Thoracic Paravertebral Block for Video-Assisted Thoracoscopic Surgery: Single Injection Versus Multiple Injections

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Objective: **Thoracic paravertebral blocks (PVBs) have been shown to be effective for analgesia after video-assisted thoracoscopic surgery (VATS) with single- and multiple-injection techniques. The efficacy of single-injection PVB was compared with multiple-injection PVB on postoperative analgesia in VATS was studied.**

Design: **Prospective, randomized study.**

Setting: **Single university hospital.**

Participants: **Fifty patients undergoing VATS.**

Interventions: **A nerve stimulator-guided PVB was performed in the sitting position before surgery using a solution of 20 mL 0.5% bupivacaine with 1:200,000 epinephrine by a single injection at T6 (group S, n = 25) or by 5 injections of 4 mL each at T4 to T8 (group M, n = 25).**

Measurements and Main Results: **A successful PVB was achieved in all patients. The times to perform the blocks were 6.8 ± 1.9 minutes in the S group and 17.9 ± 3.0 minutes in the M group ($p < 0.001$). The times to block onset were 8.3 ± 1.8 minutes in the S group and 7.2 ± 0.9 minutes in the M group ($p = 0.014$). The numbers of anesthetized dermatomes were 5.8 ± 0.8 for the S group and 6.6 ± 1.1 for the M group ($p = 0.009$). The postoperative pain scores and morphine consumption with patient-controlled analgesia were comparable in the two groups. There were no significant differences in times to the first mobilization and hospital discharge for two groups. Patient satisfaction with the analgesic procedure was greater in the S group ($p < 0.05$). No complications were attributed to the blocks.**

Conclusions: **The two techniques provided comparable postoperative analgesia. However, single-injection PVB may represent an advantage over multiple-injection PVB in patients undergoing VATS, with greater patient satisfaction associated with a shorter procedure and the likelihood of decreased complications.**

KEY WORDS: paravertebral block, postoperative pain, analgesia, video-assisted thoracoscopic surgery

VIDEO-ASSISTED THORACIC SURGERY (VATS) is increasing in popularity. The potential advantages of VATS include less postoperative pain, earlier mobilization, lower overall morbidity, a shortened hospital stay with lower costs, a cosmetic incision, and, for some procedures, a shorter operating time.[1,2] Nevertheless, even if VATS is less painful than a normal thoracotomy, pain remains an issue in the postoperative period, especially during the first hours after surgery.[3-5]

Different pain treatments for VATS have been described in the literature: nonsteroidal anti-inflammatory drugs, systemic opioids, epidural analgesia, paravertebral block (PVB) with local anesthetics, patient-controlled analgesia (PCA), cryoanalgesia, surgical wound infiltration, and transcutaneous electrical nerve stimulation.[4-9] These are used as a single treatment or as combined treatments. However, the ideal postoperative analgesia regimen for the brief but intense pain associated with VATS procedures has not been elucidated.

Recently, PVB combined with PCA with morphine has gained popularity as an alternative technique for postoperative analgesia in thoracoscopic procedures.[5] Previous studies have shown that a thoracic PVB with a single injection or multiple injections before VATS provides excellent pain relief with few side effects during the first postoperative hours.[4,10,11] However, to date, there has been no study comparing the postoperative analgesic effects obtained after a PVB with a single large bolus or multiple small injections for thoracoscopic surgery.

A modified PVB technique, including the use of a nerve stimulator, has been used increasingly for different types of surgery and has been found capable of producing excellent and surprisingly long-lasting postoperative pain relief.[12,13]

The aim of this study was to compare the effectiveness of the single- with the multiple-injection technique for nerve stimulator-guided thoracic PVB on postoperative analgesia in patients undergoing VATS.

METHODS

After ethical committee approval and written informed consent, 50 patients 18 to 65 years old, with American Society of Anesthesiologists class I to III risk undergoing elective VATS, were enrolled in this prospective, randomized, single-blinded clinical study. Patients with cardiac, renal, or hepatic failure, allergy to study medications, and uncontrolled systemic disease (eg, unstable diabetes) were excluded. Patients with a preoperative forced expiratory volume in 1 second <60% of the reference value and those with sleep apnea were excluded. At the preoperative visit, each patient was instructed in how to evaluate his/her own pain using a visual analog scale (VAS) of 0 to 10 cm (0 cm = no pain, 10 cm = worst pain imaginable) and how to use a PCA device. Before transfer to the operating room, a computer-generated random number table was used to assign each patient to receive a single-injection thoracic PVB at T6 (group S, n = 25) or multiple-injection thoracic PVBs at T4 to T8 (group M, n = 25).

