A prospective, randomised comparison of continuous paravertebral block and continuous intercostal nerve block for post-thoracotomy pain

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ABSTRACT

Background: This study aimed to compare paravertebral block and continuous intercostal nerve block after thoracotomy.

Methods: Forty-six adult patients undergoing elective posterolateral thoracotomy were randomised to receive either a continuous intercostal nerve blockade or a paravertebral block. Opioid consumption and postoperative pain were assessed for 48 hours .Pulmonary function was assessed by forced expiratory volume in 1 s (FEV1) recorded at 4 hours intervals.

Results: With respect to the objective visual assessment (VAS), both techniques were effective for post thoracotomy pain. The average VAS score at rest was 29±10mm for paravertebral block and 31.5±11mm for continuous intercostal nerve block. The average VAS score on coughing was 36±14mm for the first one and 4 ±14mm for the second group.

Pain at rest was similar in both groups. Pain scores on coughing were lower in paravertebral block group at 42 and 48 hours. Post-thoracotomy function was better preserved with paravertebral block. No difference was found among the two groups for side effects related to technique, major morbidity or duration of hospitalisation.

Conclusion: We found that continuous intercostal nerve block and paravertebral block were effective and safe methods for post-thoracotomy pain.

Introduction

Post-thoracotomy pain represents the most severe type of postoperative pain with respect to intensity and duration.[1,2] Pain is the main component in the alteration of chest wall mechanics. Various analgesic techniques have been developed to treat postoperative thoracotomy pain. According to several studies, thoracic epidural analgesia is superior to less invasive methods in the management of acute post-thoracotomy pain.[1,3] Paravertebral block described by Hugo Sellheim in 19054 may provide high quality pain relief.[5,6] Continuous intercostal nerve block has merged over the last years as a method of providing ipsilateral analgesia following thoracotomy.[7,8] However, it is not widely used. In this study we compared paravertebral block and continuous intercostal nerve block to provide analgesia after thoracotomy.

Methods

This prospective, randomised, double-blinded study was conducted for 6 months after approval from the local Ethics Committee and informed patient consent.

We studied 47 consecutives adult patients, ASA physical status II or III, undergoing pulmonary resection with elective posterolateral thoracotomy.

Exclusion criteria were: lack of patient consent, inability to comprehend pain scale, localised or systemic sepsis, contraindications to regional techniques, need for an additional incision (e.g. laparotomy), coagulopathy or metabolic diseases. Patients in whom the pleura had to be sacrificed were also excluded. Preoperatively, patients were trained for visual analogue scale (VAS) and patient-controlled analgesia. Premedication consisted of 1 mg/Kg hydroxyzine administered orally 90 minutes before intervention.

General anaesthesia was induced with 3–5 mg/kg thiopental and 2–3 g/kg fentanyl, double-lumen endotracheal intubation was facilitated by 0.5 mg/kg atracurium, and lungs were mechanically ventilated. Anaesthesia was maintained with fentanyl at the rate of 1g/kg every 30 minutes, halothane (0.6–1 minimum alveolar anesthetic concentration) and a mixture of air-oxygen (50/50), and muscle relaxation was maintained with additional doses of atracurium.

Randomisation was made in the anesthetic room using random number table. In the paravertebral block group, after chest closure, a standard epidural radiopaque catheter (Epix®, Viadana, Italy, 20 gauge); marks at 50 mm to 200 mm; was inserted by an anesthesiologist into the paravertebral space, two or three centimeters lateral to the fifth or sixth spinal processes, using the standard technique of loss of resistance to saline through a 16 gauge Tuohy needle.

In the continuous intercostal nerve block group, the same catheter was inserted by the surgeon into a localised extrapleural paravertebral pocket under direct vision as originally described by Sabanathan et al 9 Prior to closure of the thoracotomy an extra-pleural tunnel was created by peeling away the parietal pleura overlying the paravertebral gutter for three intercostal spaces above and below the level of the incision. Insertion of the extrapleural catheter was made by the same surgeon for all patients.

During chest closure, both groups received two bolus of 0.25% bupivacaine up to 10 ml, followed by continuous postoperative infusion of bupivacaïne 0.25%, at a rate of 0.1ml/Kg/H. The infusion was labeled “infusion study drug”.

Tracheal extubation was performed when weaning criteria were satisfied in postanaesthesia care unit.

