SPINAL ANAESTHESIA WITH 0.5% BUPIVACAINE 3 ML: COMPARISON OF PLAIN AND HYPERBARIC SOLUTIONS ADMINISTERED TO SEATED PATIENTS

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The level of analgesia produced when hyperbaric solutions of 0.5% bupivacaine are injected intrathecally to patients in the lateral position is higher than when plain solutions are used [1,2]. However, if large volumes (4 ml) are injected to patients who are in the sitting position, these differences in effect between hyperbaric and plain solutions appear to be minimized [3]. Since 4 ml of 0.5% bupivacaine is a large volume for routine clinical use, the aim of this study was to determine if 3 ml of this solution could produce a predictable and clinically satisfactory spread of analgesia and if any differences between hyperbaric and plain solutions (not apparent when 4 ml is used) occur with this smaller volume.

PATIENTS AND METHODS

Twenty patients undergoing transurethral resection of prostate under spinal (intrathecal) anaesthesia were studied. The study was approved by the Ethics Committee of Glasgow Royal Infirmary and informed consent was obtained from each patient.

Approximately 1 h after premedication with diazepam 10 mg by mouth, an i.v. infusion was established. Lumbar puncture was performed using a 22-gauge needle and a midline approach at L2-3 or L3-4 with the patient in the sitting position. The patients were randomly allocated to receive either 0.5% bupivacaine 3 ml plain or 3 ml of 0.5% bupivacaine with 8% dextrose. Once a free flow of CSF 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 determined from a random list and was known only to the anaesthetist performing the block. The patients were kept sitting for 2 min after injection and then placed in the supine position until ready for surgery, when they were put in the lithotomy position.

The cephalad spread of sensory blockade, the degree of motor blockade of the lower limbs, the arterial pressure and heart rate were measured during anaesthesia at 5-min intervals for the first 30 min, and then every 30 min for 5 h or until the block wore off, whichever was the sooner. All assessments were made by the author, who was blind to the solution injected. The levels of sensory blockade were assessed using a blunt needle and were tested along the anterior axillary line on the trunk, on the legs and on the perineum. Analgesia was defined as loss of sensation to pinprick and anaesthesia as loss of sensation of

SUMMARY

In a double-blind study, 0.5% bupivacaine 3 ml in plain (n = 10) or hyperbaric (n = 10) solution was injected intrathecally to 20 patients who were in the sitting position, to produce spinal anaesthesia for transurethral resection of prostate. No statistically significant differences were found in time to maximum cephalad spread of analgesia nor in the level reached. However, the plain solution produced a smaller scatter around the mean level than the hyperbaric solution. The duration of analgesia was not significantly different between two groups. There was no difference in the incidence of complete motor block, but a longer duration of lesser degrees of motor block was found with the plain solution (P < 0.05). The plain solution produced a more predictable level of blockade.

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touch. The degree of motor blockade was assessed using a modified Bromage scale [4]: 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, Hartmann's solution 500 ml was infused. If bradycardia or hypotension required treatment based on clinical indications, atropine, ephedrine or both were given i.v., as appropriate. The patients were questioned on the first or second day after surgery, about the occurrence of adverse effects, with particular reference to headaches.

The results are presented as means (SE) and were analysed using the Mann-Whitney test, Wilcoxon's rank sum test or Fischer's exact test, as appropriate. P < 0.05 was considered statistically significant.

RESULTS

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

Sensory loss

The time for maximal spread of analgesia was short in both groups: about 15–20 min (fig. 1). There was no significant difference between the groups in onset time nor in mean maximal cephalad level of analgesia. The plain solution produced a mean spread of analgesia to T5 (0.4) with a range of T3–T7; the hyperbaric solution had a mean spread to T6 (0.8) with a range of T3–T10 (fig. 2).

Over the first 4 h the mean segmental level of analgesia was always slightly higher in the plain than in the hyperbaric group, but at no point was the difference significant (fig. 3). Analgesia lasted 159 (16) min in the thoracic segments in the plain group and 135 (19) min in the hyperbaric group, but this difference was not statistically significant. There were no significant differences in the level of analgesia and anaesthesia between the left and right sides. Anaesthesia was about two to three segments lower than analgesia.

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Age (yr)</th>
<th>Weight (kg)</th>
<th>Height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain 0.5% bupivacaine 3 ml</td>
<td>10</td>
<td>70.3 (2.5)</td>
<td>70.8 (3.5)</td>
<td>170 (1.6)</td>
</tr>
<tr>
<td>0.5% bupivacaine with 8% glucose 3 ml</td>
<td>10</td>
<td>70.7 (2.9)</td>
<td>65.3 (4.1)</td>
<td>168 (1.8)</td>
</tr>
</tbody>
</table>

![Fig. 1. Onset of analgesia after plain 0.5% bupivacaine 3 ml (●—●) or 0.5% bupivacaine with 8% glucose 3 ml (▲—▲). No statistically significant difference between the two solutions.](image)
Plain and Hyperbaric Bupivacaine Compared

Onset time for complete motor block (grade 3) was short, requiring about 8 min in both groups (Table II) and was not significantly different between the groups. Complete motor blockade was obtained in all patients except one in the hyperbaric group. A significantly longer duration of motor blockade was found with the plain solution than the hyperbaric for grades 1 and 2 ($P < 0.05$), but not 3.

Quality of anaesthesia

In the plain group the quality of anaesthesia was not satisfactory in one patient who, despite a block to T6, developed pain on bladder distension and was given papaveretum 10 mg i.v. It was also unsatisfactory in one patient in the hyperbaric group following accidental retroperitoneal insertion of a urethral catheter at the end of surgery. The patient rapidly became profoundly hypotensive, confused, restless and in severe pain; general anaesthesia was administered for an emergency laparotomy. The results from both patients were included in the study.

