EFFECTS OF POSTURE AND BARICITY ON SPINAL ANAESTHESIA WITH 0.5% BUPIVACAINE 5 ML

A Double-Blind Study


Bupivacaine 0.5% is being used increasingly for spinal (subarachnoid) anaesthesia; indeed, at the time of writing it is the only agent specifically marketed in the U.K. for this purpose. The plain solution, and the hyperbaric solution containing 8% glucose, have been studied extensively in this context. Chambers, Edström and Scott [1] reported that, in a volume of 3 ml, the use of hyperbaric solutions resulted in a higher spread of block; the use of the plain solution failed to guarantee a block above the lumbar roots.

Many workers have commented on the unpredictability of spread obtained with this agent, especially in the plain formulation [2-4]. Posture has been stated to have some effect on the extent of block with the plain formulation [5] which is, in fact, slightly hypobaric, with a specific gravity of 0.998 at 37°C.

As doses in the range 2-4 ml with the hyperbaric solution seem to have only a minor effect on spread [6], it may be that 5 ml can produce more consistent results without the danger of unduly widespread spinal block.

The present study was undertaken to examine the effect of larger volumes of these agents in spinal anaesthesia, and to determine the effects of posture and baricity at this volume.

PATIENTS AND METHODS

The study was approved by the regional Ethics of Medical Research Committee and the patients gave verbal consent to participate. Forty female patients who were to undergo major elective gynaecological surgery were studied. They were free of major cardiorespiratory disease and were within the age range 25-57 yr.

Premedication was with diamorphine 5 mg and atropine 0.6 mg i.m. within 1.5 h of the induction of anaesthesia. An i.v. cannula was inserted and a slow infusion of balanced electrolyte and glucose solution (Plasmalyte 148, Baxter-Travenol) was commenced. No attempt was made to “pre-load” the patient’s circulation.

Lumbar puncture was performed at the third lumbar space with a 25-gauge spinal needle and the solution was injected at approximately 0.25 ml s⁻¹.

SUMMARY

In four groups of 10 patients, 0.5% bupivacaine 5 ml was used in spinal anaesthesia for gynaecological surgery. Group 1 received plain solution in the sitting position, group 2 plain solution in the lateral position, group 3 hyperbaric solution in the sitting position and group 4 hyperbaric solution in the lateral position. All patients were returned to the horizontal supine position, the sitting subjects 2 min after, and the lateral subjects immediately after, spinal injection. In each group the mean height of block was to the mid-thoracic segments, but there was no significant difference between the groups. There was, however, considerable scatter within each group. Posture had some effect on the speed of onset of the analgesia, but no significant effect on the final outcome. The use of 0.5% bupivacaine as a test dose in extradural blockade is discussed.
Patients were allocated at random to four groups of 10 patients in each: group 1 received 0.5% plain bupivacaine 5 ml in the sitting position maintained for 2 min and then placed supine; group 2 received 0.5% plain bupivacaine 5 ml in the right lateral position and were immediately turned supine; group 3 received 0.5% bupivacaine 5 ml in 8% glucose in the sitting position maintained for 2 min; group 4 received 0.5% bupivacaine 5 ml in 8% glucose in the lateral position and were immediately turned supine.

The degree and extent of block were assessed by an observer who had no knowledge of the solutions or postures used. The following observations were made at 6, 8, 10, 15, 20 and 30 min after injection:

(a) Upper level of analgesia to pinprick.
(b) Motor block in the legs, using a modified Bromage scale (0 = ability to raise extended leg against gravity; 1 = inability to raise extended leg; 2 = inability to flex the knee; 3 = inability to flex the ankle—complete motor block).
(c) Arterial pressure and heart rate (Dinamap 8146 automated oscillometric monitor).
(d) Any untoward reactions were also noted.

On completion of the study period, the patient was prepared for surgery, which was performed under either light general anaesthesia with thiopentone, nitrous oxide and 0.5% halothane or 0.6% enflurane, or deep sedation with i.v. chlormethiazole.

Statistical analysis was performed using the Kruskal–Wallis test (chi-square approximation) and differences between frequencies by the chi-square test, followed by pair-wise comparisons between groups, where applicable.

### RESULTS

Patient data are shown in table 1. All groups were comparable in age, weight and height.

