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Role of loco-regional anesthesia for non-intubated video-assisted thoracoscopic surgery: A tertiary care hospital in northern Thailand

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ABSTRACT:

Background: A few studies have focused on the role of regional anesthesia for non-intubated thoracoscopic surgery (NIVATS) in Thailand. The purpose of the present study was to review the feasibility and safety of loco-regional anesthesia for NIVATS in a tertiary care hospital.

Methods: All patients undergoing scheduled NIVATS under loco-regional anesthesia including thoracic epidural analgesia (TEA), intercostal nerve block (ICNB), thoracic paravertebral block, and local wound infiltration from 2018 to 2021 were assessed by a retrospective chart review. Sedation was performed with propofol infusion and bispectral index monitoring. Primary outcomes were the feasibility of surgery and safety related to loco-regional anesthesia techniques.

Results: Twenty-three patients were included. The average age was 43 (26-59) years. The two most common regional anesthesia techniques in this study were TEA and ICNB. The most common surgical procedure was wedge resection (13 patients, 56.5%) followed by pleurectomy (5 patients, 21.7%). The overall median technical feasible scores were 3 (2-3). Intraoperative hypotension (62.5% for TEA vs 20% for ICNB) and urinary retention (25% for TEA vs 0 for ICNB) were found. Among four patients with severe cough, three patients received intrathoracic vagal block and one patient required general anesthesia due to severe hypoxemia. Patients with ICNB had a higher degree of incisional pain and a higher amount of postoperative morphine consumption.

Conclusion: NIVATS under loco-regional anesthesia could be a feasible and safe technique. A further study is recommended to compare the efficacy and safety of TEA and ICNB for NIVATS.

Keywords: Non-intubated thoracoscopic surgery, Thoracic epidural anesthesia, Intercostal nerve block, Thoracic paravertebral block

INTRODUCTION

Video-assisted thoracoscopic surgery (VATS) under general anesthesia with a double-lumen endotracheal tube (DLT) or a single lumen tube with a bronchial blocker has become a standard practice for several decades. Even though general anesthesia (GA) with controlled ventilation can improve the surgical condition, intubated thoracoscopic surgery is associated with increased postoperative pulmonary complications, increased atelectasis, pneumonia, respiratory failure, or acute respiratory distress, and increased postoperative mortality [1-3]. These GA-related adverse effects involve complications related to intubations, residual effects of neuromuscular blockade, ventilator-induced lung injury, and compromised cardiopulmonary performance. To minimize these complications, non-intubated video-assisted thoracoscopic surgery (NIVATS) has been introduced for a variety of thoracic surgeries including blebectomy [4], resections of lung nodules [5], lung volume reduction surgery [6], segmentectomies, and lobectomies [7]. NIVATS procedures are also considered for high risk patients such as patients with severe emphysema [6] or interstitial lung disease [8]. Under NIVATS, surgical pneumothorax can be created and facilitate operative lung isolation without any requirement of positive pressure ventilation [9]. Several techniques of local and regional anesthesia including local wound infiltration [10]. thoracic epidural analgesia (TEA) [5,7,11-14], thoracic paravertebral block (TPVB) [15], intercostal nerve block (ICNB) [8,16,17], and serratus anterior block [18] have been successfully used during NIVATS. In addition to analgesia, intraoperative sedation is usually required to ease the patient, minimize patient's movement, and optimize the surgical condition, particularly in major non-intubated thoracic surgery [1,19]. However, oversedation may compromise the airway patency, and subsequently induce severe hypoxemia and hypercarbia resulting in conversion to GA.

Although previous studies demonstrated that non-intubated anesthesia for thoracoscopic surgery under regional anesthesia was feasible and safe [5], the selection of types of loco-regional anesthesia depend on types of surgical procedures as well as the experience of the anesthesiologists. The effectiveness of loco-regional anesthesia not only provides adequate analgesia but also facilitates the achievement of NIVATS. The use of NIVATS has been implemented in Thailand, however, a small number of studies elucidating the efficacy of regional anesthesia for NIVATS have been reported [20-22]. The present study aims to review the feasibility and safety of NIVATS under loco-regional anesthetic techniques in a tertiary care hospital.

