



# Non-intubated video-assisted thoracoscopic surgery for pleural biopsy: a narrative review

Sara Parini<sup>1,2^</sup>, Ottavio Rena<sup>1,3^</sup>

<sup>1</sup>Thoracic Surgery, Ospedale Maggiore della Carità, Novara, Italy; <sup>2</sup>Università degli Studi di Torino, Turin, Italy; <sup>3</sup>Università del Piemonte Orientale, Novara, Italy

*Contributions:* (I) Conception and design: All authors; (II) Administrative support: All authors; (III) Provision of study materials or patients: All authors; (IV) Collection and assembly of data: All authors; (V) Data analysis and interpretation: All authors; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

*Correspondence to:* Ottavio Rena. Thoracic Surgery, Ospedale Maggiore della Carità di Novara, 18, Corso Mazzini 28100, Novara, Italy. Email: ottavio.rena@uniupo.it.

**Abstract:** Video-assisted thoracoscopic surgery (VATS) has significantly improved patient care by reducing pain, complications, and recovery time, but it still carries risks related to general anesthesia especially in frail patients. To address this problem, awake VATS is gaining popularity worldwide. The most common procedures performed with this technique are pleural biopsies and pleurodesis for malignant pleural effusions. Available data suggest that, in experienced centers, awake VATS is safe and has a similar efficacy in treating pleural effusions compared to intubated VATS, with very few contraindications. Patients with multiple comorbidities, elderly patients, and those with poor pulmonary function, who are at higher risk during general anesthesia, are the ideal candidates for awake VATS. A narrative review was conducted in order to help surgeons approaching this technique make meaningful improvements in their quality of practice, in a way that is safe for the patient. This article provides a detailed overview of indications, surgical technique, advantages and disadvantages of non-intubated VATS in comparison with medical thoracoscopy and intubated VATS.

**Keywords:** Pleural effusion; pleural biopsy; non-intubated thoracic surgery; video-assisted thoracoscopic surgery (VATS); minimally invasive thoracic surgery

Received: 13 January 2021; Accepted: 25 March 2021; Published: 15 September 2021.

doi: 10.21037/vats-21-4

**View this article at:** <http://dx.doi.org/10.21037/vats-21-4>

## Introduction

A common clinical issue confronting the surgeon is the diagnosis and management of pleural disease. Most malignant pleural effusions arise from lung cancer, breast cancer, and lymphoma, and are associated with a poor prognosis. The goals of treatment are to improve quality of life, primarily by reducing dyspnea, and to minimize pleural procedures and the need for repeated hospital visits (1).

Pleural fluid cytology can provide confirmation of malignancy but has a diagnostic yield of only 65%, and it

might not differentiate between pleural adenocarcinoma and mesothelioma, or between lymphoma and reactive lymphocytosis without special studies (2). Thoracic surgeons are often called upon in the following scenarios: (I) pleural effusions undiagnosed by thoracentesis or percutaneous pleural biopsy; (II) need for histological type determination of a cytologically malignant effusion; (III) malignant pleural effusions requiring chemical pleurodesis; (IV) complete evacuation of fluid collections when chest tube placement has not been resolute (3).

<sup>^</sup> ORCID: Sara Parini, 0000-0002-6021-6247; Ottavio Rena, 0000-0002-3872-1829.

Over the years, the traditional idea of video-assisted thoracoscopic surgery (VATS) has been inevitably connected to general anesthesia and one-lung ventilation. However, establishing lung isolation carries the risk of side effects, such as hypoxemia, acute lung injury caused by positive pressure ventilation, atelectasis in the dependent lung, and laryngeal or tracheal injury. In addition, intravenous agents used during general anesthesia, primarily opioids, are associated with postoperative hyperalgesia, vomiting, nausea, and ventilatory depression. All these effects can significantly affect patient comfort and increase the need for assistance and hospital stay.

Today, awake VATS and VATS under general anesthesia can both be used in the evaluation and treatment of a malignant pleural effusion, which is currently the most common indication for tubeless VATS procedures (4,5).

