Review Article

Anesthetic consideration for nonintubated VATS

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Abstract: In the recent decade, nonintubated-intubated video-assisted thoracoscopic surgery (VATS) has been extensively performed and evaluated. The indicated surgical procedures and suitable patient groups are steadily increasing. Perioperative anesthetic management presents itself as a fresh issue for the iatrogenic open pneumothorax, which is intended for unilateral lung collapse to create a steady surgical field, and the ensuing physiologic derangement involving ventilatory and hemodynamic perspectives. With appropriate monitoring, meticulous employment of regional anesthesia, sedation, vagal block, and ventilatory support, nonintubated VATS is proved to be a safe alternative to the conventional intubated general anesthesia.

Keywords: Anesthesia; thoracoscopy; nonintubated; thoracic epidural anesthesia (TEA); intercostal nerve block; bispectral index

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Introduction

For the conventional idea of video-assisted thoracoscopic surgery (VATS), ventilation control and lung separation/isolation was presumably thought to be vital for the safety and feasibility of the procedure (1). With the advent of modern imaging and monitoring technology, nonintubated VATS has brought a new possibility of breakthrough to this tenet.

In the recent decade, nonintubated VATS has been intensively researched and reported, which has been advocated to be a rising alternative to the conventional intubated VATS with general anesthesia from several perspectives, such as surgical and anesthetic feasibility and safety (2-10), perioperative immunology (11,12), and outcome analysis (13-17).

The aim of this article is to introduce the major anesthetic consideration and the management experience of our group with a problem-based fashion, in the hope of improvement of mutual understanding between surgical and anesthetic personnel, and thus the coordination of the teamwork.

Who and which procedures are suitable for nonintubated VATS?

According the experience of the major research groups, the general patient exclusion criteria includes American Society of Anesthesiologists score 4 and higher, bleeding disorders, sleep apnea, unfavorable airway or spinal anatomy, need for contralateral lung isolation, clinically significant sputum production, bronchiectasis, asthma, extreme of body mass index (BMI), preoperative decompensated heart disease, severe pleural adhesion over targeted hemithorax, and noncompliance to the procedure or patient refusal (5,14).

With the maturation of the technique, Wu and colleagues (18) had evaluated the feasibility of geriatric patients (age ranging from 65 to 87) undergoing lobectomy, which showed comparable safety profile with control group, and opened up the possibility of nonintubated VATS on the old age group.

Initially, nonintubated VATS was tested on simpler diagnostic procedure or management of solitary and peripheral lung lesion (2,9,19,20). With the increasing body of evidence and experience, nonintubated VATS has

been extensively promoted and proved safe for treatment of pleural/pericardial effusion, empyema thoracis, bullous emphysema, non-resectional lung volume reduction surgery, spontaneous pneumothorax, biopsy of interstitial lung disease, wedge resection of lung nodules, segmentectomy and lobectomy for lung cancer, mediastinal biopsy and tumor excision (5-8,14,20,21).

What's the anesthetic goals and the corresponding management?

The main difference of the nonintubated VATS from conventional intubated general anesthesia, is to create an iatrogenic pneumothorax, a subsequently collapsed lung to be operated on, and to maintain patients' spontaneous ventilation sufficiently at the same time. Conscious sedation is sometimes required due to emotional stress or prolonged procedure-related discomfort.

Monitoring

In order to handle the physiologic derangement and the complexity of the surgical/anesthetic procedure aforementioned, standard monitoring with pulse oximeter, electrocardiogram, sphygmomanometer, and end-tidal CO_2 should always be in place. In addition, invasive arterial pressure monitor is set for most patients in our group for its versatility on monitoring arterial blood gas, real-time hemodynamic index, and fluid status inclination. For the occasion in which sedation is part of the planning, bispectral index (BIS) is highly recommended for evaluation of sedation level and advanced judgement of anesthetic depth.

Ventilatory

The goal of ventilatory manipulation is to maintain a smooth, non-effort, spontaneous respiratory pattern, aiming respiratory rate over 12 to 20 times/minute for acquiring a satisfactory surgical field with adequately collapsed lung (5).

In awake patients, preoperative communication for reassuring the patients, intraoperative coaching, mental support, verbal communication with medical personnel, and comfortable environment with low-volume music might all contribute to calm the patients down with acceptable respiration (16,22).

In sedated patients of our group, premedication with opioid agent followed by deliberate titration had been proved to control respiratory rate effectively. Meticulous use of nasal airway could be of great benefit if upper airway obstruction raises clinical concerns. If significant hypoventilation should happen, modest assisted ventilation by a mask might be required after notification of the surgical team.