METHODS

This retrospective review was approved by the Institutional Ethical Committee and written informed consent was waived. The data were collected from the medical charts and electronic medical records of patients scheduled for NIVATS between July 2018 and August 2021 at the department of Anesthesiology, Faculty of Medicine, Chiang Mai University. Inclusion criteria were patients aged 18 years or older who underwent elective NIVATS. The exclusion criteria were incomplete medical records.

KEY MESSAGES:

- The advantages of NIVATS include minimization of the effect of tracheal intubation, avoiding an effect of general anesthesia and one lung ventilation.
- Loco-regional anesthesia such as TEA or ICNB can be feasible and safe for an effective analgesia and help minimize cardiopulmonary complications.

Primary outcomes were 1) technical feasibility score [8] categorized into 4 grades: 4, excellent (defined as no adverse event; no need an adjunctive medication; and no conversion to GA or thoracotomy); 3, good (defined as minor adverse events requiring adjunctive measure or medications to achieve mild sedation; no conversion to GA); 2, satisfactory (defined as adverse events or requirement of adjunctive measures or medication to achieve deeper sedation or thoracotomy; no need of conversion to GA); 1, unsatisfactory (defined as a requirement of conversion to GA); and 0 (defined as unable to perform the procedure) and 2) adverse events related to complications of loco-regional anesthesia such as hypotension, urinary retention, local anesthetic systemic toxicity, bleeding, spinal cord injury, accidental dural puncture, or pneumothorax. Secondary outcomes were 1) anesthesia induction time (defined as the time required to perform loco-regional anesthesia) 2) anesthesia time (defined as the time required to perform anesthesia) 3) operative time (defined as the time between skin incision and skin closure) 4) global operating room time (defined the sum of anesthesia time, operating time, and time required in the postanesthesia care unit (PACU) to achieve stable clinical condition to be transferred to surgical ward) 5) postoperative incisional pain and postoperative morphine consumption during 2, 6, 12 and 24 hours 6) arterial blood gas parameters at three points (baseline, 15 minutes after surgical pneumothorax, and at 1 hour during PACU stay) 7) presence and severity of intraoperative cough 8) a conversion to general anesthesia and 9) other postoperative outcomes including intensive care unit (ICU) admission, postoperative mechanical ventilation, time of return to food intake, time to removal of chest tube, in-hospital mortality, and length of hospital stay.

Anesthesia and surgery

Before surgery, patients received one regional anesthesia technique depending on the anesthesiologist's preference and decision. The loco-regional anesthesia techniques performed in our institute were TEA, TPVB, ICNB, and local would infiltration.

Thoracic epidural analgesia

The epidural block was performed using the paramedian approach at the T5/T6 and T6/T7 interspace by 1 of 4 anesthesiologists (TP, PL, AS, SL). The Touhy needle was advanced until a loss of resistance (LOR) was encountered. Epidural waveform analysis (EWA) was applied as an adjunct to confirm the true LOR [23,24]. Step-by-step processes were 1) injecting 5 ml of saline solution through the Touhy needle 2) attaching a prime sterile pressure to the needle and 3) connecting to a pressure transducer (Figure 1). A positive epidural waveform was a pulsatile waveform within a 0-to 30-mmHg range that synchronized with the arterial pulsation (Figure 2) [24]. Then the epidural catheter was inserted and the epidural waveform was then reassessed to confirm that the catheter was also in the epidural space. A test dose with 3 ml of 1.5% lidocaine and 5 mcg/ml of adrenaline was given to detect intravascular injection. Then 6-10 ml of 0.25% bupivacaine with 5 mcg/ml of adrenaline was titrated to achieve a sensory block from T2 to T10 dermatomes.

Figure 1. Sterile extension tube was connected to the Touhy needle and a pressure transducer.

