Journal of Pain and Relief

ISSN: 2167-0846

Bakry and Salem, J Pain Relief 2018, 7:3
DOI: 10.4172/2167-0846.1000317

Research Article Open Access

Is Paravertebral Block More Effective in Thoracotomy Patients Compared to Thoracic Epidural Block?

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Received date: April 25, 2018; **Accepted date:** April 30, 2018; **Published date:** May 7, 2018

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Abstract

Purpose: Paravertebral block (PVB) is a simple and safe technique that can be more efficacious than epidural block (EPB) in controlling postoperative pain. We aimed to confirm this by comparing the two methods in patients after thoracotomy.

Methods: Patients were randomly divided into two groups, PVB or EPB (n=30 in each). Vital signs and the visual analog scale (VAS) were evaluated before giving the block then 30 minutes and 3, 6, 9 and 12 hours after thoracotomy. Complications and need for additional analgesic agents were also scrutinized.

Results: The most significant finding was better preservation of pulmonary function tests at most time points in the PVB group (<0.05). VAS scores trended to be better in the PVB group, but the difference was significant only at 30 minutes after giving the block. There were no significant differences between the groups in the incidence of complications or the need for additional analgesic agents.

Conclusion: Paravertebral and epidural blocks are effective in a similar degree in controlling post-operative pain but paravertebral block is safer and more tolerable for the patients.

Keywords: Paravertebral block; Epidural block; Postoperative pain; Thoracotomy

Introduction

The post-operative period in patients undergoing thoracotomy is often marked by severe pain which can depress respiratory function and result in complications such as pneumonia and delayed recovery [1-6]. The pain is caused by rib retraction and intercostal nerve damage which is more likely to occur when the posterolateral approach is used compared to the muscle sparing thoracotomy [7]. This is aggravated further in patients with coexisting cardiac and respiratory diseases as well as elderly and malnourished patients [8].

Many techniques have been introduced for the relief of post-operative pain. For example, systemic opiods have been used but they are associated with the risk of respiratory depression. Other agents such as non-steroidal anti-inflammatory drugs are very weak in controlling post-thoracotomy pain. Regional techniques such as epidural block are much more effective than systemic drug administration as well as intercostal and interpleural nerve blocks [9]. This technique has greatly improved pain control but it is very difficult to administer to obese patients and children and is dangerous to use in patients taking anticoagulants [10]. It can also cause significant complications such as block failure, hypotension, urinary retention, pulmonary complications and nausea [7]. Furthermore, it requires a skilled and experienced anesthesiologist to ensure that its administration is rapid, accurate and safe [10].

This is why thoracic paravertebral block has been recently introduced [11]. This procedure involves continuous infusion of a local anesthetic with or without opioids into a catheter inserted into the paravertebral space (a wedge shaped space that lies to the side of the vertebral column and contains the spinal nerve, the dorsal ramus, the rami communicantes and the sympathetic chain) [12]. This produces unilateral somatic and sympathetic block [13]. Because it involves only the unilateral sympathetic nerve, it avoids the side effects of epidural block and therefore has the potential to be more beneficial in controlling post-operative pain [10].

In the current study we aimed to demonstrate this by comparing paravertebral block and thoracic epidural block in thoracotomy patients. Our goal was to evaluate the efficacy of paraverbral block in controlling postoperative pain and to investigate whether there were any significant side effects associated with its use.

Methods

Participants

Sixty patients who underwent thoracotomy, thoracoscopy, pnemonectomy or lobectomy in Kasr Al-Aini Hospital between 2014-2016 were enrolled in this study. All of the patients underwent thoracic surgery via a postro-lateral thoracotomy incision.

Inclusion criteria

(a) Age at surgery of 20-75 years, (b) American Society of Anesthesiologists (ASA) physical status 1-2 [14], (c) Platelet count, ≥ 100,000/mm^3, (d) Prothrombin concentration >70%, (e) Serum creatinine level ≤ 2.0 mg/dl, (f) Forced expiratory volume in 1 s, ≥ 70 %.

