LC under segmental thoracic spinal anesthesia also noted 5 patients described some shoulder, and 1 some abdominal discomfort late in the procedure, all responding to modest doses of fentanyl. 2 received midazolam 2 mg for anxiety and 2 described some mild itching not requiring treatment. Unlike our study no patients experienced...
Hajong et al Feasibility Study for LC under epidural anesthesia included 20 patients found that 8 patients (40%) experienced shoulder pain and 2 patients could not tolerate the shoulder pain and were converted to general anesthesia [16]. At the end of surgery, we ask the patients about their opinion in the anesthetic technique, is it comfortable? were they satisfied? And if they advise it for their known, and we found that in epidural group 25 patients were comfortable, 6 patients were not so comfortable, and 2 patients were uncomfortable and 1 of them needed general anesthesia but in spinal group 30 patient were comfortable, 3 patient were not so comfortable, and 1 patient was uncomfortable. 30 patients in epidural group were satisfied and advise it for their known and 32 patients in spinal group were satisfied and advise it for their known, so no difference regarding patient satisfaction between both groups with relatively good patient satisfaction in spinal group. We also asked the surgeon about their opinion, the degree of abdominal relaxation and degree of technical difficulty and we found that in epidural group 20 patient had adequate abdominal relaxation and no technical difficulty, 12 patient had moderate abdominal relaxation and minimal technical difficulty, 3 patient had poor abdominal relaxation and much technical difficulty and 1 of them needed general anesthesia. On the other hand spinal group 30 patient had adequate abdominal relaxation and no technical difficulty, 3 patients had moderate abdominal relaxation and minimal technical difficulty, 2 patient had poor abdominal relaxation and much technical difficulty and 1 of them needed general anesthesia so there were significant good abdominal relaxation, surgeon satisfaction with less technical difficulty in thoracic spinal group. There was no difference between two groups as regarding post anesthesia care unit time. Ellakany MH. also showed in his study shorter post anesthesia care unit stay, better postoperative pain relief and patient satisfaction than general anesthesia [10]. Gupta A, et al found that All patients received thoracic epidural anesthesia gave an overall satisfaction score 8 or above and all resumed normal activities within few days and like our study Only in 2 patients, the surgeon found technical difficulty for surgery hence conversion to general anesthesia was done [12]. Hajong et al found that nausea/vomiting [15]. Surgeons did not have problems with abdominal relaxation, or the surgical technique, and answered that there was no difference between the technique and general anesthesia [16]. Also, Pradeep Dhumane, et al also did not encountered such problem (technical difficulty) in fact surgeons appreciated the adequate abdominal relaxation and surgical conditioning [17]. Ross et al in their study of laparoendoscopic single-site (LESS) surgery for cholecystectomy under epidural anesthesia in 20 patients has concluded that epidural anesthesia appears to be a preferable alternative to general anesthesia for patients undergoing LESS cholecystectomy with no operative or anesthetic conversions, less postoperative pain at discharge, good patient and surgeon satisfaction [18]. Similarly, Van Zundert et al also noted Postoperatively, there were minor degrees of abdominal pain, shoulder pain, or itching in small numbers of patients, all readily treatable with standard oral medication, but no nausea/vomiting, all patients resuming oral intake on the day of surgery [15]. Nandita Mehta, et al found that Postoperatively 3 patients had mild shoulder discomfort that subsided with reassurance and shoulder massage [19]. This study was the first study comparing segmental thoracic spinal versus thoracic epidural anesthesia for LC and found that both techniques can be used efficiently and successfully without major hemodynamic changes, intra and post-operative complication, with good patient and surgeon satisfaction with relative superior result for segmental thoracic spinal group.

5. LIMITATION
this study has limited number of patients (ASA I & II) so it is a small study to prove the safety of these new anesthetic technique so further studies on large number of population & different ASA status are recommended .

6. CONCLUSION
Both segmental thoracic spinal and thoracic epidural anesthesia were safe and effective anesthetic technique for laparoscopic with less shoulder pain, less technical difficulty and better abdominal relaxation in spinal group.
REFERENCES