Figure 2. A positive epidural waveform was a pulsatile waveform within a 0 to 30 mmHg range which synchronized with the arterial pulsation (waveform of pulse oximetry).

Intercostal nerve block

ICNB was performed with two techniques, ultrasound guidance by anesthesiologists and intrathoracic injection by surgeons. While ultrasound-guided ICNB was multiple injections at the 4th to 8th ribs on location posterior to the posterior axillary line during lateral decubitus position, the thoracic ICNB was infiltrated under the parietal pleura at 2 cm lateral to sympathetic chain from the 4th to 8th rib level (Figure 3). The local anesthetic was 4 ml per level of 0.5% bupivacaine.

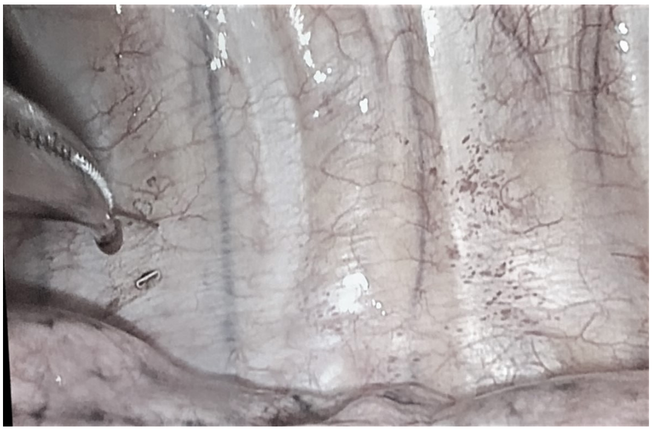

Figure 3. Intrathoracic intercostal nerve block was performed with an infusion needle by an infiltration of local anesthetic under the parietal pleura at 2 cm lateral to sympathetic chain from the 4th to 8th rib level.

Thoracic Paravertebral Block

TPVB was performed at the level of T4/T5 intercostal level in lateral decubitus position using an oblique sagittal technique. An 18-G Touhy needle was inserted in-plane from lateral to medial towards the paravertebral space. The intermittent hydro location using saline solution to see pleural displacement was used to confirm the correct needle tip position. The local anesthetic was 20 ml of a mixture of 0.25% bupivacaine and 1% lidocaine with 5 mcg/ml of adrenaline.

Intraoperatively, continuous electrocardiography, blood pressure, radial artery catheterization, arterial blood gas, pulse oximetry, end-tidal carbon dioxide ($ETCO_2$), and bispectral index (BIS) were applied. All patients were sedated to keep them relaxed and calm. The options of sedative drugs were propofol infusion using a target-controlled infusion method (Injectomat® TIVA Agilia, Fresenius Kabi, Austria) (Figure 4), dexmedetomidine infusion, ketamine bolus or infusion, and intermittent bolus of midazolam and BIS value was maintained between 50 and 70. According to the manufacture's recommendation, a BIS score of 90-100 indicates fully awake; 71-90 mild to moderate sedation; 60-70, deep sedation; and 40-60, general anesthesia. For additional analgesia, 25 mcg of fentanyl was given incrementally to maintain a respiratory rate between 12-20 breaths/minute. Other analgesic options were intravenous paracetamol and parecoxib.

All patients were placed in full lateral decubitus position, supplemented with 8-10 L/min oxygen via mask with a bag to maintain oxygen saturation > 92% by pulse oximetry (SpO_2). Permissive hypercapnia was accepted and did not need any correction until the pH was less than 7.2. To minimize coughing during the surgical procedure, 2 ml of 2% lidocaine was given by nebulizer about 30 minutes before surgery and 1.5 mg/kg of 2% lidocaine was administered intravenously and followed by 1.5 mg/kg/hr of lidocaine until the end of surgery. If patients developed a severe cough during the operation, an intrathoracic vagal blockade was performed by infiltration of local anesthetic adjacent to the vagus nerve under direct vision at the level of the aortopulmonary window for left-sided operation and the level of the lower trachea for the right-sided operation. Two ml of 2% lidocaine and 0.25% bupivacaine were used depending on the duration of the procedure.

