The Use of Continuous Thoracic Paravertebral Nerve Block under Direct Vision for Postoperative Pain Management in Thoracic Surgery

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Objective: *The purpose of the present study was to determine the quality of analgesia of continuous thoracic paravertebral nerve block after thoracic surgery by inserting a catheter under direct vision and assessing complications related to the analgesia technique.*

Material and Method: *Thirty patients with ASA I-III scheduled for pulmonary resection were enrolled in the present prospective study. Posterolateral thoracotomy was done by one surgeon. At the end of the operation before chest closure, a 16 G Touhy needle was inserted under direct vision at distance 5 cm from midline below incision interspace. The needle was advanced slowly until its tip bulged into the potential space, which is called paravertebral space, beneath the parietal pleura. Then, passing a catheter until the distal tip laid two to three intercostal spaces above the incision. A bolus of 15 to 20 ml of 0.5% levobupivacaine was given via a catheter and a continuous infusion with 0.25% levobupivacaine at rate 0.1 ml/kg/hr. Rescue treatment consisted of intravenous morphine and oral analgesic drugs. Numeric rating scale (NRS at rest, movement and cough), an amount of morphine consumption and complications related to analgesia were assessed at 2, 6, 12, 24, 48, 72, and 96 hours after operation.*

Results: *All patients completed the present study. The median numeric rating scale at rest in 24, 48, 72 and 96 hours after the operation was 2 (0-3), 0.5 (0-2),0 (0-2) and 0 (0-1) whereas the median numeric rating scale at deep breathing and coughing was 3.5 (2-5), 2 (2-4), 2 (1-3) and 2 (0-2). The median cumulative morphine consumption in 48 and 72 hours was 2 (0-4) and 3 (0-6) mg. Ten patients did not require additional morphine during the postoperative period. One patient experienced hypotension after a bolus of levobupivacaine for a few hours and recovered after supportive treatment.*

Conclusion: *The use of continuous thoracic paravertebral blockade under direct vision technique offered satisfactory pain control and less complications. It could be considered as an alternative when thoracic epidural block is difficult to access.*

Keywords: *Thoracic paravertebral block, Post-thoracotomy analgesia, Thoracic surgery*

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Thoracic surgery is associated with moderately or severely painful procedures. In addition to post-thoracotomy pain, surgical incision has a detrimental effect on respiratory function[1]. Therefore, inadequate pain control can prevent effective cough production and adequate deep breathing and increases incidence of major respiratory complications such as atelectasis, pneumonia, or respiratory failure[2]. Furthermore, a poor quality of pain relief may lead to chronic pain syndrome that persists for several months and affects the patient's daily life[1].

Thoracic epidural analgesia (TEA) is widely acceptable as a standard technique for providing analgesia after a thoracotomy. It can restore respiratory function by improving respiratory mechanics, allows early immobilization, as well as decreases postoperative morbidity and mortality[3]. On the other hand, TEA carries serious complications such as epidural hematoma, abscess, hypotension, or bradycardia[4]. Thoracic paravertebral block (TPVB) is an alternative technique to TEA for post-thoracotomy analgesia. TPVB is the technique that injects local anesthetic close to the thoracic vertebrae near the exit of the spinal nerves from the intervertebral

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foramen[5]. This technique produces unilateral somatic and sympathetic block at the level above and below the level of injection. Therefore, TPVB can minimize side effects that frequently occur in TEA such as hypotension, urinary retention. Currently, the quality of analgesia of TPVB compared to TEA in many studies is still debated[4]. Performing TPVB with loss of resistance technique is occasionally subjective and unpredictable[5]. An alternative technique of TPVB, in which catheters are placed under direct vision during the intraoperative period, can improve the success rate of this block[6-8]. The purpose of this present study was to determine the quality of analgesia of continuous thoracic paravertebral nerve block after thoracic surgery by inserting a catheter under direct vision and assessing complications related to analgesia technique.

