Spinal anaesthesia with 0.5% hyperbaric bupivacaine in elderly patients: effect of site of injection on spread of analgesia

B. TH. VEERING, P. M. TER RIET, A. G. L. BURM, R. STIENSTRA AND J. W. VAN KLEEF

Summary
In this randomized, observer-blind study, we have examined, in elderly patients, the effect of site of injection on analgesia levels after spinal injection of 0.5% hyperbaric bupivacaine solution. Thirty male patients, aged 68–87 yr, undergoing minor urological surgery during spinal anaesthesia received 3 ml of a 0.5% hyperbaric bupivacaine solution at either the L3–4 (n=15) or L4–5 (n=15) interspace. The solution was injected with the patient in the sitting position. The patient remained sitting for 2 min and was then placed in the supine horizontal position. Analgesia levels were assessed bilaterally using pinprick. The highest analgesia levels did not differ between groups (medians were approximately T7). There were no significant differences in the time to maximum cephalad spread of analgesia, maximum degree of motor block or haemodynamic changes. We conclude that injection at the L4–5 interspace has no advantage compared with injection at the L3–4 interspace. (Br. J. Anaesth. 1996;77:343–346)

Key words
Anaesthetic techniques, subarachnoid. Anaesthetics local, bupivacaine. Age factors.

Clinical studies have shown that the profile of spinal anaesthesia after subarachnoid administration of hyperbaric bupivacaine solutions changes with increasing age. The highest level of analgesia extends approximately 3–4 segments higher in elderly compared with young adult patients. Age and higher levels of analgesia appear to be the main factors associated with the development of hypotension during spinal anaesthesia. The degree of arterial hypotension after subarachnoid administration of local anaesthetics correlates with the level of sympathetic block, which is generally 2–4 spinal segments higher than the level of analgesia. Therefore, it is important to limit the levels of analgesia and the associated levels of sympathetic block. This study was designed to determine and compare the levels of analgesia after injection of a hyperbaric bupivacaine solution at the L3–4 or L4–5 interspaces.

Patients and methods
We studied 30 male patients, ASA I–III, aged 68–87 yr, undergoing minor urological surgery under spinal anaesthesia. The study was approved by the Medical Ethics Committee of the University Hospital Leiden and verbal consent was obtained from all patients. Patients with diabetes, a history of neurological disease or coagulopathy were excluded. Patients were allocated randomly to receive 0.5% hyperbaric bupivacaine solution at either the L3–4 (group 1, n=15) or L4–5 (group 2, n=15) lumbar interspace. A randomization table was made before the start of the study and codes were stored in sealed envelopes, which were opened shortly before the extradural procedure.

Patients were premedicated with temazepam 10 mg orally and atropine 0.25 mg i.m., 45 min before induction of spinal anaesthesia. Before spinal injection, 500 ml of glucose in saline were administered by rapid i.v. infusion. The appropriate lumbar interspace was determined independently by two anaesthetists. The spines of the vertebrae were counted from both the cranial and caudal directions and the iliac crest was palpated to confirm the position of the fourth lumbar vertebra. Dural puncture was performed with the patient in the sitting position by a standard midline approach using a 25-gauge Quincke spinal needle via an 18-gauge introducer. When a free flow of clear cerebrospinal fluid was obtained and after aspiration of 0.2 ml of spinal fluid, 0.5% bupivacaine HCl 3 ml in 8% glucose (Marcaine heavy, Astra, Södertälje, specific gravity 1.026 at 20°C) was injected at room temperature at a rate of 0.2 ml s⁻¹. Patients were kept sitting for 2 min after completion of the subarachnoid injection and were then placed in the supine horizontal position.

Analgesia was assessed bilaterally in the anterior axillary line by pinprick using a short bevelled 25-gauge needle. Assessments were made every 5 min during the first 30 min after injection and at 45 and 60 min thereafter. Analgesia was defined as inability to detect a sharp pinprick. When maximum cephalad spread of analgesia was produced, motor block of the lower limbs was assessed bilaterally using a modified Bromage classification by asking the patient to raise the extended leg, flex the knee and flex the ankle, and was rated per joint (0=no, 1=partial, 2=complete motor block). The results obtained on both extremities were added, giving a maximum score of 12 (complete motor block). The following
variables were recorded: time to maximum cephalad spread of analgesia; highest level of analgesia; and degree of motor block. The study was observer-blind, that is the investigator assessing the level of analgesia and intensity of motor block was unaware of the site of injection.