A conversion from non-intubated anesthesia to intubated anesthesia was based on a decision of attending surgeons and anesthesiologists in the case of inadequate analgesia, severe respiratory movement, severe hypoxemia (SpO_2 < 80%), unstable hemodynamic conditions, and intraoperative bleeding requiring open thoracotomy.

Figure 4. The patient was given with intravenous propofol by target control infusion method and breathed spontaneously through an oxygen mask with bag and anesthesia depth was adjusted by a bispectral index monitoring and end-tidal carbon dioxide.

Surgical procedure

Thoracoscopic procedures were performed with the dual port technique. All patients were placed in a lateral decubitus position. The utility port was placed at the fourth intercostal space, in the anterior axillary line. The camera port was placed at the seventh or eighth intercostal space between the anterior and posterior axillary. Surgical pneumothorax was made by creating the incision through the chest wall for the utility port and the ipsilateral lung collapsed gradually (Figure 5). Excision of the lung lesion such as lung nodule or apical lung bleb was performed with a linear stapler device. Apical pleurectomy for surgical pleurodesis was routinely performed in primary spontaneous pneumothorax patients. A chest drain 24-28 Fr was inserted via the camera port only in the case suspected of bleeding or air leakage.

Postoperative analgesics and care

The intensity of postoperative pain was assessed using a numerical rating scale (NRS), where 0 is no pain and 10 is the worst pain. In patients with a retained epidural catheter, 5-8 ml of 0.1% bupivacaine and fentanyl 1 mcg/ml was infused for one to two days. All patients were given rescue intravenous morphine 0.05 mg/kg/dose on demand every four hours for rescue analgesia if NRS > 5. Oral analgesic medications including paracetamol, gabapentin or codeine were given when patients began oral intake within six hours after surgery. Chest radiography was performed postoperatively and after chest tube removal. Criteria for chest tube removal and hospital discharge were complete lung re-expansion and no evidence of atelectasis from chest radiography, pleural drainage < 200 mL/day for two days, and no air leak.

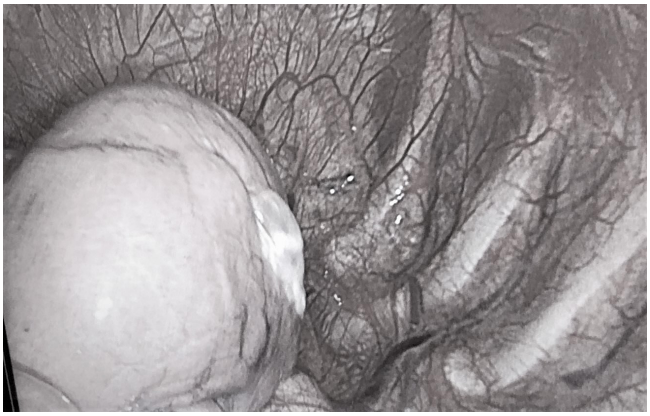

Figure 5. Gradual lung collapsed following surgical pneumothorax created during NIVATS.

Statistical analysis

Baseline characteristic was reported using descriptive statistics. Categorical data are presented as numbers and continuous data was expressed as mean ± standard deviation or median, 25th percentile, and 75th percentile (P_{25}-P_{75}), respectively. Data analysis was performed using STATA software (version 14.0, College Station, TX).

RESULTS

Twenty-three patients were included and successfully completed the surgical procedures. None of the patients was excluded due to an incomplete medical record. Patient characteristics, anesthetics and surgical details are presented in Table 1. The median age of patients was 43 (26-59) years, and 13 patients (56.5%) were male. Most patients were diagnosed with a cancerous lesion (61%) and wedge resection (56.5%) was the most common surgical procedure. The main anesthetic techniques were TEA (69.6%, 16 of 23) and ICNB (21.7%, 5 of 23).

