Uniportal video assisted thoracic surgery: hilar dissection

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Abstract: In recent years, the uniportal approach has become one of the most exciting and innovative developments in minimally invasive thoracic surgery. While the debate over its supposed advantages, learning curve and complexity continues, this manuscript explores the technical aspects of performing the hilar dissection for a lobectomy via the uniportal approach. Using a step-by-step narration, surgical details and key tips and tricks are laid out for the beginner hoping to clarify basic steps of the technique.

Keywords: Lobectomy; single port; uniportal; video assisted thoracic surgery (VATS)

Received: 01 September 2017; Accepted: 13 September 2017; Published: 14 September 2017.

doi: 10.21037/vats.2017.09.02

View this article at: http://dx.doi.org/10.21037/vats.2017.09.02

Introduction

In recent years, video assisted thoracic surgery (VATS) has intensely evolved and many different innovative approaches have been proposed. This certainly includes the uniportal (or "single port") approach originally popularized by Gonzalez-Rivas *et al.* (1) that offers a reduced invasiveness with only one single incision (2,3).

This article focuses specifically on the technical aspects of how to complete the hilar dissection during uniportal lobectomy, whose essential geometrical principles have been widely described by Bertolaccini *et al.* (4).

Operative technique

Equipment preference

The importance of the surgical instrumentation is crucial, as it helps to facilitate the surgeon working in a reduced space, therefore improving safety and quality of the dissection.

The authors strongly advise the use of specifically dedicated instruments, as conventional VATS (or open surgery) equipment are not specifically intended for uniportal approach and might create additional complications during dissection.

In our experience are needed:

(I) Thirty-degree 10 mm video-thoracoscope attached to a high-definition video camera system and high-definition monitor screen;
(II) Alexis-type soft tissue retractor/wound protector (not necessary for all cases, but very useful when the assistant is inexperienced and repeated cleaning of the scope is required);
(III) Long, curved ring forceps for lung retraction and/or sponge-holding;
(IV) Curved long suction for blunt dissection;
(V) Energy devices;
(VI) Curved long node grasper;
(VII) Endoscopic staplers (curved-tip reloads and articulation are very useful for negotiating vessels);
(VIII) Polymer vascular clips for smaller vessels;
(IX) Curved long Harken and DeBakey clamp for dissecting behind hilar structures.

Surgical technique & general aspects

Patient selection, preoperative preparation and positioning for uniportal VATS are no different from conventional VATS. The patient is placed in a lateral decubitus position and a 3–5 cm incision is performed in the 5th intercostal space in an anterior position.

The best location for the camera is the upper part of the incision, with 2 or 3 or 4 instruments inserted below

the camera and moved bimanually during hilar dissection, although the dissection can be also completed by "no-touch technique", i.e., without retracting the lung and only using the tilting of the table to expose.

Since the uniport is sited relatively anteriorly, it is more ergonomic for the surgical team to stand in the abdominal site of the patient who is turned laterally with the monitor placed opposite to the surgeon. The key is to ensure that the 'axis' video camera—wound—monitor is kept in a straight line. When performing an upper lobectomy, the surgeon typically works in a more 'feet-to-head' direction and the monitor is best placed more towards the head of the patient; when performing a lower lobectomy, the surgeon works slightly more towards the feet and the monitor may be better placed slightly more towards the patient's feet (5).

The importance of a correct siting of the uniport has been extensively illustrated by Sihoe in its paper focusing on the technique for uniportal lobectomy (5). If the wound is sited too high (4th space) the instruments enter so directly towards the hilum that there is insufficient angle for the stapler to pass without impinging on the structures behind. If the wound is too low, the axis provides a nice angle of approach for the stapler onto hilar vessels. However, the wound is far away from the hilum, and dissection by bimanual instrumentation becomes extremely tricky and can result in considerable "fighting" between instruments and with the camera.

Hilar dissection operative technique

The technique of hilar dissection is similar for all lobes, sharing same principles and goals (combination of blunt and sharp dissection, coordinated retraction and movement of the lobe to favour the engagement of staplers and instruments). What is different the sequence which the structures are dealt with and some specific cautions according to the anatomy of each lobe.

To offer a comprehensive presentation of the technique, the lobectomies are presented in sequence and for each procedure the order of surgical steps is presented first, followed by details of the specific lobe.

Right upper lobectomy

The right upper lobe (RUL) anatomical resection is ideal to illustrate the technique.

Sequence: (I) pulmonary vein (PV); (II) pulmonary artery (PA) truncus anterior branch; (III) PA posterior ascending branch; (IV) RUL bronchus; (V) fissures.

