

# Single-port thoracoscopic lobectomy in a nonintubated patient: the least invasive procedure for major lung resection?

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## Abstract

**OBJECTIVES:** General anaesthesia with single-lung ventilation was always considered a condition for thoracoscopic major pulmonary resections. However, nonintubated thoracoscopic lobectomy has been reported recently by using conventional video-assisted thoracoscopic surgery (VATS), epidural anaesthesia and vagus blockade. Here, we present a technique that reduces the surgical access trauma even more: single-incision VATS approach with no need for epidural or vagus blockade in a nonintubated patient.

**METHODS:** A 46-year old male smoker was admitted to our department for surgery. A computed tomography scan revealed a 1.5-cm nodule in the right middle lobe. A positron emission tomography scan demonstrated uptake (5.4 SUV) with no lymph node involvement. The patient was proposed for nonintubated uniportal VATS surgery. The patient received intramuscular midazolam and atropine 30 min before anaesthesia. No epidural catheter was placed. A laryngeal mask was used to control the airway and for oxygen inhalation. Sevoflurane gas and continued perfusion of remifentanyl were administered for sedation. The patient was positioned in a left lateral decubitus position. The skin and the fifth intercostal space were infiltrated with levobupivacaine.

**RESULTS:** A VATS approach through a single 2.5-cm incision was made at the level of the fifth intercostal space on the right side. No intrathoracic vagus blockade was necessary. A wedge resection of a 1.5-cm tumour on the middle lobe was performed. The frozen section confirmed a carcinoid tumour and so a middle lobectomy and a lymph node dissection were completed. The total surgical time was 80 min. The chest tube was removed within the next 16 h and the patient was discharged home 36 h after the operation.

**CONCLUSIONS:** Single-port video-assisted thoracoscopic lobectomy in nonintubated patients seems to be feasible and safe, and probably represents the least invasive approach to lobectomy. Further studies are necessary to evaluate the results with a series of patients.

**Keywords:** Nonintubated patient • Anaesthesia • Single-port VATS • Awake surgery • Lobectomy • Uniportal

## INTRODUCTION

The use of general anaesthesia and the double-lumen endotracheal tube is the most frequent management of airway control for major pulmonary resections [1]. However, nonintubated thoracoscopic lobectomy and segmentectomy have been reported recently, with excellent postoperative results [2, 3]. These patients underwent nonintubated thoracoscopic lobectomy using three to four incisions, epidural anaesthesia, intrathoracic vagal blockade and sedation. Here, we describe a lobectomy reducing the aggressiveness of the procedure: a single 2.5-cm incision, no epidural, no central vein, no intrathoracic vagus block and no urinary catheter. This is the first report of a single-port thoracoscopic major pulmonary resection in a patient with spontaneous ventilation (nonintubation surgery). To our knowledge, this procedure represents a less invasive approach to lobectomy.

## Clinical case

A 46-year old male smoker was admitted to our department for surgery. The patient suffered from cough and a computed tomography scan revealed a 1.5-cm nodule in the right middle lobe. A positron emission tomography scan demonstrated uptake (5.4 SUV) with no lymph node affection. The pulmonary function test was normal. The patient was proposed for a nonintubated uniportal video-assisted thoracoscopic surgery (VATS).

## Surgical procedure

The patient received intramuscular midazolam 0.1 mg/kg and atropine 0.01 mg/kg 30 min before anaesthesia. Standard monitoring included electrocardiogram, arterial blood pressure, pulse

oximetry and respiratory rate. The end-tidal carbon dioxide was measured by insertion of a detector into one nostril. No epidural catheter, no central vein and no urinary catheter were placed. A laryngeal mask was used to control the airway and for oxygen inhalation, with a flow of 3–5 l/min to maintain arterial oxygen saturation above 90%. Sevoflurane gas (oxygen at 50% with a minimum alveolar concentration of 1.5–2%) and continued perfusion of remifentanyl (0.04 µg/kg/min) were administered for sedation during the surgery.

