SPINAL ANALGESIA WITH HYPERBARIC BUPIVACAINE: EFFECTS OF VOLUME OF SOLUTION

K. O. SUNDNES, P. VAAGENES, P. SKRETTING, B. LIND AND H. H. EDSTRÖM

SUMMARY
The effects of 0.5% bupivacaine 1.5, 2 and 3 ml in 8% glucose were compared in a double-blind study involving 30 patients undergoing spinal analgesia. The time to the onset of maximum segmental spread of analgesia was approximately 15 min for all three volumes. Cephalad spread of analgesia was related to the volume used: 1.5 ml reached T10, 2 ml T8 and 3 ml T7. The duration of analgesia increased with increasing volume, 3 ml producing analgesia in T8-T12 for 1.5-2 h, and in the lumbar region for 2.5-3 h. Increasing the volume increased the extent of motor blockade and speeded up its onset. Significant decreases in arterial pressure were observed in the 2- and 3-ml groups. The changes in heart rate were moderate and not correlated with the amount of drug. Spinal headache occurred in two patients.

Previous studies (Hengesbach and Matthes, 1977; Nolte et al., 1977) have described the use of bupivacaine solution without glucose in the production of spinal analgesia. However, since the addition of glucose alters the anaesthetic profile of intrathecal solutions (Brown et al., 1980; Chambers, Edström and Scott, 1981), this study was undertaken to compare the efficacy of three different volumes of 0.5% bupivacaine in 8% glucose administered for spinal analgesia during urological operations.

PATIENTS AND METHODS
Twenty-nine men and one woman undergoing urological surgery with spinal analgesia were randomly allocated to receive 0.5% bupivacaine 1.5, 2 or 3 ml in 8% glucose. Information about the study was given to each patient and consent obtained according to the Helsinki declaration.

Premedication (diazepam according to age and weight) was given by mouth 45-60 min before the induction of anaesthesia. Immediately before the institution of the spinal blockade, 200-300 ml of lactated Ringer’s solution was infused i.v. Lumbar puncture was performed with a 22-gauge spinal needle using a midline approach with the patient in the lateral recumbent position. The second or third lumbar interspace was chosen for the puncture and, when a free flow of clear cerebrospinal fluid was obtained, the local anaesthetic solution was injected at the rate of 0.2-0.25 ml s⁻¹ without barbotage. Immediately after the injection the patient was positioned in the supine horizontal position, and 15-20 min thereafter in the lithotomy position.

The cephalad spread of analgesia (loss of sensation to pinprick) was determined with a short-bevelled needle every 2 min for 30 min after the induction of the block.

Motor block was assessed according to the following scale by recording the degree of motor function of the lower extremities following each determination of analgesia (Bromage, 1965): 0 = no paralysis (full flexion of knees and feet); 1 = inability to raise the extended leg (just able to move knees); 2 = inability to flex knees (able to move feet only); 3 = inability to flex the ankle joint (unable to move feet or knees).

Thereafter analgesia and motor block were assessed every 15 min until analgesia had totally disappeared or for a maximum of 5 h after injection.

Heart rate and arterial pressure (sphygmomanometry) were recorded before and 2, 5, 10, 15, 20 and 30 min after the injection and thereafter every 30 min until normal sensation had returned (maximum 3 h after injection).

The patients were observed for 48 h for possible signs of post-spinal complications.

The differences between means were analysed with Student’s t test and differences between frequencies by the Fischer exact test.
TABLE I  Summary of the clinical data for the three groups, mean values between block and start of operation (inj.–op.) and duration of surgical procedure (mean±SEM)

<table>
<thead>
<tr>
<th>Volume</th>
<th>Age (yr)</th>
<th>Weight (kg)</th>
<th>Height (cm)</th>
<th>Interval inj.–op. (min)</th>
<th>Duration of op. (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 ml</td>
<td>68.9±1.63</td>
<td>68.6±2.99</td>
<td>174±1.87</td>
<td>31.8±4.35</td>
<td>36.4±3.72</td>
</tr>
<tr>
<td>(n=10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0 ml</td>
<td>68.2±1.84</td>
<td>76.8±2.68</td>
<td>174±2.55</td>
<td>35.1±5.92</td>
<td>30.3±7.68</td>
</tr>
<tr>
<td>(n=10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.0 ml</td>
<td>68.1±2.07</td>
<td>76.7±1.37</td>
<td>177±2.78</td>
<td>28.5±3.26</td>
<td>46.1±5.35</td>
</tr>
<tr>
<td>(n=10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RESULTS

There were no statistical differences between the three groups in relation to characteristics of the patients or the duration of the operations (table I).

Sensory spread

Maximum spread of analgesia appeared 11–20 min after injection, and the onset was similar for each volume (fig. 1; table II). The spread to the S3–S5 dermatomes was rapid (within 2 min in 18 patients and within 4 min in 27 patients) regardless of the volume used. In two patients, both in the 1.5-ml group, caudal spread was unsatisfactory.

