SPINAL ANAESTHESIA WITH HYPERBARIC BUPIVACAINE: EFFECTS OF CONCENTRATION AND VOLUME WHEN ADMINISTERED IN THE SITTING POSITION

R. P. ALSTON, D. G. LITTLEWOOD, R. MEEK AND H. H. EDSTRÖM

Although the effects of concentration and volume have been studied after the administration of hyperbaric bupivacaine for spinal anaesthesia in the lateral position, it is not known if the anaesthetic profile is altered by administration in the sitting position [1]. In addition, debate continues as to whether dose or volume is the main factor influencing spread and duration of sensory loss [2,3]. The present study was undertaken to elucidate the effects of intrathecal administration of different volumes of 0.5% and 0.75% bupivacaine in 8% dextrose to patients in the sitting position.

PATIENTS AND METHODS

Fifty-eight patients undergoing transurethral resection of prostate under spinal (subarachnoid) anaesthesia were studied. Three patients underwent herniorrhaphy and one orchidectomy immediately after the resection of prostate. The study was approved by the Ethical Committee of the Royal Infirmary, Edinburgh. Informed consent was obtained from all patients before their inclusion in the study.

Approximately 1 h after premedication with diazepam 10 mg by mouth, an i.v. infusion was established and, with the patient sitting, lumbar puncture was performed with a 22-gauge needle at the L2–3 or L3–4 space using a midline approach. The patients were allocated randomly to receive 3 ml or 4 ml of 0.5% bupivacaine or 2 ml or 3 ml of 0.75% bupivacaine containing 8% dextrose, such that 10 patients received each volume of each concentration. Two millilitre of 0.5% solution and 1.3 ml of 0.75% solution was injected in a further nine patients each. Once a free flow of cerebrospinal fluid was obtained, the study solution was injected at a rate of 0.2 ml s⁻¹ (without barbotage). The solution injected in each patient was known only to the anaesthetist performing the block. The volumes were chosen to allow comparison between groups with different concentrations, but equivalent doses. It was intended that each volume of each concentration should be given to 10 patients but, for the reasons given below, only nine patients received the lowest

SUMMARY

In a double blind study, solutions of 0.5% or 0.75% bupivacaine containing 8% dextrose were compared with regard to the effect of varying concentration and volume when administered intrathecally to patients in the sitting position. Ten patients received 3 or 4 ml of 0.5% bupivacaine or 2 or 3 ml of 0.75% bupivacaine. Nine patients received 0.5% bupivacaine 2 ml and another nine received 0.75% bupivacaine 1.3 ml. The use of the 10-mg dose of both solutions was abandoned after nine patients in each group because of insufficient cephalad spread. With both solutions, the smallest volumes (bupivacaine 10 mg) had significantly shorter durations of action than both the larger ones (15–20/22.5 mg), between which there were no significant differences.
HYPERBARIC BUPIVACAINE TO SITTING PATIENTS

TABLE I. Mean (± SEM) age, weight and height of patients

<table>
<thead>
<tr>
<th>Bupivacaine solution used</th>
<th>n</th>
<th>Age (yr)</th>
<th>Weight (kg)</th>
<th>Height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5%, 2 ml (10 mg)</td>
<td>9</td>
<td>73.4 ± 2.9</td>
<td>72.3 ± 4.0</td>
<td>171 ± 2.2</td>
</tr>
<tr>
<td>0.5%, 3 ml (15 mg)</td>
<td>10</td>
<td>69.9 ± 2.9</td>
<td>72.7 ± 2.7</td>
<td>173 ± 2.1</td>
</tr>
<tr>
<td>0.5%, 4 ml (20 mg)</td>
<td>10</td>
<td>65.5 ± 2.6</td>
<td>74.3 ± 3.4</td>
<td>175 ± 2.3</td>
</tr>
<tr>
<td>0.75%, 1.3 ml (10 mg)</td>
<td>9</td>
<td>66.9 ± 2.3</td>
<td>67.7 ± 1.9</td>
<td>174 ± 3.4</td>
</tr>
<tr>
<td>0.75%, 2 ml (15 mg)</td>
<td>10</td>
<td>74.6 ± 2.5</td>
<td>67.7 ± 4.8</td>
<td>173 ± 1.7</td>
</tr>
<tr>
<td>0.75%, 3 ml (22.5 mg)</td>
<td>10</td>
<td>74.5 ± 5.3</td>
<td>74.5 ± 5.3</td>
<td>174 ± 2.0</td>
</tr>
</tbody>
</table>

The patients were kept sitting for 2 min after injection then placed supine until ready for surgery, when they were placed in the lithotomy position.

