

Role of intercostal nerve block in reducing postoperative pain following video-assisted thoracoscopy: A randomized controlled trial

ABSTRACT

Background: The main advantages of video assisted thoracoscopic surgery (VATS) include less post-operative pain, rapid recovery, less postoperative complications, shorter hospital stay and early discharge. Although pain intensity is less as compared to conventional thoracotomy but still patients experience upto moderate pain postoperatively. The objective of this study was to assess the efficacy and morphine sparing effect of intercostal nerve block in alleviating immediate post-operative pain in patients undergoing VATS.

Materials and Methods: Sixty ASA I-III patients, aged between 16 to 60 years, undergoing mediastinal lymph node biopsy through VATS under general anaesthesia were randomly divided into two groups. The intercostal nerve block (ICNB group) received the block along with patient control intravenous analgesia (PCIA) with morphine, while control group received only PCIA with morphine for post-operative analgesia. Patients were followed for twenty four hours post operatively for intervention of post-operative pain in the recovery room and ward.

Results: The pain was assessed using visual analogue scale (VAS) at 1, 6, 12 and 24 hours. There was a significant decrease in pain score and morphine consumption in ICNB group as compared to control group in first 6 hours postoperatively. There was no significant difference in pain scores and morphine consumption between the two groups after 6 hours.

Conclusion: Patients receiving intercostal nerve block have better pain control and less morphine consumption as compared to those patients who did not receive intercostal nerve block in early (6 hours) post-operative period.

Key words: Intercostal nerve block; patient control intravenous analgesia; video-assisted thoracoscopy; visual analog scale

Introduction

Video-assisted thoracoscopic surgery (VATS) is a minimally invasive surgical technique used for a variety of diagnostic and therapeutic procedures including lung biopsy, wedge resection, lobectomy, and mediastinal lymph node biopsy as well as for major surgical procedures like pneumonectomy.^[1,2] This technique is becoming increasingly popular because of a low complications rate, reduced surgical morbidity and

mortality, less pain, reduced length of stay in hospital as well as reduced cost.^[1]

Pain is a key component in the alteration of lung function after thoracic surgery and is a consequence of tissue damage including ribs, muscles, and peripheral nerves.^[3,4] One of the variables determining the outcome of patients undergoing thoracic surgery is a good postoperative analgesia which

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helps to reduce the pulmonary complications and stress response.^[5]

Different methods have been described in literature for the control of pain after thoracic surgery which commonly include systemic administration of nonsteroid anti-inflammatory drugs (NSAIDs) and opioids whether continuously, intermittently or by patient controlled methods; regional analgesia with intercostal nerve blocks, paravertebral block and thoracic epidural by either or a combination of NSAIDs, opioids and local anesthetics.^[6]

Although not as severe as thoracotomy, postoperative pain following VATS is still significant. Since the pain of thoracic procedures is principally related to stimulation of intercostal nerves, blockage of these nerves would provide better postoperative analgesia in these patients.^[7] Intercostal nerve block has been used extensively for analgesia after thoracic surgery.^[7]

The objective of this study was to evaluate the efficacy and opioid sparing effect of an intercostal nerve block in postoperative pain relief after VATS.

Materials and Methods

In this prospective, randomized, double-blinded controlled clinical trial, sixty patients aged 16–60 years of either gender undergoing elective diagnostic VATS were included after written informed consent and approval from the Ethical Review Committee of the Aga Khan University Hospital. Patients were randomly and equally divided into two groups using opaque sealed envelope technique. In the intervention group, the patients received general anesthesia along with intraoperative intercostal nerve blockade (ICNB) using 0.25% bupivacaine at the end of the surgical procedure (ICNB Group $n = 30$), while in the control group, patients received general anesthesia only (control group, $n = 30$). The exclusion criteria included American Society of Anesthesiologists (ASA) IV, age < 16 years, patient refusal, emergency surgery, psychiatric illness, history of allergy or hypersensitivity to bupivacaine and language barrier/patient unable to understand patient controlled intravenous analgesia (PCIA).

All patients were premedicated with oral midazolam 7.5 mg 1 h preoperatively. After application of ASA standard monitoring including electrocardiography lead II, noninvasive blood pressure, peripheral arterial oxygen saturation (SaO_2), and securing intravenous access, all patients were preoxygenated for 3 min. General anesthesia was induced with morphine 0.1 mg/kg, propofol 2–3 mg/kg, and atracurium 0.5 mg/kg

and after 3 min of bag-mask ventilation, patients' trachea was intubated with single lumen endotracheal tube. Anesthesia was maintained with 1 minimum alveolar concentration Isoflurane in oxygen/air mixture and fraction of inspired oxygen was adjusted to maintain $\text{SaO}_2 > 95\%$. Ventilation was adjusted to maintain normocapnia (end-tidal carbon dioxide between 35 and 45 mmHg). Concentration of anesthetic gases and capnography was also monitored continuously using Datex-Ohmeda S/5 Anesthesia Monitor (Datex-Ohmeda, Helsinki, Finland). On removal of thoracoscope, a chest drain was placed through the port of thoracoscope insertion. At the end of the surgery before extubation, patient in Group A received percutaneous ICNB, aseptically, in the intercostal spaces extending from two spaces above the incision to two spaces below on the operative side in the lateral position. ICNB was performed by using 21 g needle at the angle of rib 5 cm lateral from the midline posteriorly. Needle walk down the rib technique was used to locate the intercostal space and after negative aspiration, 4 ml of bupivacaine 0.25% was be injected into each space. Following this, the patients' trachea was extubated, and patients were shifted to the postanesthesia care unit (PACU).