After the application of standard monitoring, including electrocardiography, noninvasive blood pressure, and pulse oximetry, an intravenous saline infusion (8 mL/kg/h) was started. Patients were given oxygen by facemask and sedated in the sitting position with midazolam, 1 to 3 mg, and fentanyl, 50 to 100 μg. Thoracic PVBs were performed as an adjunct to general anesthesia using a nerve stimulator-guided technique. PVBs in the two groups were performed by the same anesthesiologist (G.T.) who was not involved with the intra- and postoperative patient care and data collection. After the needle entry sites were marked 2.5 cm lateral to each spinous process, the skin was cleansed with chlorhexidine, and the injection sites were infiltrated with lidocaine 2%, 2 mL, with 1:200,000 epinephrine. At each level, a 22-gauge, 50-mm insulated stimulating needle (Stimuplex; B Braun AG, Melsungen, Germany) connected to a nerve stimulator (initial current 2.5 mA, 0.3 ms, 1 Hz) was introduced perpendicularly to the upper injection point. When the transverse process of the vertebra was contacted, the depth was noted. Then, the needle was withdrawn to the skin level and

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reinserted at a 10° inferior needle angulation so as to pass anterior to the process. After the paravertebral space had been entered, the stimulating current was decreased to <0.5 mA. When an intercostal motor response was elicited or a subjective sensation of muscle contraction was reported (if no contraction was detected, the stimulating needle was manipulated gently a few millimeters upward or downward until the contraction was confirmed) and when it was confirmed that blood or cerebrospinal fluid was not aspirated, the local anesthetic solution was injected. A mixture of 0.5% bupivacaine, 20 mL, with 1:200,000 epinephrine was used. For patients in group M, 4 mL of the solution were injected at each level. For patients in group S, 20 mL of the solution were injected in a single dose. The total dose, volume, and concentration of bupivacaine were selected based on previous studies, all of which showed the efficacy of only bupivacaine in concentrations ranging from 0.2% to 0.5% applied as a bolus dose of 15 to 20 mL (3 to 4 mL for the blockade of a single thoracic segment of a multilevel PVB). The total dose of bupivacaine did not exceed 3 mg/kg. Before this study, a fixed-volume technique was chosen because of the relation between the injected volume and the number of adjacent segments covered by the block.[14] Thus, paravertebral injections were performed using the same total volume of local anesthetic mixture for standardization.

In the two groups, the interval between the introduction of the blockade needle and the local anesthetic injection was recorded as the time to perform the block. The patients were then positioned supine. To determine the success rate of the PVBs, sensory blockade was tested with the pinprick method. Onset time was described as a decreased sensation to the pinprick in the appropriate dermatomal levels after the end of injections. The patient then was transferred to the operating room. The anesthesiologists managing intra- and postoperative patient care and all data collection were unaware of the group assignment. Before surgery, the patient had a decreased sensation to the pinprick in the appropriate dermatomal levels unilaterally.

In the two groups, anesthesia was induced with propofol, 2 mg/kg, and fentanyl, 1 μg/kg. Rocuronium, 0.6 mg/kg, was given to facilitate the endobronchial intubation (Bronchocath tube; Mallinckrodt Medical, Athione, Ireland). Patients also were monitored with an invasive blood pressure catheter after the induction of anesthesia. Anesthesia was maintained with 0.5% to 2% sevoflurane and 50% nitrous oxide in oxygen. During one-lung ventilation, the inspired oxygen concentration was increased to 100%. The mechanical ventilation of the lung was adjusted to maintain normocapnia (end-tidal carbon dioxide concentration 35 to 45 mmHg). In each patient, the aim was to maintain mean arterial pressure (MAP) within 80% to 120% of baseline values. Increases in MAP >20% above baseline were treated by administering fentanyl as a 1-μg/kg bolus and/or raising the inspired sevoflurane concentration to 2%. A decrease in MAP was treated by decreasing the sevoflurane concentration. Heart rate, MAP, peripheral oxygen saturation, and inspired sevoflurane concentration were recorded at 10-minute intervals by a resident anesthesiologist who was blinded to the patient group. The intraoperative total dose of fentanyl used also was recorded. At the end of surgery, anesthesia was discontinued, the neuromuscular blockade was reversed, and the patient was extubated when awake. The patient then was transferred to the postanesthesia care unit and observed for 1 hour. After extubation, patients were encouraged to take supplementary doses of morphine from a PCA device (Abbott Pain Management Provider; Abbott Laboratories, Chicago, IL). The PCA device was programmed to provide a bolus dose of morphine, 30 μg/kg, with a 10-minute lockout time. In addition, during the first 24 hours postoperatively, intramuscular diclofenac (75 mg, b.i.d.) was administered in all patients.

