

# Nonintubated video-assisted thoracic surgery under epidural anesthesia – Encouraging early results encourage randomized trials

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Nonintubated video-assisted thoracic surgery (VATS) that is also defined awake VATS entails thoracoscopic procedures performed by regional anesthesia in spontaneously ventilating, mildly sedated or fully awake patients.

The rationale is the avoidance of side-effects of intubated general anesthesia with single-lung mechanical ventilation, and maintenance of a more physiologic muscular, neurologic, and cardiopulmonary status, in order to minimize the overall surgery- and anesthesia-related trauma, fasten recovery, optimize outcome and possibly reduce costs.

Until a few years ago the main concern against nonintubated VATS was the fear that a surgical pneumothorax could be poorly tolerated under spontaneous ventilation. However, data that have progressively accumulated have contradicted this empiric thought showing that following creation of a surgical pneumothorax, satisfactory oxygenation can be easily maintained for up to several hours (1) and even in subjects with compromised ventilatory function (2).

Reported nonintubated VATS procedures include management of pleural effusion (3), bullectomy for spontaneous pneumothorax (4) and giant bullous disease (5), resection of pulmonary nodules (6) and of primary or secondary lung tumors (7-11); thymectomy (7,12); lung volume reduction surgery (2); and lung biopsy of interstitial lung disease (13). Overall, these early series have suggested patient-friendly and globally minimally-invasive surgical options, which offered an immediate resumption of daily life activities, low morbidity rates and short hospital stay.

## Strategies and approaches

There are several differences amongst the various nonintubated VATS programs including anesthesia protocols and surgical

details.

Aside from the preference of having a patient fully awake or in conscious sedation on the operating table, the main physiologic difference between all nonintubated VATS strategies and intubated general anesthesia, is that with the latter the diaphragm is pharmacologically paralyzed and ventilation is mechanically driven whereas with the formers, spontaneous ventilation and an efficient contraction of the diaphragm are maintained leading in lateral decubitus to optimal ventilation/perfusion matching in the dependent lung. During nonintubated VATS, the degree of lung collapse achieved by creation of the surgical pneumothorax is usually comparable to that achievable by intubated single-lung ventilation whereas surgical maneuvering may be somewhat more technically demanding due to rhythmic diaphragmatic movement and to the risk of inadvertent stimulation of the coughing reflex. In this respect, the attitude of thoracic surgeons involved in nonintubated VATS has been variable.

Chen and coworkers, first reported on thoracoscopic lobectomy (9) and segmentectomy (10) carried out by an innovative nonintubated VATS protocol which included the use of the bispectral index to monitorize the targeted level of conscious sedation and the block of the vagus nerve by the intrathoracic local injection of lidocaine, which permitted to abolish the coughing reflex for up to 2-3 hours.

In our program we have preferred to employ epidural anesthesia in fully awake and cooperative patients to maintain neurologic vigilance that we consider an ideal way of physiologic monitoring and which allows a constant verbal communication with the surgical staff. On one hand, this can be extremely reassuring inducing a sense of retaining control and a better perception of immediate

recovery to the patient. On the other, panic attacks can rarely develop in anxious patients although these can be easily controlled by switching from a typical awake procedure to one under targeted conscious sedation without conversion to intubated anesthesia. In addition we do not employ any measure to abolish the coughing reflex and we simply learned to avoid putting into traction the pulmonary hilum to minimize the risk of coughing although we acknowledge that in some instances the block of the vagus nerve can prove useful.

Thoracic Epidural Anesthesia has been preferred by the majority of the teams performing nonintubated VATS even though intercostal (14) and paravertebral blocks have been also reliably employed and have shown pros and cons. Disadvantages of epidural anesthesia include the risk of hemorrhagic complications including spinal hematoma whereas the old-fashioned fear that epidural anesthesia could lead to impaired compensatory ventilation and bronchial constriction due to adrenergic blockade though not specifically addressed has been largely contradicted by the excellent results repeatedly reported by nonintubated VATS with epidural anesthesia performed in fully awake patients with severe emphysema (2).

In most of instances indications for standard VATS are equally valid for nonintubated VATS. However, in a large series from Taiwan (1), small body-sized female patients with small tracheal caliber have been deemed optimal candidates for nonintubated anesthesia due to higher risks for intubation-related complications.

The main contraindications can be considered an American Society of Anesthesiology score greater than 3, morbid obesity, and an arterial carbon dioxide tension >55 mmHg. Bleeding disorders, and unfavorable spinal deformity are specific contraindications for nonintubated VATS under epidural anesthesia.

Most commonly, a three-ports access has been preferentially employed for nonintubated VATS even though some surgeons have successfully employed the single-port access for talc pleurodesis in management of recurrent pleural effusions (4), to resect isolated pulmonary nodules (15) or very recently, even to perform nonintubated lobectomy (16).

