POSTOPERATIVE ANALGESIA AFTER PAEDIATRIC ORCHIDOEPLY: EVALUATION OF A BUPIVACAINE-MORPHINE MIXTURE†

A. R. WOLF, D. HUGHES, A. WADE, S. J. MATHER AND C. PRYS-ROBERTS

SUMMARY
The value of combining morphine with bupivacaine for caudal analgesia was investigated. Thirty children, undergoing orchidopexy, received a caudal block of 0.125% bupivacaine with or without morphine 0.05 mg kg\(^{-1}\). Analgesia, side-effects, ventilatory frequency and oxygen saturation (Sa\(_{O_2}\)) were recorded after operation. None of the 15 patients receiving the bupivacaine-morphine mixture required postoperative opioids, whereas eight of 15 patients receiving bupivacaine alone needed additional opioid analgesia. The incidence of side effects after surgery was similar for the two groups and there was no detectable difference in ventilatory frequency or Sa\(_{O_2}\).

KEY WORDS

Caudal injections of bupivacaine are used routinely to provide analgesia after lower abdominal and urogenital surgery in children [1, 2]. However, the analgesic effects of the caudal block often terminate early in the postoperative period and supplementary i.m. injections of opioids are required [3]. Recent studies [4–7] have reported the use of caudal morphine in children for postoperative analgesia with doses varying from 0.03 to 0.1 mg kg\(^{-1}\). The greater doses provided longer-lasting analgesia than bupivacaine, but side-effects (nausea, vomiting, urinary retention and pruritus) were common and a case of ventilatory depression in a 2-yr-old child after a 0.1-mg kg\(^{-1}\) injection of caudal morphine has been reported [8]. Smaller doses have few side-effects, but are short-acting and unreliable. We therefore compared the analgesic efficacy and side-effects of a combination of bupivacaine and morphine with bupivacaine alone.

PATIENTS AND METHODS
After approval from the Hospital Ethics Committee and informed parental consent, we studied 30 children, aged 9 months to 11 yr, undergoing elective orchidopexy. The children were otherwise healthy (ASA status I or II), fasted and unpremedicated. EMLA cream was applied to both hands at least 90 min before surgery; anaesthesia was induced with thiopentone and atracurium and maintained with nitrous oxide, oxygen and enflurane given by face mask. After induction of anaesthesia and before surgery, patients were placed in the left lateral position and a 20-gauge needle inserted into the caudal space through the sacrococcygeal ligament using an aseptic technique. If no blood or CSF was aspirated, a 0.75-ml kg\(^{-1}\) caudal injection of either 0.125% bupivacaine or 0.125% bupivacaine with morphine 0.05 mg kg\(^{-1}\) was given by random allocation, in each case the composition being


*Address for correspondence: Sir Humphry Davy Department of Anaesthesia, University of Bristol, Bristol Royal Infirmary, Bristol BS2 8HW.

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known only to one person who was then excluded from further contact with the patient.

After surgery, the patients were transferred to a recovery area and observed for 1 h before returning to the general ward. The time from induction of anaesthesia to the end of surgery, and the time from the end of surgery to spontaneous opening of the eyes were noted. The quality of analgesia was assessed hourly for the first 6 h and then every 3 h for 20 h, by trained observers who remained unaware of the treatment given. The assessments were based on an observational scoring system modified from Hannallah and colleagues [9], using five criteria: crying, movement, agitation, posture and localization of pain. Each criterion scored 0–2 to give a summed score of 0–10. A total score less than 4 was taken as an indication of adequate analgesia, based on previous experience with this technique [3]. Nalbuphine 0.3 mg kg$^{-1}$ i.m. or oral paracetamol 15 mg kg$^{-1}$ was given by the observers as they felt appropriate. Postoperative recordings included the times of administration of nalbuphine and paracetamol, the time to first micturition after surgery and the incidence of side effects such as nausea, vomiting and pruritis. Patients were discharged home the following morning, provided they had passed urine and were fully mobile without pain.