(I) The superior PV is the first structure facing the surgeon in the uniport. The lung is retracted posteriorly to expose this vessel and the mediastinal pleura over the vein is opened. To completely isolate the PV, the fascia over it needs to be cleaned to the sub-adventitial layer using a combination of sharp and blunt dissection. Energy devices and the curved sucker are ideal for blunt dissection. Curved dissector is advanced laterally and behind the RUL superior PV sparing the middle lobe vein and repeatedly opened and closed gently to create enough space around and behind. Encircling the structure with a silicon loop (or similar) is not mandatory but could help in some circumstances, especially when the angle for the stapler anvil engagement along the left margin of the RUL PV is not straightforward despite the lung is retracted forwards and in an upper direction. This movement opens up space behind the vein, between the vein and artery behind it. At the same time, the movement of the stapler is also crucial, being not infrequently vascular injuries more related to the inexperienced advancement of the instrument rather than to an imprecise dissection (6): whilst each surgeon must decide individually the type of instrument preferred, the use of articulated staplers and curved tip reloads make stapling in general much easier.

(II) The anterior PA truncus is seen running vertically and superiorly once the vein is divided, originating from the intermediate PA lying almost posteriorly to the plan of the divided RUL PV. The PA truncus is dissected using sharp and blunt dissection in the same manner as with the PV. The lung is then retracted forwards and in a cephalad direction to open up space behind the artery, between it and the bronchus behind. The stapler should be advanced directly towards the artery, with the anvil engaging the left margin of the vessel, taking care not to force and impinge on the RUL bronchus behind the artery. After the artery is divided, the RUL bronchus can now be seen clearly, usually covered by peri-bronchial lymphatic tissue and nodes.

(III) The PA posterior ascending branch should be carefully identified following the interlobar PA. Despite different techniques, our preference is to tackle with this arterial branch before dissecting and dividing the RUL bronchus: is the last vessel

and then more retraction can be applied to the lobe in order to complete the lobectomy afterwards and moreover encircling the bronchus at its take-off could become complicated and risky if this vessel is not divided firstly. Following the bronchial tree and the interlobar nodes (constant landmark in this area), the posterior ascending branch of PA arises vertically (laterally) up from the interlobar artery to enter the RUL. Retraction should be applied very gently to the rest of the lung in this phase. The posterior ascending branch (occasionally branches) is dissected using sharp and blunt dissection in the same manner as with the PV and PA truncus, curved forceps are again used to go around behind the branch(es) and very gentle opening and closing helps develop the space behind. It can be divided with a stapler or between polymer vascular ligating clips or more recently with the energy device according to situation and surgeon preference. It must be noted that this vessel is usually very thin, often thinner than a stapler, then the risk of tearing vessel with a rough passage of the anvil should be always considered.

Once the arterial branches have been divided, the original retraction of the RUL laterally and posteriorly exposes the RUL bronchus rising vertically up from the right main bronchus soon after it emerges from under the azygos vein. The landmark is a constant interlobar lymph node invariably found to the left border of the RUL bronchus, demarcating it from the bronchus intermedius. This lymph node needs to be dissected away before, leaving enough space for instruments to tackle the left border of the RUL bronchus, looping around behind it. A stapler can be at this stage inserted along the left edge of the RUL bronchus and fired. Occasionally, emergence of the stapler anvil may be blocked posteriorly by impingement against lung parenchyma and mediastinal pleura. If this occurs, gentle rotation is usually sufficient for the anvil to progress over the bronchus. Contrarily to other team we do not favour testing for inflation of the middle and lower lobes because this might lead to inflation of the RUL also (interlobar parenchymal connection channels) making subsequently the specimen extraction more complicated. We feel that after adequate experience this manoeuvre is not to be mandatory in the clear majority of the cases.

At this stage, the lobectomy is completed by detaching the RUL from the right middle and lower lobes according to the fissure-last (or fissure-less) technique (fissure to be divided last to prevent air leak). Before firing the stapler to complete the fissures it is important to check that the stapling line does not accidentally include major structures (middle lobe PV or interlobar PA) or polymer vascular clips (if they have had been used). A useful trick is normally to follow the position of the middle lobe vein anteriorly when dividing the horizontal fissure and then follow the line of the posterior interlobar fissure accommodating medially the anvil of the stapler just on top of the intermediate PA. This usually offers the chance to optimally include all the elements of the RUL into the specimen without inadvertently dividing mediastinal structures that should be spared.

The resected lobe is placed inside a specimen bag and retrieved out of the uniport.

For all cases of malignancy, systematic lymph node dissection is mandatory. For any right-sided lobectomy, this author routinely dissects stations 2R, 3a, 4R, 7, 8R, 9R and 10R.

A single 24–28 Ch chest tube is inserted via the uniport and anchored to the wound, closed in layers around the chest tube.

Right middle lobectomy

Sequence: (I) middle lobe PV; (II) middle lobe bronchus; (III) middle lobe branch(es) of PA; (IV) fissures.