After intervention, all patients also received rectal indomethacin 50 mg x 3/day, intravenous propacetamol 60 mg/kg/day and intravenous patient-controlled analgesia using morphine (1 mg bolus and 7 min lockout period). The regional technique was maintained for 48 hours. All of the patients were taken post-operatively to ICU for at least two days where they had the same physiotherapy. Postoperative data were collected for 48 hours by one resident blinded to the regional technique. To quantify the postoperative pain, the patients were asked to use a 100-mm VAS graduated from 0 (no pain) to 100 mm (the worst possible pain). VAS scores were recorded at rest and after coughing every 4 hours. Morphine requirements were also recorded. Patients were assessed with a sedation scale (wide awake = 0; mildly sleepy and responsive to verbal command = 1; moderately sleepy =2; extremely sleepy and unresponsive to nociceptive stimulation = 3). Side effects as pruritus, nausea and vomiting, hypotension, defined as a decrease in preoperative systolic blood pressure of 30% or more, urinary retention, local anesthetic toxicity signs (hypotension, neurologic complications and arrhythmia) were recorded. Oxymetry, respiratory rate and forced expiratory volume in 1 s (FEV1) were recorded 4-hourly.

Motor blockade was evaluated daily in terms of a modified four-grade Bromage scale to seek complication as spinal anaesthesia after paravertebral block.

In the two groups, a chest X-Ray was performed at 6 hours postoperative with contrast injection into the catheter to improve the reliability of space location. Postoperative respiratory morbidity; such as atelectasis, pneumonia and dysrythmia was recorded.

For statistical analysis, we used the statistical package SPSS 10.0 for Windows. Unless otherwise specified, all data are expressed as the means ± standard deviation (SD). Quantitative variables were tested using the Mann-Withney test and student's t test. For qualitative variables, the Fisher exact test was used. $P < 0.05$ was considered to indicate statistical significance.

Results

Forty-seven patients were randomly assigned to one of the two groups. One patient was excluded because of the desinsertion of the catheter in the paravertebral group. Ultimately, 46 patients were considered eligible for further evaluation (23 in the paravertebral bloc group, 23 in the continuous intercostals nerve block group).

The both groups of patients were similar with respect to weight, age, sex, preoperative diseases, and ASA status (Table I). No difference was observed in the duration and type of surgery, incision size, and fentanyl consumption (Table II). The adequate position of the catheter, in paravertebral block (Fig. 1) and continuous intercostal nerve block (Fig. 2), was confirmed by the X-Ray screening with contrast injection.

Table I: Patients' characteristics in the two groups

Characteristics	PVB (n=23)	CINB (n=23)
Age (years)	47±13	44±15
Preoperative diseases		
Chronic obstructive pulmonary disease	*5*	*4*
Diabetes	*2*	*2*
Arterial hypertension	*2*	*2*
Patient ASA status (II/III)	15/8	14/9

PVB: Paravertebral block; CINB: Continuous intercostal nerve block
Values are mean ± SD or absolute numbers. No statistical difference between the two groups.

With respect to the objective visual assessment (VAS), both techniques were effective for post thoracotomy pain. The average VAS score at rest was 29±10mm for paravertebral block and 31.5±11mm for continuous intercostal nerve block. The average VAS score on coughing was 36±14mm for the first one and 4 ±14mm for the second group.

Table II: Comparison of the two treatment groups during anaesthesia

	PVB (n=23)	CINB (n=23)
Duration of surgery (min)	121±30	111±34
Incision size (cm)	12±1	11±1
Type of surgery		
Lobectomy	9	10
Kystectomy	10	8
Double lobectomy	1	3
Pneumonectomy	1	2
Pleurectomy	2	0
Fentanyl consumption (g)	300±41	280±54

PVB: Paravertebral block; CINB: Continuous intercostal nerve block
Values are mean ± SD or absolute numbers. No statistical difference between the two groups.

Figure 1: Postoperative X-ray screening showing the catheter in the paravertebral space

