Surgical Technique on Thoracic Surgery

Technical steps in single port video-assisted thoracoscopic surgery lobectomy

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Abstract: Video-assisted thoracoscopic surgery (VATS) has transformed the way of treating patients with lung diseases over the past two decades and this is particularly true referred to patients with lung carcinoma. The indication for surgical treatment could be extended to those patients that were functionally unable to receive a thoracotomy and overall this approach shortened the length of stay in hospital and improved the quality of life of these patients postoperatively. The best VATS technique for lobectomy has not been well defined yet. The VATS approach to lobectomy can be performed via 1–4 incisions without rib spreading with similar outcomes. Over the last few years the single port VATS approach has generated a growing interest in the scientific thoracic surgery community as less invasive for the patients and comfortable for the performing surgeon. The aim of this video-article is to show the different steps of this technique and to provide some tips and tricks to improve and facilitate the execution of the uniportal VATS lobectomy.

Keywords: Uniportal video-assisted thoracoscopic lobectomy; single port minimally invasive thoracic surgery

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Introduction

Video-assisted thoracoscopic surgery (VATS) has transformed the way of treating patients with lung diseases over the past two decades. This is particularly true referred to patients with lung carcinoma. The VATS approach has proven to be superior to thoracotomy in many regards, in particular regarding the treatment with patients with lung cancer (1). The best VATS technique for lobectomy has not been well defined yet. The VATS approach to lobectomy can be performed via 2–4 incisions without rib spreading with similar outcomes. The final step in the evolution of the technique is the use of a single-port approach. Gonzalez-Rivas *et al.* described the first uniportal VATS lobectomy in 2010 (2). The development of angulated instruments and articulated staplers has helped to perform lobectomies and other major pulmonary resections through a single incision approach.

Patient selection and workup

The VATS lobectomy technique is considered nowadays the standard treatment for early stage of lung cancer (3), but there are still some uncertainties in relation to the potential difficulties and complications regarding thoracoscopic major pulmonary resections in patients with advanced lung cancer. Recent studies showed that it is feasible to perform these kind of procedures safely and reliably, providing perioperative outcomes similar to those obtained in early stage tumours operated through this same technique (uniportal or not) (4,5). In this context it is possible to extend the indication for VATS also in those patients who previously would have undergone a thoracotomy, upon the appropriate expertise of the surgeon (6). An appropriate preoperative workup and patient selection is mandatory in order to avoid complications and to maintain a low conversion rate (7).

Figure 1 Specific adapted instrumentation with distal articulation and articulated staplers.

Figure 2 Dissection of the fissure and of the lower lobe pulmonary artery using the Harmonic® Unltrasonic Device (9). Available online: http://www.asvide.com/articles/843

Figure 3 Incision in the 5th intercostal space anterior axillary line (12). Available online: http://www.asvide.com/articles/844

Pre-operative preparation

Planning for a VATS resection as safely as possible involves the consideration of the patient's characteristics and the anticipated technical aspects of the case. The patients can be included in an enhanced recovery pathway, that refers to a combination of perioperative interventions designed to minimise the impact of surgery on patients' recovery in order to reduce postoperative complications (8).

Equipment preference card

Single port VATS lobectomy can be performed with conventional instruments, but the use of especially adapted instrumentation with distal articulation (*Figure 1*), articulated staplers, vascular clips, modern energy devices (*Figure 2*) and high definition 30° cameras can facilitate the surgeon in performing a successful uniportal VATS lobectomy (10).

Role of team members

The modern thoracic surgical team includes one surgeon who operates together with the first assistant who holds the camera and a scrub nurse (11). The surgeon and his assistant should be positioned in front of the patient in order to have the same thoracoscopic vision during all steps of the procedure for more coordinated movements. The scrub nurse is located on the opposite side of the operating table. An experiences anaesthetist should also be present in case of complications.

Procedure

General aspects

The uniportal VATS lobectomy technique follows the oncological principles of major pulmonary resections by VATS (individual dissection of veins, arteries and lobar bronchus combined with complete mediastinal lymphadenectomy). The procedures are performed under video-assisted visualisation and with no rib spreading.

Under general anesthesia and double lumen intubation, the patient is placed in a lateral decubitus position as usual for a conventional VATS. The 4–5 cm long incision is usually placed in the 5th intercostal space anterior axillary line to get access to the hilar structures and lymph node stations (*Figure 3*). This location also allows a good angle for hilar dissection and insertion of staplers. The proper

Figure 4 Use of 45° applier for polymer clips to divide the vessels (13). Available online: http://www.asvide.com/articles/845

Figure 5 Use of the stapler to avoid traction (14). Available online: http://www.asvide.com/articles/846

placement of the incision is crucial in order to have an adequate exposure to ease the dissection and to avoid instrument interference. The size of the incision will allow removing the specimen without performing any further utility incision. A wound retractor can be used, a trocar for the thoracoscope is not needed. The thoracoscope is usually placed at the posterior part of the incision, so that the surgeon can work with the instruments in the anterior part. It is helpful to rotate the surgical table away from surgeon during the hilar dissection and towards the surgeons for the lymph node dissection. The use of vascular clips for proximal vascular control and energy devices for distal division of small vascular branches is recommended.