The cephalad spread of sensory blockade, the degree of motor blockade of the lower limbs and the arterial pressure and heart rate (Dinamap) were measured during anaesthesia. The levels of sensory blockade were assessed using a blunt needle and were tested along the anterior axillary line on the trunk, the legs and the perineum. Analgesia was defined as loss of sensation of pinprick and anaesthesia as loss of sensation of touch. The degree of motor blockade was assessed on a 0–3 scale (0 = full movement of legs; 1 = inability to raise extended leg; 2 = inability to flex knee; 3 = inability to flex ankle). During the first 30 min of assessment, 500 ml of Hartmann's solution was infused.

If hypotension required treatment, ephedrine or methoxamine was given. Patients were questioned 1–2 days after the operation, about the occurrence of adverse effects and, in particular, about headache.

The results were analysed using Wilcoxon rank tests or Irwin–Fischer exact test, where appropriate. P < 0.05 was considered statistically significant.

RESULTS

There were no statistically significant differences between the mean ages, weights and heights of patients in the six groups (table I).

Sensory loss

Onset time for maximal spread of analgesia was generally short, the mean times varying from 17 to 30 min, with no differences between the groups (table II; figs 1, 2).

Bupivacaine 0.5% produced a statistically significant increase in cephalad spread with increasing volume between 2 ml and 4 ml (P < 0.05) and 3 ml and 4 ml (P < 0.05), but not
between 2 ml and 3 ml. With 0.75% bupivacaine, increasing volume produced a statistically significant increase in cephalad spread between 1.3 ml and 2 ml ($P < 0.05$) and 1.3 ml and 3 ml ($P < 0.01$), but not between 2 ml and 3 ml. No statistically significant differences were found when comparing the 15-mg and 20/22.5-mg doses, but 2 ml of 0.5% bupivacaine produced a significantly ($P < 0.05$) higher cephalad spread than 1.3 ml of 0.75% bupivacaine.

The spread of anaesthesia was on the average two or three segments lower than that of analgesia.

**Motor blockade**

Statistically significant differences in regard to onset times to complete motor blockade were found between 10 mg and 20/22.5 mg; that is, between the smallest and the largest doses. When comparing equal doses, no differences were found between the solutions. Motor blockade degree 1 and 2 was seen in nine of nine and eight of 10 patients given 0.5% bupivacaine and in six of nine and four of nine patients given 0.75% bupivacaine. Complete motor blockade of the lower limbs occurred in eight and 10 patients in the larger dose groups (15 mg and 20/22.5 mg), but only in six of nine and two of nine of the patients given 0.5% bupivacaine 2 ml and 0.75% bupivacaine 1.3 ml, respectively (table III). No differences in the frequency of the degrees of motor blockade were found in the 0.5% bupivacaine groups. In the 0.75% bupivacaine groups, statistically significant differences were found for all degrees (1-3) of motor blockade between 1.3 ml and 2 ml and between 1.3 ml and 3 ml, but not between 2 ml and 3 ml.

**Duration**

With both 0.5% and 0.75% bupivacaine, increasing the dose from 10 mg to 15 mg (but not from 15 mg to 20/22.5 mg) produced a significantly longer total duration of analgesia (figs 1, 2). Mean duration of analgesia in the thoracic segments and total duration of analgesia (that is, until no sensory loss could be detected) are shown in table IV. No significant differences were found when equivalent doses were compared.

With the 0.5% bupivacaine solution, duration of motor blockade tended to increase with increasing dose. Statistically significant differences in duration of complete motor blockade were found between the 2-ml group and both the 3- and 4-ml groups ($P < 0.01$). No differences could be ascribed to the different volumes of 0.75% bupivacaine. When equal doses were compared, no significant differences were found between the solutions.

**Table III. Mean (±SEM) onset time (min) and frequency of complete motor blockade of the lower limb**

<table>
<thead>
<tr>
<th>0.5% Bupivacaine</th>
<th>0.75% Bupivacaine</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 ml</td>
<td>3 ml</td>
</tr>
<tr>
<td>Onset (min)</td>
<td>18.7±2.2</td>
</tr>
<tr>
<td>$P$</td>
<td>$&lt; 0.05$</td>
</tr>
<tr>
<td>Frequency</td>
<td>6/9</td>
</tr>
<tr>
<td>$P$</td>
<td>$&lt; 0.05$</td>
</tr>
</tbody>
</table>
Quality of anaesthesia

Two patients who received 0.75 % bupivacaine 1.3 ml had insufficient analgesia as a result of minimal cephalad spread. One of these required general anaesthesia and, as a result of this, this dose group was omitted from the rest of the study. One patient given 0.75 % bupivacaine 2 ml had sufficient analgesia for transurethral resection of prostate, but not for the subsequent hemiorrhaphy, and required i.v. papaveretum. One patient given 0.75 % bupivacaine 3 ml complained of discomfort on bladder distention and required general anaesthesia, despite analgesia to T8-9.