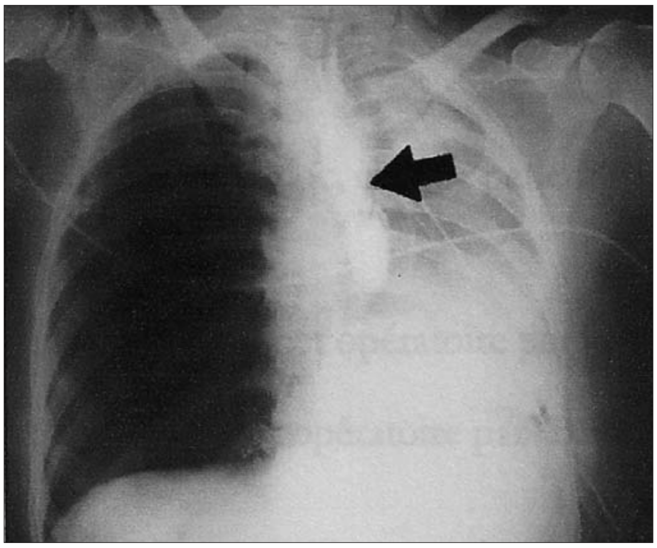
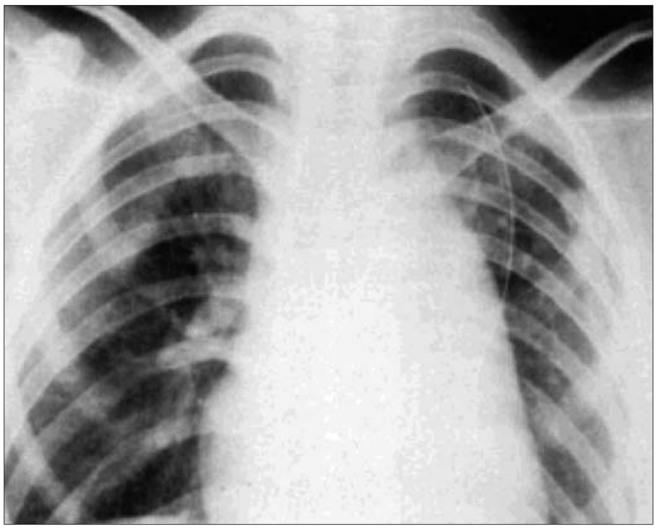
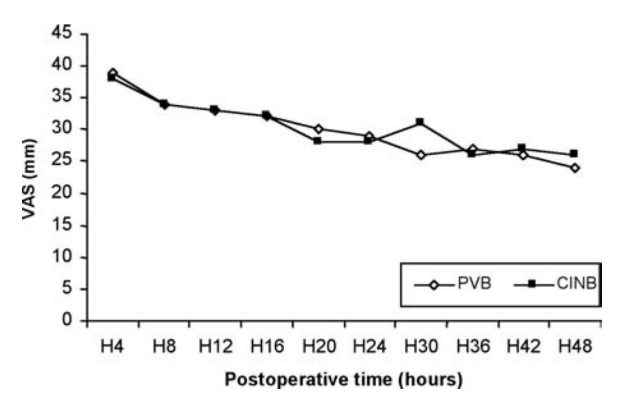


Figure 2: Postoperative X-ray screening showing the catheter in the extrapleural tunnel



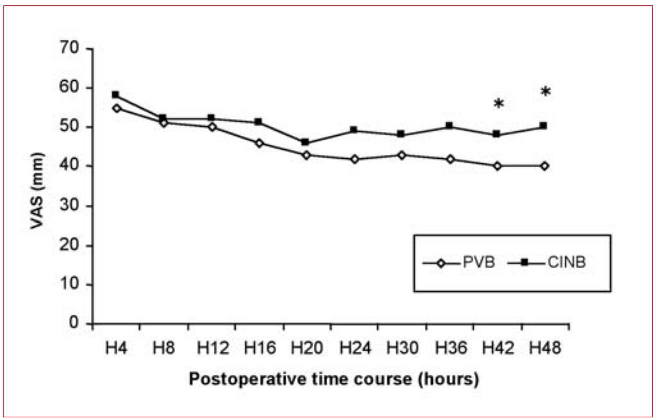
VAS scores at rest were similar in all groups (Fig. 3). However, VAS scores on coughing were lower in paravertebral block group with the difference being significantly lower at 42 and 48 H (Fig. 4). Cumulative morphine consumption was lower in paravertebral block group during the study period, but did not reach the statistical significance (35.7 ±17 vs 41 ±21 mg) (Fig. 5).

Figure 3: Time course of postoperative visual analogue pain scores at rest. No statistical difference between the two groups.



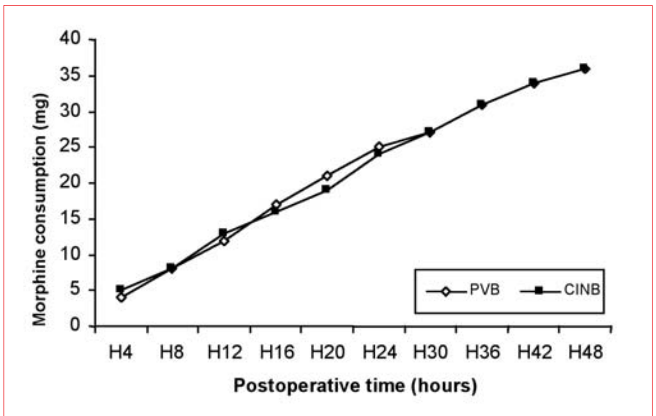
PVB: Paravertebral block; CINB: Continuous intercostal nerve block

Figure 4: Time course of postoperative visual analogue pain scores on coughing.



