

Non intubated video-assisted thoracoscopic lung resections (NI-VATS) in COVID times

ABSTRACT

The emergence of epidemic Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) in December 2019 in Wuhan, China causing Coronavirus Disease 2019 (COVID-19) and its rapid expansion around the world, leading to a global pandemic of dimensions not observed at least since the “Spanish influenza” pandemic in 1917-18, has had great consequences at all levels, including social, health and economic spheres. This pandemic situation forces us, as health care workers, to redefine our medical and surgical actions to adapt them to this new reality. It is important, when the rules of the game change, to rethink and to reevaluate if the balance between risk and benefit have moved to a different point of equilibrium, and if our indications of certain surgical interventions need to be redefined. In this article we try to answer the doubts that arise about the suitability of the NI-VATS technique and assess whether its use in these new pandemic circumstances might add advantages, especially in relation to minimize the risks of virus contagion between patients and all healthcare personnel during the surgical procedure, as well as the known advantages described in many articles the last ten years.

Key words: Awake surgery; COVID-19; non-intubated patient; SARS-Cov-2; uniportal VATS

Introduction

Sometimes, throughout our lives, we see ourselves playing a starring role in a movie we would not have to play. In such a situation, as an unwanted perfect storm, Italian and Spanish people found ourselves from March 2019; a virus with an infectivity and lethality far superior to what the Chinese authorities published in their initial reports,^[1,2] resulted in an exponential increase of cases without time to prepare societies paralyzed by fear of the unknown, health systems trying to learn how to fight against an unknown enemy, and governments trying to find their way to optimize weakened health systems for years of economic cuts and provide

protection teams when, at the same time, taking steps to limit mobility and social interaction without guarantee of success.


The frontline struggle of healthcare workers (HCWs) in overwhelmed primary care facilities and hospitals without the right protective equipment led Spain, at last, to be the first worldwide for once in something: to lead the list of health workers infected with SARS-CoV-2 throughout the first half of 2019.

In a recent published meta-analysis about this subject,^[3] infected HCWs are about 2.5% of total SARS-Cov-2 infections,

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with 14.5% severe or critical cases and overall mortality of 1.3%. In the early days of the pandemic (March-April 2020), Spain reported data of infected HCWs account for 20.4% of cases (23728/116386) according to ISCII, equivalent to the National Center of Epidemiology (<https://www.isciii.es>). Compared to data in the same period in Italy, infected HCWs were about 10.7% of cases (18553/173730) according to official data (<https://www.portale.fnomceo.it>). Similar numbers were reported those days in the US^[4] and in Saudi Arabia.^[5]

In developing and third world countries, the data for SARS-Cov-2 contagions in their HCWs are difficult to know accurately, but we must assume high astonishing results in response to their lack of resources and protection equipment, as well as the massification of their health systems.^[1,6]

All these numbers remain a striking remainder of the risk HCWs face standing at the frontline for fighting COVID-19.

It's our duty to be able to do our job with the highest standards of efficiency and quality, while minimizing the risk of contagion the coronavirus that has mediatized our lives and professional performance over the past few months.

Non-Intubated Vats: History and Advantages

Video assisted thoracoscopy (VATS) is on track to become, if not already, the gold standard as surgical technique in almost every lung resections^[2,7] because of its less damage and postoperative pain for the patients with each time less small incisions; especially following the publication by Dr. González-Rivas^[8] of the first single-port video-assisted thoracoscopic lobectomy in 2011 and his ongoing effort travelling around the world showing and teaching the technique and developing new material that makes more affordable the performance of the thoracic surgeons and enhance the potential of uniportal-VATS for the resection of more complicated injuries.^[9,10]

Anesthesiologists cannot stand apart from all these technical and surgical advances; it seems unreasonable to keep our anesthetic techniques not evolving when, progressively, surgical techniques in thoracic surgery are becoming less and less aggressive. It could end up giving the paradox that the facilitating procedure of surgery (anesthetic procedure) was becoming more aggressive than the surgery itself, which would be unacceptable from any point of view.