### Randomized trials

Until the recent trial reported from China (17), there were only four small randomized studies investigating results of nonintubated VATS, which entailed wedge resection

of undetermined pulmonary nodules (6), bullectomy with pleurectomy for treatment of spontaneous pneumothorax (4), lung volume reduction surgery (2) and talc pleurodesis for malignant pleural effusion (3). Three of these studies entailed VATS procedures performed by sole epidural anesthesia in awake patients (2,4,6) whereas one included awake procedures carried out under either epidural anesthesia or intercostals blocks. Common findings emerging from these previous trials included excellent feasibility with low conversion rates (0-7%) as well as shorter hospital stay and lower costs than procedures carried out by intubated general anesthesia. Limitations included the small cohorts and the unicenter designs of these trials, which were all performed by the same surgical team.

For this reason the randomized study recently published by Liu and coworkers in the *Surgical Innovation Journal* (17), is timely and particularly welcome.

This unicenter trial is the largest to be completed so far. It enrolled 354 patients undergoing bullectomy, pulmonary wedge resections and lobectomy who were randomized either to nonintubated VATS with epidural anesthesia (174 patients) or to standard intubated VATS management (180 patients).

Seven patients in the nonintubated group were withdrawn due to by necessity changes in type of anesthesia. Reasons for conversion included pleural adhesions contraindicating the procedure, carbon dioxide retention and hypoxemia, unsatisfactory lung collapse, intraoperative bleeding and need to switch from wedge to lobectomy.

The reported outcomes have been highly satisfactory. In particular, independent by the type of surgical procedure, nonintubated anesthesia resulted in shorter fasting time and duration of postoperative antibiotics. A shorter hospital stay occurred in the groups undergoing nonintubated bullectomy or lobectomy whereas a decreased volume of postoperative pleural drainage occurred in the nonintubated lobectomy group only.

Finally, in patients undergoing bullectomy, nonintubated VATS was associated with a decreased difference between pre-to-postoperative concentration of tumor necrosis factor- $\alpha$  level in the bronchoalveolar lavage fluid.

Limitations of this study include a per-protocol design provided that patients in whom the approach was converted to general anesthesia have been excluded from the outcome analysis; the lack of standardized objective criteria for discharge and of perioperative physiologic data comparisons. On the other hand, unconventional strengths of this trial were the assessment of postoperative antibiotics duration that was calculated on the basis of the presence/

absence of symptoms/signs of pulmonary infection including the serum white blood cells level and of serum/bronchoalveolar lavage levels of inflammatory cytokines.

### Future perspectives

I foresee three main paths towards which the next future clinical research on nonintubated VATS may be driven.

The first is a standardization of the indications to perform simple and fast procedures including management of recurrent pleural effusion and of spontaneous pneumothorax for which feasibility of nonintubated VATS has been shown to be excellent whereas intubated general anesthesia with single-lung mechanical ventilation might be deemed an unnecessary luxury as suggested by Katlic and Factor (14). This assumption implies the need for comparative cost-effectiveness assessments and seems to fit pretty well with a general concept coming from the mentors of our mentors and saying that in surgery, unnecessary or redundant maneuvers should be avoided since they are potentially dangerous.

The second path entails surgical procedures performed in patients with impaired respiratory function in whom general anesthesia and one-lung ventilation per se represents a not negligible risk factor. In this respect the experience on awake lung volume reduction surgery for severe emphysema (2) as well as that on awake lung biopsy for interstitial lung disease (13), are promising examples that respectively involve patients with obstructive or restrictive ventilatory defect patterns and that in my opinion merit further thorough investigation.

The third highly promising path is the application of nonintubated VATS to oncologic procedures for which optimal indications are still controversial.

In fact, although metastasectomy (8), segmentectomy (10), lobectomy (7,9), and even pneumonectomy (7) have been shown to be feasible by nonintubated VATS, it is likely that to perform major lung procedures requiring fine vascular dissection, most of thoracic surgeons would still prefer general anesthesia with single-lung ventilation, which provides deeper sedation and an immobile, collapsed lung.

However, it is worth noting that reduced postoperative stress hormone response (18) and a lesser impairment in lymphocytes activity (19) have been both reported in preliminary clinical studies and if confirmed by future investigations with long follow-up might open novel oncologic perspectives including a better self-immunologic defense against cancer spread and higher survival rates.

In addition, complementary combinations of the results achieved in each path might potentially allow to define more precisely optimal indications and add novel perspectives such as the adoption of nonintubated VATS in fast track programs and to increase operability of patients with lung cancer who are currently deemed at high-risk for intubated anesthesia due to an advanced age, associated comorbid conditions or severe ventilatory defects.

### Conclusions

In conclusion, research on nonintubated VATS has successfully switched to a new critical phase in which encouraging early results encourage accomplishment of well designed randomized studies and I look forward to learn further interesting insights on this intriguing topic in the near future.

### Acknowledgements

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