PVB: Paravertebral block; CINB: Continuous intercostal nerve block. Asterisks (*) denote significant difference between the groups ($p < 0.05$)

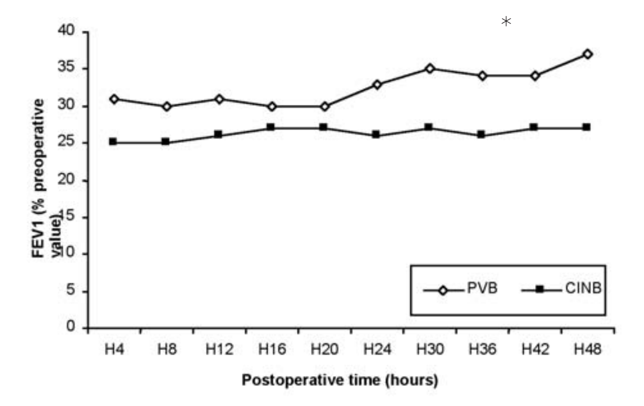
Figure 5: Cumulative morphine consumption in the two groups. No statistical difference between the two groups.



PVB: Paravertebral block; CINB: Continuous intercostal nerve block

Compared to the preoperative level, the ventilatory function as assessed by FEV1, decreased in all patients. The mean value of FEV1 was better in the paravertebral block group with the difference being significantly better at 48 H (Fig. 6).

Figure 6: Time courses of forced expiratory volume in 1 second (FEV1) expressed as percentages of the preoperative value. Asterisks (*) denote significant difference between the groups ($p < 0.05$).



PVB: Paravertebral block; CINB: Continuous intercostal nerve block

No patient required the administration of naloxone, or presented hypotension, or respiratory depression.

The incidence of cardiac arrhythmias, pulmonary complications, nausea or vomiting, itching and urinary retention was not statistically different between the groups. The length of time of chest drainage and the length of stay in the hospital were not different between the groups. No patient expressed sedation or motor block.

Discussion

We found that paravertebral and continuous intercostal nerve block provide similar level of pain at rest. However, pain scores on coughing were lower in paravertebral block group with the difference being significantly lower at 42 and 48 hours. Post-thoracotomy function was better preserved with paravertebral block than with continuous intercostals nerve block. No difference was found among the two groups for side effects related to technique, major morbidity or duration of hospitalisation.

Pain from a posterolateral thoracotomy incision is considered to be severe and intense.[2] It results from tissue damage to the ribs, muscles, and peripheral nerves. This pain can prolong patients' stay in the intensive care unit and the hospital, as well as increase morbidity and mortality.[11,12] Deterioration of respiratory mechanics, in response to pain, can lead to atelectasis, mucous plugging, hypoxia, and pulmonary infectious.[12] Because of these factors, adequate pain control should be considered an integral part of patient rehabilitation after thoracic surgery. Various methods for pain management after thoracic surgery are used.[13,14] Controversy exists, however on what to give, when to give it and where to administer it. Thoracic epidural analgesia has been considered the gold standard method for pain control after thoracic surgery.[1] However, the catheter insertion requires considerable experience[15] and may be technically difficult. Potential complications such as dural puncture, hematoma and infection at the catheter implantation side have to be taken into consideration.[3,16] Furthermore, epidural analgesia is contraindicated in some cases such as, infection or neurologic disease.[17] Alternative methods, such as unilateral techniques have to be implemented.

Several recent studies have suggested that paravertebral block can be an effective alternative to epidural analgesia in thoracotomy patients.[18] Richardson et al found that, compared with epidural analgesia, paravertebral block provide lower pain scores, less postoperative morphine consumption and lower postoperative side effects.[19] The mechanism of action of paravertebral analgesia is by direct penetration of local anesthetic into the intercostals nerve, including its dorsal ramus, the rami communicantes and the sympathetic chain.[20]

Paravertebral block generally have a low incidence of adverse effects. In a multiple-centred, prospective study, Lönnqvist et al found an overall failure rate of 10.1%. The frequency of complication was: hypotension 4.6%; vascular puncture 3.8%; pleural puncture 1.1%; and pneumothorax 0.5%.21 Some cases of total spinal block[22] and a post puncture headache[23] have been described. In our study no complication has been noted. Furthermore, extrapleural adhesions and scar tissue following a previous thoracotomy can make paravertebral space location more difficult. In our study, the insertion of the catheter was possible in all patients.