After positioning a patient in the lateral position for the operation, the surgical procedure was performed using standardized thoracoscopy by the same surgical team. Three thoracoscopy ports were used in all cases. A 1-cm incision was made in the seventh intercostal space in the midaxillary line for camera insertion, and a 2-cm access incision was made for the insertion of surgical instruments in the third or fourth intercostal space without rib spreading. Chest tube placement after completion of the surgical procedure was performed through the existing camera port incision, with the chest tube directed posteriorly and inserted up to the apex of the operative side.

The VAS pain scores (at rest and with coughing) and cumulative morphine consumption were assessed postoperatively at 0, 1, 2, 4, 8, 12, and 24 hours. The times to the first analgesic requirement, first mobilization, and hospital discharge and VAS pain scores at the first analgesic requirement were recorded. Side effects, including nausea, vomiting, respiratory depression, sedation, pruritus, drowsiness, confusion, dizziness, and hallucinations, were recorded and treated with the appropriate medication. All patients were questioned as to their satisfaction with the analgesic procedure using a 4-point scale (0 = very unsatisfied, 1 = unsatisfied, 2 = satisfied, 3 = very satisfied). The postoperative assessments were performed by anesthesiologists who were blinded to the PVB technique.

The sample size required was calculated by choosing a difference of 2.5 cm in VAS as the minimum desired difference between the groups. Setting $\alpha = 0.05$, assuming a standard deviation of 0.2 cm (observed in a previous study on VATS pain),[10] and investigating 22 subjects per group, the study could detect a significant difference of 2.5 cm with a power of 0.9 (2-sided hypothesis). The normality distribution of the variables was tested using the Shapiro-Wilke test. Differences between the two groups were compared with Student's t test for normally distributed data and the Mann-Whitney U test for non-normally distributed data. Categoric variables were analyzed using the Pearson χ^2 test. All p values <0.05 were considered to indicate statistical significance. Data were analyzed using SPSS 10.0 (SPSS, Inc., Chicago, IL).

RESULTS

A successful PVB was achieved in all patients. All patients completed the study. Patient and surgical data were comparable for the two groups (Table 1). The characteristics of PVBs, intraoperative anesthetic doses, and hemodynamic data are presented in Table 2. The perioperative heart rate and MAP remained within a 20% range of the baseline values in the two groups. A vasoactive drug requirement was not observed in any

Table 1. Demographic Data

	Group S (n = 25)	Group M (n = 25)	p Value
Male/female	20/5	18/7	
Age (y)	52.7 ± 5.9	53.1 ± 7.8	0.836
Weight (kg)	73.1 ± 9.2	72.2 ± 7.6	0.704
Height (cm)	167.5 ± 7.9	168.5 ± 9.2	0.678
ASA class I/II/III	3/18/4	5/17/3	0.701
FEV_1 (% predicted)	84.2 ± 6.8	86.9 ± 7.6	0.188
FVC (% predicted)	87.9 ± 7.6	88.3 ± 8.1	0.856
Type of surgery			
Wedge resection (n)	5	7	0.741
Lung biopsy (n)	6	5	1.0
Pleural biopsy (n)	8	7	1.0
Pleurodesis (n)	6	6	1.258
Duration of surgery (min)	49.7 ± 9.8	46.8 ± 8.3	0.263

NOTE: Data are presented as the number of patients or mean ± standard deviation.

Abbreviations: ASA, American Society of Anesthesiologists; FEV_1, forced expiratory volume in 1 second; FVC, forced vital capacity.