INFLUENCE OF OBESITY ON SPINAL ANALGESIA WITH ISOBARIC 0.5% BUPIVACAINE

W. J. D. McCulloch and D. G. Littlewood

In recent years the factors influencing height of blockade in association with spinal anaesthesia have been studied extensively. The influence of the position of the patient during injection, the speed of injection, the spinal space, the dose of drug, the specific gravity of the solution, the volume of fluid injected, and the posture of patient after injection have all been investigated (Brown et al., 1980; McClure, Brown and Wildsmith, 1982; Kalso, Tuominen and Rosenberg, 1982). However, even if these are standardized there is still a wide variation in the level of blockade achieved.

The object of this study was to determine if obesity influenced the height of blockade following spinal anaesthesia with plain 0.5% bupivacaine 4 ml—a dose which has been found to be adequate in clinical practice.

PATIENTS AND METHODS

Fifty patients aged between 51 and 89 yr consented to take part in the study. All were ASA grade 1 or 2 and required cystoscopic procedures, transurethral resection of the prostate or removal of bladder tumours. Patients were premedicated with diazepam 10 mg by mouth 60–90 min before the induction of spinal anaesthesia. In the anaesthetic room an i.v. infusion of Hartmann’s solution was administered slowly, but no attempt was made to preload the patient. Baseline values of heart rate and arterial pressure were recorded with the patient in the supine position, and the ECG was monitored continuously. Subarachnoid puncture was performed at the L3–4 space using a 22-gauge needle (Yale) with the patient in the sitting position. After a small volume of cerebrospinal fluid had been withdrawn to verify the placement of the needle, plain 0.5% bupivacaine 4 ml was injected over 10 s. After injection the patient was placed supine for 5 min and, thereafter, in the lithotomy position. At 2, 5, 10, 15, 20 and 30 min after the injection, arterial pressure and heart rate were recorded and the segmental level of sensory analgesia was evaluated using a short-bevelled needle. Analgesia was defined as loss of sensation to pinprick. All anaesthetics and observations were performed by the authors.

RESULTS

The mean age of the patients was 68.1 yr (range 51–89 yr), their mean weight was 72.5 kg (45–122 kg) and their mean height was 1.72 m (range 1.57–1.93 m). Operating conditions were satisfactory in all cases and the average spread of blockade was to T7 (16 segments). The maximum level of analgesia was plotted against the patient's age (fig. 1), height in metres (fig. 2), weight in kg (fig. 3), weight/height (fig. 4) and weight/height² (fig. 5).

Spearman Rank correlation coefficients were calculated to show the interrelationships between the variables listed and the level of analgesia (table I).


SUMMARY

In an unblinded study 50 patients undergoing cystoscopic procedures received a spinal anaesthetic of plain 0.5% bupivacaine 4 ml administered in the sitting position at the L3–4 space. There was a correlation between the height of blockade assessed by pinprick analgesia and the degree of obesity of the patients measured by weight, weight/height, and weight/height². Using this dose of spinal anaesthetic agent, high blockade may be anticipated in obese patients.
FIG. 1. Relationship between level of analgesia and patient age.

FIG. 2. Relationship between level of analgesia and patient height.

FIG. 3. Relationship between level of analgesia and patient weight.

FIG. 4. Relationship between level of analgesia and patient weight/height.
FIG. 5. Relationship between level of analgesia and patient body mass index (weight/height$^2$) (all patients).

TABLE I. Correlation between the five variables and the extent of sensory block

<table>
<thead>
<tr>
<th></th>
<th>Spearman Rank Coefficient</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-0.32</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Height</td>
<td>-0.10</td>
<td>ns</td>
</tr>
<tr>
<td>Weight</td>
<td>0.51</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Weight/height</td>
<td>0.61</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Weight/height$^2$</td>
<td>0.60</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Multiple regression analysis of the height of sensory blockade on age, height, weight and weight/height$^2$ showed that age did not affect the level of blockade significantly for a given weight or weight/height$^2$; that is the univariate correlation is explained by the older people being thinner. Regression analysis also showed that height had a significant ($P < 0.01$) negative effect on the level of blockade for a given weight; that is taller patients of a given weight tended to have less extensive blocks than shorter patients. Finally, height did not affect significantly the level of blockade for a given weight/height$^2$.