**Sensory block.** The mean (± SEM) interval until the cephalad spread was maximal varied from 18.8 (±2.3) min in group 4 to 22.2 (±2.8 min) in group 1. The mean upper level of block in all groups after 30 min was to the mid-thoracic segments (T4–6). Those groups receiving hyperbaric solution achieved a block one to two segments higher than those receiving plain solution, but these differences were not statistically significant. There was considerable scatter of results within each group (fig. 1). No group exhibited greater consistency than any of the others.

One patient in group 4 had a final upper level of analgesia to T11, but there was some difficulty in determining anatomical dermatomes in this patient, whose umbilicus was very close to the xiphisternum.

**Onset of block** (fig. 2). The sitting position made no significant difference to the ultimate height of block with either the hyperbaric or plain solutions. However, with the plain solutions, the initial onset of the block was significantly faster ($P < 0.01$) in the sitting group. With the hyperbaric groups, the onset was slower in the sitting patients, but this difference was not statistically significant.

**Motor block.** Figure 3 shows the percentage of patients with complete motor block of the lower limbs after 30 min (Bromage grade 3). Thirty-eight patients developed complete motor block of the lower limbs. The two remaining patients were able only to flex the ankles; one received the plain solution, one the hyperbaric solution. The onset time to complete motor block was shorter (ns)

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<th>TABLE I. Details (mean ± SD) of the four groups of patients</th>
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**FIG. 1.** Cephalad spread of sensory block 30 min after sub-arachnoid injection of 0.5% bupivacaine 5 ml at L3–4. $n$ = 10 in each group. $\bigcirc$ = Group 1: plain, sitting. $\bullet$ = Group 2: plain, lateral. $\bigtriangleup$ = Group 3: hyperbaric, sitting. $\blacktriangle$ = Group 4: hyperbaric, lateral.
POSTURE, BUPIVACAINE BARICITY AND SPINAL ANAESTHESIA

FIG. 2. Onset of sensory block to pinprick after subarachnoid injection of 0.5% bupivacaine 5 ml at L3-4. Mean ± SEM. n = 10 in each group. X = Sitting; O = lateral.

with the hyperbaric solution, varying from a mean (± SEM) of 9.5 (±1.3) min in group 4 to 11.6 (±1.4) min in group 2. The mean onset time to grade 1 motor block was 6 min in all groups.

All patients had an adequate block for the proposed surgical procedure. Thirty-two patients underwent lower abdominal surgery and eight underwent vaginal operations. Abdominal relaxation was satisfactory in those patients who underwent lower abdominal surgery although two patients, one each from groups 2 and 4, required a small dose of a neuromuscular blocking drug at the end of surgery to assist peritoneal closure (2 h after the spinal injection).

Those patients undergoing abdominal operations were provided with postoperative pain relief by means of a continuous infusion of bupivacaine delivered through an extradural catheter inserted at the T11–12 space at the end of surgery. For this reason we have no data on the duration of the subarachnoid block in these patients.

Untoward effects. Six patients (two in the plain groups, four in the hyperbaric groups) received ephedrine 10–15 mg i.v. for hypotension (systolic arterial pressure less than 80 mm Hg, or lesser degrees of hypotension accompanied by bradycardia or nausea).

Four patients developed the typical features of "post-spinal headache" in the subsequent few days: three required an autologous extradural blood patch, which was immediately effective in all cases.

FIG. 3. Complete motor block. Percentage of patients unable to flex ankle joint after subarachnoid injection of 0.5% bupivacaine 5 ml at L3-4. n = 10 in each group. Group 1 = plain, sitting; group 2 = plain, lateral; group 3 = hyperbaric, sitting; group 4 = hyperbaric, lateral.

DISCUSSION

McClure, Brown and Wildsmith [7] showed that the range of block obtained with isobaric amethocaine was narrower when the chosen dose of drug was injected in a small volume. However, with plain bupivacaine, no significant improvement in predictability was found with equal doses of the drug given as 0.75% compared with 0.5% solutions [4].

Chambers, Edström and Scott [1], using 3 ml of 0.5% bupivacaine, showed that hyperbaric solutions were more suitable for abdominal surgery,
since the plain solution frequently failed to achieve a sufficient height of block. With 3 ml of plain solution given in the lateral position the mean height of block was T10. In this study, 5 ml of plain solution resulted in a mean height of block to T6, which should be satisfactory for lower abdominal surgery. Such an increase in the height of block was not seen with the hyperbaric solution. In the lateral position, the corresponding height of block was T5 with 3 ml and T4–5 with 5 ml.

