PREDICTION OF THE SPREAD OF REPEATED SPINAL ANAESTHESIA WITH BUPIVACAINE

M. TUOMINEN, M. PITKÄNEN, T. TAIVAINEN AND P. H. ROSENBERG

SUMMARY

We have studied in 56 patients the predictability of spread of repeated spinal anaesthesia in the same patient on the basis of a previous block. With plain 0.5% bupivacaine, prediction of the second block was accurate. A significantly higher or lower spread of analgesia than in the previous block was achieved when plain 0.5% bupivacaine was administered using a modified technique—sitting position or lower interspace, respectively. When hyperbaric 0.5% bupivacaine was injected instead of plain solution for the second block using a similar technique, no baricity-related correlation was found between the first and second blocks. Change in technique did not reduce interindividual variation in the spread of analgesia. We conclude that individual anatomical properties may play a more important role than, for example, baricity in subarachnoid distribution of a local anaesthetic solution.

KEY WORDS


Although the spread of a spinal block with plain 0.5% bupivacaine is difficult to predict [1, 2], a repeated block in an individual patient, using exactly the same method, results in a block similar to the first [3, 4]. Some factors, such as position of the patient during injection [5] or warming the anaesthetic solution before injection [6] may affect the level of block. It has been shown also that the spread of the block is reduced when plain 0.5% bupivacaine 3 ml is injected at the L4–5 interspace instead of L2–3 or L3–4 [7, 8].

We have examined the effect of changing the anaesthetic technique and solution used for successive spinal blocks in the same patient.

PATIENTS AND METHODS

After approval by the Ethics Committee, we carried out a prospective study in orthopaedic patients undergoing spinal block with plain 0.5% bupivacaine according to our usual techniques:

(1) Interspace L3–4 is used most frequently with the patient in a lateral horizontal position [9].
(2) Interspace L4–5 is used with the patient in a lateral horizontal position when a low block is required [7, 8].
(3) Injection of local anaesthetic is made at interspace L3–4 with the patient in a sitting position for 2.5 min, if a high block is required [5].
(4) Interspace L2–3 is used rarely [9].

Data were collected for injection technique and spread of analgesia in all patients having spinal block with plain 0.5% bupivacaine. In 56 of these patients (ASA I–II), two blocks were performed for surgery on the lower extremities during the prospective period (table I). Thus these patients served as their own controls. According to the spread of analgesia during the first block, patients were allocated to three groups for the subsequent block as follows:

Group 1 included 17 patients who had a block to T10 or below, during the first spinal anaesthetic. For the second spinal anaesthetic, the injection technique was changed and included interspace L3–4 (one patient L2–3) with the patient in a sitting position during injection and for 2.5 min thereafter, in order to obtain a higher block.

Group 2 included 23 patients who had a block to T9 or higher during the first spinal anaesthetic. For the second spinal anaesthetic the injection technique was changed to interspace L4–5 with the patient in a lateral horizontal position in order to produce a lower block.

Group 3 included 16 patients who received hyperbaric 0.5% bupivacaine instead of plain solution. We have examined the effect of changing the anaesthetic technique and solution used for successive spinal blocks in the same patient.

Table I. Patient characteristics (mean (SD) [range]). For definitions of groups, see text

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>17</td>
<td>23</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>41 [14–68]</td>
<td>51 [17–81]</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>169 (7)</td>
<td>169 (8)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>68 (12)</td>
<td>75 (15)</td>
</tr>
<tr>
<td>Body mass index (kg·m−²)</td>
<td>23.8 (3.1)</td>
<td>25.9 (4.1)</td>
</tr>
<tr>
<td>Interspace used for first block (No. patients)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L2–3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>L3–4</td>
<td>9</td>
<td>21</td>
</tr>
<tr>
<td>L4–5</td>
<td>7</td>
<td>—</td>
</tr>
<tr>
<td>Time between anaesthetics (months)</td>
<td>8 [0–21]</td>
<td>10 [0–33]</td>
</tr>
</tbody>
</table>

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ution for the second spinal anaesthetic, irrespective of the height of the first block. The injection technique (interspace, position of the patient, volume of solution (3 ml) and speed of the injection) was the same as during the first spinal block.

Subarachnoid blocks were performed using 25-, 26- or 27-gauge spinal needles and a standard midline approach. The needle size was unchanged for the second block. All injections of local anaesthetic were made over 15 s. In groups 1 and 2 the same volume (mean 3.1 ml, range 2.8-4.0 ml) of plain 0.5% bupivacaine was used for both blocks. The segmental spread of analgesia was studied by pinprick (27-gauge needle) at 15-min intervals by an anaesthetist who was unaware of the outcome of the first anaesthetic. Analgesia was defined as inability to appreciate sharp pinprick. Assessments made 60 min after the injection of plain bupivacaine were considered to indicate maximal spread of analgesia. If the block was not symmetrical, the higher level of block was recorded.