Exclusion criteria

(a) Lack of patient consent, (b) Patients with serious cardiac complications, (c) Patients with a history of allergy to topical anesthetics or narcotics, (d) Patients with contraindication to regional techniques, (e) History of ipsilateral thoracotomy, (f) Patients with history of tuberculosis or at risk of intrathoracic adhesion, (g) Patients with interstitial pneumonia, pulmonary fibrosis, or severe pulmonary emphysema, (h) Patients with a need for an additional incision, (i) Patients previously subjected to radiotherapy involving the thoracic wall/cavity, (j) Patients with active infectious disease, liver cirrhosis or renal failure, (k) Pregnant women, (l) Mentally challenged patients.

The patients were randomly divided based on the procedure performed post-thoracotomy into two groups. Group 1, paravertebral block (PVB); n=30. They received a paravertebral injection of 10 ml bolus of 2% Lidocaine followed by infusion of 10 ml/hr of 0.25% bupivacaine and 4 μg/ml fentanyl, between T5 and T9 and Group 2, epidural block (EPB); n=30. They received an epidural injection of 10 ml bolus of 2% lidocaine followed by infusion of 10 ml/hr of 0.25% bupivacaine and 4 μg/ml fentanyl between T5 and T9. In both groups the block was activated after the end of surgery.

The study was approved by the local ethics committee and informed written consent was obtained from each patient.

Anaesthetic technique

Prior to surgery, all patients were evaluated clinically, biochemically and radiologically including spirometery. The patients were all fasting for at least eight hours prior to the surgery and were given 10 mg oral diazepam and 50 mg ranitidine the night before. None of the patients were given any narcotics.

When the patients arrived to the operation room, all the pre-operative vital signs were checked and patient was monitored by 5 lead ECG, IABP, Spo 2%, capnometry and arterial blood gases were measured. Induction was performed by injecting fentanyl 2 μg/kg IV, propofol 2 mg/kg and atracurium besylate 0.1 mg/kg. Lidocaine 1.5 mg/kg was given 90 seconds prior to intubation. Patients were then intubated with double/single ETT and anaesthesia was maintained with oxygen, isoflurane and atracurium besylate 1 mg/kg/hr and mechanical ventilation.

Baseline haemodynamic vitals were recorded prior to the administration of either the paravertebral or epidural drug.

At the end of the surgery, all patients were given assisted ventilation till spontaneous respiratory attempts, and then reversed with 50 μg/kg of neostigmine and 10 μg/kg atropine. They were then extubated and transferred to the surgical ICU where continuous oxygen was given at 4 litres/minute for the next 72 hours.

1. Paravertebral block

At the end of the surgery and after skin closure, while the patients were in the lateral position, skin preparation was performed and a 16 gauge epidural catheter was inserted via 16 gauge epidural needle at the T5-T9 intervertebral space. Infusion of 2 ml of 1% lidocaine hydrochloride was done as a test dose. When the absence of any adverse effects was confirmed, 10 ml of 2% lidocaine was infused, followed by infusion of 10 ml/hr of 0.25% bupivacaine and 4 μg/ml fentanyl solution through an infuser pump.

2. Epidural block

At the end of the surgery and after skin closure, while the patients were in the lateral position, skin preparation was performed and a 16 gauge epidural catheter was inserted via 16 gauge epidural needle at the T5-T9 intervertebral space. The epidural space was identified by loss of resistance method. First a 10 ml bolus of 2% lidocaine was given followed by infusion of 10 ml/hr of 0.25% bupivacaine and 4 μg/ml fentanyl solution administered through the epidural catheter.

Post-operative assessment

Pain was assessed using visual analogue scale (VAS; 0=no pain; 10=worst imaginable pain) at 30 min, 3 hrs, 6 hrs, 9 hrs and 12 hrs after administrating the drug. VAS score of 0 was taken as complete analgesia and a score<4 as effective analgesia. Whenever VAS was ≥ 4, patients were given IV morphine 4 mg. Any complications or side effects such as respiratory depression, hemodynamic changes like bradycardia, hypotension, nausea, vomiting, urinary retention were recorded.

Statistical analysis

Data collected are described in detail under results. Descriptive statistical analysis was used. The t test was used for comparison of continuous variables between the two groups and the Chi-square test or the Fisher's exact test was used for categorical variables. A two-sided $P<0.05$ was considered significant for these comparisons.

