A prospective, randomized comparison of interpleural and paravertebral analgesia in thoracic surgery

J. Richardson, S. Sabanathan, A. J. Mearns, R. D. Shah and C. Goulden

Summary
We have undertaken a prospective, randomized comparison of the superficially similar techniques of interpleural and paravertebral (extrapleural) analgesia in 53 patients undergoing posterolateral thoracotomy. Local anaesthetic placed anterior to the superior costotransverse ligament and posterior to the parietal pleura produces a paravertebral block and instilled between the parietal and visceral pleurae produces an interpleural block. Patients received preoperative and postoperative continuous bupivacaine paravertebral blocks in group 1 and interpleural blocks in group 2. Premedication comprised diclofenac and morphine, and after operation all patients had regular diclofenac and patient-controlled morphine (PCM). Analgesia was assessed by visual analogue pain scores (VAS), PCM requirements, ratio of preoperative to postoperative spirometric values (PFT), rates of postoperative respiratory morbidity (PORM) and hospital stay, all recorded by blinded observers. Eight patients were withdrawn and data from 45 patients were analysed. Patient characteristics, surgery, VAS scores and PCM use were similar in both groups. PFT were significantly better ($P < 0.03$ for $P < 0.0001$) in group 1, and PORM was lower and hospital stay approximately 1 day less in this group. Five patients in group 2 became temporarily confused, probably because of bupivacaine toxicity ($P < 0.02$). We conclude that bupivacaine deposited paravertebrally produced greater preservation of lung function and fewer side effects than bupivacaine administered interpleurally. (Br. J. Anaesth. 1995; 75: 405–408)

Key words

Interpleural analgesia is induced by placing local anaesthetic either into the paravertebral space, which lies anterior to the superior costotransverse ligament and posterior to the parietal pleura, or into the interpleural space, which lies between the parietal and visceral pleurae. Both methods produce regional analgesia of the chest or abdominal wall and have the same indications which include breast, renal, gall bladder and thoracic surgery, and chronic pain [1, 2]. Although they are anatomically separate, they have been reviewed together [1], with the conclusion that “variations on the technique of interpleural analgesia... appear to (have) little to choose between them”. Our disagreement with this statement [3], the lack of comparative data and general confusion on this topic stimulated this prospective, randomized, observer-blinded study in order to clarify the choice of interpleural or paravertebral analgesia for thoracic surgery.

Patients and methods
With local Ethics Committee approval, we studied 53 consecutive consenting adults, aged 17–80 yr, undergoing elective posterolateral thoracotomy. Exclusion criteria were: sepsis in the chest cavity (empyema), bullous emphysema, previous or planned pleurectomy; known allergy to amide-type local anaesthetics or non-steroidal anti-inflammatory drugs (NSAID); contraindications to NSAID; psychiatric disease; and poor command of the English language.

Following an explanation of the use of the hand-held spirometer (Respiradyne, Cheeseborough-Ponds Inc, USA) [4], a preoperative baseline pulmonary function measurement (PFT) was obtained. Linear visual analogue pain scores, using a 10-cm line with 0 at one end representing no pain and 10 cm at the other representing the worst pain imaginable, were also explained, as was the use of the patient-controlled analgesia machine (PCA; Baxter UK). Premedication for all patients comprised morphine 10 mg i.m. and diclofenac 100 mg by suppository 1 h before operation. Randomization took place in the anaesthetic room by sequential allocation to computer-generated random numbers.

Anaesthesia was induced with propofol and vecuronium, and maintained with isoflurane in oxygen-enriched air in sufficient concentrations to obtund cardiovascular responses. The tracheas of all patients were intubated with a double-lumen endobronchial tube. Intraoperative systemic analgesics were limited to fentanyl in unrestricted doses. After assumption of the lateral decubitus position, patients in group 1 had a preoperative percutaneous paravertebral injection using the method of Eason and Wyatt [2]. In patients in group 2, the interpleural
space was identified in the mid-scapular line by gradual advancement of a Tuohy needle until a “click” and loss of resistance to saline were noted. In both groups the dermatomal level of the injection (T5–8) corresponded with the planned level of the incision, and 0.5 % plain bupivacaine 20 ml was injected at least 10 min before skin incision. Towards the end of surgery, before chest closure, an extradural side-holed catheter was placed under direct vision either into the paravertebral space, using the method described by Sabanathan and colleagues [5] (group 1), or into the interpleural space, alongside the vertebral column, with its tip at the intercostal level of the incision (group 2). During chest closure a further 20 ml of 0.25 % bupivacaine were given.

All patients had an infusion of 0.5 % plain bupivacaine at a rate of 0.1 ml kg\(^{-1}\) h\(^{-1}\) which was started approximately 1 h after the end of the anaesthetic. In addition to regular, 18-hourly diclofenac 100-mg suppositories for 5 days, patients had continuous access to PCA using morphine, with a 1-mg bolus, a 5-min lockout period and no background infusion.