In PACU, one of the investigators who were unaware of the group attached the PCIA to all the patients in either group. PCIA setting for both the groups remained same (morphine in a concentration of 1 mg/ml with a bolus of 1 mg morphine, lockout time of 10 min and background infusion of 0.5 mg/h). Postoperative pain was assessed using visual analog scale (VAS) at 1, 6, 12, and 24 h. Morphine 1 mg intravenous bolus was given if pain score exceeded 5 on VAS at any point during the study as rescue analgesia. The history from PCIA, pain severity score, rescue analgesia, nausea, vomiting, and sedation were recorded on a predesigned data collection form for each patient.

The sample size calculation was based on a previous study Taylor *et al.*^[8] who reported a 24 h morphine requirement of 40–45 mg with a standard deviation of 15–20 mg. For the purpose of the sample size calculation, a 25% absolute reduction in morphine consumption was considered to be a clinically important difference in the ICNB group as compared to control group. It was calculated that 27 patients per group were required for experimental design, using an alpha of 0.05 and beta of 0.2. To minimize any effect of data loss, thirty patients in each group were recruited assuming a 10% dropout rate. All statistical analysis was performed using statistical packages for social science version 19 (SPSS Inc., Chicago, IL, USA). Mean and standard deviation were estimated for age, weight, height, body mass index, duration of surgery, and VAS pain score while frequency and percentage were computed for categorical variables. Independent sample *t*-test and Chi-square test were

used to observe the difference between groups for quantitative and qualitative variables respectively. Repeated measures ANOVA was also applied to observe the between and within effect. The $P \leq 0.05$ was considered statistically significant.

Results

Patients' demographic characteristics and duration of surgery were comparable among both the groups [Table 1]. There was a significant reduction in morphine consumption in ICNB group at 6 h as compared to control group (12.7 ± 7.09 mg vs. 17.33 ± 8.44 mg, $P < 0.05$) while the requirement for rescue analgesia was also higher but not statistically significant between groups. Similarly, total morphine consumption at 6 h was also significantly higher in the control group than ICNB group as shown in Table 2.

From 6 h onwards, PCA morphine consumption was similar in both groups as was the requirement of rescue analgesia and total morphine consumption. For the total period of study, i.e., 24 h, PCA morphine consumption, although

lower in ICNB group, did not reach statistical significance. The need for rescue analgesia was significantly higher in control group ($P < 0.05$) while total morphine consumption was insignificantly lower in ICNB group [Table 2].

Mean pain score was also significantly lower in ICNB group when compared to control group at all-time intervals, i.e., at 1, 6, and 24 h [Figure 1]. None of the patients had nausea, vomiting or sedation in either group. There were no reported complications associated with intercostal nerve block used in ICNB group.

Discussion

Over the past few years, VATS has become an increasingly popular technique and has replaced a number of indications of conventional thoracotomy and mediastinoscopy. Procedures such as pleurodesis, lung and pleural biopsies, wedge resections, lung volume reduction and even anatomical pleural resections can be performed with this technique. VATS is considered to be less invasive with less interruption of a chest wall and less tissue damage, it is assumed that patients undergoing VATS would experience less pain as compared to a thoracotomy and would recover from surgery more quickly.^[8] Despite all these advantages, VATS procedure can induce significant morbidity, including postoperative pain and temporary impairment of lung function. Studies have shown that these patients may experience moderate

Table 1: Comparison of demographic and duration of procedure between groups

Variable	ICNB group (n=30)	Control group (n=30)	P
Age (years)	39.9 (14.7)	40.8 (15.1)	NS
Weight (kg)	64.6 (15.6)	68.5 (14.5)	NS
Height (cm)	163.3 (8)	164.2 (9.7)	NS
BMI (kg/m ²)	24.08 (4.7)	25.3 (4.3)	NS
Duration of procedure (min)	50.8 (17.1)	50.3 (22.9)	NS
Gender* (%)			
Male	16 (53.3)	17 (56.7)	NS
Female	14 (46.7)	13 (43.3)	NS

Data presented as mean±SD and n (%). NS: Not significant; BMI: Body mass index; ICNB: Intercostal nerve blockade; SD: Standard deviation

