SUBARACHNOID ANAESTHESIA WITH 0.75% BUPIVACAINE IN PATIENTS WITH CHRONIC RENAL FAILURE

R. ORKO, M. PITKÄNEN AND P. H. ROSENBERG

Regional anaesthesia may be an alternative to general anaesthesia in patients with chronic renal failure (CRF) (Weir and Chung, 1984). For example, subarachnoid amethocaine 14–20 mg has been used for renal transplantation without major complications (Linke and Merin, 1976). However, our experience suggests that the duration of subarachnoid anaesthesia is shorter in patients with CRF than in normal patients, and this has been demonstrated for brachial plexus blockade also (Bromage and Gertel, 1972). We have carried out a controlled study to determine whether there were any statistically significant differences between subarachnoid blockade with 0.75% bupivacaine plain in patients with or without CRF. The duration of the blockade with this agent (22.5 mg) demonstrated in non-uraemic patients (Pitkänen, Tuominen and Rosenberg, 1985) was considered adequate for appropriate surgery (graft nephrectomy) in patients with CRF or for the introduction of a catheter for peritoneal dialysis.

PATIENTS AND METHODS

Twenty consecutive patients with chronic renal failure (CRF) and 20 control patients were studied (table I). Fifteen of the CRF patients underwent haemodialysis on the day before surgery at least 16 h before the operation; four were undergoing continuous peritoneal dialysis and one did not require dialysis. The design of the study was approved by the Ethics Committee of the hospital, and all patients gave their informed consent. The site of surgery was in the lower abdomen (L1–T9) (table I).

SUMMARY

Twenty consecutive patients with chronic renal failure (CRF) and 20 control patients received subarachnoid anaesthesia with 3 ml of 0.75% bupivacaine plain for surgery in the lower abdomen. Sensory analgesia (onset) developed significantly more rapidly in the CRF patients: maximum segmental level of pin-prick analgesia was reached in an average of 21 min in the CRF patients and in 35 min in the control patients. An observed tendency to acidosis and a possible reduced intrathecal space in the uraemic patients may account for the more rapid blockade. The mean spread of the sensory block in CRF patients (T4) was two segments higher than that in the control patients, but because of marked inter-individual variation this difference cannot be considered clinically important. Three CRF patients and two control patients had insufficient analgesia for surgery. In the CRF patients, both sensory and motor blockades were of shorter duration than in the control patients. The incidence of complaints of nausea and backache was similar in the groups. One control patient had a headache.

All patients were premedicated with diazepam 5–20 mg by mouth 1–2 h before the induction of subarachnoid blockade. Five millilitre of blood was drawn from a cubital vein before blockade for analysis of acid–base status and the concentrations of potassium, sodium, creatinine and protein. An i.v. infusion of 0.9% saline was commenced and 200 ml was given before the subarachnoid injection and then 4 ml kg⁻¹ was infused over the first 20 min of blockade. Additional i.v. fluids were given, as required.

The lumbar puncture was performed in the
TABLE I. Patient characteristics: age, height and weight (means ± SEM), medication and type of surgery

<table>
<thead>
<tr>
<th></th>
<th>CRF group</th>
<th>Control group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (F/M)</td>
<td>7/13</td>
<td>3/17</td>
<td></td>
</tr>
<tr>
<td>Age (yr)</td>
<td>40±3.2</td>
<td>51±2.7</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>169±2.0</td>
<td>173±1.9</td>
<td>ns</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>65±3.1</td>
<td>75±2.7</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Antihypertensive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>medication (No. patients)</td>
<td>7</td>
<td>0</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Type of surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graft nephrectomy</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insertion of catheter</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>for peritoneal dialysis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inguinal hernia</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

midline through the L3–4 space using a 25-gauge needle while the patient was in the sitting position. One millilitre of cerebrospinal fluid (CSF) was aspirated for the analysis of protein concentration and in the last five patients in both groups also, for the determination of pH and the concentrations of potassium and sodium. Bupivacaine 0.75% 3 ml was injected over 15 s and finally CSF 0.2 ml was aspirated and reinjected. All patients remained sitting for 2 min, after which they were placed in the supine horizontal position, in which they remained throughout surgery. Pin-prick analgesia (using a short-bevel 27-gauge needle) and motor blockade (Bromage's score 0–3 (Bromage, 1965)) were tested 5 and 10 min after the subarachnoid injection and, thereafter, at 10-min intervals for up to 1 h. Testing was continued at 30-min intervals until sensation had returned in the two most cranial of the blocked segments. Testing was continued by trained nurses, who assessed the recovery of the S1 segment, and of motor function, at 1-h intervals.