Results

As demonstrated in Table 1, No significant differences were found between the patients in group 1 and group 2 and they were comparable in terms of demographic and clinical characteristics as well as the surgical procedures performed. The only time the pulse rate differed between the two groups was 30 minutes after administrating the drug where it was significantly lower in the PVB group (Group 1, Table 2). Apart from that pulse rate was comparable between the two groups both prior to drug administration and all time intervals after 30 minutes. Systolic blood pressure dropped in both groups after administrating the drug, however, as with pulse rate, the only time point where a significant difference in systolic blood pressure was found between the two groups was after 30 minutes of giving the drug, being lower in the PVB group (Table 3).

Characteristic	PVB group (n=30)	EPB group (n=30)
Age (year)	54.3 ± 9.5	59.2 ± 10.1
Height (cm)	164.6 ± 7.3	160.2 ± 8.1
Weight (kg)	76.2 ± 9.8	77.4 ± 9.4
Gender M/F	17/13	19/11
Duration of anesthesia (min)	254.6 ± 40.1	266.3 ± 39.8
Operation time (min)	191.3 ± 44.7	194.9 ± 46.2
Blood loss	98.4 ± 124.6	109.1 ± 113.4
Length of skin incision (cm)	16.1 ± 2.6	15.9 ± 5.7
Time for insertion of catheter (s)	327.9 ± 147.9	478.8 ± 162.0

Table 1: Patient Characteristics.

Pulse	PVB group (n=30)	EPB group (n=30)
Before giving the drug	110.3 ± 19.5	109.2 ± 14.3
After 30 minutes**	93.4 ± 9.8	105.4 ± 11.1
After 3 hours	94.7 ± 8.1	94.3 ± 7.5
After 6 hours	91.8 ± 7.3	93.6 ± 8.6
After 9 hours	89.1 ± 9.4	91.1 ± 6.8
After 12 hours	88.4 ± 8.4	89.1 ± 6.5

Table 2: Pulse rate/minute in the two groups of patients **= P<0.001.

Systolic Blood Pressure	PVB group (n=30)	EPB group (n=30)
Before giving the drug	139.7 ± 6.9	141.4 ± 7.2
After 30 minutes**	113.7 ± 9.3	129.1 ± 7.5
After 3 hours	125.5 ± 10.1	128.9 ± 9.0
After 6 hours	121.9 ± 6.9	123.5± 9.6
After 9 hours	125.4 ± 11.1	126.0 ± 7.4
After 12 hours	125.9 ± 8.1	129.2 ± 4.9

Table 3: Systolic blood pressure (mm Hg) in the two groups of patients **= P<0.001.

The mean respiratory rate was comparable between the two groups at all-time points both prior to and following the administration of the drug (Table 4). As shown in Table 5, The peak expiratory flow rate (PEFR) was similar in both groups prior to drug administration 30 minutes after giving the drug PEFR rose significantly in the PVB group rose but not as much in the EPB group. PEFR values dropped in both groups 3 hours later, however they continued to be significantly higher in the PVB group at all-time points thereafter. Overall, analgesia was better in the PVB group compared to the EPB group but the only time VAS was significantly lower in the PVB group was after 30 minutes of drug administration (Table 6). The frequency of administration of additional analgesia is summarized in Table 7. There was no significant difference between the PVB and EPB groups on the day of surgery or on postoperative days 1 or 2. Overall adverse effects were minimal in both groups but hypotension nausea and vomiting was reported much more frequently in the EPB block group (Table 8). In several patients more than one complication was observed.

Respiratory Rate	PVB group (n=30)	EPB group (n=30)
Before giving the drug	25.9 ± 3.4	25.4 ± 4.8
After 30 minutes	13.6 ± 2.1	14.1 ± 1.9
After 3 hours	13.1± 1.5	13.0 ± 1.1
After 6 hours	13.5 ± 1.5	13.3 ± 1.8
After 9 hours	13.7 ± 2.0	12.9 ± 1.4
After 12 hours	12.5 ± 1.6	12.8 ± 1.6

Table 4: Respiratory rate (per min) in the two groups of patients.