Historically, non-intubated thoracic surgery is not a thing of the recent years: from 1928, when Guedel presented the

endotracheal tube^[11] and 3 years later, Gale and Waters put this tube in the bronchus of the healthy lung to achieve one-lung ventilation (OLV) until the 1960's when mechanical ventilation was introduced, ventilation was spontaneous or manually assisted, with the preservation of the diaphragm activity, and lung mobility was present until the surgeon managed iatrogenic pneumothorax. It was in 1956 when Vischnevski developed a multimodal technique with the blockade of the phrenic and vagus nerves in the neck, plus an extensive intercostal blockade, combined with the Novocain in the lung hilum after opening the hemithorax.^[12]

This technique allowed him the performance of more than 600 major lung procedures. Four years later, Ossipov published a series of more than 3000 patients operated with a similar technique.^[13] After 1960, the introduction of mechanical ventilation and new improvements for OLV allowed the further development of thoracic surgery.

It was in the early years of the 21th century when the development of endoscopic surgery and minimal surgical trauma led both anesthesiologists and surgeons to perform again no-intubated thoracic surgery. These first cases were peripheral small nodules, bullectomies and similar^[14,15] but today, under expert hands even major resections are feasible under spontaneous ventilation.^[16-18]

The first cases were with thoracic epidural blockade and deeper sedation, but nowadays, uniportal VATS technique, with only a 3-4 cm incision and just one intercostal space involved allows the possibility of avoiding intubated general anesthesia and the maintenance of effective spontaneous ventilation under minimal sedation.^[19]

The advantages of non-intubated VATS include:

- *Avoid morbidity derived from the endotracheal intubation technique*; especially in patients with a difficult airway and the need of one-lung ventilation with bronchial blockers or selective double-lumen tubes, to achieve the intubation might be challenging and might also have potential complications^[20] (mucosal ulceration, throat pain and laryngeal or tracheal injuries,...)
- *Avoid morbidity derived from general anesthesia*, with more systemic and hemodynamic effects than those patients awake or under light sedation. Deep anesthesia might also increase the risk of postoperative cognitive dysfunction,^[21] especially in oldest patients. Drugs used to perform general anesthesia might also have important side-effects:
 - Muscle relaxants, increase risk of residual muscular block and diaphragmatic dysfunction.

- Opioids (high doses), increase risk of postoperative nausea and vomiting, ventilatory depression and hyperalgesia, associated with reduction of patient's comfort and prolongation of postoperative stay in hospital.^[22] It is important not forget potential relationship between high doses of opioids with higher risk of metastasis.^[23,24]
- Volatile anesthetics have been reported to inhibit hypoxic pulmonary vasoconstriction^[25] (sevoflurane) and may promote hypoxemia and airway irritation (desflurane).
- *Avoid morbidity derived from mechanical ventilation;* barotrauma due to high intrapulmonary pressure, damage related to alveolar overdistension and repetitive opening and closing, atelectasis in dependent which might increase ventilation/perfusion mismatch and hypoxaemia.^[26] Minor respiratory impairment due to subclinical ventilator-related lung injury is really frequent and might lead to inflammatory changes and other postoperative complications.^[27]
- *Maintenance of spontaneous ventilation;* minimizes ventilation/perfusion mismatch, increasing efficiency of hypoxic pulmonary vasoconstriction, and hemodynamic instability related to decrease of venous return due to the positive intrathoracic pressure, even in the expiratory time.
- *Regional anesthesia lead to better surgical neuroendocrine stress response to surgery;* less stress hormones and pro-inflammatory mediators related to the avoidance of mechanical ventilation.^[28] This is something that also has relationship with regional techniques (thoracic epidural, paravertebral block, intercostal block, vagus block), but even they are mandatory in non-intubated surgery are not exclusive of it and combined anesthesia (general plus regional) is commonly used in patients in mechanical ventilation.^[29]

Non-Intubated Vats: Protocol and Indications

First of all, is necessary to indicate this is a technique that requires expert hands and high skills in every side of the surgical field (surgeons, anesthesiologists and nurses in the operating room and the recovery unit), with motivation and implication to perform this technique, accepting new challenges who can put them out of their comfort zone. A protocol must be done for the right and secure performance of non-intubated VATS surgery, that has to include criteria of inclusion and exclusion, patient consent and the knowledge of the technique to perform for each patient by every actor involved in each surgery.