Arterial pressure (sphygmomanometer) and ECG were monitored in the operating theatre and the recovery room. All patients were interviewed on the first day after operation.

Statistical evaluation was performed using Student's t test, Fisher's exact test and linear regression analysis. P < 0.05 was taken as the level of statistical significance.

RESULTS

Blood and CSF were more acid in the patients with CRF than in the control patients, but only in the

**TABLE II. Blood and CSF laboratory analysis (means ± SEM)**

<table>
<thead>
<tr>
<th></th>
<th>CRF group</th>
<th>Control group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemoglobin (g dl⁻¹)</td>
<td>7.9±0.45</td>
<td>14.9±0.34</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Haematocrit</td>
<td>0.24±0.02</td>
<td>0.42±0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>pH</td>
<td>7.35±0.01</td>
<td>7.39±0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Serum creatinine (μmol litre⁻¹)</td>
<td>908±62.4</td>
<td>66±4.5</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Serum protein (g litre⁻¹)</td>
<td>60±2.9</td>
<td>71±2.2</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Plasma potassium (mmol litre⁻¹)</td>
<td>4.9±1.8</td>
<td>4.0±0.08</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Plasma sodium (mmol litre⁻¹)</td>
<td>137±1.1</td>
<td>142±0.89</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>CSF protein (g litre⁻¹)</td>
<td>0.55±0.08</td>
<td>0.41±0.03</td>
<td>ns</td>
</tr>
<tr>
<td>CSF pH</td>
<td>7.32±0.02</td>
<td>7.35±0.01</td>
<td>ns</td>
</tr>
<tr>
<td>CSF potassium (mmol litre⁻¹)</td>
<td>2.8±0.05</td>
<td>2.6±0.03</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>CSF sodium (mmol litre⁻¹)</td>
<td>140±1.7</td>
<td>142±0.5</td>
<td>ns</td>
</tr>
</tbody>
</table>

**RESULTS**

Blood and CSF were more acid in the patients with CRF than in the control patients, but only in the pH of blood was there a significant difference (P < 0.01) (table II).

Analgesia for surgery was satisfactory in 17/20 of the patients with CRF and in 18/20 of the control patients. The three patients with insufficient analgesia in the CRF group had a pin-prick analgesia level at T3, T7 and T8, and those of the control group at T6 and T11, respectively. However, they had painful sensations during surgery even before the level of pin-prick analgesia had begun to recede, and the operation had to be completed under general anaesthesia. The observations in these patients are included in the calculations of mean values. In addition, three patients in the CRF group and four in the control group required fentanyl or a benzodiazepine i.v. for pain or discomfort during surgery.

There were some statistically significant differences in the properties of the subarachnoid blockade between the patient groups (table III, fig. 1), the most noticeable being the speed of the spread of sensory analgesia, and the time to regression of analgesia by a magnitude of two segments. The maximum mean extent of sensory analgesia was T4 (range C8–T8) in the CRF patients and T6 (range T2–T12) in the control patients (P < 0.01). The time of latency of maximum motor blockade was similar in both groups, while the mean recovery of the motor blockade was significantly more rapid in the CRF patients: 4.6 h v. 6.1 h (P < 0.01). In the uraemic patients, there was no correlation between the
serum creatinine concentration, or the time from the onset of uraemia, or the time from initiating the haemodialysis programme and the spread of sensory analgesia.

The mean decrease in systolic arterial pressure during the first 1 h of anaesthesia was 38 mm Hg (range 10-100 mm Hg) in the CRF group and 33 mm Hg (range 0-85 mm Hg) in the control group (ns). Six CRF and three control patients required sympathomimetic or anticholinergic medication, or both, for hypotension (ns).

When the patients were interviewed on the day after surgery, the most common complaint was nausea, in four of the CRF patients and in seven of the control patients (ns). Backache occurred in two of the CRF and in two of the control patients.

Difficulties with micturition were reported by three of the control patients. Headache, beginning late on the first day after operation, developed in one of the control patients (male, 58 yr). The treatment was conservative and the headache disappeared in 2 days.