Body mass index (BMI) (kg m\(^{-2}\)) was calculated from the formula weight/(height)\(^2\). The normal values for Finnish adults are 20.2-24.6 kg m\(^{-2}\) for females and 21.1-25.9 kg m\(^{-2}\) for males [10].

Data were analysed using Student’s t-test. \(P < 0.05\) was considered statistically significant. Results are expressed as mean (SD).

RESULTS

In groups 1 and 2, the difference in maximal cephalad spread of sensory block between the first and second spinal anaesthetic was significant \(\left(P < 0.001\right)\) (fig. 1, table II). In group 1 the mean level of analgesia increased from T11 (range L2-T10) to T7 (range T11-T3) when the technique was changed for the second block. In group 2 the mean level of analgesia decreased from T6 (range T9-T1) to T10 (range L2-T4). In group 3, there was no correlation between the blocks when the first spinal anaesthetic was with plain bupivacaine and the second one was with hyperbaric solution (fig. 1). Eight patients had a higher, three patients a lower and five patients the same spread of analgesia during the repeated block compared with the first. The difference between the first and second blocks was 1.3 (3.7) segments.

Anaesthesia was adequate for surgery of the lower extremities in all patients and there were no complications.

<table>
<thead>
<tr>
<th>Table II. Characteristics of the spinal blocks (mean (SD) [range]). For definitions of groups, see text</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1</strong></td>
</tr>
<tr>
<td>First anaesthetic</td>
</tr>
<tr>
<td>No. segments blocked</td>
</tr>
<tr>
<td>Second anaesthetic</td>
</tr>
<tr>
<td>No. segments blocked</td>
</tr>
<tr>
<td>Difference between first and second anaesthetic</td>
</tr>
<tr>
<td>(No. segments)</td>
</tr>
</tbody>
</table>

DISCUSSION

The results of this study confirm earlier observations that the use of the sitting position of the patient maintained during injection and for a subsequent 2.5 min increased the level of spinal block compared with a lateral horizontal position [5]. In addition, injection at L4-5 interspace instead of L3-4 or L2-3 resulted in a lower level of anaesthesia [7, 8] when plain 0.5% bupivacaine was used.

Interindividual variation in the spread of sensory block was considerable in this study. In all patients, irrespective of technique, the variation in spread of analgesia was 13 segments, ranging from L2 to T1. In group 1 the variation was four segments for the first anaesthetic (segmental level T10 or lower) but eight segments in the second block. In group 2, the variation was eight segments for the first block (segmental level T9 or higher) and 10 segments for the second. Change of the method of injection did not reduce interindividual variability, possibly because BMI was not standardized. Extensive spread of analgesia has been demonstrated in patients with high BMI values in several studies [8, 11, 12]. Some of our patients also had BMI values outside the normal range, and this may also have contributed to the large interindividual variation. The only exception in group 2 was a patient with a relatively
The study was supported by a grant from the Sigrid Juselius Foundation (P.H.R.). Difficulty in identification of lumbar interspaces in such an obese patient may account for the unexpected spread of anaesthesia. Two patients in whom a higher block was not reached in the second anaesthetic had normal BMI values.

It has been shown that, when hyperbaric 0.5% bupivacaine is injected with the patient in the horizontal position, the height of block is increased in comparison with the same dose of plain bupivacaine [13–16]. However, our data do not support these findings. Recent studies by other investigators support our results; there were no differences between spinal blocks with plain and hyperbaric 0.5% bupivacaine when the injections were made with the patients in the lateral or sitting positions [17, 18].

Individual anatomical properties may play a more important role than expected in the subarachnoid spread of local anaesthetic. This view is supported by three findings, namely: spread of a block with plain bupivacaine may be predicted well on basis of a previous block in the same patient; lack of a systematic correlation between the effects of plain and hyperbaric solutions; and great interindividual variation in the spread of block. The anatomical configuration of the spinal cord with individual variations in extent of lumbar lordosis, the variable extent of the spinal cord, the volume of cerebrospinal fluid and other physical properties of the patient, such as obesity, are mainly responsible for the initial distribution of a local anaesthetic within CSF and for the great interindividual variability in extent of block produced by spinal anaesthesia. The extent of block is affected also by the baricity of the solution in relation with the position of the patient [19].

ACKNOWLEDGEMENT

The study was supported by a grant from the Sigrid Juselius Foundation (P.H.R.).

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