Material and Method

The institutional review board approved the present study and written informed consent was obtained from all patients. Thirty patients aged between 18 and 80 years old, ASA I-III scheduled for pulmonary resection between March 2009 and January 2011 were recruited into the present study. Exclusion from the present study were patients with coagulopathy, liver impairment, tumor occupying at thoracic paravertebral space, infection at the site of block placement. All patients were given diazepam 0.1 mg/kg the night before surgery. General anesthesia was induced with propofol 2 to 2.5 mg/kg, fentanyl 1 to 1.5 μg/kg and vercuronium 0.1 mg/kg and then maintained with 1 to 1.5% Sevoflurane in 50% N2O and oxygen. All patients were intubated with a double-lumen endotracheal tube for one lung ventilation.

The standard posterolateral thoracotomy was performed at the fourth or fifth intercostal space for all patients. Before closing the chest wall, the fifth spinous process was used as a landmark and approximately 5 cm far from that point. A 16-G Touhy needle was inserted perpendicular to skin at the intercostal space one to two levels below the incision. The needle was placed medial to keep its curve towards the parietal pleura until the tip bulged into the potential space, which was called paravertebral space. Next, the stylet was removed and 3 to 5 ml of saline was injected via the needle to expand this space. The catheter was placed until its tip lay two to three spaces above the incision. If the parietal pleura was perforated, the needle was removed and replaced with the same technique. A bolus of 15 to 20 ml of 0.5% levobupivacaine (Chirocaine®, Abbott laboratories, Nycomed Pharma AS, Elverum, Norway) was injected via the catheter followed by a continuous infusion with 0.25% levobupivacaine at rate 0.1 ml/kg/hr which was started at the postanesthesia care unit and the dosage of levobupivacaine infusion was decreased by 10% after the first 48 hours in order to decrease the cumulative dose of levobupivacaine and increase the safety of TPVB. The catheter was then sutured at the skin to prevent the displacement of catheter. Rescue treatment consisted of 0.05 mg/kg of intravenous morphine every four hours if NRS was more than 4. All patients were also given oral paracetamol 1 gm every six hours and oral non-steroidal anti-inflammatory drugs (NSAIDs) as appropriate. Data were collected at 2, 6, 12, 24, 48, 72 and 96 hours after surgery by anesthesia residents and nurses at surgical wards. The following data were assessed: (1) numeric rating scale at rest and deep breathing or coughing, (2) total amount of morphine requirement for rescue analgesia, (3) adverse event related to analgesia technique including nausea and vomiting, sedation, Horner's syndrome, hypotension, bilateral blockade, and weakness of arm or leg and (4) the area of segmental spread of pinprick analgesia. Data are presented as mean $\pm$ SD, median and inter-quartile range for continuous data and frequencies and percentages for categorical variables.

Results

Thirty patients (19 males and 11 females) completed the present study. Patient's characteristics are presented in Table 1. Numeric rating scale at rest and deep breathing or coughing in 2, 6, 12, 24, 48, 72 and 96 hours after operation was shown as box plots (25 and 75 percentiles) in Fig. 1 (A, B). Three patients (10%) had severe pain (NRS = 8) and two patients required morphine supplement particularly in the first two hours after the operation. Seventeen patients (57%) had moderate pain and received intermittent intravenous morphine during the first 24 hours and oral paracetamol and NSAIDs for breakthrough pain. Ten patients (33%) did not require additional morphine during postoperative period and received oral paracetamol alone for relieving mild pain intensity. The mean cumulative morphine consumption at different time interval was shown in Fig. 2. Three patients (10%) developed post-thoracotomy ipsilateral shoulder pain and four patients (13%) experienced pain at the scapular region. One patient developed hypotension after a bolus of levobupiva-caine 15 ml. However, he had hemodynamic stability after receiving supportive