The study period lasted for 48 h after operation and data collection was carried out by the ward nursing staff who were unaware of the randomization group. We recorded: 4-hourly pain scores at rest, opioid requirements, a 2-h and then 12-hourly Respiradyne recordings, any untoward effects, complications and length of hospital stay.

Pain, opioid use and PFT data were analysed by the Mann–Whitney \(U\) test. The chi-square test with Yates’ correction factor and Student’s \(t\) test were used for comparison of means. Data on confusion were assessed by Fisher’s exact test.

**Results**

Five patients from group 1 were withdrawn, the reasons being: chest wall tumour invasion in two patients, 2 NSAID prescribed in one patient, a postoperative panic attack and preoperative use of opioids. Three patients in group 2 were withdrawn because of: tumour involvement of the chest wall, accidental omission of diclofenac and death on the first postoperative day. There were no significant differences between the two groups in patient characteristics (table 1).

The mean intraoperative dose of fentanyl was 218 (range 100–400) \(\mu\)g in group 1 and 195 (100–400) \(\mu\)g in group 2. There were no significant differences in pain scores and opioid use between the two groups (figs 1, 2).

<table>
<thead>
<tr>
<th>Complications</th>
<th>Other</th>
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<tbody>
<tr>
<td>Death</td>
<td>PORM</td>
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<td>3</td>
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**Table 1** Patient and surgical data in the paravertebral and interpleural analgesia groups. LoS = Length of hospital stay, PORM = postoperative respiratory morbidity. (Note, five patients in the paravertebral group and three in the interpleural group were withdrawn from the study.)

There was a highly significant improvement in all PFT values in group 1 compared with group 2, the differences being most marked at 2 h (figs 3, 4). Two pneumothoraces were found at thoracotomy in the interpleural group compared with none in the paravertebral group. Excluding these, PORM was found in three patients in group 1 compared with seven in group 2. No patient in group 1 was confused after operation compared with five in group 2 (\(P = 0.02\)). One patient in group 1 developed urinary
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retention. There were three deaths in group 1, the causes of which were: one massive bowel infarction and two cases of post-pneumonectomy right heart failure, one including a pulmonary embolus. There was one death in group 2 caused by postoperative haemorrhage.

Discussion

Posterolateral thoracotomy produces severe suffering with marked respiratory impairment [6] which is almost entirely determined by the quality of pain relief [7]. Excellent analgesia can reduce the consequent pain-related morbidity [8] and effective management may be provided by preoperative and continuous postoperative afferent block coupled with regular NSAID [7–9].

Both groups of patients in this study were comfortable, as assessed by pain scores at rest. However, the significantly better pulmonary function in the paravertebral group is important as it demonstrates that there was less pain on vigorous chest movement, although the consequent reduction in PORM and shorter hospital stay in the paravertebral group was not statistically significant.

The worse PFT values in group 2 may have resulted from impairment of respiration by pooling of bupivacaine on the diaphragm. Interpleural distribution of local anaesthetic, even with an intact negative interpleural pressure, is known to be gravity-dependent [10], but following thoracotomy which produces a postoperative size mismatch between the lung and chest cavity [6] and with elimination of subatmospheric pressure, this effect would be almost complete. As we nurse our patients in the sitting position, diaphragmatic function was probably adversely affected by this mechanism. Intermittent clamping of the dependent chest drain would be unlikely to improve analgesia or pulmonary function, and this has been confirmed clinically [11, 12]. In many studies patients are kept supine for up to 20 min after a bolus to facilitate diffusion of local anaesthetic through the parietal pleura into the intercostal nerves [10–15]. We used a postoperative continuous infusion regimen, which has been recommended in the interests of efficacy [13, 15–17], but which would require a continuous supine posture for optimum analgesic effect.

Paravertebral administration is much less gravity-dependent, and solutions remain confined but well distributed within the paravertebral space, in direct proximity to the intercostal nerve roots, their posterior primary rami and the sympathetic chain [3, 18]. Intercostal spread usually produces reliable block of four or more dermatomes around the site of instillation [1, 5, 18–20].

A significant number of patients in group 2 were confused in the postoperative period, probably because of bupivacaine toxicity, as it responded in all patients to temporary cessation of infusion. Plasma local anaesthetic concentrations with interpleural administration are known to vary markedly, some studies observing acceptable concentrations [21, 22], some demonstrating high concentrations [13, 15, 16] and some leading to unacceptable clinical toxicity [23, 24]. Our dose regimens were chosen because in previous studies paravertebral [5] and interpleural [17] administration of similar doses produced acceptable plasma concentrations, previously devoid of toxic reactions.

In summary, we have found that bupivacaine deposited paravertebrally produced greater preservation of lung function and fewer side effects than bupivacaine administered interpleurally and we question the use of interpleural analgesia in thoracic surgery.

Acknowledgements

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References

4. Jenkins SC, Barnes NC, Moxham J. Evaluation of a hand-held spirometer, the Respiradyn for the measurement of forced expiratory volume in the first second (FEV1), forced vital capacity (FVC) and peak expiratory flow rates (PEFR). *British Journal of Chest Diseases* 1988; 49: 70–75.