PEFR	PVB group (n=30)	EPB group (n=30)
Before giving the drug	102.5 ± 23.4	105.9 ± 21.9
After 30 minutes**	153.7 ± 16.5	129.1 ± 19.9
After 3 hours**	149.2 ± 19.7	135.0 ± 20.3
After 6 hours*	143.4 ± 16.4	133.9 ± 18.5
After 9 hours*	140.4 ± 20.0	132.8 ± 21.2
After 12 hours*	152.6 ± 19.3	139.9 ± 19.7

Table 5: Peak expiratory flow rate (PEFR) in the two groups of patients *= P<0.05 and **= P<0.001.

Pain Score	PVB group (n=30)	EPB group (n=30)
Before giving the drug	6.4 ± 0.7	5.9 ± 0.9
After 30 minutes*	1.2 ± 0.6	2.0 ± 0.4
After 3 hours	1.1 ± 0.5	1.3 ± 0.1
After 6 hours	1.1 ± 0.3	1.2 ± 0.3
After 9 hours	1.3 ± 0.0	1.2 ± 0.4
After 12 hours	1.5 ± 0.3	1.5 ± 0.6

Table 6: Pain Score (VAS) in the two groups of patients *=P<0.05.

	PVB group (n=30)	EPB group (n=30)
Operative day	1.3 ± 1.2	1.4 ± 1.0
Post-operative day 1	1 ± 1.0	1 ± 0.7
Post-operative day 2	1 ± 0.9	1 ± 0.9

Table 7: Frequency of administration of additional analgesic agents.

Side Effect	PVB group (n=30)	EPB group (n=30)
No adverse effects	18	15
Hypotension	4	9
Urinary retention	1	4
Nausea and vomiting	3	7

Table 8: Incidence of adverse effects of the anesthetic agents.

Discussion and Conclusion

Post thoracotomy pain is one of the severest forms of pain that can be experienced by a patient. It occurs as a result of stretching of the costo-vertebral and cost-transverse joint ligaments as a result of rib retraction and is mediated by the posterior primary ramus and sympathetic chain [15]. Post-thoracotomy pain is especially marked in the dorsal region, where pain is transmitted via the posterior branches of the thoracic nerves [10]. The intense pain caused by this delays

ambulation and increases cost of care and hospital stay. Provision of good post-operative pain management will thus overcome these problems and is primarily reliant on a professional and highly skilled anaesthesiologist [8].

Peripheral intercostal nerve blocking is of limited value for post-operative pain control because it cannot block the sympathetic trunk. It is this trunk that mainly transmits pain through the posterior branches of the thoracic nerves [16]. Epidural anaesthesia is much more effective as it blocks all peripheral nerves involved in post-thoracotomy pain but it may fail and is associated with a number of adverse effects such as urinary retention, nausea, vomiting, hypotension, and respiratory depression [17]. Paravertebral anaesthesia was introduced as a method of compartment blocking. Segmentation of sympathetic nerve into small bundles in the fat of paravertebral space makes the nerve easy to block. Thus, it is a very effective technique for controlling post-thoracotomy pain with reported efficacy comparable to that of epidural block [18]. Moreover, it overcomes the severe autonomic dysfunction that occurs in association with neuraxial techniques [8].

In the current study we found that both PVB and EPB were effective in a similar degree in controlling post-operative pain but paravertebral block was safer and more tolerable for the patients. This is in keeping with most of the reports comparing the two techniques [8,10,19]. There was also no significant difference in the frequency of administering additional analgesia between the groups which confirms that pain control was achieved adequately using both techniques [10].

Perhaps the most important finding was related to safety and tolerability. We found higher PEFR values in the PVB group. This was also reported by others [8,20]. This indicates better preservation of pulmonary function in the paravertebral group and thus its superiority in terms of safety. This is further demonstrated by the much lower occurrence of adverse effects in the paravertebral group in our study as well as others [8,10]. This is related to the fact that the paravertebral technique results in unilateral block and was specifically designed to avoid the risk of hypotension and urinary retention that is associated with epidural block.

In conclusion, thoracic paravertebral block results in at least similar analgesic effects to epidural anaesthesia and is associated with a lower risk of complications. It is therefore a better option than epidural block to control pain after thoracotomy surgery.

Acknowledgements

The authors wish to thank the surgeons, ICU doctors and nurses and lab technicians for their help and Ms. Fatima Mohamed and Ms. Mariam Ibrahim for help with patient recruitment and data organization.

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