Table 1. Patient characteristics and operative data

Characteristics	n = 30
Age (yr) mean ± SD	59.93 ± 12.21
Gender (n, %)	
Male	19 (36.67%)
Female	11 (67.33%)
BW (kg) mean ± SD	52.88 ± 10.92
Ht (cm) mean ± SD	158.97 ± 7.37
BMI (kg/m^2) mean ± SD	20.87 ± 3.83
ASA (n, %)	
I	3 (10%)
II	22 (73.33%)
III	5 (16.67%)
Underlying disease (n, %)	
HT	13 (43.33%)
DM	3 (10 %)
Chronic obstructive lung disease	2 (6.67%)
Old CVA	1 (3.33%)
Renal impairment	2 (6.67%)
Side of operation (n, %)	
Right	15 (50%)
Left	15 (50%)
Type of operation (n, %)	
Lobectomy	22 (73.33%)
Bilobectomy	3 (6.67 %)
Segmentectomy	4 (13.33%)
Lobectomy and chest wall reconstruction	1 (3.33%)
Duration of surgery (min) mean ± SD	151.96 ± 48.96
Intraoperative fentanyl (μg) mean ± SD	104.33 ± 31.99
Thoracic dermatome of sensory blockade	
Superior level	4 (2-5)
Inferior level, median (ranges)	8 (6-11)
Length of hospital stay (day), median (ranges)	9 (7.5-13)

BW = body weight; Ht = height; BMI = body mass index; ASA = American Society Association physical status; HT = hypertension; DM = diabetes mellitus; Old CVA = old cerebrovascular accident

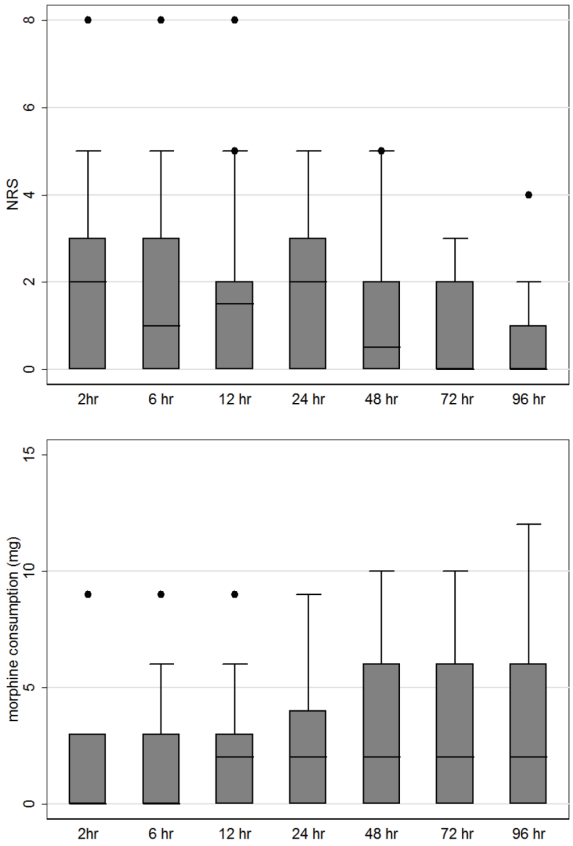

Fig. 1 Numeric rating scale (NRS) at rest (A) and deep breathing and coughing (B) during the first 96 hours was shown as box plots (25-75 percentiles). The horizontal bars represent the median values and the vertical bars represent the 10th and the 90th percentiles. The close circles represent the extreme values

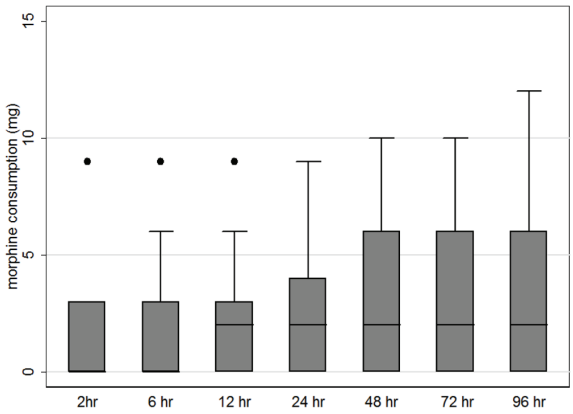

Fig. 2 Cumulative morphine consumption at different interval was shown as box plots

treatment in the first few hours after the operation and then the continuous infusion of levobupivacaine was started without any complication. None of the patients developed nausea and vomiting, respiratory depression, Horner's syndrome or bilateral sensory, or motor blockade.