The patient was positioned in a left lateral decubitus position. The skin and intercostal space were infiltrated with local anaesthesia [thoracoscopic nerve block was achieved by infiltration of 5 ml of levobupivacaine in the fifth intercostal space (5 mg/ml)]. A VATS approach through a single 2.5-cm incision was made at the level of the fifth intercostal space on the right side (Fig. 1). After performing the incision, the lung was collapsed due to an iatrogenic pneumothorax (Video 1). During the surgery, the patient spontaneously breathed oxygen through a laryngeal mask. Target-controlled infusion of remifentanyl was modified during the procedure to allow spontaneous ventilation and avoid excessive patient hyper-reactivity, apnoea or carbon dioxide retention. To attenuate the impact of mediastinal oscillation during surgery, the anaesthesiologist increased the amount of this opioid based on the operation, as well as reduced the breathing frequency and the respiratory tidal volume, thereby reducing the amplitude of the swing. At the same time, appropriate ventilation was provided based on the results of blood gas analysis to avoid severe hypercapnia, so as to maintain the body's acid-base balance.

No intrathoracic vagus blockade was necessary and no lidocaine spray was used on the surface of the lung. The lung was explored by digital palpation and a 1.5-cm nodule was located in the middle lobe. A wedge resection was performed, with a histological result of carcinoid tumour and so a middle lobectomy was performed (Fig. 2). The vein, bronchus and fissure were divided by using articulated endostaplers, and the artery was transected by using vascular clips (click aV, Grena) (Videos 1 and 2). The patient did not suffer from cough during bronchial dissection and transection (Video 2), or during the paratracheal and subcarinal lymph node dissection.

The lung collapse was excellent during the whole procedure. The intraoperative hypercapnia was tolerable, transient and improved quickly when the bilateral lungs resumed spontaneous ventilation.

The total surgical time was 80 min. A single chest tube was inserted through the incision at the end of the procedure. Before the chest wall was closed, the anaesthesiologist used the laryngeal mask to assist the patient in ventilation to inflate the lung and 4

mg of ondansetron was injected intravenously to prevent nausea and vomiting.

The patient was transferred to the recovery room showing a basal spO<sub>2</sub> of 100%, no pain, no sore throat and excellent spontaneous breathing. The drain was removed within the next 16 h and the patient was discharged home 36 h after the operation with oral analgesia. The final pathological examination revealed a 1.4 cm atypical carcinoid tumour with no lymph node involvement.

## DISCUSSION

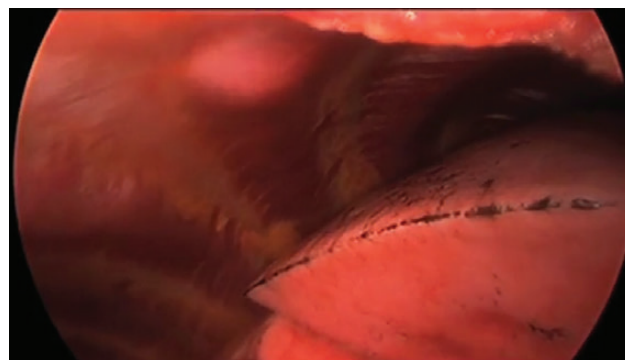
Traditionally intubated general anaesthesia with one-lung ventilation has been considered mandatory during thoracoscopic procedures, especially for lobectomy [1]. Since Pompeo reported awake conventional VATS pulmonary nodule resection in 2004 [4] and Rocco in 2010 by using only one incision [5], several groups have performed more complex procedures, such as lobectomy or segmentectomy, in patients with spontaneous ventilation [2, 3, 6]. These procedures try to minimize the adverse effects of tracheal intubation and general anaesthesia, such as intubation-related airway trauma [7], ventilation-induced lung injury [8], residual neuromuscular blockade [9], impaired cardiac performance [10] and postoperative nausea and vomiting. Avoidance of general anaesthesia also results in a reduction in hospital stay and procedure-related costs and a faster recovery with immediate return to daily life activities.