Patient's strict exclusion criteria in this surgical technique are well described in the literature^[17,30] and are common for almost major research groups:

- ASA ≥ 3
- Patients with expected difficult airway
- Hemodynamically unstable patients
- Obesity (BMI > 30)
- Sleep apnea Coagulopathy
- Persistent cough or high airway secretion
- Patient with elevated risk of regurgitation
- Neurological disorders Extensive pleural adhesions
- Hypoxemia (PaO₂ ≤ 60) or Hypercarbia (PaCO₂ ≥ 50)
- Central hypoventilation syndrome
- Contraindications for use of regional anesthesia technique specifically selected.

Usually, after the acceptance of the technique by the patient and the obtention of his consent, is important to agree among every member of the team the technique to perform.

Standard monitoring includes electrocardiogram, non-invasive blood pressure, pulse oximetry, bispectral index and an approximation of the end-tidal carbon dioxide and respiratory rate with a catheter placed in one nostril.

After a preoxygenation of ten minutes via facial mask (6 lpm of oxygen), we administer to the patient 0.15-0.2 mg/kg of intravenous Midazolam with the double target of avoid patient's anxiety and unpleasant memories during surgical time.

Then, we balance patient's depth with targeted infusion of remifentanil and propofol, adapting infusion rate to the patient's response and to the aggressiveness of each period during the surgery. We prepare a 50 ml infusion with 20 ml levobupivacaine 0.5%, 10 ml lidocaine 2% and 20 ml saline solution 0.9% to use for every need of local anesthetic during the surgery.

After skin infiltration, the camera is placed in thoracic cavity and under direct view the intercostal block of just the space of the incision, is performed. Only if necessary, the vagal block is performed with 3-4 ml of the local anesthetic solution under direct view.

We don't use epidural thoracic block because we not consider necessary when your incision is just in one intercostal space, and epidural may contribute to hypotension and lack of contraction of intercostal muscles.

Only in some patients we must use supraglottic devices, as nasopharyngeal tube or Guedel cannula, to prevent positive

pressure in the airway during the expiration and to avoid the insufflation of the collapsed lung.

With this protocol we performed over the last six years more than four 400 patients, including:

- Lobectomies
- Wedge resections
- Pleural effusions
- Sympathectomies
- Thymectomies (3 myasthenia gravis)

About 25% of our patients need one or more doses of opioids (morphine) in the postoperative time, often related with pain around the placement of the drainage tube. Our rate of conversion to general anesthesia with mechanical ventilation is less than 4% (12 patients), usually related with discomfort of the surgeon with excessive respiratory movements of the diaphragm, with subsequent unacceptable increase of difficulty to achieve successful surgical results.

Non-Intubated Vats: Its Place in Covid Times

After China announced an outbreak of a new coronavirus in the city of Wuhan on December 31, 2019,^[31] the world has become pandemic. Severe cases from the Huanan Seafood Wholesale market in Wuhan were confirmed pneumonia with the infection of a novel coronavirus, named SARS-CoV2 (International Committee on Taxonomy of Viruses). At the beginning, we all thought in a limited epidemic, as it happened with previous coronaviruses transmitted from animals to humans (SARS-CoV,^[32] Guangdong, China, (2003) and MERS-CoV,^[33] Arabian Peninsula (2012-15)), but this 29.903 nucleotides of single-stranded viral RNA came to change our lives as individuals and as society worldwide; a global pandemic affected us all. Taken together, both previous outbreaks this century of other members of the coronavirus family (SARS-CoV) and MERS-CoV) did not produce even 1% of the global harm already inflicted by SARS-CoV-2.