Discussion

Posterolateral thoracotomy was the main approach in the present study and this type of incision is associated with severe pain and respiratory complications particularly in patients without

adequate analgesia. TEA has been currently used for management of post-thoracotomy pain. However, several limitations including failure of catheterization due to anatomical difficulty, inexperience of the clinician and some contraindications such as coagulopathy, sepsis or neurological diseases may preclude the use of TEA[1,6]. The present study showed that the use of TPVB by direct vision technique provided a good quality of analgesia after thoracic surgery. The authors found that most patients had an acceptable pain score at rest and on coughing and required less morphine consumption particularly in the 48 hours after the operation compared to the study of Marret et al (cumulative PCA morphine consumption 51 $\pm$ 29 mg). The efficacy of TPVB in thoracic surgery has been described in many studies[7-9]. Nevertheless, various regimens of TPVB have been presented in the literature including dose and choice of local anesthetic, administration techniques (continuous infusion or intermittent) or timing of TPVB[10]. Furthermore, different approaches have been used for TPVB including the classical approach (loss of resistance technique)[5], intercostal approach[11], percutaneous approach[12], placement catheters under direct vision[5,6] or ultrasound guided[13]. The placement of paravertebral catheter under direct vision had been chosen in the present study because the authors have little experience with TPVB. This approach is also simple, easy to perform and has a high success rate of catheterization as well as it can be performed by a surgeon or an anesthesiologist during the time of surgery. Although this is the first time of our institution to perform TPVB under direct vision, all catheters were successfully placed in the paravertebral space. In addition, this technique can be performed when patients required unexpectedly extensive procedures or thoracic epidural anesthesia is contraindicated or difficult to establish[5,6,14]. The position of the paravertebral catheter can also be verified by observing the location of catheters under the parietal pleura and the spreading of local anesthetic after injection as shown in Fig. 3. To minimize leakage of levobupivacaine into pleural space, the integrity of the parietal pleura needs to be checked after a bolus of local anesthetic. Many studies frequently used thoracic paravertebral block for 48 or 72 hours[7,15-17], whereas the present study had extended the study period to 96 hours after the operation.

This finding also founded that one patient (3.3%) developed hypotension after a bolus of levobupivacaine during the operation. Previous study[5,18] described that the incidence of hypotension requiring treatment was about 5% during thoracic or lumbar paravertebral blockade. Nevertheless, the frequency and severity of hypotension was less in TPVB than TEA because it produced unilateral sympathetic blockade and its extension of spreading was quite limited compared to TEA. In addition, hypotension could develop in some patients having TPVB due to vaso-vagal episode[5].

Levobupivacaine is a long-acting local anesthetic and the pure S-enantiomers of bupivacaine. Levobupivacaine was chosen instead of bupivacaine in the present study for several reasons. First, TPVB requires high concentration and volumes of local anesthetic compared to TEA[19]. There might be a potential of systemic accumulation over a few days for continuous infusion of local anesthetic and prolonged use of bupivacaine may increase the risk of toxicity[16,17]. Next, levobupivacaine has higher margin of safety and has less cardiotoxic and neurotoxic effects when compared to racemic bupivacaine at an equipotent dose[2,20]. Finally, because of its favorable pharmacokinetic profile, levobupivacaine is an appropriate local anesthetic for TPVB especially when continuous infusion is considered[21]. Levobupivacaine provides similar potency to racemic bupivacaine in many studies[22-24], whereas Casati et al[20] concluded