Although VATS under general anesthesia is a common procedure in most thoracic surgeries across the world, there are few surgeons that can boast years of experience in awake VATS; thus, most studies come from centers of excellence in this field. Since pleural biopsies are among the simplest thoracic procedures, they are frequently the first to be performed by awake VATS. However, there is a paucity of literature summarizing available data and providing practical guidance to those approaching the technique for the first time.

In this overview, we synthesize available literature and discuss indications, surgical technique, as well as advantages and disadvantages of non-intubated VATS in comparison with medical thoracoscopy and intubated VATS.

We present the following article in accordance with the Narrative Review reporting checklist (available at <http://dx.doi.org/10.21037/vats-21-4>).

## Methods

A PubMed literature review was performed using key phrases such as “awake thoracoscopy pleural effusion” (771 results), “awake VATS” (106 results), “awake pleural biopsy” (11 results), “tubeless VATS” (24 results), “non-intubated VATS pleural biopsy” (8 results). This search was performed in January 2020, and captured all research conducted prior to this date (from 1966).

Inclusion criteria were the following: studies on pleural biopsies without general anesthesia and one-lung ventilation; studies pertaining to either medical or surgical thoracoscopy; studies written in English.

Relevant studies were determined using the aforementioned inclusion criteria. Articles were reviewed

by the authors to determine relevance, and references were reviewed in order to expand the relevant data collection. After final review, a total of 26 articles were identified as pertinent to this review.

## Discussion

### *Medical versus surgical thoracoscopy*

Although it is widely perceived as a modern technique, the long history of awake thoracoscopy dates back to 1910, when it was first described by its inventor Hans Christian Jacobaeus. It was approximately 50 years after William T.G. Morton and John Collins Warren made history by performing the first surgical operation under general anesthesia at Massachusetts General Hospital in Boston, on October 16, 1846. After Jacobaeus, this procedure was gradually phased out until two decades ago, when it has gained new popularity with the advent of the semirigid thoracoscope (6,7).

Thoracoscopy is a term used to indicate a variety of minimally invasive methods to access the chest, in contrast to open thoracotomy. Two different approaches have been described: VATS and medical thoracoscopy (8).

Medical thoracoscopy, also known as pleuroscopy, can be performed by either surgeons or pneumologists, usually under local anesthesia and conscious sedation in spontaneously breathing patients. A combination of a short-acting benzodiazepine, such as midazolam, and an opioid, such as fentanyl, are the most commonly used agents (9). The incision is made at the level of fifth or sixth intercostal space on midaxillary line. Blunt dissection of the chest wall allows for the introduction of the trocar and thoracoscope. Air inhaled through the open trocar induces a pneumothorax, which helps creating more pleural space. If present, fluid is suctioned to gain enough space to examine the pleura thoroughly, move instruments and biopsy the parietal pleura. Both rigid and semi-rigid or flex-rigid thoroscopes can be used. Rigid thoracoscope provides a larger working channel, that can incorporate a telescope with a light and a camera, allows the operator to obtain larger tissue samples and a more efficient visualization. Despite different biopsy size, rigid and flex-rigid thoracoscope achieve a similar diagnostic yield (10,11). On the other hand, rigid thoracoscope potentially increases discomfort due to the pressure of the metal tube between the ribs. Flex-rigid thoracoscope, preferred by most pneumologists, has a small diameter and a flexible tip to ease maneuvering (7). Its channel size is also the main

disadvantage, since it can only accommodate small flexible forceps. Two important aspects of medical thoracoscopy are that it can be done in an outpatient setting, and that many institutions perform the procedure in an endoscopy unit rather than in the costly environment of an operating room.

Video-assisted thoracoscopic surgery, or VATS, is generally done by thoracic surgeons under general anesthesia, with double or single lumen intubation. However, VATS can also be performed with sedation and local anesthesia, a procedure known as “awake VATS”. In this setting, the patient is placed in lateral decubitus position. A rigid thoracoscope is inserted for the examination of the thoracic cavity and, depending on surgeon’s preference, the procedure can be performed via uniport or multiport approach.

### *Diffusion of awake VATS*

The first series was published by Rusch and Mountain in 1987 (3). The authors described 46 thoracoscopy cases performed under regional anesthesia and mild sedation for pleural disease. They found that the procedure had no operative deaths and essentially no morbidity. It seemed a safe, effective and relatively simple procedure.