This virus has its main transmission among humans via droplets, and that's why anesthesiologists are required to heightened precautions, minimizing the many aerosol-generating procedures during general anesthesia. In these pandemic times, seems clever to avoid any airway manipulation, prioritizing regional anesthesia in to order to preserve respiratory function avoiding aerosolization and hence viral transmission. As well as the general benefits of reduced pain, less opioid consumption, less PONV and less cognitive dysfunction and delirium offered by regional anesthesia over general anesthesia, in these pandemic times we think the main advantage should be the avoidance of

airway manipulation and potential patient coughing during intubation and extubation.^[34]

After some exotic tries of safe intubation, designing carton-made or methacrylate-made boxes,^[35] it is obvious to say there is no better way to avoid aerosol generation than non-airway manipulation.^[36]

This protocol is for programmed surgery in patients of Thoracic Surgery and if it is not mentioned is following the general protocol for NI-VATS explained in the previous chapter; it is important to notice that a PCR testing for COVID-19 diagnosis must be done 24-48 hours prior to surgery and if PCR testing is positive, our recommendation is to delay the surgery until its negativization, if it's possible.

- The patient must be placed from the ward to the OR with no intermediate stays and every procedure we perform to the patient must be done there (review, regional anesthesia techniques and early recovery).^[37]
- The number of personnel within the OR should be kept to a minimum, preference for the most expert and skilled professionals.
- Oxygen therapy was identified as an independent risk for super-spreading nosocomial outbreaks.^[38,39] That's why our patients -even when sedated- wear surgical face mask during all the time they stay in the OR, with the aim of preventing airborne and droplet transmission. We try to avoid the use of respiratory devices as high flow nasal cannula or venturi mask, due to the evidences of higher risk of aerosolization. We keep flow of oxygen as low as possible to maintain proper oxygen saturation.
- To prevent coughing, we perform vagal block more often than in previous circumstances, because coughing could the dispersion distance further, even with the surgical face mask placed.
- In every moment, personnel in the OR must take appropriate respiratory precautions and keep the principles of safe oxygen delivery, wearing a fit-tested N95 face mask, disposable work caps, shoe covers and gloves. Other personal protective equipment eyes glasses or shield, goggles are at discretion of each HCW.
- Even with spontaneous ventilation, we use the Y respiratory circuit of the anesthesia machine connected with the facial mask of the patient to deliver flow of oxygen and have the ease to pressurize patient's respiratory system when is required (re-expansion of the lung, PEEP, etc.) with the overpressure valve of the anesthesia machine. Facial mask is fitted to the patient with flexible rubber strips around his head.
- Some groups recommend the use of preprocedural chlorhexidine wipes, 2 doses nasal within one hour of

incision and chlorhexidine mouth rinse,^[40] but these aspects are under discussion and not actually included in our protocol.

Under these guidelines, we performed 35 NI-VATS the last six months of 2020:

- 10 Sympathectomies
- 8 Pleural effusions
- 11 Wedge resections
- 6 Lobectomies

The results were equivalent to those obtained in the pre-pandemic period and didn't have virus outbreak or data of cross infection in our patients.

Conclusions

If in the recent years, awake and non-intubated uniportal-VATS procedures were increasing its indications among thoracic surgeons worldwide, with this new scenario of pandemic will become a huge part of the thoracic surgical armamentarium. Represented by the avoidance of general anesthesia and all the benefits derived from that, this multidisciplinary program will increase the speed of its implantation. The success of this technique remains not only in its feasibility, safety and cost-effectiveness, in the strength of outcome data derived from large numbers of registries. Another key aspect of the success of this technique and its rapid implantation everywhere remains in the generosity of those who started and described this technique and the collaboration with dedicated anesthesiologists and surgeons.

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Conflicts of interest

There are no conflicts of interest.

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