In one patient analgesia at the L5 dermatome was delayed for 22 min, while the L4 and S1 dermatomes were blocked within 4–5 min.

The mean maximum spread of analgesia tended to increase with increasing volume, from T10 with 1.5 ml to T7 with 3 ml, the differences between 1.5 and 2 ml and between 1.5 and 3 ml being significant (P<0.05) (fig. 1).

Fig. 1. Segmental spread of analgesia for different volumes (ml) of bupivacaine (mean±SEM). P-values show differences between the groups at different time intervals.
VOLUME EFFECT OF SPINAL BUPIVACAINE

Table II. Maximum upper segmental level of analgesia and time to attain this for each volume (dependant side). Mean±SEM

<table>
<thead>
<tr>
<th>Volume</th>
<th>Thoracic level</th>
<th>Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5ml (n=10)</td>
<td>10.1±0.48</td>
<td>11.8±6.48</td>
</tr>
<tr>
<td>2.0ml (n=10)</td>
<td>8.3±0.70</td>
<td>14.4±1.63</td>
</tr>
<tr>
<td>3.0ml (n=10)</td>
<td>7.6±1.08</td>
<td>15.7±2.31</td>
</tr>
</tbody>
</table>

There was no correlation between the site of injection, the maximum cephalad spread of analgesia and the time to reach this level.

In 13 patients analgesia reached a higher maximum upper level on the dependant compared with the non-dependant side. The difference was usually only one, occasionally two segments (except in patient No. 9: five segments), and this feature was distributed equally among the groups, although it was more pronounced in the 1.5-ml group (fig. 2). In 15 patients there was no difference between the two sides and in two patients the highest level was reached on the non-dependant side.

Motor blockade

The time of onset for different degrees of motor blockade did not differ significantly between the three volumes. Six patients in the 3-ml group, four patients in the 2-ml and one in the 1.5-ml group, had complete motor blockade (degree 3) of both lower extremities (table III). The difference in frequency between 1.5 ml and 3 ml was significant (P<0.05).

Table III. Frequency of total motor blockade and time for complete recovery (mean±SEM) for each volume (dependant side)

<table>
<thead>
<tr>
<th>Volume</th>
<th>Duration (min)</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>84.6±9.18</td>
<td>3</td>
</tr>
<tr>
<td>2.0</td>
<td>128.0±9.92</td>
<td>6</td>
</tr>
<tr>
<td>3.0</td>
<td>162.0±19.00</td>
<td>8</td>
</tr>
</tbody>
</table>

Duration

Figure 1 shows that the duration of analgesia at different segmental levels increased with increasing volume of the local anaesthetic solution. Significant differences in duration at different levels were found between the smaller volume (1.5 ml) and the larger volumes (2 and 3 ml). No significant difference was found between 2 ml and 3 ml, nor was there any significant difference in the duration of analgesia on the dependant and non-dependant sides.

In 20 of 25 patients the S5 dermatome was the last dermatome in which normal sensation was restored. In six patients (five in the 3 ml and one in the 2-ml group) analgesia lasted for longer than the period of assessment (5 h) in both the S3 and the S5 dermatomes. In six patients (2 ml: four, 3 ml: one, 1.5 ml: one) regression was faster in the L5–S1 dermatomes on the non-dependant side and this is illustrated in one patient in figure 3. In one patient this occurred exclusively on the dependant side and, in another, more rapid regression was observed in the L5–S1 dermatomes bilaterally.

The duration of motor blockade of different degrees increased with increasing volume. In the 3-ml group complete paralysis of both lower extremities occurred in six of 10 patients with a mean duration of 127±50 min.

After the return of normal sensation residual motor blockade did not occur. Significant differences in duration were found between 1.5 ml and 2 ml, and between 1.5 ml and 3 ml.

Adequacy of analgesia

For transurethral resection 2–3 ml of the solution was required to produce adequate analgesia. Systemic analgesics were needed in three patients and additional sedation in two.
Arterial pressure and heart rate

Arterial pressure did not differ significantly between the groups before blockade. After injection arterial pressure decreased from $131 \pm 5$ mmHg to $119 \pm 5$ mmHg ($P<0.1$), from $128 \pm 5$ mmHg to $107 \pm 3$ mmHg ($P<0.0025$), and from $131 \pm 6$ mmHg to $107 \pm 5$ mmHg ($P<0.005$) in the 1.5-, 2- and 3-ml groups respectively. Eight patients (four in the 3-ml group, three in the 2-ml group, and one in the 1.5-ml group) received ephedrine after institution of the blockade because of a decrease in arterial pressure to $100$ mmHg or less. Atropine was administered to one patient because of a concomitant decrease in heart rate and arterial pressure. All of those patients who required ephedrine or atropine had a cephalad spread of analgesia up to, or above, T9.