The overall median technical feasibility score was 3 (2-3) indicating that most patients were in satisfactory and good condition regardless of the type of loco-regional anesthetics. Severe cough occurred in four patients receiving TEA. Of these, three patients required an intrathoracic vagal block. While the other patient received general anesthesia with a laryngeal mask airway (LMA) due to severe hypoxemia. No patient was converted to open thoracotomy or required ICU admission.

Between the two most common regional anesthesia techniques in this study, the TEA and the ICNB, a total amount of intraoperative propofol, midazolam, dexmedetomidine, fentanyl, an average intraoperative BIS score, anesthesia induction time, total anesthesia time, surgical time, PACU time, global surgical time, time to first postoperative oral intake, time to chest tube removal, and length of hospital stay were comparable (Table 2). Both techniques provided similar changes in intraoperative PaO_2 and $PaCO_2$. Postoperatively, however, patients with ICNB required a higher amount of postoperative morphine consumption than those receiving TEA. Consistently, postoperative NRS during the first 24 hours seemed higher in patients with ICNB (Figure 6). Concerning the block-related complications, TEA was observed to be associated with intraoperative hypotension, postoperative urinary retention (POUR), postoperative nausea and vomiting (PONV).

Table 1. Patient's characteristics, anesthetic and surgical details

Variables	N = 23
Age, years	43 (26-59)
Male, n (%)	13 (56.5)
Smoking exposure, n (%)	2 (8.7)
Co-morbidities, n (%)	
Hypertension	4 (17.4)
Diabetes mellitus	2 (8.7)
Coronary artery disease	1 (4.4)
Chronic kidney disease	2 (8.7)
Asthma	1 (4.4)
ASA PS, n (%)	
I: II: III	10 (43.5) / 10 (43.5) / 3 (13)
Diagnosis, n (%)	
Benign lesion	2 (8.7)
Cancerous lesion	14 (60.8)
Spontaneous pneumothorax	5 (21.7)
Hyperhidrosis	1 (4.4)
Interstitial pulmonary fibrosis	1 (4.4)
Operative procedure, n (%)	
Wedge resection	13 (56.5)
Pleurectomy	5 (21.7)
Biopsy	3 (13)
Sympathectomy	1 (4.4)
Diaphragmatic plication	1 (4.4)
Side of operation, n (%)	
Right side	12 (52.2)
Left side	7 (30.4)
Both sides	4 (17.4)
Vagal nerve block, n (%)	3 (13)
Anesthetic techniques, n (%)	
Thoracic epidural analgesia	16 (69.7)
Thoracic epidural analgesia with opioids	7 (43.7)
Intercostal nerve block	5 (21.7)
Thoracic paravertebral nerve block	1 (4.3)
Local wound infiltration	1 (4.3)
Conversion to general anesthesia, n (%)	1 (4.3)
Intraoperative intravenous medications, n(%)	
Midazolam	17 (74)
Propofol	22 (95.6)
Ketamine	3 (13.0)
Dexmedetomidine	4 (17.4)
Fentanyl	22 (95.6)
Paracetamol	3 (13.0)
Parecoxib	3 (13.0)
Maximal sedation score during surgery, n (%)	
1 (Response to verbal)	6 (26.1)
2 (Response to pain)	8 (34.8)
3 (Deep)	9 (39.1)

Values are median and 25th and 75th percentiles or number (percentage)
Abbreviations: ASA PS; American Society of Anesthesiologists Physical Status

DISCUSSION

This study demonstrated that loco-regional anesthesia in combination with intraoperative sedation was feasible and safe for NIVATS. The two most common techniques in our institute were the TEA and ICNB. Both techniques provided effective analgesia during surgery without significant intraoperative and postoperative complications. Only one patient, who received TEA, required conversion to general anesthesia due to acute bronchospasm from severe cough. The benefit of the TEA over ICNB was prolonged postoperative pain control. However, the TEA was related to increased intraoperative hypotension, POUR, and PONV. These results in our study were consistent with the findings of previously published studies [4,5,8,25].

