Interaction between baricity (glucose concentration) and other factors influencing intrathecal drug spread

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Summary

The effects of intrathecal injection of 0.5% bupivacaine in solutions containing various concentrations of glucose have been studied in four groups of 20 patients. When solutions containing 0.8% glucose were injected at the L3–4 interspace the median maximum extent of block was higher, and the range of blocks wider, with the 8% solution. All patients receiving 0.8% glucose had blocks between the T5 and T10 dermatomes, confirming previous work on the benefits of this concentration of glucose. In the two other groups 0.5% bupivacaine containing 0 or 0.8% glucose was injected at the L2–3 interspace. In both groups of patients a wider range of blocks, with a median maximum extent that was higher, was produced. These results demonstrate how glucose concentration may be used to influence the spread of intrathecal solutions and how other factors can obscure the effect of glucose concentration. (Br. J. Anaesth. 1994; 73: 744-746)

Key words

Anaesthetic techniques, subarachnoid. Anaesthetics local, bupivacaine. Physics, baricity.

The spread of local anaesthetic solution through the CSF after intrathecal injection is influenced by many factors [1]. Several of these are patient variables that are outside the control of the anaesthetist. However, those factors that relate to the properties of the injectate and the technique of injection may be the subject of deliberate attempts to influence spread. Perhaps the factor most frequently manipulated is the baricity of the solution, and previous work [2] has suggested that injection of a solution with a baricity only slightly in excess of the CSF may have advantages. Solutions containing 0.8% glucose produced relatively consistent blocks with an extent that was suitable for much of the surgery performed under spinal anaesthesia when injected at the L3–4 interspace. Predictability of block to the umbilicus was increased and the risk of extensive spread decreased. However, this work was performed in only a small number of patients and used a very carefully defined anaesthetic technique. The present study was designed to allow the predictability of solutions containing low concentrations of glucose to be tested in larger numbers of patients and in situations where other aspects of the anaesthetic technique were varied in a controlled fashion.

Patients and methods

Eighty patients (table 1) gave informed consent for the study which was approved by the local Ethics Committee. Fifty percent of patients were undergoing elective urological procedures (cystoscopy, bladder neck incision or transurethral resection of the prostate) and the other 50% elective replacement of the hip or knee joint. All patients were premedicated with oral temazepam approximately 1 h before anaesthesia; urological patients received 10 mg and orthopaedic patients 20 mg. On arrival in the anaesthetic room, arterial pressure (sphygmonanometry) and heart rate (ECG) were measured and a suitable vein cannulated. The orthopaedic patients received 250 ml of normal saline, but the urological patients did not receive fluid.

Lumbar puncture was performed with a 26-gauge Quincke needle and 3 ml of local anaesthetic solution was injected. In the urology patients the L3–4 interspace was used with the patient seated, and the solution was injected over 10 s. The patient was then laid supine for 15 min before being placed in the lithotomy position for surgery. In the orthopaedic patients the L2–3 interspace was used with the patient in the left lateral position and the solution was injected over 15 s before the patient was placed supine. No sedation was administered during the study.

Each group of 40 patients was allocated randomly to receive one of two local anaesthetic solutions (groups A and B in urology; groups C and D in orthopaedics). Group A received the commercial preparation of 0.5% bupivacaine in 8% glucose (baricity 1.0203 at 23 °C). Groups B and C received freshly prepared 0.5% bupivacaine with 0.8% glucose (1 ml of commercial hyperbaric bupivacaine mixed thoroughly with 9 ml of plain bupivacaine: baricity 1.0045 at 23 °C). Group D received 0.5% plain bupivacaine (baricity 1.004 at 23 °C).

The developing block was observed by an investigator who was unaware of which solution had been injected. The extent of sensory block (analgesia to pinprick with a 27-gauge short level dental
Baricity and spread of local anaesthetic

Table 1  Patient characteristics, details of anaesthetic technique and results of block in the urological (groups A and B) and orthopaedic (groups C and D) patients receiving spinal anaesthesia (mean (sd or range) or median (range))

