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Research Paper

Intraoperative multiple intercostal nerve blocks exert anesthetic-sparing effect: A retrospective study on the effect-site concentration of propofol infusion in nonintubated thoracoscopic surgery

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ABSTRACT

Objective(s): Less general anesthetic is required in patients with regional blocks than in those without, as assessed through commonly used anesthesia monitoring parameters such as blood pressure, heart rate, and bispectral index (BIS). Although intraoperative regional anesthesia has become more widely adopted, few studies have confirmed or monitored its anesthetic-sparing effects. Using recent reports of nonintubated video-assisted thoracoscopic surgery (VATS) by BIS-targeted propofol infusion and intraoperative multilevel thoracoscopic intercostal nerve blocks (TINBs), this retrospective study investigated whether the anesthetic-sparing effect can be realized by reducing the effect-site concentration (Ce) to the targeted BIS level or by reducing the blood pressure at the onset of regional blocks.
Methods: A retrospective study of a prospectively collected case series of non-intubated VATS.
Results: Data on 56 adult patients who underwent nonintubated VATS were collected and analyzed. The mean operative time was 121 ± 32 minutes. BIS levels before and after one-lung ventilation/TINBs and surgery were 48% ± 11% and 47% ± 12%, respectively. The Ce of propofol infusion decreased significantly from 3.4 ± 0.8 μg/mL to 3.0 ± 0.7 μg/mL ($p < 0.01$) after surgery with TINBs. Blood pressure did not change significantly, whereas the heart rate increased moderately but significantly (77 ± 14 beats/minute to 82 ± 15 beats/minute, $p < 0.01$).
Conclusion: With comparable BIS and blood pressure in the subsequent surgical procedure, the adequacy of anesthesia and the anesthetic component provided by intraoperative TINBs and vagal nerve could be monitored adequately. The anesthetic-sparing effect of intraoperative nerve blocks can be realized when the Ce of propofol infusion was reduced to the target BIS level.

1. Introduction

Effective regional anesthesia is reported to have an anesthetic-sparing effect, with some reports suggesting that lower total amounts of general anesthesia are required in patients who received regional anesthesia than in those who did not receive regional blocks.[1–3] However, the anesthetic component provided by different regional anesthesia for different operations may vary widely. Regional anesthesia is a usual adjuvant or analgesic technique in infraumbilical surgical procedures. By contrast, regional anesthesia such as thoracic epidural blocks provide a major anesthetic component in thoracic operations. Nonintubated video-assisted thoracoscopic surgery (VATS) can be performed on patients using an effective thoracic epidural anesthesia in various levels of consciousness, from being awake to being sedated with intravenous general anesthesia.[4] Sedation or hypnosis is favored

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not only because it is preferred by patients but also because it blunts the cough reflex and movement from artificial pneumothorax and one-lung ventilation (OLV).[5,6] For safety and complete lung collapse in nonintubated VATS, intravenous anesthesia should be well-controlled to balance smooth spontaneous respiration and anesthetic depth.[7,8] However, the anesthetic components provided by either intravenous general or regional anesthesia may vary a lot. Intraveous anesthesia is adequate for simple and short thoracoscopic precedures, such as wedge resection or biopsy on peripheral lung parenchyma. For nonintubated VATS lobectomy or segmentectomy, pulmonary manipulations are difficult without an effective regional anesthesia. As intraoperative regional anesthesia, such as multilevel thoracoscopic intercostal nerve blocks (TINBs) or paravertebral blocks, has been applied for VATS, few reports have monitored the effects of or confirmed the anesthetic component provided by regional anesthesia administered intraoperatively.

Physiologic parameters such as blood pressure, heart rate, respiratory rate, and bispectral index (BIS) are commonly monitored and measured to demonstrate the comparable anesthetic depth and the anesthetic-sparing effect of regional anesthesia. However, the validity of these conventional monitoring evaluations is questionable because OLV simultaneously affects hemodynamics and ventilation. We have previously reported an effective anesthetic combination for nonintubated VATS using intraoperative multilevel TINBs and BIS-targeted general anesthesia.[5] When TINBs are used instead of thoracic epidural blocks with sedation, the effects of TINBs should be confirmed before starting pulmonary manipulations. Moreover, during a prolonged precedure, anesthesiologists must monitor TINB fading and the need for repetitive nerve blocks.

In this study, we hypothesized that intraoperative TINBs provide a regional anesthetic component and exert an anesthetic-sparing effect. The sparing effect may be applied to confirm, realize, and monitor the anesthetic components of intraoperative regional anesthesia. In addition to the conventional hemodynamic parameters, such as blood pressure and heart rate, the effect-site concentration (Ce) to the targeted BIS level was also recorded to analyze the anesthetic-sparing effect. This retrospective study was designed to determine (1) whether the anesthetic-sparing effect is present with intraoperative multilevel TINBs, and (2) whether the Ce of propofol infusion or conventional physiological parameters, such as blood pressure, can differentiate the anesthetic effects of intraoperative TINBs.