Oxygenation could be facilitated with O_2 supplement by nasal cannula 3-4 liters/minute or by Venturi Mask. Overly hypercapnia should be avoided, a good-quality end-tidal CO_2 trace and serial arterial blood sampling before/after iatrogenic open pneumothorax should mostly suffice for close monitoring.

Analgesia

The target of the analgesia is to block the unpleasant sensation throughout the surgical manipulation. With the temporal sequence, VATS ports are first to be set, which bring about painful sensation from skin to parietal pleura; after ports are set, the manipulation of lung and traction of intrathoracic structures would cause irritation over visceral pleura.

Regional anesthesia had been long reported to be effective for analgesia covering chest cage and parietal pleura (23). Various approaches have been developed and proved feasible, including the current mainstream of thoracic epidural anesthesia (TEA), paravertebral nerve block, and percutaneous or thoracoscopic intercostal nerver block, intrapleural analgesia. In our group practice, we add vagus nerve block and intravenous narcotic to minimize the visceral component of irritating sensation.

Traditionally, before minimal invasive procedure era, thoracotomy was traumatic procedure with large incision, and thus epidural anesthesia was favored for its better quality of postoperative pain control and reduction of respiratory and cardiac complication (23). But with the paradigm shift to VATS, Yie *et al.* (24) had reported Epidural anesthesia holds no superior postoperative analgesic benefits over narcotic-based intravenous patient-controlled analgesia (IVPCA). The optimal postoperative analgesia remains an open issue, other promising modalities such as continuous intercostal-intrapleural analgesia or continuous paravertebral block worth more attention and further investigation (25,26).

Amnesia

Surgery, more or less, could bring forth mental stress to the patients, which might consequently has detrimental effects on patient's physiology (27) and even jeopardize the safety of surgery by panic attack. Sedation with amnesia

could offer a stress-free environment even for the relatively vulnerable groups, especially with the prolonged procedure like lobectomy, which makes keeping same position for hours intolerable.

For sedation, our group employs BIS for monitoring sedation level. Empirically speaking, premedication with 50 to 100 mcg fentanyl, followed by propofol with target controlled infusion (TCI), aiming for BIS over 40 to 60, would mostly create a balanced status without significant ventilatory or hemodynamic disorder.

Areflexia

When approaching central intrathoracic lesion, cough reflex is an inevitably encountered problem that requires effective but temporary suppression of the reflex. On the other hand, as an intrinsic protective mechanism, recovery of cough reflex is beneficial on reduction of postoperative respiratory complication.

Pre-operative inhalation of aerosolized lidocaine (28) and ipsilateral stellate ganglion block (29) had been proposed to reach cough control in some extent. In our group experience, Chen and colleagues (5) has routinely performed intraoperative thorascopic vagal block, which has been proved effective on cough reflex suppression without causing hemodynamic instability. For more swift procedures, for the sake of decreasing cough suppression duration, incremental intravenous fentanyl is applied in place of vagal block.

Prepare for conversion to general anesthesia

Despite of extra vigilance and preparation aforehand, intraoperative conversion to intubated general anesthesia is inevitable occasionally due to significant bleeding, pleural adhesion, and insufficient anesthesia (5,30). Plan B should always be in hand.

Intubation in lateral decubitus position with VATS instruments in place presents itself as a technical challenge to anesthesiologists. Direct laryngoscopy might stands a chance, but fiberoptic bronchoscopic intubation, video-assisted system, and laryngeal mask airway (LMA) are the trustworthy back-up plan.

How are intraoperative hemodynamic and ventilatory index change?

The hemodynamic and ventilatory index are the core of perioperative monitoring and evaluation. Different protocols would naturally bring out diverse outcomes. During one lung ventilation, heart rate, respiratory rate, PaO_2 and CO_2 elimination will change significantly but they can be kept physiologically adequate.

Generally speaking, the hemodynamic and ventilatory index remained in the acceptable range without causing detrimental hypotension, hypoxemia, hypercapnia, nor acidosis.

Conclusions

Nonintubated VATS has been extensively and safely applied to various surgical procedures involving pleura, lung, and mediastinum. The main challenges for anesthesiologists are coping with the physiologic derangement upon iatrogenic open pneumothorax and balancing the benefits and risks of different anesthesia techniques. With a well-controlled, well-monitored anesthetic combinations of regional anesthesia, sedation, and postoperative pain service, nonintubated VATS has been proved to be safe and feasible amongst a wide variety of patient groups.

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