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
<th>Group D</th>
</tr>
</thead>
<tbody>
<tr>
<td>No./sex (M/F)</td>
<td>19M</td>
<td>20M</td>
<td>6M/14F</td>
<td>4M/16F</td>
</tr>
<tr>
<td>Age range (yr)</td>
<td>72 (56-85)</td>
<td>74 (54-82)</td>
<td>66 (47-76)</td>
<td>67 (51-81)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>170 (6)</td>
<td>171 (7)</td>
<td>163 (9)</td>
<td>164 (9)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>76 (12)</td>
<td>74 (10)</td>
<td>64 (13)</td>
<td>69 (13)</td>
</tr>
<tr>
<td>% Glucose</td>
<td>8</td>
<td>0.8</td>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td>Injection level</td>
<td>L3-4</td>
<td>L3-4</td>
<td>L2-3</td>
<td>L2-3</td>
</tr>
<tr>
<td>Duration (s)</td>
<td>10</td>
<td>10</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Time T10 (min)</td>
<td>6.7 (3.4)</td>
<td>9.1 (4.2)</td>
<td>2.3 (1.2)</td>
<td>2.9 (1.8)</td>
</tr>
<tr>
<td>Max. level (Median)</td>
<td>T5.5</td>
<td>T7.5</td>
<td>T3.5</td>
<td>T3.0</td>
</tr>
<tr>
<td>(Range)</td>
<td>T2-T9</td>
<td>T5-T9</td>
<td>C7-T8</td>
<td>C5-T7</td>
</tr>
<tr>
<td>Max. motor block</td>
<td>2.5 (0.7)</td>
<td>2.8 (0.6)</td>
<td>3.0 (0.0)</td>
<td>2.9 (0.4)</td>
</tr>
</tbody>
</table>

Results

The urology patients were significantly older ($P < 0.05$), taller ($P < 0.001$) and heavier ($P < 0.05$) than the orthopaedic patients (table 1). However, there were no statistically significant differences between subgroups A and B or C and D in age, height or weight. One patient in group A developed a poor quality block, required a general anaesthetic for the surgery and was excluded from analysis. In the other 79 patients the block provided good operating conditions without supplementation.

Onset of block was rapid in all four groups and mean block height was maximal at 20 min after injection. However, the mean time to block the T10 dermatome was shorter in the orthopaedic than in the urological patients (table 1). In the urological groups the mean time to block the T10 dermatome was shorter (6.7 min) in patients who received 8% glucose than in those who received 0.8% glucose (9.1 min), but this difference was not statistically significant ($P < 0.1$).

The blocks that developed in the two orthopaedic subgroups were almost indistinguishable, but were more extensive and more variable in maximum extent than in the urological patients (table 1). At all times after 2 min the mean block in the urological patients who received 8% glucose was more extensive than in those who received 0.8% glucose, although this difference was only statistically significant at 10 and 15 min after injection. The range of blocks seen after 0.8% glucose was less than that seen after 8% glucose (3 vs 8 dermatomes) (table 1).

Motor block was adequate for surgery in all patients, but the mean degree of block that developed in patients in group A (urology: 8% glucose) was less than that in the three other groups (table 1). The difference between group A and groups C and D (orthopaedics) was statistically significant, but not that between group A and group B (urology: 0.8% glucose). The power of the study to distinguish a difference of 2 dermatomes was 87% for group A vs group B, and 89% for group B vs group C.

There was a modest reduction in mean arterial pressure after establishment of block in all four groups, but there were no statistically significant differences in arterial pressure or heart rate between the groups.

Discussion

The aim of this study was to compare the behaviour of 0.5% bupivacaine in 0.8% glucose after intrathecal injection with other preparations of the same local anaesthetic, but in clinical situations slightly different from those in which it was evaluated previously. Thus the baricity of the "control" preparation, and factors such as the level and rate of injection, and the posture of the patients, were left to the discretion of the anaesthetists normally involved with the patients, although these factors were standardized in each subgroup.

Our results confirm the findings of Bannister, McClure and Wildsmith [2], but in a different clinical setting (urological as opposed to varicose vein surgery) and in older patients, that the injection of 0.5% bupivacaine in 0.8% glucose at the L3-4 interspace produced a relatively narrow range of predictable blocks in patients placed supine after injection (group B). The results also confirm that relatively minor differences in technique, patient characteristics, or both, may obscure this effect. Although patients in group C received the same solution, they had different characteristics and an injection technique that differed in several respects, but particularly in the level of needle insertion. However, patient characteristics are not considered to have a major influence on intrathecal drug spread [3] and others have shown that higher levels of injection result in more variable and more extensive spread [4, 5].

We conclude that local anaesthetic solutions containing low concentrations of glucose, sufficient to make the solution only marginally hyperbaric in comparison with CSF, have potential advantages when injected in the L3-4 interspace. Block to the
level of the umbilicus is assured so that the predictability of spinal anaesthesia is increased, but the upper thoracic dermatomes are unaffected so that the risk of block of the cardioaccelerator nerves is decreased. The other factors that influence intrathecal drug spread can obscure this effect, but the approach is worthy of wider use and investigation.

References


5. Taivainen T, Tuominen M, Rosenberg PH. Influence of obesity on the spread of spinal analgesia after injection of plain 0.5% bupivacaine at the L3–4 or L4–5 interspace. *British Journal of Anaesthesia* 1990; 64: 542–546.