Laparoscopic Cholecystectomy Under Low Thoracic Combined Spinal Epidural Anaesthesia: A Comparative Study Between Isobaric And Hyperbaric Bupivacaine

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Abstract

Background: Thoracic spinal anaesthesia has proven its efficacy over general anaesthesia as a routine anaesthetic technique for laparoscopic surgeries. This study aimed to compare the block characteristics of isobaric and hyperbaric bupivacaine in thoracic spinal epidural anaesthesia for laparoscopic cholecystectomies.

Materials and methods: The study included 60 ASA I and II patients undergoing elective laparoscopic cholecystectomy, divided randomly into two equal groups. Both the groups were given thoracic combined spinal epidural anaesthesia (CSE) at the T9-T10 / T10-T11 interspace using 1.5 ml of isobaric bupivacaine 0.5% (5 mg/ml) + 25µg (0.5 ml) of fentanyl in group I and 1.5 ml of hyperbaric bupivacaine 0.5% (5 mg/ml) + 25µg (0.5 ml) of fentanyl in group H.

Results: The onset of analgesia was comparable in both the groups. In contrast to the longer time taken to reach T4(7.8 min) by hyperbaric bupivacaine which also showed longer motor(220 min) than sensory block(117 min); isobaric bupivacaine showed lesser time to reach T4(2 min) and a shorter duration of motor block (90 min) than the sensory block (160 min).

Conclusion: By providing a sensory block of longer duration than the motor block isobaric bupivacaine is reflected in a better indication for upper abdominal laparoscopic surgeries.

Keywords: Baricity, hyperbaric bupivacaine, isobaric bupivacaine, laparoscopic cholecystectomy, thoracic combined spinal epidural anaesthesia.

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I. Introduction

Thoracic spinal anaesthesia has come a long way since its introduction by Jonnesco in 1909. Initially used in patients with severe lung disease who could not tolerate general anaesthesia [1]. It was eventually demonstrated to be an effective anaesthetic technique in healthy patients for laparoscopic cholecystectomies with significant post operative benefits [2]. Studies have shown thoracic spinal anaesthesia to provide satisfactory operating conditions and shorter latency of the block with excellent haemodynamic stability for laparoscopic cholecystectomies. Many studies in the past have compared solutions of different baricities in lumbar spinal anaesthesia [3,4] but very few such studies are present for thoracic spinal anaesthesia. Also thoracic subarachnoid space is anatomically different from lumbar thecal space as shown by Hogan QH et al [5]. Hence the aim of this study was to compare the quality of anaesthesia as well as the sensory and motor block characteristics during thoracic combined spinal epidural anaesthesia of a patient group undergoing laparoscopic cholecystectomy with isobaric bupivacaine to those of another patient group treated with hyperbaric bupivacaine.

II. Materials and methods

After obtaining approval from the institutional ethics committee written consent was obtained from all 60 patients scheduled for elective laparoscopic cholecystectomy. Inclusion criteria were ASA I and 2 patients aged between 18-65 years with normal coagulation status. Patients belonging to ASA status 3 and 4, acute cholecystitis, acute pancreatitis, severe cardiovascular/renal disability and BMI >30 kg/m² were excluded from the study. They were divided randomly by computer generated numbers into two equal groups. Patients were kept fasting six hours prior to surgery and premedicated with tablet alprax 0.25 mg, pantoprazole 40 mg and domperidone 10 mg on the night prior to surgery. Patients were informed about CSE in detail and assured that...
The patients were enrolled in the study and no patient was excluded. No difference was observed between the groups with respect to gender, age, height and weight [TABLE 1].

The onset of analgesia was fast and similar among the two solutions – 2 min (TABLE 2). The peak block height achieved was higher (T2 – T3 ) with isobaric bupivacaine than with hyperbaric solution (T3 – T4 ) (p value < 0.0001). Epidural top up was required in 2 patients in hyperbaric group for the extension of the level of block. Time to reach peak block height was significantly lesser in isobaric group ( 4 min ) than in hyperbaric group ( 8 min). Similarly time taken to reach T4 was 7.8 min in hyperbaric group which was significantly longer.

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than in isobaric group ( 2 min ). Lowest segment blocked ranged from L3 –L4 in isobaric group and S1 – S2 in hyperbaric group. Maximum motor block achieved was bromage 1 in 15 patients in isobaric group and bromage 3 in 22 patients in hyperbaric group (p value - <0.0001). Time to reach the maximum motor blockade was significantly longer in isobaric group ( 6.8 min ) than hyperbaric group (2.13 min) [TABLE 2]. The duration of motor block was significantly higher with hyperbaric (220 min) vs 90 min in isobaric whereas the duration of sensory block was significantly higher with the isobaric solution ( 160 min) vs 117 min for hyperbaric with significant inverse correlation (value - P < 0.001) [TABLE 2].