Adequate intraoperative pain control is necessary for NIVATS to facilitate smooth surgery and minimize perioperative stress of the patient. Among various loco-regional anesthesia techniques for non-intubated thoracic surgery [5,7,8,10-16,26]. TEA was the most common use for regional anesthesia for NIVATS and followed by ICNB and TPVB. The advantages of TEA over conventional general anesthesia in NIVATS were lower level of stress hormone release [27], faster time to resume oral intake [12,14], better patient satisfaction [5], less severity of postoperative sore throat, shorter duration of antibiotic use [12], and shorter length of hospital stays [4,5,14]. In this study, TEA was chosen as the main anesthetic technique for NIVATS because of its reliability in providing analgesia during thoracic surgery, particularly in open thoracotomy. In addition, the authors applied the EWA as an adjunct to conventional LOR to increase the accuracy of correct placement of the epidural catheter and adequate intraoperative analgesia. A previous study demonstrated that EWA was an accurate and reliable method for confirmation of LOR with the sensitivity and specificity of 91.1% and 83.8%, respectively [24]. Because of simplicity and less, the ICNB was the second most common regional anesthesia in this study. The ICNB can be performed either by percutaneous or intrathoracic direct vision method. Intrathoracic ICNB is reliable and adequate local anesthetic delivery to intercostal nerves beneath the parietal pleura is ensured [8]. A previous retrospective cohort study concluded that patients receiving ICNB had shorter anesthesia induction time, shorter operation time, less duration of chest tube drainage, and more stable hemodynamics, less frequency conversion to intubation, less blood loss and shorter hos-

Table 2. A comparison of clinical outcomes between patients receiving TEA and ICNB for NIVATS

Variables	Total (N =21)	TEA (N =16)	ICNB (N =5)
Propofol, mg	300 (227-420)	325 (255-575)	200 (160-234)
Midazolam, mg	1 (0-2)	1 (0-2)	1.5 (1-2)
Dexmedetomidine, mcg	0 (0-0)	0 (0-0)	42 (0-90)
Fentanyl, mcg	75 (75-100)	75 (62.5-100)	87.5 (75-100)
Average BIS score	62.2 (59.1-72.5)	61.7 (58.2-73)	64.5 (62-67)
Anesthesia induction time, min	30 (30-45)	30 (30-45)	40 (30-45)
Total anesthesia time, min	105 (90-130)	105 (95-135)	100 (70-105)
Surgical time, min	45 (45-75)	55 (45-82.5)	45 (45-45)
PACU time, min	60 (60-60)	60 (60-60)	60 (60-60)
Global surgical time, min	225 (205-265)	230 (210-290)	205 (175-210)
Baseline $PaCO_2$, mmHg (n =18)	43.5 (40.5-48)	44.5 (43-49)	40.5 (39-42)
Baseline PaO_2, mmHg (n =18)	255 (162.5-308)	275.5 (177-310)	170.5 (148-193)
Intraoperative $PaCO_2$, mmHg	53 (51-65)	53 (50-65)	58 (51-65)
Intraoperative PaO_2, mmHg	170 (90-270)	193 (90-288)	92 (64-120)
Technical feasibility score	3 (2-3)	3 (2-3)	3 (2-3)
Conversion to general anesthesia, n (%)	1 (6.3)	1 (6.3)	0
Total intraoperative fluid administration, ml	400 (300-700)	400 (275-650)	500 (300-850)
Cumulative morphine consumption during 24 hrs, mg	5 (0-16)	0 (0-6)	18 (10-20)
Intraoperative complications, n (%)			
Hypotension (SBP < 90 mmHg)	11 (47.8)	10 (62.5)	1 (20)
Desaturation (SpO_2 < 90 %)	2 (8.7)	2 (12.5)	0
Hypercarbia ($PaCO_2$ > 50 mmHg)	10 (77)	7 (43.7)	1 (20)
Bradycardias (HR < 50 bpm)	1 (4.3)	0	1 (20)
Cough severity, n (%)			
No cough	16 (76.3)	12 (75)	4 (80)
Moderate cough (3-5 coughs)	1 (4.3)	0	1 (20)
Severe cough (> 5 coughs))	4 (17.4)	4 (25)	0
Postoperative complications, n (%)			
Bradycardias	2 (8.7)	2 (12.5)	0
Urinary retention	5 (31.2)	5 (25)	0
Nausea and vomiting	6 (26.1)	6 (37.5)	0
Time to return oral intake, hrs	6 (5-6)	6 (5-8)	5.5 (5-6)
Duration of chest tube drainage, days	2 (1-3)	1.5 (1-2.5)	3 (2-3)
Length of hospital stays, days	5 (3-7)	5 (3-7)	5 (5-7)