In 1990s, Katlic (5,12) started performing uniportal VATS under local anesthesia and sedation in Baltimore. Firstly, he treated mainly pleural effusions and early emphysemas in frail patients, and later offered the technique to all patients suffering from these surgical conditions. By adding additional ports, this technique has been extended to other indications in the subsequent years, such as pericardial windows and lung biopsies. His experience in awake VATS is described in a series of 529 patients, where the most common awake procedure was drainage of pleural effusion and pleural biopsy [368], of which 302 with talc insufflation.

In the early 2000s, the “Awake Thoracic Surgery Research Group” was founded in Rome by Mineo (4). Throughout the years, this pioneer group has treated more than 1,000 patients using tubeless techniques. They started with benign conditions, such as pneumothorax, emphysema, pleural infection and interstitial lung disease, and then extended their indications to pleural effusions, peripheral lung nodules and mediastinal masses.

In 2015, Pompeo *et al.* (13) surveyed the European Society of Thoracic Surgeons members on their experience with non-intubated thoracic surgery. Of 105 responders, 62 declared to have experience with this technique, mainly for pleural biopsies (98%). Less than 30% of responders had performed other procedures, such as decortication,

lung biopsies, pericardial windows and mediastinal biopsies. According to this survey, intercostal block with mild sedation was the preferred method (59%), followed by laryngeal mask (43%), and thoracic epidural catheter with sedation (20%).

### *Technique of awake VATS for pleural biopsy*

#### **Patient selection**

The experience of the team is, and should be, a factor influencing case selection. Patient cooperation is the key prerequisite for awake VATS. In general, patient population tends to include either very healthy patients undergoing minor procedures, or high-risk patients in whom the risk associated with general anesthesia could be reduced.

Awake thoracoscopy for pleural biopsy should generally be undertaken in patients with a confirmed pleural effusion. Dyspnea secondary to the effusion is likely to be relieved by the procedure, thus it is not a contraindication *per se*. Awake VATS should be offered to patients whose survival is expected to be reasonable, when a tissue diagnosis will affect subsequent management, and when the diagnostic/therapeutic benefit is judged to be worth the burden of an invasive procedure and hospital stay. For these reasons, it is not appropriate in terminally ill patients. Moreover, it involves intravenous sedation, so a reasonable level of oxygen saturation (>90% with additional oxygen during the procedure) is required. According to the British Thoracic Society, lung adherent to the chest wall, hypercapnia or severe respiratory distress, uncontrollable cough, and lack of informed consent are the absolute contraindications to the procedure (14). Furthermore, the presence of massive bleeding, pus, alveolar proteinosis or bronchopleural fistula requires lung isolation to protect the contralateral parenchyma; thus, awake VATS should be avoided in these cases (15). Conversely, most authors agree on the fact that advanced age, extreme body mass index, or multiple comorbidities are not contraindications to awake VATS (5).

#### **Preoperative care**

To ensure a safe operation, communication of anticipated steps and concerns between surgeons, anesthesia team and operating room personnel is essential. Contingency plans for intubation and conversion to thoracotomy include immediate placement of a chest tube via one port site and occlusive dressings to any others, then turning the patient supine for intubation. An alternative is placement of a laryngeal mask airway while the patient is still lateral (16).

Patients are sedated with an individualized combination

of midazolam, fentanyl, and propofol. The depth of sedation depends on the expected duration of the procedure, and it must be discussed with the anesthesia team beforehand. Drainage of a pleural effusion with pleural biopsy via a single port may not require a sedation as deep as a two- or three-port lung biopsy. Playing music of patients' choice before and during surgery has proved to increase their relaxation and reduce anxiety and sedative requirements (17). Supplemental oxygen is administered via nasal cannula or facemask or both. Oxygen saturation, electrocardiogram, and blood pressure are monitored. End-tidal carbon dioxide may be assessed through a catheter inserted into an oral airway. If necessary, flexible bronchoscopy is carried out through the pharynx, after lidocaine topical spray of the vocal cords. The patient is then turned into full lateral position, similarly to any VATS procedure (5,16).