The field of vision is only obtained through the anterior access site but the movements of the 30-degree thoracoscope along the incision will create different angles of vision. Using the thoracoscope in coordination with the instruments allows the direct vision of the target tissue, thus we can obtain similar angle of view as for open surgery. Instruments should be long and curved to allow the insertion of 3 or 4 instruments simultaneously. The dissection can be performed with energy devices.

For upper lobectomies, the pulmonary artery is normally divided first, followed by vein, bronchus and fissure. In case of lower lobectomies the normal sequence of dissection should be as follows: inferior pulmonary ligament, inferior pulmonary vein, pulmonary artery, bronchus and finally completion of the fissure. When the lobectomy is completed, the lobe is removed in a protective bag and a systematic lymph node dissection is performed. The intercostal spaces are infiltrated with local anaesthetic at the end of the surgery under thoracoscopic view. A single-chest tube is placed in the posterior part of the incision.

Right upper lobectomy

The surgical steps for the right upper lobectomy are very similar to conventional VATS. It is recommended starting the procedure by dividing the anterior arterial trunk in order to facilitate the insertion of the staplers in the upper lobe vein. Once this arterial branch is stapled, the vein is easily exposed. As a rule, for upper lobes ideally staplers should be used for all hilar structures, but the use of vascular clips or tie off the vessels can be very helpful in the division of segmental branches of the pulmonary artery and vein (*Figure 4*). If the angle is no good, stapling the anterior portion of the minor fissure (anvil of the stapler placed between the upper and middle lobe vein pulling the parenchyma into the jaws of the stapler) can provide a better retraction of the lobe, thus improving the angle for the insertion the staplers to the upper vein. It is important to dissect the vein as distal as possible for optimal stapler insertion. The use of tip-curved staplers is also recommended to avoid major tractions (*Figure 5*).

When the remaining arterial branches are divided, the bronchus can be dissected. The last step would be to complete the fissure from anterior to posterior. After identifying the artery for the middle lobe, we can continue to divide the fissure by placing the stapler over the surface of the interlobar artery, pulling the parenchyma anteriorly making sure that the middle lobe artery is left out to the left side of the stapler. The vascular and bronchial stumps are kept out from the staplers' jaws. During the approach to the minor fissure, the camera is placed in the anterior portion of the utility incision and the instruments at the posterior. This is the only step in which the camera position is changed, but it provides a direct view of the hilum.

Figure 6 Difficult bronchus dissection during left upper lobectomy (15). Available online: http://www.asvide.com/articles/847

Figure 7 Division of the anterior portion of major fissure and of the main for the middle lobe (16). Available online: http://www.asvide.com/articles/848

Left upper lobectomy

The surgical steps for this lobe are similar to right upper lobectomy: anterior and apical segmental trunk, upper vein, posterior segmental artery, upper bronchus and fissure. Probably, this is the most difficult lobectomy using the uniportal approach, especially when the fissure is incomplete. It is recommended starting the procedure by dividing the anterior arterial trunk and then the vein, in order to help the insertion of the stapler to the upper vein as described in the right upper lobe. Prior to the management of the upper vein, the anterior portion of the major fissure should be stapled.

Another option for the management of the upper lobe vein is to open the fissure as first step and dissect the plane between upper and lower vein with the identification of bronchus and artery. The stapler is then inserted over the artery to divide the fissure and the lobe is mobilized to allow the stapling of the vein from a different angle.

When the remaining arterial branches are divided, the bronchus can be dissected. It can be transected at this point or left for the final step. The management of the bronchus during left upper lobectomies is more difficult because it must be taken with the lingular artery, which usually lies behind the bronchus. We have four different forms to manage the upper lobe bronchus. The first option consists of exposing the lingular artery and subsequently dividing it in the fissure (when the fissure is complete or the artery can be easily exposed). At this point, the insertion of an endostapler for the bronchus is easy. In the second option, if the fissure is not complete or the artery is hidden, a thoracoabdominal (TA) stapler can be used to divide it in order to avoid injury of the lingular artery. The third option entails dividing the bronchus with scissors and closing it at the end of the surgery (by manual suture or by using a stapler) (*Figure 6*). The final and fourth option focuses on inserting an endostapler after division of superior trunk (and optionally posterior ascending artery) and vein. This last option must be pursued only by experienced uniportal VATS surgeons.