Data are presented with mean ± standard deviation, median and 25th and 75th percentiles or number (percentage). Abbreviations: TEA, thoracic epidural analgesia; ICNB, intercostal nerve block; PACU; postanesthesia care unit, SBP; systolic blood pressure; HR, heart rate

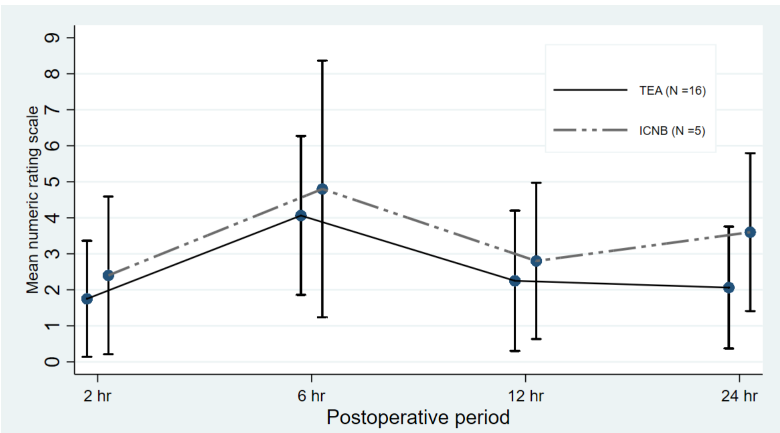

Figure 6. Numeric rating scales of TEA and ICNB during the first postoperative 24 hours

pital stays than patients receiving TEA, while postoperative pain scores and the incidence of postoperative complications were comparable [17]. These were consistent with our results that demonstrated no difference between the TEA and ICNB in anesthetic induction time, anesthetic time, surgical time and global surgical time, postoperative pain score, amount of morphine consumption and duration of hospital stays, while postoperative pain score and amount of morphine consumption seemed higher in patients with ICNB. This was possibly that some patients with TEA received a single shot TEA with local anesthetics and opioids (43.7%, 7 of 16 patients) and 19% of patients (3 of 16 patients) had a continuous infusion of TEA for one or two days after the operation, whereas only one-time bolus of the multiple injection of 0.5% bupivacaine was performed for ICNB group. Therefore, TEA could provide longer postoperative pain control as well as lower analgesic requirement compared to ICNB in our study.

The potential complications of TEA related to regional anesthesia technique deserve discussion. The TEA causes perioperative hypotension caused by sympathetic blockade which is more common than ICNB. Hypotension increases the need for perioperative fluid replacement and vasopressor requirement. However, the amount of fluid replacement and the vasopressor requirement was similar between TEA and ICNB in our study. PONV and POUR were the first and second most common postoperative complications after NIVATS in our study and were found only in patients receiving TEA. POUR can lead to the need for bladder catheterization and catheter-related complications [28]. Epidural local anesthetics can cause POUR by acting on the sacral and lumbar nerve fiber and blocking the transmission of afferent and efferent nervous impulses from and to bladder, while epidural opioids can produce the rostral spread of opioids in the cerebrospinal fluid to the pontine micturition center [29]. POUR occurred in five patients. Of these, two patients received epidural infusion with bupivacaine alone and three others received epidural opioids. Although the incidence of POUR in TEA was lower than lumbar epidural analgesia, all patients receiving TEA should be assessed for the time of first voiding. Bladder catheterization is recommended if the bladder volume is more than 600 ml for at least two hours to prevent voiding dysfunction [29].