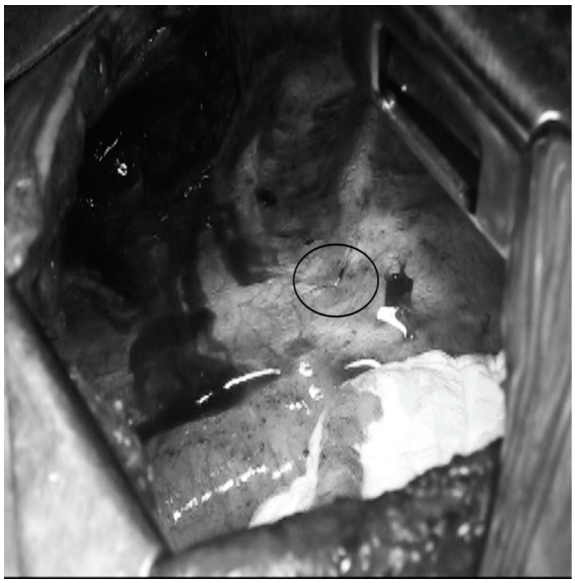

Fig. 3 Tip of the paravertebral catheter (black circle) was seen below the parietal pleura

that potency of levobupivacaine is lower than racemic bupivacaine. The dosage and concentration of levobupivacaine in the present study was selected from dose of bupivacaine in the study of Garutti and Myles et al[6,12]. Although the total amount of levobupivacaine in the present study was slightly higher than the recommendation of the manufacturer (400 mg in 24 hours)[22] especially in obese patients, none of these patients developed signs of toxicity from the local anesthetic. In addition, an amount of bupivacaine dosage in the present study is classified as 'the lower dose group' according to the study of Kotze et al[10]. In this category, patients received bupivacaine infusion of TPVB ranging from 325 to 472.5 mg in 24 hours.

There are some limitations of this present study. Firstly, TPVB was performed just before the chest closure so that a pre-emptive effect of TPVB might not be obtained. However, sixty percent of the patients (n = 22) had acceptable numeric rating scale and required less morphine supplement during the present study period. In addition, previous studies[7,10] showed that there was no significant difference in severity of postoperative pain score at rest or on coughing according to timing of TPVB. Secondly, this technique did not provide complete analgesia in 40% of the patients (n = 12), who still required morphine supplement particularly during the first 24 hours. It was possible that the lower level of sensory blockade might not be adequate to provide complete analgesia. Hence, an increased amount of levobupivacaine infusion might provide better analgesia and reduce the amount of morphine consumption. Next, the authors did not measure plasma concentration of levebupivacaine during the continuous TPVB. However, no patient developed the symptoms and signs of local anesthetic toxicity. Lastly, the present study did not compare the effectiveness of TPVB with TEA for post-thoracotomy analgesia.

In conclusion, the present study demonstrated that continuous thoracic paravertebral block under direct vision offered a satisfactory pain control after thoracic surgery with fewer complications. This technique may be an alternative to thoracic epidural block for postoperative pain control in thoracic surgery.

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Potential conflicts of interest

None.

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การระงับปวดหลังการผ่าตัดทรวงอกโดยการสกัดกั้นเส้นประสาท thoracic paravetebral อย่างต่อเนื่องผ่านสายซึ่งใส่โดยวิธี direct vision

ตันหยง พิพานเมฆาภรณ์, สมเจริญ แซ่เต็ง

วัตถุประสงค์: เพื่อประเมินประสิทธิภาพของการระงับปวดภายหลังการผ่าตัดทรวงอกโดยเทคนิคการใส่สายเข้าไปสกัดเส้นประสาทโดยตรง และประเมินผลข้างเคียงที่เกิดขึ้นจากการใช้เทคนิคดังกล่าว