Using the larger dose of 5 ml did not increase predictability in an individual patient with either the plain or the hyperbaric solutions as we had hoped. Some patients in both groups had an upper level of block which would be considered barely adequate for lower abdominal surgery (although in the event it was adequate), while others had blocks which were a good deal higher than necessary. However, the high blocks were not accompanied by significant respiratory paralysis or marked hypotension.

The adequacy of muscle relaxation for abdominal surgery in this study contrasts with the observations of Chambers, Edström and Scott [1] that, in six of eight patients who received 3 ml of the plain solution, relaxation was inadequate. The increase in dose to 5 ml thus makes the plain solution more suitable for abdominal surgery.

It is of interest that neither baricity nor position had any statistically significant effect on the spread of bupivacaine in this volume. While Axelsson, Edström and Widman [8] showed a clear dose–response relationship with the plain solution in volumes of 1.5–4 ml, and Axelsson and colleagues [9] found a similar response with the hyperbaric solution in patients, we have shown little or no difference in spread between 2, 3 and 4 ml of the hyperbaric solution [6]. It is possible that, with a volume of 5 ml, the effects of volume per se overtake those of baricity and posture, thus accounting for the observed similarities between the groups.

There now exists some evidence that, if posture is to be used to control the ultimate spread of solutions in spinal anaesthesia, the chosen posture must be maintained for much longer than 2 min [10]. However, in those patients in whom a mid-thoracic block is expected, the maintenance of the sitting posture may be attended by an unacceptable degree of hypotension as blood is pooled in the lower limbs as sympathetic block develops.

We did not determine the duration of spinal blockade in this study, but previous work [6,9] has indicated that increasing the dose of local anaesthetic in spinal anaesthesia increases the duration of blockade. It is reasonable, then, to expect that 5-ml injections will last longer than 4-ml ones.

If L3–4 spinal anaesthesia with 0.5 % bupivacaine is to be used for lower abdominal surgery, plain solution in a 3-ml dose would be unsuitable because of inadequate relaxation of the abdominal muscles, although the same volume of the hyperbaric solution would usually be adequate [1]. From this study, 5 ml of plain solution provides a more adequate sensory block than 3 ml of hyperbaric solution, the block always being to T9 or higher with the former. There was little to choose between injection in the sitting position maintained for 2 min or the lateral position. An inadequate height of sensory block could be associated with the use of plain 0.5 % bupivacaine 4 ml [4]. The choice, therefore, appears to be between 3 ml of hyperbaric bupivacaine and 5 ml of plain bupivacaine. We anticipate that sensory and motor block would last longer with the 5-ml dose. The unpredictability of the height of sensory block might result in excessive cephalad spread with either dose. We should emphasize that all our subjects were gynaecological patients and our results cannot be extrapolated to patients in late pregnancy, when the spread of local anaesthetic solution within the subarachnoid space may be different from that in the non-pregnant state.

The results of the present study are also of interest in regard to the use of test doses in extradural blockade. They show that, even with the large dose of 5 ml, the plain solution of 0.5 % bupivacaine did not produce widespread and obvious spinal block by 6 min; approximately 20 min was required on average to approach maximum cephalad spread. Although some degree of blockade was obvious when the patient was adequately tested, reliance on voluntary movement only would have failed to reveal the subarachnoid injection: 95 % of patients who received plain bupivacone were able to flex the ankle after 6 min, and 50 % after 10 min. Although complete motor block was present early in a greater proportion of patients following hyperbaric bupivacaine, it was not until 20 min after injection that 90 % were unable to flex their ankles—a delay similar to that seen with the plain solution. If test doses are to be accurately interpreted, sensory block should be relied upon
rather than motor block. Demonstrable analgesia is present in the great majority of patients after 5 min, both with plain and with hyperbaric solutions. However, in some patients demonstrable analgesia may also be present following the injection of 5 ml of local anaesthetic into the extradural space, and thus give a false positive test. We have previously advocated the use of a 2-ml dose of hyperbaric solution to test for subarachnoid injection [11]. Such a test dose, if injected into the subarachnoid space should, after 5 min, give clear indication of a relatively extensive sensory blockade, but would not cause blockade of more than one or two segments if injected into the extradural space.

ACKNOWLEDGEMENTS
We thank Kerstin Danielson and Eva Holmqvist, nurse anaesthetists, for their assistance.

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