<table>
<thead>
<tr>
<th>Grade of block</th>
<th>Plain</th>
<th>Hyperbaric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset time (min)</td>
<td>1</td>
<td>5 (0)</td>
</tr>
<tr>
<td>2</td>
<td>5 (0)</td>
<td>5.5 (0.5)</td>
</tr>
<tr>
<td>3</td>
<td>8 (1.5)</td>
<td>7.8 (1.2)</td>
</tr>
<tr>
<td>Frequency (min)</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Duration (min)</td>
<td>1</td>
<td>222 (20)*</td>
</tr>
<tr>
<td>2</td>
<td>207 (20)*</td>
<td>144 (50)</td>
</tr>
<tr>
<td>3</td>
<td>192 (20)</td>
<td>133 (15)</td>
</tr>
</tbody>
</table>

Within the 60 min surgical period, no statistically significant difference in the spread of analgesia was observed between the solutions.

![FIG. 2. Mean maximum cephalad spread of analgesia (SEM ——; range ——). No statistically significant difference between the two solutions.](image)

![FIG. 3. Duration of analgesia after plain 0.5% bupivacaine 3 ml (●—●) or 0.5% bupivacaine with 8% glucose 3 ml (△—△). No statistically significant difference between the groups.](image)
Side effects

There was no statistically significant difference in systolic arterial pressure between the two groups nor in heart rates. No serious side effects were noticed in the postoperative period, although two patients in the hyperbaric group developed a headache which resolved with conservative treatment.

DISCUSSION

When injected intrathecally to patients in the lateral position, it is known that 3 ml of a hyperbaric solution of 0.5% bupivacaine produces significantly higher maximum cephalad spread of analgesia than 3 ml of a plain solution [1]. The present study has demonstrated that, when the same volume is administered to patients who are in the sitting position, there is no significant difference in maximum cephalad spread between hyperbaric and plain solutions in contrast to that noted when 4 ml of 0.5% bupivacaine was used [3].

The administration of 0.5% bupivacaine to patients in the sitting position appears to minimize the difference in cephalad spread of analgesia between hyperbaric and plain solutions which is very apparent and clinically relevant when injections are made to patients who are in the lateral position. This effect of the sitting position can be explained by its action on the spread of both hyperbaric and plain solutions within the intrathecal space. The sitting position would be expected to, and it appears does, restrict upward movement of hyperbaric solutions [5]. As plain solutions are, in fact, slightly hypobaric (specific gravity 1.004 at 20° C and 0.998 at 37° C) compared with cerebrospinal fluid (specific gravity 1.0063–1.0075 at 25° C), the sitting position would result in greater cephalad spread [6].

Ideally, all patients in the present study should have remained supine until the maximum level of analgesia had been reached, as moving to the lithotomy position may influence the movement of the solution within the intrathecal space. For this reason, it was planned to keep all patients supine until completion of the first 30 min of assessment but, to prevent unwarranted delays to the progress of the surgical list, this was not always possible and some patients were placed in the lithotomy position before this time. However, any differences in the spread of analgesia between the two groups that might have resulted should have been nullified by the randomization.

Several investigators [7-9] have commented that plain solutions of bupivacaine injected to patients in the lateral position produce unpredictable levels of analgesia. In the present study, the plain solution resulted in a more predictable block than the hyperbaric. Again, this can possibly be explained by the effect of the sitting position on the spread of both hyperbaric and plain solutions. A hyperbaric solution, when injected to patients who are sitting, will start to "sink" caudally within the intrathecal space. Then, when the patient is placed flat, it will move cranially down the lumbar curve. However, a variable proportion will be "trapped" on the sacral side of the lumbar curve, which will result in a greater unpredictability in the level of analgesia produced. As already described, plain solutions of bupivacaine are slightly hypobaric, so will tend to rise within the intrathecal space. If the patient is in the sitting rather than the horizontal position, the curvatures of the spine will be less liable to impede cephalad movement of the bupivacaine solution and so give a more predictable level of block.

The duration of analgesia was longer with the plain than with the hyperbaric solution, but this was not a significant difference. Axelsson and colleagues [3] did find a significantly longer duration of analgesia with plain 0.5% bupivacaine when using 4 ml than with a hyperbaric solution. If a larger population of patients had been used in the present study, the difference in duration might have become significant but, in the context of transurethral resection of prostate, it would be of little clinical importance as both solutions provided adequate durations of analgesia.

The duration of the motor block produced by the plain solution was longer than that associated with the hyperbaric solution, although this was only statistically significant for grades 1 and 2. This is similar to the results obtained by Axelsson and colleagues [3] and Bengtsson, Edstrom and Lofstrom [10], who found longer durations of motor block (of all degrees) when using the plain solution.

In conclusion, 3 ml of 0.5% bupivacaine, in either a hyperbaric or plain solution, when injected intrathecally to patients in the sitting position for spinal anaesthesia, will produce a clinically satisfactory spread of analgesia. However, a plain solution will produce a more predictable maximum level of analgesia and a longer duration of motor block.
ACKNOWLEDGEMENTS

The author would like to thank Diane E. McCorkindale for typing the manuscript and the Department of Medical Illustration for preparing the figures.

REFERENCES

6. Kalso E, Tuominen M, Rosenberg PH. Effect of posture and some CSF characteristics on spinal anaesthesia with isobaric 0.5% bupivacaine. British Journal of Anaesthesia 1982; 54: 1179-1186.