วัสดุและวิธีการ: เป็นการศึกษาไปข้างหน้าโดยทำการศึกษาในผู้ป่วยจำนวน 30 รายที่มี ASA 1-3 และมารับการผ่าตัดปอดผู้ป่วยทุกรายได้รับการผ่าตัดทรวงอกแบบเปิด โดยศัลยแพทย์คนเดียวกัน ในช่วงท้ายของการผ่าตัดก่อนที่จะปิดทรวงอก ศัลยแพทย์จะแทงเข็ม Touhy ขนาด 16 G บริเวณทรวงอกในตำแหน่งที่อยู่ห่างจากแนวกึ่งกลางลำตัวประมาณ 5 เซนติเมตร ในช่องกระดูกซี่โครงระดับที่ต่ำกว่าแผลผ่าตัด ค่อย ๆ ดันเข็มเข้าไปจนกระทั่งปลายเข็มเข้าไปอยู่ในช่องที่อยู่ข้างกระดูกสันหลังซึ่งอยู่ใต้ต่อเยื่อหุ้มปอด (parietal pleura) จากนั้นใส่ catheter ผ่านทางเข็มจนกระทั่งปลายสายเข้าไปอยู่บริเวณช่องกระดูกซี่โครงที่อยู่เหนือแผลผ่าตัดประมาณ 2-3 ช่อง จากนั้นฉีดยา 0.5% levobupivacaine ในปริมาณ 15-20 มิลลิลิตร ผ่านทาง catheter และให้ยา 0.25% levobupivacaine ในปริมาณ 0.1 มิลลิลิตร, กิโลกรัม/ชั่วโมง ในกรณีที่ผู้ป่วยปวดแผลผ่าตัดมากจะได้รับยามอร์ฟีนทางหลอดเลือดดำ และรับประทานยาระงับปวด ผู้ป่วยจะได้รับการประเมินระดับความเจ็บปวดโดยใช้ numeric rating scale โดยประเมินในขณะพักเคลื่อนไหว หรือ ไอ บันทึกปริมาณยามอร์ฟีนที่ได้รับ และผลข้างเคียงต่าง ๆ ที่เกิดขึ้น ในระหว่าง 2, 6, 12, 24, 48, 72 และ 96 ชั่วโมงตามลำดับ

ผลการศึกษา: ผู้ป่วยทุกรายอยู่ในการศึกษาตลอดระยะเวลาที่ทำการศึกษา ค่ามัธยฐานของค่า numeric rating scale ในขณะพักในระหว่าง 24, 48, 72 และ 96 ชั่วโมง เท่ากับ 2 (0-3), 0.5 (0-2), 0 (0-2) และ 0 (0-1) และค่ามัธยฐานของค่า numeric rating scale ในขณะเคลื่อนไหวในช่วงเวลาเดียวกันเท่ากับ 3.5 (2-5), 2 (2-4), 2 (1-3) และ 2 (0-2) ค่าเฉลี่ยสะสมของปริมาณ morphine ที่ผู้ป่วยได้รับในระหว่าง 48 และ 72 ชั่วโมง เท่ากับ 2 (0-4) และ 3 (0-6) มิลลิกรัม ผู้ป่วยจำนวน 10 ราย ไม่ต้องการยามอร์ฟีนเพิ่มตลอดช่วงระยะเวลาของการศึกษาผู้ป่วยจำนวน 1 ราย มีภาวะความดันต่ำประมาณ 1-2 ชั่วโมง ภายหลังการฉีดยา levobupivacaine และตอบสนองดีต่อการรักษาตามอาการ

สรุป: การระงับปวดหลังการผ่าตัดทรวงอกโดยการสกัดกั้นเส้นประสาท thoracic paravetebral อย่างต่อเนื่องผ่านสายซึ่งใส่โดยวิธี direct vision สามารถระงับปวดภายหลังการผ่าตัดทรวงอกได้ดี มีภาวะแทรกซ้อนค่อนข้างน้อย และสามารถใช้เทคนิคดังกล่าวได้ในกรณีที่ผู้ป่วยรายนั้น ๆ ไม่สามารถใช้เทคนิคการระงับปวดโดยการใส่สาย เหนือช่องดูราได้