2. Methods

2.1. Patients

Ethical approval for the study (201307030RIND) was provided by the Research Ethics Committee of National Taiwan University Hospital, Taipei, Taiwan (Chairperson Professor Hong-Nerng Ho) on June 6, 2015. This study was approved by the Institutional Review Board of National Taiwan University Hospital. The anesthesia records of the study patients were collected and analyzed. Before the operation, all patients consented to undergo nonintubated VATS after being apprised of the type of anesthesia and surgical procedures that would be used. A prospectively maintained database of all patients who underwent nonintubated VATS from January 2009 to July 2013 was retrospectively reviewed to identify patients who underwent nonintubated VATS with TINBs and vagal nerve block. Patients considered appropriate for nonintubated thoracoscopic surgery have been described elsewhere.[5] Patients were excluded in non-intubated VATS, if they had an American Society of Anaesthesiologists score of 4 or more, bleeding disorders, sleep apnea, or unfavorable airway or spinal anatomy. Patients were also excluded if they required contralateral lung isolation, had significant sputum production, bronchiectasis, asthma, or a high body mass index. In addition, patients were excluded if they had preoperative decompensated heart disease or severe pleural adhesions or if they refused to undergo the suggested procedures.

2.2. Anesthetic management and BIS-controlled propofol infusion

Anesthetic management for nonintubated VATS procedures has been previously described.[5] All patients were premedicated with fentanyl (50–100 μg intravenously) and glycopyrollate (0.2 mg). Electrocardiography, arterial blood pressure, pulse oximetry [peripheral capillary oxygen saturation (SpO_2)], and respiratory rate were monitored. A BIS Quatro sensor (Aspect Medical Systems, Norwood, MA, USA) was attached to the forehead of patients to monitor their consciousness levels. End-tidal carbon dioxide was continuously monitored using a detector inserted inside one of the nostrils. Anesthesia was induced by administering propofol intravenously (1% Fresfol, Fresenius Kabi GmbH, Graz, Austria) using a target-controlled infuser pump based on Schneider's pharmacokinetic model (Injectomat TIVA Agilia; Fresenius Kabi GmbH), targeting a BIS level between 40 and 60. Incremental intravenous injections of fentanyl (25 μg) were given as required to maintain a respiratory rate of 12–20 breaths/minute. An arterial line was inserted for monitoring blood pressure and blood gases. The respiratory rate, heart rate, blood pressure, Ce of propofol infusion, and BIS level were continuously monitored and recorded every 5 minutes. Arterial blood gas concentrations were obtained after achieving the targeted level of consciousness 15 minutes after commencing OLV.

2.3. Intraoperative thoracoscopic internal intercostal and vagal nerve blocks after artificial pneumothorax

Each patient was placed in the lateral decubitus position. After local infiltration of 2% lidocaine, a 1.5-cm incision was made for thoracoscopy in the seventh or eighth intercostal space in the midaxillary line. This procedure marked the start of OLV because the incision created an artificial pneumothorax, and the lung collapsed gradually with the patient's spontaneous breathing. In addition to the thoracoscopic port, an incision in the sixth or seventh intercostal space was made as a working port. Subsequently, TINBs were administered through the working port by infiltration of 0.5% bupivacaine (1.5 mL for each intercostal space) from the third to the eighth intercostal nerve under the parietal pleura, 2 cm lateral to the sympathetic chain using a 25-G top-winged infusion needle. After completion of TINBs, thoracoscopic vagal nerve block was administered by infiltration of 0.5% bupivacaine (3 mL) adjacent to the vagus nerve. Bupivacaine was injected at the level of the lower trachea for the right-sided procedures and at the level of the aortopulmonary window for the left-sided procedures to prevent coughing during thoracoscopic manipulations. The position of nerve blocks is shown in Figure 1.

2.4. Procedures following the thoracoscopic surgery

After administering TINBs and vagal nerve block, another utility port (2–5-cm incision) was made in the chest wall. This port was used to perform pulmonary resections with and without mediastinal lymph node dissection via a three-port approach as described by McKenna.[6] After the operation, a 28-Fr chest tube was passed through the lowest incision. Next, the operated lung was manually expanded through mask ventilation to check for air leakage, and the propofol infusion was stopped. After surgery, the patient was asked to breathe deeply or cough to expand the collapsed lung further. Adequate analgesia was provided to maintain a visual analog scale score of less than 3.

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