Local anesthesia consists of an infiltration of 1% lidocaine without epinephrine, 10 to 30 mL depending on the number of incisions. The dose limit of lidocaine 1% (10 mg/mL) is 4.5 mg/kg, approximately corresponding to 30 mL for an adult weighing 70 kg. An effective local anesthesia technique, as recommended by Katlic (12), is numbing the skin and subcutaneous tissues first, dissecting the tissues onto the ribs and infiltrating intercostal muscle and pleura. Then, entering the pleural cavity must be more by repeated spreading dissection rather than by pressure, resulting in less pain. Migliore *et al.* (18) described a similar four-step technique, using 10 mL of 7.5% ropivacaine. Some groups use intercostal block (20 to 30 mL of 2% lidocaine and 7.5% ropivacaine), or thoracic epidural analgesia (15,19).

### Surgical technique

In general, one, two or three ports may be used. Drainage and pleural biopsies are usually performed via a single port (5). Instruments, such as cup biopsy forceps and talc insufflation catheter can be passed alongside the short trocar, or through the working channel of the thoracoscope. In case of multiloculated effusion, chronic hemothorax, or empyema, additional ports enable the use of other instruments to disrupt adhesions. Given the pre-existing lung collapse, patient discomfort due to the open pneumothorax is usually well tolerated (4,5).

Biopsy of the parietal pleura should be performed over a rib to avoid the neurovascular bundle, grasping the parietal pleura overlying the rib, and removing the pleura with a long tearing rather than a grab-and-pull motion. Biopsies with the flexible-rigid pleuroscope are smaller since they

are limited by the size of the flexible forceps, which in turn depends on the diameter of the working channel. The flexible forceps also lack mechanical strength in obtaining pleural specimens of sufficient depth, a major factor that affects the diagnostic yield when mesothelioma is suspected (20). Pleurodesis by insufflation of 4 grams of sterile talc over lung surface (talc poudrage) can be undertaken during thoracoscopy, if the pleura appears abnormal on inspection and lung re-expansion is satisfactory.

### Postoperative care

In selected patients, a long-term indwelling pleural catheter may be placed at the end of the case for at-home palliation. However, the majority of patients are discharged the same or following day with a chest tube, which is removed in the outpatient clinic when appropriate (5).

The combination of nonsteroidal anti-inflammatory drugs (NSAIDs) and paravertebral block has been reported to provide excellent pain control (21). In practice, in most circumstances, postoperative analgesia can be achieved by either on-demand or patient-controlled analgesia, using NSAIDs, paracetamol, or opioids.

### Outcomes

#### Safety

Despite widespread concerns regarding risk of conversion, that may have favored VATS over pleuroscopy performed outside the operating room, this event seems unlikely. In Katlic's series, no patient out of 529 required conversion to thoracotomy or intraoperative intubation. The author reported no deaths due to operation (5). Similar results are described by Kocatürk *et al.* (22) in a recent randomized trial comparing awake and intubated VATS. Likewise, McDonald *et al.* (23) observed no difference in the rate of major complications, whereas Mineo *et al.* (19) reported lower perioperative mortality and morbidity in tubeless VATS.

#### Diagnostic yield and pleurodesis efficacy

According to the analysis by McDonald *et al.* (23), sensitivity, specificity, positive predictive value, and negative predictive value of awake VATS versus general anesthesia were respectively 85% versus 93%, 100% versus 94%, 100% versus 99%, and 79% versus 76%, with no significant difference in diagnostic performance. In a case-matched study comparing intubated and non-intubated VATS, the success rate for talc pleurodesis is similar between the two groups (83.5% versus 85.7%) (19). A prospective

randomized study comparing awake and intubated VATS in diagnosing pleural diseases found that safety and diagnostic yield are similar, while operative and postoperative costs are significantly lower in the awake VATS group (22).

### Inflammatory response

Some studies suggest a reduced inflammatory response after awake VATS compared to general anesthesia. Tacconi *et al.* (24) found that serum cortisol, glucose and C-reactive protein levels were lower in the awake group for 2 days after surgery. In a randomized study, awake VATS demonstrated smaller impact on lymphocyte response, as shown by the significant postoperative decrease in the proportion of natural-killer cells and in lymphocyte count (25).

