



MINI-REVIEW

Nonintubated video-assisted thoracoscopic pulmonary resections



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Summary Video-assisted thoracoscopic surgery (VATS) has become a common and globally accepted mode of resection of pulmonary tumors. One-lung isolation using double-lumen endobronchial tubes or endobronchial blockers has been traditionally considered mandatory for VATS. However, recent reports showed that VATS pulmonary resections can also be performed safely using regional anesthesia without tracheal intubation. Mostly, nonintubated VATS pulmonary resections are performed using regional anesthesia, either a thoracic epidural anesthesia or intercostal blocks, in a spontaneously breathing state after an iatrogenic open pneumothorax. Conscious sedation is usually necessary for longer and intensively manipulating procedures. Intraoperative cough reflex can be effectively inhibited by ipsilateral intrathoracic vagal blockade to facilitate major pulmonary resections. The early outcomes of nonintubated VATS pulmonary resections include a faster postoperative recovery and a lower complication rate as compared with its counterpart of intubated general anesthesia, which may be translated into a fast track VATS program. The future directions of nonintubated VATS should focus on its long-term outcomes, especially on oncological perspectives and overall survival in lung cancer patients.

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1. Introduction

Since its introduction in the 1990s, video-assisted thoracoscopic surgery (VATS) has become a common and globally accepted treatment of choice in managing various thoracic diseases involving the lungs, pleura, and mediastinum.¹ Compared with traditional thoracotomy, VATS is demonstrated to be superior in shortening the length of hospital stay, alleviating postoperative pain, improving postoperative lung function, and reducing overall morbidities after surgery.² Because a quiet, optimally visualized surgical environment is a vital prerequisite during VATS, intubated general anesthesia with one-lung isolation, and the use of a double lumen endobronchial tube or an endobronchial blocker, was considered mandatory in the past.¹ However, complications and adverse effects following intubated one-lung ventilation are inevitable, including intubation-related airway trauma, ventilation-induced lung injury, residual neuromuscular blockade, impaired cardiac performance, and postoperative nausea and vomiting.^{3–5}

To avoid intubation-related complications and to facilitate a smoother postoperative recovery, interests and efforts have been recently focused on adopting a thoracoscopic technique without tracheal intubation (i.e., awake or nonintubated VATS). Satisfactory results are accumulating not only from sporadic case reports of difficult and high-risk patients not suitable for an intubated general anesthesia,⁶ but also from systemic applications of this technique to various VATS procedures, including various pulmonary resections (wedge resection, segmentectomy, and lobectomy), management of pneumothorax, excision of mediastinal tumors, and lung volume reduction surgery.^{7–19} Encouragingly, the safety and feasibility of nonintubated VATS were well established in these studies.^{7–19}

As lung cancer is still the leading cause of cancer death worldwide and also in Taiwan, and current low-dose computed tomography screening programs identify increasing numbers of indeterminate small lung nodules, a combination of minimally invasive surgery and a less invasive anesthetic technique would be appealing and is expected in the armamentarium of thoracic surgery.²⁰ It may serve either a diagnostic or a therapeutic purpose and increase patients' chances of being surgically treated.¹⁸ In this article, we revisit the current literature of nonintubated VATS focusing on pulmonary resections for lung cancer or undiagnosed lung tumors. We also summarize our experiences on nonintubated VATS.

2. Nonintubated VATS for pulmonary resections

Surgical treatment of lung tumors includes wedge resection, anatomical segmentectomy, lobectomy, or pneumonectomy with or without mediastinal lymph node dissections, depending on the nature of the lung tumors.

2.1. Wedge resection

Traditional pulmonary resections via a thoracotomy approach were in fact performed under regional anesthesia without tracheal intubation in the 1940s.²¹ After the

introduction of a double-lumen endobronchial tube, however, tracheal intubation with one-lung isolation in modern thoracic surgery has widely been considered mandatory, especially in the era of minimally invasive thoracoscopic surgery.¹ In 2004, Pompeo et al⁸ were among the first pioneers to re-evaluate the feasibility of thoracoscopic surgery without tracheal intubation for pulmonary resections. Thirty patients with solitary pulmonary nodules underwent VATS wedge resection under sole thoracic epidural anesthesia. Compared to patients with intubated general anesthesia, their results showed that the awake technique was safe and feasible with more patient satisfaction, less requirement of postoperative nursing care (2.5 calls/day vs. 4 calls/day) and shorter in-hospital stay (2 days vs. 3 days). Nonetheless, there were two awake patients who had their anesthesia converted to intubated general anesthesia because of lung cancer requiring lobectomy via a thoracotomy approach.⁸ They further reported similar results in patients with metastatic lung tumors using awake VATS metastasectomy, but some patients experienced anxiety or panic which necessitated conscious sedation.⁹ Additionally, awake thoracoscopic laser resection of subpleural nodules in 28 patients under local anesthesia only were also reported by Lesser.²² Three of them were converted to have intubated general anesthesia because of lung cancer requiring further lobectomy.²²

Our group has employed nonintubated VATS using thoracic epidural anesthesia to perform wedge resections for peripheral lung nodules since 2009.^{12–17} In contrast to the awake technique, we prefer to sedate the patients under the guidance of the Ramsay sedation score (target at level III: patients are sedated but retain response to commands) and yielded a 4.3% conversion rate of tracheal intubation by a needlescopic approach.¹⁵ After applying thoracoscopy-guided intercostal blocks to replace thoracic epidural anesthesia and bispectral index monitoring to precisely target the sedation level, the conversion rate was further improved and the duration of anesthesia induction was also shortened.^{18,19} Our method was also applied to simultaneous bilateral VATS for indeterminate pulmonary nodules in both lungs.¹⁴ Similar results were also reported by Dong and his colleagues²³ (Table 1).

2.2. Anatomical major pulmonary resections, including segmentectomy and lobectomy

For surgical management of primary lung cancer or central located benign tumor, anatomical pulmonary resections such as segmentectomy or lobectomy with or without mediastinal lymph node dissection are usually necessary.¹ However, these procedures are associated with a longer operating time, frequent lung traction, and intense hilar manipulation, which can trigger a cough reflex in awake patients.^{1,24} The reactivity of the coughing response can be further exaggerated when thoracic epidural anesthesia is used alone, because of an unbalanced parasympathetic activity after sympathetic block.²⁴ While stellate ganglion block has been applied to attenuate the cough reflex, our group used thoracoscope-guided intrathoracic vagal block to achieve effective inhibition of the cough reflex.^{12–19} In addition, intravenous opioid and propofol were titrated

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