SPREAD OF SPINAL ANAESTHESIA WITH PLAIN 0.5% BUPIVACAINE: INFLUENCE OF THE VERTEBRAL INTERSPACE USED FOR INJECTION

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Prediction of the final level of a spinal block is poor when plain bupivacaine is used as the local anaesthetic [1-4]. Wide variation in the spread of the block has been observed, even when the same space has been used for the injection of the same volume of local anaesthetic [5,6]. However, spread to a predictable segmental level which avoids haemodynamic complications would be a useful characteristic.

A volume of 2.7 ml of plain 0.75% bupivacaine resulted in a clinically greater extent of analgesia, accompanied at times by arterial hypotension, when injected at L2/3 instead of L3/4 [7]. In controlled studies, a volume of 3 ml of plain 0.5% bupivacaine injected at L3/4 for spinal anaesthesia provided satisfactory conditions for surgery of the lower limb [1,3,6,8-10].

This study was undertaken to determine if injection of the same volume (3 ml) of plain 0.5% bupivacaine at a higher or lower spinal interspace could improve prediction of the level of the subsequent spinal block.

PATIENTS AND METHODS

Following Ethics Committee approval, we studied 40 patients, aged 22-59 yr (ASA I), scheduled to undergo orthopaedic surgery of the lower extremity. The patient data, type of surgery and its duration are shown in table I. Patients aged less than 20 yr or more than 60 yr and those outside the normal range of body mass index (BMI) values for Finnish adults [11] were excluded from the study. All patients received diazepam 0.15 mg kg^{-1} by mouth for premedication. In the operating room, an infusion of Ringer's solution was started and a volume of 6 ml kg^{-1} was administered during the 30 min following the subarachnoid injection.

Spinal anaesthesia was performed with the patient lying in the lateral horizontal position...
using a 25- or 26-gauge spinal needle with plain 0.5% bupivacaine 3 ml at room temperature (sp.gr 1.004). In random order, 50% of the patients received the injection at the L2/3 space and the other 50% were injected at L4/5. The determination of the interspace for the puncture was always made by two anaesthetists. The spines of the vertebrae were counted from both cranial and caudal directions and palpation of the iliac crest was made to confirm the position of the fourth lumbar vertebra. All punctures were made in the mid-line and aspiration of spinal fluid 0.2 ml was made at the beginning and at the end of the injection of bupivacaine which was made over 15 s. Thereafter, the patients were moved to the supine horizontal position. Pinprick analgesia (27-gauge needle) and motor block (Bromage Scale 0–3 [12]) were tested at 5, 15, 30 and 60 min and then at 30-min intervals until the recovery of the L1 spinal segment. The moment when the patient was able to produce a visible contraction in the rectus femoris muscle was taken as the time of recovery from the motor block.

The data were analysed using Student’s t test for comparison between groups and analysis of variance (ANOVA) within groups. For comparison of the standard deviations Bartlett’s χ²-test, d.f. = 1, was used.

RESULTS

Injection at L2/3 produced a significantly higher level of analgesia than injection at L4/5 (P < 0.001 at each testing time) (fig. 1). The interindividual variability of the cephalad spread of analgesia was greater in group L2/3 and there was a significant difference in the standard deviations of the segmental levels between the groups from 5 min to 60 min (P < 0.001 at 60 min).

The maximum block (mean (SD)), T7 (3.9) in group L2/3 and T11 (1.8) in group L4/5 (figs 1, 2) was reached within 60 min. The change in spread of analgesia from 15 to 30 min was statistically significant (P < 0.05) in both groups. Three patients in group L2/3 and 10 patients in group L4/5 had an increase in the cephalad spread at 30–60 min. All the blocks were symmetrical: no patient developed a block that varied by more than one segment between the two sides of the body.

In all patients, anaesthesia satisfactory for surgery of the foot, knee or thigh (two patients) was achieved. Four patients in group L2/3 and seven in group L4/5 received diazepam 2.5–15 mg, midazolam 2.5–7.5 mg or fentanyl 0.05–0.3 mg
for sedation, pain induced by the tourniquet after inflation of the cuff, or both.

In both groups, 18 patients had complete motor block. One patient with injection at L4/5 developed no measurable motor block despite sensory block to T12 (fig. 3).

Mean (SD) time interval from injection of bupivacaine to recovery of the L1 segment was 173 (53) min in group L2/3 and 142 (38) min in group L4/5. Times to the start of motor recovery were 192 (36) min and 169 (39) min, respectively, in the two groups. These differences were not significant.

One patient (female, 30 yr) required ethyl-phenylephrine hydrochloride 1 mg for a decrease in systolic arterial pressure exceeding 30%. Her final block level was T1 after injection of bupivacaine at L2/3. Another patient (female, 36 yr, 25-gauge spinal needle) developed postspinal headache that was treated successfully with an extradural blood patch on the third day after operation. Her block had reached T12 after injection of bupivacaine at L4/5.

**DISCUSSION**

There was less variation in the segmental level of sensory block when 3 ml of plain 0.5% bupivacaine was injected at the L4/5 level than after injection at L2/3. In spite of the lower spread of pinprick analgesia, sufficient anaesthesia was obtained for orthopaedic surgery of the knee and the foot with moderate tourniquet inflation times (mean 83 min in the L4/5 group and 88 min in the L2/3 group). In some instances, the slow onset of anaesthesia delayed the clinical preparation of the patient for surgery, but supplementation with fentanyl, diazepam or both made inflation of the thigh tourniquet tolerable before the extremity was fully anaesthetized.

The cause of the wide variation in spread of block when injection was made at L2/3 is unclear. We assume that anatomical properties of the lumbar region may play an important role in the spread of plain bupivacaine in cerebrospinal fluid. This is supported by our recent study which demonstrated an almost identical spread of analgesia when a spinal block with the same dose and at the same space was repeated in the same patient [13]. Higher spread of block is produced by the sitting posture [8], older age [5, 6] and increased BMI [10, 14] of the patient, in addition to warming of the injected solution [9]. These factors were excluded in the present study, and 40% of blocks injected at the L2/3 level reached T4 or even higher.

Although only one patient needed treatment for hypotension in the present study, the injection of local anaesthetic at L2/3 is known to cause hypotension in relatively young adults also [7].

In this study, two anaesthetists identified the spinal interspace and in no case was there disagreement on the location of the injection site. Using radiography, Moore [15] found that, in 50% of subjects, the spinal needle did not rest in the predicted interspace. Therefore, special care should be taken to identify the correct lumbar space in studies evaluating segmental spread of spinal anaesthesia. As shown in the present study, a difference of two lumbar interspaces for subarachnoid injection significantly affects the spread of sensory block.

Spread of analgesia continued for more than 30 min in both groups after injection. If maximal spread of sensory levels is to be compared between study groups, testing should be continued for at least 60 min after injection of plain bupivacaine [6].

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**REFERENCES**

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