V. Tables

<table>
<thead>
<tr>
<th>TABLE 1- Demographics</th>
<th>Hyperbaric bupivacaine</th>
<th>Isobaric bupivacaine</th>
<th>P value</th>
</tr>
</thead>
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<tr>
<td>age</td>
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<td>45.30</td>
<td>0.724</td>
</tr>
<tr>
<td>Weight</td>
<td>71.83</td>
<td>69.81</td>
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</tr>
<tr>
<td>ASA( 1/2)</td>
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<td>17/13</td>
<td>0.634</td>
</tr>
<tr>
<td>Sex( F/M )</td>
<td>17/13</td>
<td>15/15</td>
<td>0.342</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 2- Block characteristics</th>
<th>Hyperbaric group</th>
<th>Isobaric group</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset of sensory block(min)</td>
<td>2.07</td>
<td>2.13</td>
<td>0.562</td>
</tr>
<tr>
<td>Onset of motor block(min)</td>
<td>2.07</td>
<td>4.00</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Time to T4 (min)</td>
<td>7.80</td>
<td>2.00</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Peak block height( T2/T3/T4)</td>
<td>2/9/19</td>
<td>15/12/3</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Time to peak block height(min)</td>
<td>8.00</td>
<td>4.00</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Max motor block ( B1/B2/B3)</td>
<td>0/8/22</td>
<td>15/9/6</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Time to max motor block(min)</td>
<td>2.13</td>
<td>6.80</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Sensory block duration(min)</td>
<td>117.07</td>
<td>160.10</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Motor block duration (min)</td>
<td>220.47</td>
<td>90.33</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>
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VI. Discussion

Thoracic spinal anaesthesia has been demonstrated to be safer than the lumbar approach. Imbelloni et al [6] showed that at the thoracic level the distance between the dura and spinal cord is more than that at the lumbar level. Lee et al [7] suggested that this margin of safety is further augmented by the sitting position of the patient which increases the posterior separation of the duramater and spinal cord. Thus in our study thoracic CSE was performed in the sitting position and the tenth interspace was chosen as it lies in the center of the surgical field as shown by Zundert et al [8].

The time period of onset of analgesia with the isobaric solution was the same as with the hyperbaric solution. Our results are similar to a study by Imbelloni et al [10] who evaluated thoracic spinal anaesthesia in patients undergoing different laparoscopic surgeries. This can be explained by the lower amount of CSF in the chest region in relation to the lumbar segment as shown by Hogan et al [5]. They also showed that thoracic roots are thinner compared to segments above and below this level [9]. Thus, there is less anaesthetic dilution per segmental unit of distance from the site of injection, and the roots are easily blocked due to their small size, both factors predicting efficient blockade of these segments.

Hyperbaric bupivacaine achieved lower peak block height than isobaric bupivacaine. This can be explained by the fact that we administered the block in the sitting position after which the patient was laid supine. Hyperbaric drug being heavier than CSF tends to settle down in the spinal column under the influence of gravity till the patient is made supine. After the patient lies down, the curvatures of the spinal column affect the drug distribution before the drug finally becomes fixed. In the supine position, lumbar lordosis produces “splitting” of the local anaesthetic solution with some portion flowing caudad toward the sacrum and the remainder flowing cephalad into the thoracic kyphosis. The cephalad extent of the block then depends on what fraction of the injected drug flows cephalad. This explains our observation where a fraction of the hyperbaric drug had already flown caudad under gravity in the sitting position and the rest produced a block in the mid thoracic region after patient was made supine. This sitting position of patient at the time of intrathecal procedure helps to limit the cephalad spread of local anaesthetic. The same phenomenon also explains the longer time taken by the hyperbaric drug to reach the desired T4 level.

On the other hand isobaric drug being of approximately the same density as CSF behaves differently. Because of its minimal gravitation to the dependent regions of the spinal cord in the sitting position there is a greater proportion of the drug available to move cephalad when the patient is made supine. Also as suggested by Fettes et al [11], clinically isobaric drug begins to behave slightly hypobaric when it reaches the CSF and its temperature becomes 37°C within a short period of time. This explains the higher peak block height achieved and a shorter time to reach T4.

The hyperbaric drug was shown to produce a higher grade of motor block and a more caudad extent of the sensory block than isobaric drug. This can again be explained by difference in baricity. In the sitting position hyperbaric drug being heavier than CSF tends to immediately settle to the lower segments of the spinal cord thus blocking the lumbosacral plexus and producing dense motor and sensory block of the lower extremities. On the other hand isobaric drug distribution is minimally affected by gravity so it shows a segmental nature of the block with lesser grade of motor block in the lower extremities and a sensory block ending in the more cephalad segments than hyperbaric bupivacaine.

In our study isobaric bupivacaine gave a longer duration of sensory than motor block whereas hyperbaric bupivacaine gave a longer motor block than sensory. Our results are in direct contradiction to those of Imbelloni et al [12] who found hyperbaric bupivacaine to produce a longer sensory block in orthopaedic surgeries. This should be viewed in light of the end points chosen to determine the duration of block. Regression upto T12 was chosen as the end point for analgesia in our study as opposed to the complete regression of sensory block chosen by them because in upper abdominal surgery patient complains of pain as soon as the level regresses below T12. This means the end of analgesia for the patient even if the segments below T12 may still be anaesthetised. Hyperbaric bupivacaine due to its greater spread to the dependent segments under gravity leaves lesser drug molecules to anaesthetise upper abdominal segments causing them to recover earlier than isobaric bupivacaine. Similarly the motor block ends when the patient gains the ability to ambulate. This is better provided by the segmental block of isobaric drug than the dense lumbosacral block achieved with hyperbaric bupivacaine. Thus isobaric bupivacaine is reflected in a better indication for upper abdominal surgeries.

VII. Conclusion

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Isobaric bupivacaine by providing a longer sensory than motor block is better for use in thoracic combined spinal epidural anaesthesia for laparoscopic cholecystectomies.

References