Right middle lobectomy

This lobectomy is usually performed from caudal to cranial: anterior portion of major fissure, vein, bronchus, artery, anterior portion of minor fissure and finally the posterior portion of the major fissure. The identification of middle and lower lobe veins indicates the location to place the stapler to divide the anterior portion of major fissure (the anvil of the stapler is placed between the two veins and the lung parenchyma is pulled into the jaws of the stapler). This manoeuvre facilitates the dissection and insertion of stapler to transect the vein (*Figure 7*). Only when the fissure is complete the artery can be easily exposed, dissected and divided before doing the same with the bronchus. Finally, the minor fissure and the posterior part of the major fissure are stapled and the lobe can be removed.

Right lower lobectomy

The technique for lower lobectomies may be different depending on whether the fissure is complete or not. If fissure is complete, the artery in the fissure should be dissected and stapled. Sometimes it is easier to individually divide the arterial branches of the superior and basilar

Figure 8 Fissureless technique in left lower lobectomy (17). Available online: http://www.asvide.com/articles/849

Figure 9 Dissection on the paratracheal lymph nodes (18). Available online: http://www.asvide.com/articles/850

segments. Upon retracting the lobe, the pulmonary ligament should be resected in order to find the vein. Then the vein is dissected and divided. After the exposure of the lower lobe bronchus, this should be dissected and stapled as well. The last step is to staple the fissure and remove the lobe.

In the presence on an incomplete fissure or no visible artery, the technique may change. The best method does not involve the dissection within the fissure in order to avoid postoperative air leaks. Once the lobe is retracted cranially, the sequence of the dissection should be as follows: inferior pulmonary ligament, inferior vein and inferior bronchus. Care must be taken to avoid injuring the bronchus or the artery of the middle lobe. After the section of the lower bronchus, the artery is identified and stapled. The fissure is the last step (fissureless technique). The removal of the intrabronchial lymph nodes is recommended to better define the anatomy.

Left lower lobectomy

The technique for this lobectomy is very similar to right lower lobectomy. The most difficult step during the left lower lobectomy is the dissection of the bronchus so that a particular care should be taken in order to avoid injuries in the basilar artery. An optimal plane must be created between the bronchus and the artery to staple without traction. Once the bronchus is transected, the artery can be divided. The last step is to complete the fissure (*Figure 8*).

Lymphadenectomy

The anti-Trendelenburg position can be very helpful for paratracheal dissection because it naturally allows the lung to "fall down". It is recommended to carry out the procedure by opening the pleura inferiorly to the azygos vein, lifting the vein and retracting the superior vena cava to the right side, allowing a successfully dissection of the paratracheal space from an inferior approach (*Figure 9*).

The Trendelenburg position and the anterior table rotation facilitate the exposure for subcarinal dissection and the preliminary division of the pulmonary ligament gives us a better access to the subcarinal space. For left subcarinal dissection, it is helpful to insert two 10-mm endopeanuts in the lower part of the utility incision to retract the aorta, esophagus and lung. This operation facilitates the dissection with instruments placed above the peanuts and below the camera. For right subcarinal lymph node dissection, the esophagus and the intermediate bronchus must be separated to facilitate the procedure.

For hilar and N1 station lymphadenectomy, it is important to move and rotate the operating table posteriorly in order to place the lung in the back position.

Post-operative management

A recent review suggests that except for pain score the uniportal VATS reveals no differences in most postoperative outcomes in minor or major thoracic procedures (19).

Currently, the evolution of the thoracoscopic surgery to less invasive techniques, such as the uniportal VATS allows us to considerer the possibility of avoiding intubation and general anesthesia. The combination of non-intubated thoracoscopic surgery and single port VATS technique represents the least invasive procedure for pulmonary resections. Due to avoidance of intubation, mechanical ventilation and muscle relaxants, the anesthetic side effects are minimal allowing patients to be mobilized right after surgery and to be discharged faster (20).

Figure 10 Dissection of the superior pulmonary vein using the curved sucker (22).
Available online: http://www.asvide.com/articles/851

Tips and tricks

Complications can be around the corner, particularly early in the surgeon's learning curve. The best strategy for facing complications of VATS lobectomy is to prevent them from happening. Awareness of the possibility of intraoperative complications of VATS lobectomy is mandatory to avoid them, and the development of management strategies is necessary to limit morbidity if they occur (21). A very helpful trick in finding the artery in the fissure in case of fissureless lobes consists in identifying the superior pulmonary vein. This should be dissected until the partial exposure of the bronchus, normally located behind it. Then a stump dissection of the tissue should be performed in the direction of the fissure, until the artery can be seen and identified. Finally, the fissure can be divided positioning the stapler in the dissected tunnel, on top of the artery. In case of difficult isolation of the vein, the sucker can be used to facilitate the insertion od the stapler to divide it (*Figure 10*). To facilitate the assistant in the use of the scope, a sling can be applied to the upper part of the incision in order to hold the camera.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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