The nonintubated VATS for lobectomy was initially described in 2007 as an attempt to reduce the aggressiveness of the procedure, improve outcomes and reduce cost [11]. Since then, only two groups have published their results using a VATS approach with several incisions, therefore also using an epidural catheter [2, 3, 6]. Chen *et al.* [6] reported the safety and feasibility of thoracoscopic resection under nonintubated anaesthesia in 285 consecutive patients and He *et al.* [3] reported more complex resections, such as segmentectomies, in nonintubated patients with excellent postoperative results. Recently, Hung *et al.* [12] published a series of patients operated on by only infiltrating several intercostal spaces (from T3 to T8) instead of using an epidural catheter.

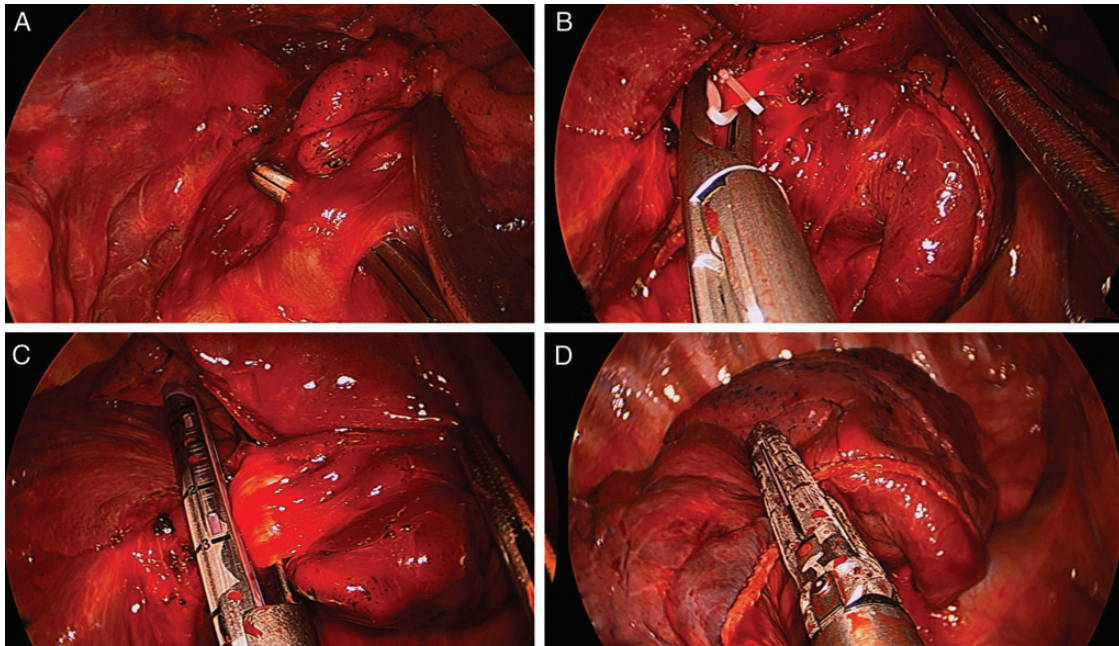
If the aim here is to reduce the surgical access trauma, we have hypothesized that nonintubated thoracoscopic lobectomy can also be performed by using only one incision based on our previous experience with the technique [13, 14]. Given that only one intercostal space is opened, the use of local anaesthesia and blockade of a single intercostal space is enough for pain control at the beginning and during the surgery. We use no trocar and, during instrumentation, we try to avoid pressure on the intercostal nerve so that we reduce the risk of intercostal bundle injury [15].



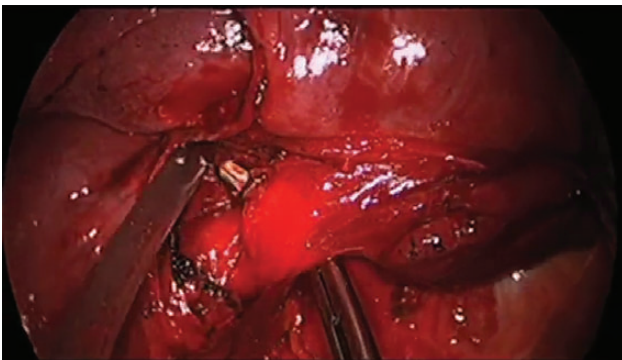
Figure 1: Surgical image of a 2.5 cm incision.