Table 2: Morphine consumption at different time intervals

Morphine consumptions	ICNB group (n=30)	Control group (n=30)	P
PCA morphine			
0-6	12.7±7.09	17.33±8.44	<0.05
6-24	26.13±8.3	27.5±7.29	NS
Total	38.9±13.9	44.8±13.5	NS
Rescue morphine			
0-6	0.13±0.57	0.76±1.86	NS
6-24	0.2±0.6	0.26±0.82	NS
Total	0.33±0.84	1.4±2.1	<0.05
Total morphine (h)			
0-6	12.9±7.2	18.1±9.3	<0.05
6-24	26.3±8.5	27.7±7.5	NS
Total	39.2±14.2	46.2±14.6	NS

Data presented as mean±SD and analyzed by independent t-test. ICNB: Intercostal nerve blockade; SD: Standard deviation; PCA: Patient-controlled analgesia; NS: Not significant

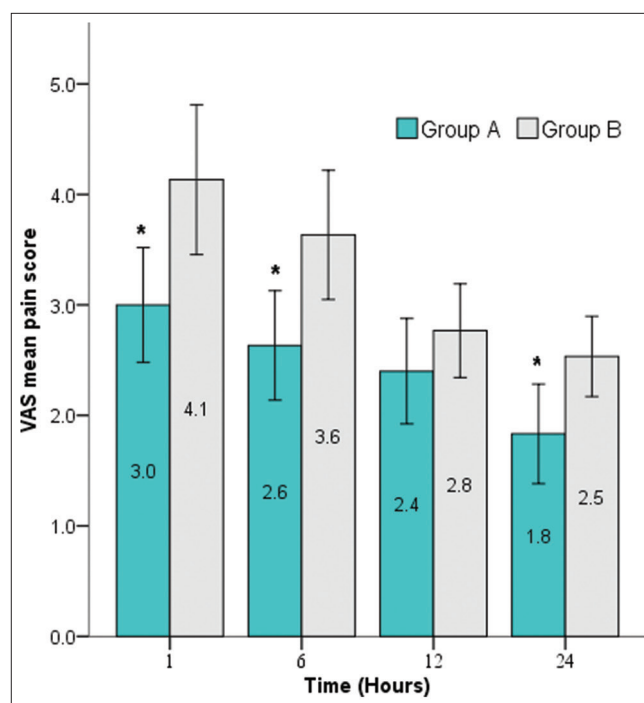


Figure 1: Comparison of visual analogue scale mean pain score with respect to time. (* $P < 0.05$) (Group A – intraoperative intercostal nerve blockade, Group B – control)

to severe pain, especially during the first few hours after the surgery. Benedetti *et al.* assessed the postoperative pain scores in patients undergoing VATS. They found that patients undergoing VATS have pain score of 3.2 ± 2.4 .^[9] In this study, the similar pain score was found to be of mild to moderate intensity indicating the need for intensive pain management.

Sanjay *et al.* compared ICNB using 0.25% bupivacaine versus thoracic epidural analgesia for postthoracotomy pain relief and found that the effect of intercostal nerve block would wear off after 4 h.^[10] Taylor *et al.* reported good quality analgesia for a median duration of 16 h with a significant reduction in morphine requirements with bupivacaine 0.375%.^[8] In this study, 0.25% bupivacaine was used for intercostal nerve blocks and this is probably the reason for the median duration of 6 h of effective analgesia provided by the intercostal blocks. Although the requirement of Morphine is significantly less in the first 6 h, following that the morphine consumption was similar in both the groups up to 24 h. This can be attributed to the intercostal nerve block which provided effective analgesia during this period resulting in less morphine requirement.^[11]

The overall morphine consumption, although higher in the control group (46.2 mg), but was lower than that mentioned by Landreneau *et al.*, who showed a morphine consumption of 57 mg in the first 24 h.^[12]

The pain scores were significantly higher in the control group as compared to the ICNB group at all times. The initial difference could be explained by the presence of intercostal nerve block which provided better pain relief than PCIA alone, but in the later stages, this trend continued probably because of the development of pain sensitization by the earlier better quality of analgesia. Furthermore, the rescue analgesia used was significantly higher in the control group and despite this, the pain scores were higher in this group. A possible explanation could be the initial better pain relief in the intercostal group contributed to alteration in the threshold of pain which was, at all times, lower in the control group. This aspect, however, needs further evaluation in larger trials.

This study was conducted in patient undergoing VATS for biopsy in which intercostal nerve block will cover both incision and visceral pleura pain. Further studies are required to look at the efficacy of intercostal nerve block in patient undergoing procedure other than biopsy like decortication or lobectomy in which pain due to lung damage will be significant and probably will not be covered by intercostal nerve block.

Conclusion

VATS with biopsy is associated with significant pain in the postoperative period. Single shot percutaneous intercostal nerve block following VATS procedure is a simple and safe technique in reducing postoperative pain and opioid requirement and may be beneficial in “fast-track” thoracoscopic surgery.

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Conflicts of interest

There are no conflicts of interest.

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