Systemic arterial pressure, measured with an automatic cycling device (Accutor 1, Datascype, Helsinki, Finland) and heart rate (from the electrocardiogram) were monitored before injection, during induction, during surgery and in the recovery room at the following times: at 5-min intervals during the first 0.5 h and then at 15-min intervals until the patient was returned to the ward. If systolic arterial pressure decreased more than 30% below the preanaesthetic value or to less than 90 mm Hg, ephedrine 5 mg was given i.v. Bradycardia (heart rate < 55 beat min⁻¹) was treated with atropine 0.25 mg i.v.

Group sizes were based on power analysis, which showed that with the variance in the highest level of analgesia observed in patients older than 65 yr in a previous study, 15 patients would be required per group to achieve an 80% probability of detecting a difference of two segments between the groups at the 0.05 level of significance. Data are presented as mean (sd), median (95% confidence intervals (CI)) or frequencies, as appropriate. Medians and confidence limits were corrected for the presence of tied observations. Patient characteristics were analysed using the two-tailed, two-sample t test. Neural block characteristics were analysed with the two-tailed Mann–Whitney U test. Fisher’s exact test was used for comparison of proportions. Haemodynamic data were examined using a repeated measurements analysis of variance design. Maximum changes in systolic arterial pressures (SAP) and heart rate (HR) were compared between groups using the two-tailed Mann–Whitney U test. P<0.05 was considered statistically significant.

Results

The groups were comparable in age, height and weight (table 1). Block characteristics are summarized in table 2 and were comparable between the groups. In all patients symmetrical analgesia levels were obtained. The median highest level of analgesia was T7.0 (CI T4.6–T9.0) in group 1 and T7.2 (T5.7–T8.0) in group 2 (fig. 1). Median times to reach the highest level of analgesia in individual patients after injection at the L3–4 interspace were 15 (12–23) min in group 1 and 16 (10–19) min in group 2. The same presumably holds for levels of sympathetic block that are associated with analgesia levels, but are generally 2–4 segments higher. Consequently, the highest levels of sympathetic block are often in the upper thoracic region in elderly patients, which may explain the higher group 2 required ephedrine for treatment of hypotension. No patient developed post-spinal headache.

Discussion

Several studies have shown that analgesia levels obtained after subarachnoid injection of a hyperbaric local anaesthetic solution are approximately 3–4 spinal segments higher in elderly compared with young adults patients. The same presumably holds for levels of sympathetic block that are associated with analgesia levels, but are generally 2–4 segments higher. Consequently, the highest levels of sympathetic block are often in the upper thoracic region in elderly patients, which may explain the higher

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Neuronal block characteristics (median (95% CI) or number of patients (%)). Group 1 = injection at the L3–4 interspace; group 2 = injection at the L4–5 interspace. No significant differences between groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analgesia</td>
<td></td>
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<tr>
<td>Highest level</td>
<td>Group 1 (n=15)</td>
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<tr>
<td>Time to maximal cephalad spread (min)</td>
<td>15 (12–23)</td>
</tr>
</tbody>
</table>

| Motor block |                                                                                                       |
| Patients with complete block | 15 (100) | 14 (93) |

Figure 1 Highest levels of analgesia in individual patients after injection of 0.5% hyperbaric bupivacaine 3 ml at the L3–4 or L4–5 interspace. Horizontal lines = medians (corrected for ties).
frequency of cardiovascular side effects in elderly compared with young adult patients\textsuperscript{45}. Factors that contribute to the more extensive block in the elderly include gradual degeneration of the central and peripheral nervous system\textsuperscript{7},\textsuperscript{8}, changes in the anatomical configuration of the lumbar and thoracic spine\textsuperscript{9}, and possibly a reduction in the volume of the cerebrospinal fluid\textsuperscript{10}.