The basic approach is similar to that for the RUL. The right middle lobe (RML) is retracted posteriorly and the anterior mediastinal pleura opened, allowing the hilar structures to be approached in sequence from an anterior position.

The oblique fissure is often complete while the horizontal fissure usually requires stapling.

The main challenge with the RML is that its hilum is usually close to the uniport wound, in obese and small patients this could make relatively difficult to insert staplers and to move instruments inside.

Right lower lobectomy

Sequence: (I) PV; (II) oblique fissure between right lower lobe (RLL) and RML; (III) PA into the fissure; (IV) RLL bronchus; (V) remaining part of the oblique fissures.

Once the inferior pulmonary ligament is freed, the inferior PV is easily dissected and divided.

At this stage, the dissection could follow two different options.

Our preference (7) is—after the vein is divided—to complete the anterior part of the oblique fissure between

RLL and RML and expose the PA in the fissure, which is dissected with sharp and blunt dissection (as previously described), looped and staple-divided. If the take-off of the PA superior segment branch is too separated from the basal trunk, and difficult to be isolated in a single step, the artery could be divided in two separated steps. Once the PA is divided, the RLL bronchus could be seen and dissected from the bronchus intermedius and divided (care must be taken to clearly visualize the middle lobe bronchus take-off before firing).

A different sequence (vein, bronchus, artery and fissure in the end) is advocated by some authors in order to reduce postoperative air-leaks (fissure-last technique).

This approach could be undoubtedly employed in the more favourable conditions but makes the step of bronchus isolation more complicated and in some circumstances more risky, laying the PA on the posterior aspect, largely hidden by the bronchus itself and deeply located into the fissure.

Left upper lobectomy

Sequence: (I) PA truncus anterior branch; (II) superior PV; (III) PA posterior ascending branch(es); (IV) left upper lobe (LUL) bronchus; (V) PA lingular branch; (VI) fissure.

A similar technique as with the RUL is used to dissect the pulmonary hilum. On left side for the LUL our preference is to have the PA anterior trunk divided first in order to facilitate the tackling of the superior PV. Once the vein is divided, all the posterior PA branches are gently dissected and stapled following the curvature of the PA at this level. These branches could be multiple (1 to 4) and are often small calibre and short: polymer ligating vascular clips or energy device are frequently useful rather than the stapler for the same reasons above discussed when dealing with small vessels.

The most critical step in LUL is the isolation and division of the bronchus. This step must be taken with extreme caution and the forceps must be kept in contact with the back wall of the bronchus at all times to avoid disastrous injuries to the interlobar PA laying behind. Division of the anterior part of the interlobar fissure may often help improve exposure and access to the LUL bronchus. Once the bronchus is divided, lateral retraction of the LUL exposes any remaining lingular branch(es) of the PA. The posterior part of the fissure is the last step. Occasionally the division of the bronchus might result almost impossible with the usual instruments due to excessive and unfavourable angles: in these circumstances the TA stapler could be an option as described by Anile *et al.* (8).

Again, for all cases of malignancy, systematic lymph node dissection is mandatory. For any left-sided lobectomy, these authors routinely dissect stations 5/6, 7, 8, 9 and 10 L.

Left lower lobectomy

Same principles of the RLL lobectomy apply to the left lower lobe (LLL).

Sequence: (I) PV; (II) anterior part of oblique fissure between LLL and LUL; (III) PA into the fissure; (IV) LLL bronchus; (V) remaining posterior part of the oblique fissures.

As per RLL lobectomy occasionally the interlobar fissure may be entirely fused and exposure of the PA might become tricky. In this case, after division of the vein, the LLL bronchus is exposed first, dissected and divided. After division of the bronchus, with the LLL kept in retraction, the interlobar PA becomes visible with its basal trunk and superior segment branches; at this point can be dissected and divided in a safer way. The lobectomy is then completed by staple-division of the fissure. Same cautions of bronchus isolation with the PA still in place apply.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the Guest Editors (Marco Scarci and Roberto Crisci) for the series "VATS Special Issue dedicated to the 4th international VATS Symposium 2017" published in *Video-Assisted Thoracic Surgery*. The article has undergone external peer review.

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/vats.2017.09.02). The series "VATS Special Issue dedicated to the 4th international VATS Symposium 2017" was commissioned by the editorial office without any funding or sponsorship. LB serves as an unpaid editorial board member of *Video-Assisted Thoracic Surgery* from Jul 2016 to May 2019. 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. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). All the subjects considered for surgical procedures in our Institution have signed the informed consent forms; data retrieved from hospital medical record system have been secured.

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doi: 10.21037/vats.2017.09.02
Cite this article as: Solli P, Bertolaccini L, Lacava N, Forti Parri S, Kawamukai K, Bonfanti B, Pardolesi A. Uniportal VATS: hilar dissection. Video-assist Thorac Surg 2017;2:58.