The nursing staff recorded ventilatory frequency every 30 min for the first 6 h after operation and then hourly for a further 6 h. In addition, ventilatory frequency and oxygen saturation were recorded using a Hewlett-Packard ECG/impedance pneumography unit and a Novo-

### Table 1. Patient data and duration of anaesthesia and surgery (median and ranges)

<table>
<thead>
<tr>
<th></th>
<th>Bupivacaine alone</th>
<th>Bupivacaine–morphine</th>
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<tbody>
<tr>
<td>Age (yr)</td>
<td>5.2 (1.2–10.5)</td>
<td>5.0 (0.9–10.6)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>16.9 (11.5–28.0)</td>
<td>17.0 (9.0–42.0)</td>
</tr>
<tr>
<td>Duration of procedure (min)</td>
<td>45 (15–60)</td>
<td>45 (20–60)</td>
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</tbody>
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Statistical significance was determined with the Fisher exact test or chi-square analysis with Yates’ correction where appropriate for nominal data, the Mann–Whitney $U$ test for non-parametric data and Student’s $t$ test for parametric data. The mean and the variance of the computerized ventilatory data were compared using the $Z$ and $F$ test [11].

**RESULTS**

There were 15 patients in each treatment group; mean ages and weights and duration of anaesthesia and surgery were similar for both groups (table I). There were significant differences between the groups in the requirement for postoperative i.m. analgesia (fig. 1). Three patients in the bupivacaine alone group required nalbuphine during the first 1 h after operation, and the cumulative

![Figure 1](image-url)

**FIG. 1.** Postoperative analgesic requirements for bupivacaine alone (B) and bupivacaine–morphine (M).

- = Injected nalbuphine; □ = oral paracetamol.
number of patients given nalbuphine over 20 h was 8 for the bupivacaine alone group and 0 for the bupivacaine and morphine group. This difference in analgesic requirement was significant ($P < 0.05$). In addition, three patients required a second injection of nalbuphine during the study period, bringing the total number of administrations of nalbuphine to 11 for the bupivacaine alone group compared with none for the combined bupivacaine and morphine group. Paracetamol requirements were similar for the two groups: after 20 h, 10 patients in the bupivacaine alone group and seven in the bupivacaine and morphine group had received oral paracetamol. Two patients in the bupivacaine alone group were given additional doses of paracetamol.

Correspondingly, fewer patients in the bupivacaine alone group maintained adequate postoperative analgesia (a pain score of less than 4) in the absence of nalbuphine (fig. 2). After 20 h, only six of the 15 patients in the bupivacaine alone group had received adequate analgesia, compared with 13 for the bupivacaine and morphine group.

The addition of morphine to the caudal block did not delay recovery from anaesthesia and the mean time to the first micturition after surgery was similar for both groups (table II). Five patients in the bupivacaine alone group and six in the bupivacaine and morphine group had episodes of vomiting or retching. Two patients in both groups had three or more episodes of vomiting in the postoperative period. Nasal pruritus occurred in two patients, both in the bupivacaine and morphine group, but this did not distress the patients.

Ventilatory frequencies observed by the nursing staff for the first 12 h after operation were similar for both groups (fig. 3). The recorded ventilatory data derived from impedance measurements were analysed separately as data from the first 1 h and data from 1 h to 12 h, because it was felt that ventilatory depression caused by systemic absorption of morphine would be most noticeable during the first hour. The data for an individual patient were extracted as the time spent at each ventilatory frequency and summed for all the patients in the group to derive the total time at each frequency. Absolute values were converted into percentages to allow comparison between groups. We were unable to detect differences in ventilation, and mean ventilatory frequency and variance in the population were similar for the two groups, both in the first 1 h and from 1 h to 12 h (fig. 4).

Patients were given oxygen by face mask for a variable period in the recovery ward, and oxygen
satisfaction data were therefore not stored in the first 1 h. The median oxygen saturation for 1–12 h for each patient was extracted and combined for each treatment group to give a mean and standard deviation of the median values. The averaged median value of oxygen saturation for the bupivacaine alone group was slightly higher than the bupivacaine and morphine group, with a value of 98.0% (SD 1.6) compared with 96.7% (SD 2.0), but the difference was not statistically significant and an oxygen saturation of less than 85% was not recorded in any patient. Some traces showed isolated decreases in saturation to less than 90%, but these were transient and not associated with a particular treatment group.