The main objective of this study was to determine if injection of a hyperbaric bupivacaine solution at a lower (L4–5) than usual (L3–4) lumbar interspace reduced cephalad spread of local anaesthetic solution and thereby limited the highest analgesia levels. The study was based on earlier observations which showed that a hyperbaric local anaesthetic solution produced bimodal spread when the patient was turned supine and remained on a horizontal plane after midlumbar (L3–4) subarachnoid injection. In this situation the solution is under the influence of gravity and migrates preferentially to the low levels of the subarachnoid space, that is below L3 in the lumbo sacral concavity or above L3 in the thoracic concavity\textsuperscript{11}. If, however, the epicentre of the injection lies at L4–5 in the declining portion of the lumbar lordosis, a greater portion of the solution may spread in a caudad direction. The study was encouraged by recent observations of Hirabayashi and colleagues\textsuperscript{12} who examined the anatomical configuration of the spinal column in supine volunteers using magnetic resonance imaging (MRI). They demonstrated that the median highest point was not located at L3, as is commonly believed, but at L4 (range L3–4 to L4), explaining partly why a uniform dose of hyperbaric anaesthetic solution shows variable levels of analgesia when injected via either the L3–4 or L4–5 interspace. It should be emphasized, however, that Hirabayashi and colleagues studied younger patients (aged 16–63 yr). In elderly patients, such as in this study, the highest point may have migrated because of degenerative processes.

As it is well known that lumbar interspaces may be easily misidentified\textsuperscript{13}, identification in this study was made independently by two anaesthetists who counted the spines of the vertebrae from both the cranial and caudal directions and palpated the iliac crest to confirm the position of the fourth lumbar vertebra. Despite these precautions it is possible that misidentification occurred in some patients. More definite identification of the correct interspaces would have required x-ray marking. However, we abstained from such procedures for ethical reasons. Moreover, such identification techniques may invalidate the results for prospective use in routine clinical practice, where these techniques are not used.

The results of this study confirm that there is considerable spread in the highest levels of analgesia when a hyperbaric solution is administered to elderly patients. Furthermore, the results are in keeping with those of two earlier studies from our institute on the influence of age on the quality of neural block after subarachnoid administration of hyperbaric bupivacaine at the L3–4 interspace\textsuperscript{14}. Median highest levels of analgesia in elderly patients (>65 yr) in those studies were approximately T9 and T7, respectively. The results of this study were, however, disappointing in that injection at the L4–5 interspace did not result in lower analgesia levels compared with injection at the L3–4 interspace, and haemodynamic changes did not differ between groups. The lack of effect of the site of injection on analgesia levels is consistent with the findings of Sundnes and colleagues\textsuperscript{15}, the only investigators who have reported on the effect of site of injection on analgesia levels attained with hyperbaric bupivacaine, and they observed no correlation between the site of injection (L2–3 or L3–4) and the highest level of analgesia. However, their study was designed primarily to study the effects of volume of injected solution and patients were not allocated randomly to the puncture site.

The effects of varying sites of injection have not been studied as extensively with hyperbaric as with plain bupivacaine solutions. However, with plain solutions there are discrepancies between studies that have examined the influence of different injection sites on analgesic spread\textsuperscript{15–18}. There was no significant difference in maximal level of sensory block when plain bupivacaine solutions were injected in elderly patients at different levels, with patients in the sitting position during injection and until 2 min thereafter, when patients were turned supine\textsuperscript{15,16}. In contrast, when solutions were injected with the patient in the lateral horizontal position and then turned immediately supine after injection, highest analgesia levels were 4 segments higher when the injection was at the L2–3 interspace compared with the L3–4 or L4–5 interspace\textsuperscript{17,18}. Although comparisons between studies may be confounded by differences in the temperature of the injected solutions (room temperature vs body temperature), which affects baricity (at room temperature 0.5% plain bupivacaine is usually slightly hyperbaric, at body temperature usually slightly hypobaric, depending on the density of the CSF, which may vary between patients), these observations suggest that the effect of the site of injection is dependent on the positioning of the patient, at least with plain bupivacaine solutions.

References