In the group given 0.5 % bupivacaine 2 ml, two patients had insufficient analgesia and required general anaesthesia. One had an initial block to L4 that spread to L1 by 30 min and T12 by 120 min, which was satisfactory for transurethral resection of prostate, but not for the orchidectomy that followed. The other, despite a block to T8, had lower right abdominal pain which was unrelieved by i.v. papaveretum. This dose group also was omitted for the rest of the study. Two patients who received 0.5 % bupivacaine 3 ml had insufficient analgesia. One, with a block to T7, had good analgesia for 130 min but, because of prolonged surgery, required general anaesthesia at that time. The other only had spread to T11 and required i.v. papaveretum to relieve an aching sensation. All patients given 0.5 % bupivacaine 4 ml had sufficient analgesia for surgery.

Cardiovascular changes

Arterial pressure and heart rate did not differ statistically significantly between the groups before blockade. The systolic and diastolic arterial pressures decreased by 10–20 % on the average in each group, and heart rate, which initially increased by approximately 5 %, then decreased by approximately 10 % after 20 min. No statistically significant differences were found between the groups.

Four patients received ephedrine and seven methoxamine for treatment of hypotension. All but one had spread to T8 or above and were equally distributed among the groups.

Adverse effects

No adverse effects were noted in this study.

DISCUSSION

Increasing the volume of 0.5 % bupivacaine from 2 to 3 ml did not increase the cephalad spread of analgesia, whereas increasing the volume from 3 to 4 ml did. This is the contrary of the results reported by Axelsson and colleagues [4]. It is difficult to explain the differences as the techniques used were similar, but it might, perhaps partly result from borderline statistical significances (in both directions) in both studies.

When hyperbaric 0.5 % bupivacaine is given to patients in the sitting position, there seems to be a certain relationship between the dose and the cephalad spread. This does not seem to occur when the same solution and volumes/doses are used for spinal anaesthesia in patients in the supine position. With 0.5 % bupivacaine, increases of the volume administered (from 2 to 4 ml) had no effect on the cephalad spread of analgesia, whereas with 0.75 % bupivacaine, increasing the volume administered resulted in a statistically greater spread [1]—again opposite to the results of the present study.

Sitting the patient for administration of hyperbaric bupivacaine does change the profile of anaesthetic effect, although it is possible that the lithotomy position also has an influence. Apart
from ease of performance of lumbar puncture and patient comfort during its performance, the main advantage of the sitting position is the possibility of limiting the spread to the mid-thoracic dermatomes, as has been shown in the present study, using 15–20/22.5 mg. On the other hand, doses of 10 mg seem to be disadvantageous in terms of spread and duration of analgesia.

From our results, the use of hyperbaric 0.75 % bupivacaine for spinal anaesthesia appears to confer no advantages over hyperbaric 0.5 % bupivacaine, as has also been shown by Chambers and colleagues [1].

In the present study, when equivalent doses were compared, the only significant difference was found at the 10-mg dose, where 0.5 % bupivacaine 2 ml spread higher than 0.75 % bupivacaine 1.3 ml.

With regard to duration of analgesia, both solutions acted similarly, in that the lowest dose (10 mg) of each concentration was significantly shorter acting than both of the higher doses (15 mg, 20/22.5 mg)—between which no significant differences were found. When equivalent doses were compared, there was no significant difference except at the 10-mg dose when 0.75 % bupivacaine 1.3 ml lasted for a significantly shorter time than 0.5 % bupivacaine 2 ml at L2. Evidently, the posture of the patient, together with the volume and, possibly, concentration of the local anaesthetic, affect the cephalad spread of the spinal blockade when hyperbaric solutions of bupivacaine are used.

REFERENCES


3. Tuominen M, Kalso E, Rosenberg PH. Effects of posture on spread of spinal anaesthesia with isobaric 0.75 % or 0.5 % bupivacaine. British Journal of Anaesthesia 1982; 54: 313–318.