**DISCUSSION**

Although there were some statistically significant differences in the subarachnoid blockade between the two groups of patients, the ranges of the observations overlapped to a considerable extent. Thus the difference in the mean maximum spread of analgesia between the groups may have little clinical significance. The poor predictability of the spread of spinal blockade with plain bupivacaine (Nolte et al., 1977; Kalso, Tuominen and Rosenberg, 1982; Pitkänen et al., 1984) was corroborated in the present study. With similar manoeuvres and 0.75% bupivacaine plain in subarachnoid anaesthesia in non-uraemic patients, the mean upper segmental levels of analgesia of T4 (Tuominen, Kalso and Rosenberg, 1982) and T6 (Bengtsson, Edström and Lofström, 1983) have been reported, but with large interindividual variations in relatively small study groups. There was a difference in the mean age between the groups in our study, the control patients being 11 years older, on average. However, an age difference of this magnitude has only a small, if any, effect on the spread of the spinal blockade with plain bupivacaine (Pitkänen et al., 1984).

One difference between the groups which may be of clinical significance was the time of the maximum spread of analgesia (onset). The slightly greater generalized acidity of CRF patients may be partly responsible for a more rapid onset of blockade, as a result of the greater degree of ionization of the local anaesthetic at lower pH (Covino and Vassallo, 1976). In patients with normal renal function, however, the pH of CSF did not correlate with the spread of spinal blockade with bupivacaine plain (Kalso, Tuominen and Rosenberg, 1982). A high potassium concentration, often coexistent with acidosis, would decrease the latency and intensify local anaesthetic blockade (Bromage and Burfoot, 1966), but the difference in potassium concentration between the two groups (4.9 v. 4.0 mmol litre⁻¹) may have been too small to affect the blockade.

Manifestations of uraemic neuropathy, including demyelination of neurones (Nielsen, 1971;
Raskin and Fishmann, 1976), could also explain the rapid onset of sensory analgesia in CRF patients. The similarity in the onset time of analgesia in brachial plexus blockade (Bromage and Gertel, 1972) and of motor blockade (myelinated fibres) in subarachnoid anaesthesia in patients with or without CRF seems to refute this hypothesis. Further, there was no correlation between the extension of sensory blockade and the severity of the uraemic symptoms. A third possible explanation for the rapid spread of the blockade in uraemic patients could be related to the reduced lumbar intrathecal space resulting from distension of extradural and spinal veins accommodating a hyperdynamic circulation (low haematocrit, high cardiac index) (Mostert et al., 1970).

The hyperdynamic circulation may be the main reason for the fast elimination, that is washout, of the local anaesthetic from the site of action in the CRF patients (Bromage and Gertel, 1972). Despite some overlap in the times of recovery from subarachnoid blockade, the shorter mean duration of both motor and sensory blockade in CRF patients has clinical relevance. The shorter duration of the blockade seems to exclude the routine use of a subarachnoid blockade with 0.75% bupivacaine 3 ml for renal transplantation which, in our hospital, usually lasts for more than 2 h. Another constraint on the routine use of subarachnoid anaesthesia with 0.75% bupivacaine plain for surgery of the lower abdomen emerged because supplementary general anaesthesia was required in five patients, in four of whom the level of analgesia (as assessed by pin-prick) was well above the site of the surgical procedure.

No correlations between measured laboratory variables and duration or extent of the blockade could be established. Bupivacaine is 88–96% bound to plasma proteins (Cousins and Bridenbaugh, 1980). Proteins in CSF reflect those in serum, but the concentration in CSF is only about one-hundredth that in serum, suggesting that small concentration differences should not influence the spread of subarachnoid blockade. Indeed, the spread of analgesia with plain bupivacaine does not correlate with CSF protein concentrations in non-uraemic patients (Kalso, Tuominen and Rosenberg, 1982).

Seven of our 20 CRF patients had severe hypertension and were receiving antihypertensive medication. A similar decrease in systolic arterial pressure occurred in both study groups, but more of the CRF patients were given sympathomimetic or anticholinergic medication for hypotension (6/20 v. 3/20) at the induction of anaesthesia.

Subarachnoid anaesthesia in CRF patients could theoretically produce an extradural haematoma. CRF patients do have a tendency to bleed, which is attributed mainly to a qualitative defect of platelets. However, if the patient is on an adequate dialysis programme, the primary platelet dysfunction is reversed (Encke, Breddin and Fassbinder, 1984; Weir and Chung, 1984). The CRF patients in this study were all in our transplantation programme and were, as a result, carefully assessed and managed. The risk of extradural haematoma was considered to be small when a 25-gauge needle was used.

Complications after surgery were minor: the incidence of postdural puncture headache (1/40, that is 2.5%) is similar to that in previous studies when a 25-gauge spinal needle was used (Scott and Thornburn, 1975; Pitkänen et al., 1984).

ACKNOWLEDGEMENTS

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