DISCUSSION

The main finding of this study was that there was a positive correlation between the height of blockade and obesity, whether measured by weight, weight/height or weight/height$^2$, after spinal anaesthesia with plain 0.5% bupivacaine 4 ml injected at L3–4. The injections were made with the patients in the sitting position and the assessments were made with the patients either supine or in the lithotomy position. It is possible that the sitting position may have resulted in more extensive blockade than injections in the lateral position (Tuominen, Kalso and Rosenberg, 1982).

It was not possible to perform this study in a double-blind manner because the patient's degree of obesity could not be concealed from the assessor, although the results of calculations based on height and weight were not known until after the study had been completed. Greater objectivity would have been achieved had a trained individual, who was unaware of the nature of the study, performed the assessments of the level of blockade. This was not possible, however, and this must be regarded as very much a preliminary report. Nevertheless, we believe that the results are of interest.

In this study the Body Mass Index (BMI) which is weight/height$^2$ was chosen initially because it has been shown to correlate well with body density measurement (Keys et al., 1972)—the most accurate (Benke, Feen and Welham, 1942), but also the most difficult way of estimating the proportion of fat in the body. In fact, when we used weight/height the correlation was as good as weight/height$^2$ and significantly better than the correlation with weight alone. This is not surprising as Keys and colleagues (1972) showed that the correlation between body density and...
weight/height was not significantly different from that between body density and weight/height.

It might be expected that skinfold thickness would correlate well with obesity, and this has been shown by several workers (Pascale et al., 1956; Durnin and Womersley, 1974). However, since Keys and colleagues (1972) showed that the correlation between body density and the sum of skinfold thicknesses was not significantly different from the correlation between body density and either weight/height or weight/height, skinfold thickness was not used in this study.

In this study the correlation between the height of blockade and the age of the patient was -0.32. This differs from the study of 33 patients by Cameron and co-workers (1981) which demonstrated a correlation (r = 0.5) between the extent of blockade and age; however, the level of analgesia was poorly predictable. In a more recent study of 124 patients in whom 0.5% isobaric bupivacaine was used, Pitkanen and associates (1984) found a poorer correlation (r = 0.227) between age and height. In our study the weights of the oldest patients were less than expected (Geigy Scientific Tables). Neither Cameron and co-workers (1981) nor Pitkanen and associates (1984) comment on their patients' weights, but if their elderly patients were heavier this could explain the difference in results between the series.

Greene (1981) has suggested that there might be an association between a patient's height and the extent of spinal anaesthesia, but our study failed to show any correlation between these two factors (r = -0.10).

We can only speculate why there should be a correlation between obesity and the extent of spinal analgesia. Robinson (1949) showed that if the inferior vena cava was occluded blood flow increased through the lumbar vertebral plexus. The vena cava may be more compressed in the obese patient as a result of the increased weight of the abdominal contents and if the extradural veins become distended the volume of cerebrospinal fluid may be reduced. This in turn could increase the spread of spinal anaesthetic solutions. Evidence to support this theory comes from Barclay, Renegar and Nelson (1968) who showed that, during myelography with a radiopaque material, abdominal compression increased dispersion of the radiopaque material. They also showed that increasing intra-abdominal pressure with an abdominal binder increased the spread of analgesia following the intrathecal administration of amethocaine.

An alternative theory is that obese patients may have an increased volume of fat in the extradural space which is responsible for a reduction in the volume of cerebrospinal fluid.

Evidence to support this theory would be provided by repeating this study in two groups of patients, both with high BMI, one group with a high fat content and, therefore, a low body density and one with a high proportion of muscle and a high body density. If an increased amount of extradural fat is responsible for the high blockade, then the fat group would be expected to have more extensive blocks than the muscular group. If it is caused by IVC compression alone, as a result of the increased weight of abdominal contents, then a difference between the two groups is less likely. It would also be interesting to examine the influence of obesity when hyperbaric solutions are used, and whether posture is important.

In conclusion, this study suggests that obesity may well be yet another factor influencing the height of blockade in spinal anaesthesia, and in all patients who appear obese a high block should be anticipated so that problems of hypotension and occasional respiratory embarrassment can be treated speedily.

REFERENCES


Keys, A., Fidanza, F., Karvonen, M. J., Kimura, N., and


Tuominen, M., Kalso, E., and Rosenberg, P. H. (1982). Effects of posture on the spread of spinal anaesthesia with isobaric 0.75% or 0.5% bupivacaine. Br. J. Anaesth., 54, 313.