### Operating room time, hospital length of stay, and cost

Tubeless VATS seems to decrease total operating room time, mainly by reducing anesthesia time and recovery room time (19,22). Additionally, awake VATS procedures are associated with a shorter median hospital stay. In most institutions, VATS cases under general anesthesia are admitted to the hospital, whereas the majority of awake procedures are performed in an outpatient setting. VATS pleural biopsies under general anesthesia are associated with a higher procedure-related mean cost compared to awake thoracoscopy, with no difference in additional procedures required (19,22,23).

### Patient choice

Although the vast majority of patients experience no intraoperative pain, awareness or recall during the procedure, there is still no evidence supporting the hypothesis that awake VATS makes surgery more acceptable for patients (5,26).

### Conclusions

General anesthesia has become safer throughout the years, but it still carries serious potential risks especially in frail patients. To address this problem, awake VATS is gaining popularity worldwide. Available literature shows that non-intubated VATS is safe and has a similar efficacy in treating pleural effusions compared to intubated VATS, with very few contraindications.

Advantages include reduced risk related to general anesthesia, reduced operating room time, faster recovery, shorter hospital length of stay, and lower procedure-related cost, as it can be done in an outpatient setting.

Compared to medical pleuroscopy, awake VATS allows a wider inspection of the pleural cavity and larger biopsies. Since it is performed in the operating room and not in an endoscopy suite, it is associated with a higher procedure-related cost. Nevertheless, in the event of a major complication requiring surgery, the situation cannot be managed anywhere but in the operating room.

This study has some potential limitations. The first is the possibility that some studies used terms outside the aforementioned key terms. The second arises from the fact that awake thoracic surgery is still performed in specialized centers, whereas intubated VATS is a routine procedure in most thoracic surgeries. Thus, available data on awake VATS come from few high-volume institutions, where it is performed by surgeons intensively trained in this technique. For this reason, its advantages and disadvantages need to be further validated.

### Acknowledgments

*Funding:* None.

### Footnote

*Provenance and Peer Review:* This article was commissioned by the Guest Editors (Francesco Guerrera, Paolo Albino Ferrari and Roberto Crisci) for the series “Non-Intubated Thoracic Surgery. A Global Perspective” published in *Video-Assisted Thoracic Surgery*. The article has undergone external peer review.

*Reporting Checklist:* The authors have completed the Narrative Review reporting checklist. Available at <http://dx.doi.org/10.21037/vats-21-4>

*Conflicts of Interest:* Both authors have completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/vats-21-4>). The series “Non-Intubated Thoracic Surgery. A Global Perspective” was commissioned by the editorial office without any funding or sponsorship. The authors have no other conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

*Open Access Statement:* This is an Open Access article distributed in accordance with the Creative Commons



Attribution-NonCommercial-NoDerivs 4.0 International License (CC BY-NC-ND 4.0), which permits the non-commercial replication and distribution of the article with the strict proviso that no changes or edits are made and the original work is properly cited (including links to both the formal publication through the relevant DOI and the license). See: <https://creativecommons.org/licenses/by-nc-nd/4.0/>.