DISCUSSION

This study demonstrates that the addition of morphine 0.05 mg kg⁻¹ to a 0.125% solution of bupivacaine improved significantly both quality and duration of pain relief after orchidopexy.
without increasing side effects noticeably. The presence of morphine in the caudal space did not result in any detectable differences in oxygen saturation or ventilatory frequency, although more sophisticated tests such as the ventilatory response to carbon dioxide may show depression of ventilatory drive after extradural opioids [12]. Minor changes in the carbon dioxide–ventilation response curve are of little clinical significance and probably unrelated to the sudden onset of severe ventilatory depression that has been reported occasionally after extradural morphine in adults. Ventilatory monitoring or close observation is needed immediately after caudal administration of morphine, but it is important to set a time limit to the risk period for ventilatory depression. The estimate must be conservative, but take into account available clinical experience. Ventilatory depression occurring more than 6 h after extradural administration is extremely rare [13] and associated with factors that include large and repeated doses of extradural morphine, additional opioid or sedative drugs, patients with significant systemic disease (ASA III/IV) and rostral delivery of the opioid. The administration of a very small dose of morphine at the caudal limits of the extradural space as a single injection under light general anaesthesia without additional sedative or opioid drugs minimizes the above risk factors. We believe, therefore, that when a single dose technique is used for caudal morphine, special monitoring can be discontinued safely after 6 h, provided the patient has shown no signs of excessive sedation within the preceding 6 h, and that the patient remains under nursing supervision for a total of 12 h after the injection. If additional doses of morphine are given either caudally or systemically within the first 12 h, monitoring should be continued accordingly.

Caudal blocks with bupivacaine alone can provide excellent analgesia in the early postoperative period after orchidopexy, but may allow the false impression that the patient will remain pain free thereafter. Longer inpatient studies, lasting 8 h or more, have shown that, as the caudal block wears off, systemic opioid analgesia is required often [3, 14]. In this present study, eight of 15 patients (53%) receiving 0.125% bupivacaine alone required supplementary i.m. analgesia in the postoperative period. These results are similar to a previous study on orchidopexy [14] in which, despite the use of higher concentrations and volumes of bupivacaine, 53% of patients required further analgesia. This confirms the view that increasing the concentration of bupivacaine to more than 0.125\% [3] or the volume to more than 0.75 ml kg\(^{-1}\) [15] offers little therapeutic advantage for this particular procedure.

Morphine given by the caudal route is not merely an exotic alternative to the i.m. route. Systemic uptake of caudal morphine is rapid and provides analgesia in the immediate operative and postoperative period. However, 1 h after caudal injection of morphine 0.05 mg kg\(^{-1}\), plasma concentration is less than 12 ng ml\(^{-1}\) [16], and is unlikely to be associated with significant analgesia. Therefore, the prolonged postoperative pain relief following caudal morphine is caused probably by a specific action on the spinal cord.

Caudal morphine may offer analgesic advantages over bupivacaine alone, but the incidence of side effects increases in parallel with both the duration of analgesia and the dose of morphine [7]. In this study we were unable to detect an increase in side-effects caused by addition of morphine. The overall incidence of vomiting in this study (11 of 30 (36%)) seems high, but is consistent with previous postoperative studies on orchidopexy in children. The children were not encouraged actively into attempts at micturition. A more pressurized approach might have resulted in differences between the groups, but we felt that passive observation was clinically more realistic.

Caudal morphine has not been established as a routine technique in paediatric anaesthesia and this may reflect partly the fear of potentially serious side effects. Minimizing the dose of morphine to provide effective analgesia without side effects is therefore an important goal in the development of the technique. Local anaesthetics may potentiate the analgesic effects of spinal morphine, resulting in improved analgesia at lower doses. A recent study in mice [17] has shown that addition of bupivacaine to morphine increases the intensity of antinociception with a time course similar to that of morphine alone, but of greater potency and reliability. In addition, doses of morphine or bupivacaine that on their own have little or no antinociception may produce an enhanced effect when combined.

REFERENCES