Changes in heart rate varied from $+10.6\%$ to $-8.8\%$. Twelve patients (equally distributed among the groups) had an initial and persistent decrease in heart rate, while in seven patients an initial increase was rapidly followed by a persistent decrease.

Complications

Post-spinal headache was encountered in two patients ($6.8\%$) and two patients complained of backache at the site of injection. Another two patients complained of headache which was not attributed to the spinal anaesthesia.
It was apparent that increasing the dosage from 2 to 3 ml did not increase spread and duration to the same extent as the increase from 1.5 to 2 ml (up to 2.5–3 h).

There were no differences in the spread of analgesia between injections made at the L2/3 or the L3/4 levels. However, the number of patients was small and the choice of puncture site was not randomized.

Contrary to previous reports on regression of analgesia (Nolte and Stark, 1979) we found a more persistent effect in the lowest dermatomes (S2/S5). This may be of practical value in surgical procedures of the urethra and the anal regions.

Failure to achieve satisfactory analgesia at the L5 and S1 dermatomes has been associated with extradural blockade (Knoche, Traub and Dick, 1979). We observed the same problem in nine patients although, to our knowledge, this has not been reported with spinal analgesia. The complication can be explained by postulating a common site of action for both central neural blocks, but the underlying mechanism is not clear.

Motor blockade was satisfactory for transurethral resection in all groups. However, the frequency of complete blockade was low, even in the 3-ml group (six of 10). This must be considered when this method is used and full muscular relaxation is desired. The changes in arterial pressure and heart rate were considered to be moderate although eight patients received ephedrine. A decrease in arterial pressure was often related to a concomitant slowing of the heart rate. This has been observed with intrathoracic intercostal nerve blockade and may be related to a secondary sympatholytic effect on the heart (Skretting, 1981).

With a 22-gauge needle post-spinal headache was observed in only 6.8% of patients. This low frequency is probably related to the relatively high mean age of our patients. In other reports of younger patient groups a frequency of post-spinal headache of up to 20% has been registered although needles of finer bore have been used (Chambers, Edstrom and Scott, 1981).

ANESTHESIE RACHIDienne A L'AIDE DE BUPIVACAINE HYPERBARE EFFETS DU VOLUME DE LA SOLUTION

RESUME

Nous avons comparé au cours d'une étude à double insu les effets de la bupivacaïne à 0.5%, administrée à raison de 1,5 2 et 3 ml dans 8% de glucose, cela mettant en cause 30 patients devant subir une anesthésie rachidienne. Le temps nécessaire au départ de la propagation segmentaire maximale de l'anesthésie a été d'environ 15 min pour les trois volumes. La propagation de l'anesthésie en direction de la tête a été liée au volume utilisé: 1,5 ml a atteint T10, 2 ml T8 et 3 ml T7. La durée de l'analgésie a augmenté en fonction de l'augmentation du volume, 3 ml produisant une analgésie dans la région

REFERENCES

T8–T12 pendant 1,5–2 h et dans la région lombaire pendant 2,5–3 h. L’accroissement du volume a entrainé une augmentation du blocage moteur et accéléré son déclenchement. Nous avons observé dans les groupes 2 ml et 3 ml des diminutions importantes de la pression artérielle. Les variations dans la fréquence cardiaque ont été modérées et n’ont pas subi d’influence liée à la quantité d’agent anesthésiant. Deux patients se sont plaints de céphalée spinale.

LUMBAL ANALGESIE MIT HYPERBAREM BUPIVACAIN: AUSWIRKUNGEN DES LÖSUNGSVOLUMENS

ZUSAMMENFASSUNG


BRITISH JOURNAL OF ANAESTHESIA

ANALGESIA DE LA ESPINA DORSAL MEDIANTE BUPIVACAÍNA HIPERBARICA: EFECTOS DE LA SOLUCION EN FUNCIÓN DEL VOLUMEN

SUMARIO

Se compararon los efectos de 1,5, 2 y 3 ml de bupivacaina al 5%, en glucosa al 8%, en un estudio de doble anonimato efectuado en 30 pacientes sometidos a analgesia de la espina dorsal. El tiempo transcurrido hasta el comienzo de la máxima dispersión segmental fue de aproximadamente 15 minutos para los tres volúmenes. La dispersión cefálica de la analgesia estuvo en función del volumen usado: 1,5 ml alcanzaron T10, 2 ml alcanzaron T8 y 3 ml alcanzaron T7. La duración de la analgesia aumentó al aumentar el volumen, produciendo el volumen de 3 ml una analgesia de T8–T12 por espacio de 1,5 a 2 horas, y en la región lumbar por espacio de 2,5 a 3 horas. El incremento del volumen incrementó el alcance del bloqueo motor y aceleró su comienzo. Se observaron disminuciones significativas en la presión arterial en los grupos de 2 y de 3 ml. Los cambios del ritmo cardíaco fueron moderados y sin correlación con la cantidad de droga. Dos de los pacientes sufrieron dolores en la espina dorsal.