For NIVATS, intraoperative sedation is usually required in order to keep patients calm and immobile, optimize surgical condition, and reduce an excessive movement of mediastinum caused by surgical pneumothorax [1,19]. Short-acting anesthetic agents include propofol, remifentanil, or dexmedetomidine are commonly used and controlled by the use of target-controlled infusion method. Sedative medications should be adjusted to maintain mild to moderate sedation levels and spontaneous ventilation. Continuous $ETCO_2$ monitoring helps detect upper airway obstruction. Serial blood gas measurement is useful to diagnose excessive hypercapnia which could be due to oversedation and one-lung ventilation. Hypoxia during sedation is generally improved with the supplement of a nasal cannula, a fitted mask, or a venturi mask. Various airway devices including LMA, endotracheal tube, and lung separation techniques should be prepared in advance for an unexpected conversion to general anesthesia. In addition, intraoperative sedation helps to attenuate intraoperative cough, which possibly causes excessive lung movement, interferes with the surgical procedure, and produces life-threatening intrathoracic complications [19]. Cough reflex is frequently generated by stimulation of the phrenic and vagus nerve during major pulmonary resection. This reflex is not effectively abolished by TEA and ICNB [30]. On the contrary, the TEA is a contributing factor of cough because TEA increases bronchial tone and airway hyper-reactivity [9]. Several methods including aerosolized lidocaine [30], spray of lidocaine onto the lung surface [31], intravenous remifentanil [32], stellate ganglion block [33], or intrathoracic vagal block [16,26] have been demonstrated to prevent and treatment of cough reflex. In our study, three out of four patients with a severe cough could be successfully relieved by using intrathoracic vagal block, while the other developed severe hypoxemia and required general anesthesia with LMA.

There were some limitations in this study. Firstly, this was a retrospective study. Various types of loco-regional anesthesia were performed depending on the decision of attending anesthesiologists and patient's condition. Therefore, the same protocols could not be set up. Secondly, this study might not clearly demonstrate the feasibility of loco-regional anesthesia for NIVATS due to small numbers of sample sizes. Some types of regional anesthesia such as ICNB and TPVB were too small and could not be compared with other regional anesthesia techniques. Thirdly, several factors such as severity of pulmonary disease, co-morbidity, type of surgical procedure and the competency of surgeons and anesthesiologists also have an influence on the feasibility of loco-regional anesthesia for NIVATS in addition to type of loco-regional anesthesia. Finally, NIVATS is considered a new surgical technique for our surgical personnel and anesthesiologists and all surgical members need more practice to provide more experiences, therefore, some clinical outcomes might differ from other studies. Further studies with a randomized control trial study, a larger sample size as well as the multi-center study are recommended to compare the following outcomes among regional anesthesia techniques 1) intraoperative and postoperative analgesia, intraoperative oxygenation, and ventilation 2) technique for suppressing or preventing of cough reflex 3) technique of intraoperative sedation for NIVATS in order to demonstrate the feasibility of loco-regional regional anesthesia for NIVATS before an implementation into our clinical practice.

CONCLUSION

This study demonstrated that loco-regional anesthesia including TEA and ICNB under sedation may be technically feasible and safe for NIVATS without increased serious morbidity and mortality. A randomized controlled study is suggested to compare the analgesic efficacy and safety of both techniques for NIVATS.

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All authors have participated in drafting the manuscript, read and approved the final version of the manuscript.

AUTHORS' CONTRIBUTIONS

(I) Conception and design: All authors; (II) Administrative support: Pipanmekaporn T; (III) Provision of study materials or patients: Siwachat S; (IV) Collection and assembly of data: Pipanmekaporn T, Leurcharusmee P, Samerchua A, Lorsomradee S, Panjasawatwong K; (V) Data analysis and interpretation: All authors; (VI) Manuscript writing: All authors; (VII) Final approve of manuscript: All authors.

SUPPLEMENTARY MATERIALS

none

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