Video 1: Middle lobectomy (part 1).



**Figure 2:** (A) Dissection of a middle lobe vein. (B) Division of a middle lobe artery with vascular clips. (C) Bronchial division. (D) Minor fissure stapling.



**Video 2:** Middle lobectomy (part 2).

Cough reflex and unexpected lung movement during anatomical hilar dissection can be troublesome when performing nonintubated major pulmonary resection. Chen *et al.* [6] described the use of vagus blockade as mandatory for these procedures and He *et al.* also added a spray of lidocaine on the surface of the lung [3]. However, we did not need to use intrathoracic vagal blockade or lidocaine spray in this particular case, and the patient did not show significant cough during the lobectomy and lymph node dissection. The adequate management and correct dosage modification of remifentanyl by an expert anaesthesiologist throughout the surgery could be enough to prevent a cough reflex and excessive patient hyper-reactivity instead of applying the vagus blockade. Furthermore, we avoided the epidural anaesthesia-associated sympathetic blockade that could lead to increased bronchial tone and airway hyper-reactivity. However, the vagus blockade or instillation of topical anaesthesia over the lung surface and hilum could be useful in some cases.

The iatrogenic pneumothorax produced once the incision was performed leads to an excellent collapse of the lung during the surgery. The transient hypercapnia observed was acceptable and did not affect the haemodynamic status and surgical procedure. Hypoventilation caused by partial collapse of the operated lung

and a rebreathing effect could explain this permissive hypercapnia, which is usually resolved more rapidly than in patients who are operated on under general anaesthesia.

One of the adverse effects of general anaesthesia is the post-operative residual neuromuscular blockade, which can be associated with impaired clinical recovery as reported by several authors [9]. It is very likely that, owing to the avoidance of tracheal intubation and muscle relaxants, the anaesthetic adverse effects were minimal. Therefore, the use of nonintubated VATS may allow a fast-track protocol avoiding the intensive care unit. It allowed this patient to have effective cough minutes after surgery as well as have an earlier oral intake and ambulation immediately after the operation. The patient did not suffer from a sore throat or other adverse symptoms related to general anaesthesia intubation.

As with previous reports, we also consider this procedure feasible for selected patients classified as ASA I–II and Mallampati grade I–II, with no obesity (body mass index <30), tumours <6 cm and with good cardiopulmonary function [16]. In addition, this surgery should only be performed by experienced anaesthesiologists and thoracoscopic surgeons (preferably skilled and experienced with complex or advanced cases and bleeding control through VATS). We recommend to start with minor resections and, once both surgeon and anaesthesiologist acquire enough experience with the technique, lobectomy can be attempted. The clinical cases must be carefully selected during the learning curve and patients with difficult intubation should not be subjected to this approach. We recommend conversion to intubated general anaesthesia in case of complex hilar dissection (as in silicotic or tuberculous patients), strong adhesions, significant mediastinal movement, persistent hypoxaemia or tachypnoea and major bleeding. These patients must be intubated without hesitation to reduce the rate of complications and the risk of emergency intubation.

In case that intubation is needed, the planned strategy is to insert a single-lumen endotracheal tube under the guidance of a bronchoscope, followed by insertion of a bronchial blocker without changing the patient's position. However, an expert and skilled

anaesthesiologist could achieve a double-lumen intubation with the patient maintained in the lateral decubitus position.

In conclusion, the performance of a single-port thoracoscopic lobectomy in a nonintubated patient, with no epidural and vagus blockade, seems feasible and safe in selected patients. High-risk patients for intubated general anaesthesia are good candidates for this minimally invasive approach.

**Conflict of interest:** none declared.

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