## References

1. Feller-Kopman D, Light R. Pleural Disease. *N Engl J Med* 2018;378:740-51.
2. Heffner JE, Klein JS. Recent advances in the diagnosis and management of malignant pleural effusions. *Mayo Clin Proc* 2008;83:235-50.
3. Rusch VW, Mountain C. Thoracoscopy under regional anesthesia for the diagnosis and management of pleural disease. *Am J Surg* 1987;154:274-8.
4. Mineo TC, Tamburrini A, Perroni G, et al. 1000 cases of tubeless video-assisted thoracic surgery at the Rome Tor Vergata University. *Future Oncol* 2016;12:13-8.
5. Katlic MR. Five Hundred Seventy-Six Cases of Video-Assisted Thoracic Surgery Using Local Anesthesia and Sedation: Lessons Learned. *J Am Coll Surg* 2018;226:58-63.
6. Marchetti GP, Pinelli V, Tassi GF. 100 Years of Thoracoscopy: Historical Notes. *Respiration* 2011;82:187-92.
7. Ernst A, Hersh CP, Herth F, et al. A novel instrument for the evaluation of the pleural space: an experience in 34 patients. *Chest* 2002;122:1530-4.
8. Shojaee S, Lee HJ. Thoracoscopy: medical versus surgical in the management of pleural diseases. *J Thorac Dis* 2015;7:S339-51.
9. Astoul P, Maldonado F. Anesthetic Drugs Managed by Pulmonologists during Medical Thoracoscopy: One Size Does Not Fit All! *Respiration* 2014;88:265-7.
10. Khan MAI, Ambalavanan S, Thomson D, et al. A comparison of the diagnostic yield of rigid and semirigid thoroscopes. *J Bronchology Interv Pulmonol* 2012;19:98-101.
11. Rozman A, Camlek L, Marc-Malovrh M, et al. Rigid versus semi-rigid thoracoscopy for the diagnosis of pleural disease: a randomized pilot study. *Respirology* 2013;18:704-10.
12. Katlic MR. Video-Assisted Thoracic Surgery Utilizing Local Anesthesia and Sedation: How I Teach It. *Ann Thorac Surg* 2017;104(727-30).
13. Pompeo E, Sorge R, Akopov A, et al. Non-intubated thoracic surgery-A survey from the European Society of Thoracic Surgeons. *Ann Transl Med* 2015;3:37.
14. Rahman NM, Ali NJ, Brown G, et al. Local anaesthetic thoracoscopy: British Thoracic Society pleural disease guideline 2010. *Thorax* 2010;65:ii54-60.
15. Kao MC, Lan CH, Huang CJ. Anesthesia for awake video-assisted thoracic surgery. *Acta Anaesthesiol Taiwan* 2012;50:126-30.
16. Qaqish TR, Cox S, Carr R, et al. Treatment of Pleural Effusions with Nonintubated Video-Assisted Thoracoscopic Surgery. *Thorac Surg Clin* 2020;30:25-32.
17. Lepage C, Drolet P, Girard M, et al. Music Decreases Sedative Requirements During Spinal Anesthesia. *Anesth Analg* 2001;93:912-916.
18. Migliore M, Giuliano R, Aziz T, et al. Four-Step Local Anesthesia and Sedation for Thoracoscopic Diagnosis and Management of Pleural Diseases. *Chest* 2002;121:2032-5.
19. Mineo TC, Sellitri F, Tacconi F, et al. Quality of life and outcomes after nonintubated versus intubated video-thoracoscopic pleurodesis for malignant pleural effusion: comparison by a case-matched study. *J Palliat Med* 2014;17:761-8.
20. Lee P, Mathur PN, Colt HG. Advances in Thoracoscopy: 100 Years since Jacobaeus. *Respiration* 2010;79:177-86.
21. Fibla JJ, Molins L, Mier JM, et al. The efficacy of paravertebral block using a catheter technique for postoperative analgesia in thoracoscopic surgery: a randomized trial. *Eur J Cardiothorac Surg* 2011;40:907-11.
22. Kocatürk C, Kutluk AC, Usluer O, et al. Comparison of awake and intubated video-assisted thoracoscopic surgery in the diagnosis of pleural diseases: A prospective multicenter randomized trial. *Turk Gogus Kalp Damar Cerrahisi Derg* 2019;27:550-6.
23. McDonald CM, Pierre C, de Perrot M, et al. Efficacy and Cost of Awake Thoracoscopy and Video-Assisted Thoracoscopic Surgery in the Undiagnosed Pleural Effusion. *Ann Thorac Surg* 2018;106:361-7.
24. Tacconi F, Pompeo E, Sellitri F, et al. Surgical stress hormones response is reduced after awake videothoracoscopy. *Interact Cardiovasc Thorac Surg* 2010;10:666-71.
25. Vanni G, Tacconi F, Sellitri F, et al. Impact of awake videothoracoscopic surgery on postoperative lymphocyte responses. *Ann Thorac Surg* 2010;90:973-8.
26. Pompeo E. Awake thoracic surgery--is it worth the trouble? *Semin Thorac Cardiovasc Surg* 2012;24:106-14.

doi: 10.21037/vats-21-4

**Cite this article as:** Parini S, Rena O. Non-intubated video-assisted thoracoscopic surgery for pleural biopsy: a narrative review. *Video-assist Thorac Surg* 2021;6:30.