Because of theses complications and techniques difficulties, the continuous intercostal nerve block has been considered in our institution as a further option.

The blockage of intercostal nerves interrupts C-fibers afferent transmission to impulse to the spinal cord. A single intercostal injection of local anesthetic can provide analgesia for up to 6 hours.[24] To achieve longer duration of analgesia and to obtain multiple dermatomes analgesia, a continuous extrapleural intercostal nerve block has been developed by Sabanathan.[9] In our study, it was possible to insert the catheter in all the cases except in one patient who had kyphoscoliosis. There was no complication related directly to the catheter insertion, which is in agreement with previous study.[7,8,25] Continuous intercostal nerve block analgesia is by direct penetration of local anesthetic into the intercostal nerve. It could be expected that the rami communicantes or the dorsal ramus are not blocked. Willdeck-Lund et al have reported back or shoulder pain in patients who had intercostal nerve block for pain after postero-lateral thoracotomy probably because of failure to block these structures.[26] In our study pain scores at rest were similar in the two groups; however pain scores on coughing were lower in the paravertebral group with the difference being significant at 42 and 48 hours. Opiate requirements were similar in the two groups. No patient had back or shoulder pain.

It has been suggested that a true anatomical tunnel will not persist due to a leakage of local anesthetic into the pleural space.[27] Barron et al demonstrated, using the cardio-thoracic scanning images, that the extrapleural tunnel was intact 48 hours after surgery.[28] In our study, there was no evidence of leakage of contrast into the pleural space on the chest X-Ray images.

A recent review showed that extrapleural infusion of bupivacaïne has been very well tolerated.[29] Local complications (transient hypotension and transient Horner's syndrome) were noted in 0.6% of patients.[28,30,31] Systemic bupivacaine toxicity (confusion) was seen in 0.8% of patients.[28,30]

Average plasma concentrations of bupivacaine during continuous infusion ranged between 3 and 4 µg/ml32-37 which is below the accepted threshold of 5 µg/ml for central nerve system toxicity.37 Others have reported much higher bupivacaine concentration (7.48 µg/ml during continuous infusion of paravertebral block36 and 10.25 µg/ml in continuous intercostals nerve block33 but no sign of bupivacaine toxicity were detected in theses patients. In our study, we did not measure the plasma bupivacaine level, but no patient had experience toxicity in the two groups under close observation during 48 hours.

Our choice of the infusion rate is based on previous studies. The vast majority of authors use 0.5% bupivacaine,[9,19] although some use 0.25% bupivacaine.[25,28,34] The rate of infusion is generally 5 to 7 ml/h for an average-sized adult (0.1ml/kg/h).[9,19,34]

Posterolateral thoracotomy may result in a substantial decrease in pulmonary function. Although surgical reduction of lung parenchyma contributes, this deterioration is thought to be caused mainly by the respiratory effects of severe postoperative pain.38 In our study, the number of patients who underwent pulmonary resection was similar in the two groups. Richardson et al found that pulmonary function as assessed by the peak expiratory flow rate (PEFR) was significantly better preserved in the paravertebral block group when compared with epidural analgesia.[19]In our study, the mean value of FEV1 was better in the paravertebral group with the difference being significantly better at 48 hours. We speculate that the reason of this difference may be explained by lower postoperative pain scores on coughing in paravertebral block. In fact, pain scores were a factor associated with the postoperative FEV1 variation.[39] Varela et al found that the residual FEV1 was greater in patients with lower postoperative pain score.[40]

Conclusion

We found that continuous intercostal nerve block and paravertebral block as part of analgesic regimen were effective and safe methods for post-thoracotomy pain. We therefore believe that the two methods might be a valuable alternative to thoracic epidural analgesia for unilateral surgical procedures. Finally, we suggest that continuous intercostal nerve block should be considered when paravertebral block is contraindicated or seems to be technically difficult.

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Conflict of Interest: No

Implications Statement: In this study, continuous paravertebral block and continuous extra-pleural block after thoracic surgery offered an efficiency analgesia allowing good respiratory rehabilitation, decreasing the risk of opioids toxicity and haemodynamic effects. Might be replacing thoracic epidural analgesia after thoracotomy.

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