Single incision video-assisted thoracoscopic anatomic segmentectomy

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Introduction

Anatomic segmentectomy was first described in 1939 by Churchill and Belsey (1). Although segmentectomy is usually indicated for benign lesions or for metastasis when the goal is resecting the lesion while sparing parenchyma, anatomic segmentectomy has also been demonstrated to be effective in the resection of small lung cancers (2). Recently, due to the increasing incidence of small lung tumors, there has been renewed interest in the use of anatomic segmentectomy, especially for patients unable to tolerate lobectomy. Several recently published studies have shown that segmentectomy can be performed safely without compromising oncologic results (3,4). Video-assisted thoracoscopic surgery (VATS) is currently a better choice than thoracotomy for segmentectomy. Although most surgeons use three to four incisions, the surgery can also be performed using only one (5).

Surgical technique

Single-incision VATS segmentectomy follows the principles of major pulmonary resections by VATS: individual dissection of segmental veins, segmental arteries and the segmental bronchus, as well as complete mediastinal lymphadenectomy with a video-assisted thoracoscopic approach and no rib spreading.

The size of the incision is comparable to the utility incision commonly used in a double- or triple-port approach and is usually smaller than that for a lobectomy, approximately 3 cm long (6). The incision is usually made at the level of the 5th intercostal space to provide access to upper hilar structures and lymph node stations. Both the surgeon and assistant are positioned anteriorly to the patient in order to have the same thoracoscopic vision during all the steps of the procedure and be more coordinated with the movements. Instruments with a proximal and distal articulation are preferable as they reproduce the same experience as a conventional instrument but also allow the insertion and manipulation of three to four instruments simultaneously (Scanlan International, Inc., MN, United States).

Optimal exposure of the lung is crucial for facilitating the dissection of the segmental structures and to avoid instrument malposition. The 30° high-definition thoracoscope is usually placed in the posterior part of the incision and the instruments are placed below the camera. Bimanual instrumentation is crucial to achieve a successful segmental resection through a single port VATS. A single chest tube is placed at the end of the procedure through the same working incision.

In this video we show seven different anatomic segmentectomies performed through a single incision thoracoscopic approach, including: (I) Right upper lobe apico-posterior segmentectomy (S1-S2); (II) Right upper lobe apical segmentectomy (S1); (III) Left upper lobe trisegmentectomy (S1-S2-S3); (IV) Left lower lobe superior segmentectomy (S6); (V) Right lower lobe basilar segmentectomy (S7-S8-S9-S10); (VI) Anatomic lingulectomy using vascular clips (S4-S5); and (VII) Anatomic lingulectomy using endostaplers (S4-S5).

Right upper lobe apico-posterior segmentectomy (S1-S2)

Exposure of the vein is achieved by retracting the upper lobe posteriorly. The common apico-posterior segmental vein is dissected as distal as possible and divided with an endostapler.

The upper lobe is then retracted upward and forward in order to expose the apical artery which is dissected and

divided using a stapler.

When the fissure is complete, the posterior ascending artery can be easily dissected and divided from the fissure. When the fissure is incomplete, a fissureless technique is performed in order to expose the posterior artery. The anterior portion of the intersegmental plane is divided using a stapler to expose the posterior ascending artery and the bronchus. A posterior segmental artery is then discovered. A vascular clip for proximal transection and ultrasonic energy device to do the distal division. Now the trifurcation of the upper lobe bronchus is exposed. The apical and posterior lobar bronchus are dissected separately and freed from its attachments to the upper lobe. A loop is passed around the two segmental branches and both bronchus are cut with an endostapler.

Finally, the parenchyma is divided by placing the stapler in the border between the apico-posterior and the anterior segment plane. The specimen is inserted into a protective bag and retrieved through the single incision.

Right upper lobe apical segmentectomy (S1)

The second video shows an apical segmentectomy of a 2.5 hilar tumor not possible to remove with a wedge resection. The first step is to identify the mediastinal trunk of the artery. Once the segmental vein for segment 1 is dissected we use a vascular stapler to divide it. We usually insert the staplers through the inferior part of the incision and the camera is normally placed above.

By using scissors we release the adherences of the anterior branch of the artery from the inferior portion of the tumor.

We divide the apical artery using vascular clips. The anterior portion of the intersegmental plane is divided by a 60 mm stapler. After identification of the branches for the anterior and posterior segment, we continue with the division of the parenchyma by placing the staplers above the stumps. In this particular case, the apical bronchus is divided through the intersegmental plane due to the benign nature of the tumor.

Left upper lobe trisegmentectomy (S1-S2-S3)

The third case shows a trisegmental resection of left upper lobe (also known as lingular-sparing lobectomy). The view of the apico-anterior arterial trunk is direct, and this branch is approached anteriorly, dissected and ligated by a stapler. The upper division of the pulmonary vein is dissected and divided [anterior, apical and posterior veins, preserving the lingular vein (LV)]. The trisegmental bronchus is easily visualized after ligation of the segmental vein and arteries, with care taken during this dissection to avoid injury of the lingular artery. After the bronchus is stapled, the posterior artery is usually visualized and is then divided by using vascular clips. The last step is to divide the parenchyma through the segmental plane by using staplers.

Left lower lobe superior segmentectomy (S6)

The resection of the superior segment (S6) of the lower lobe is straightforward as there are consistent anatomical landmarks. The conduct of segmentectomy will vary slightly depending on whether the fissure is complete or not. In this case, the fissure is complete so the superior segment artery is exposed through the fissure. The artery is easily divided by using an endostapler.

With a long lung grasper, the lower lobe was held and the pulmonary ligament was cut to find the segmental vein for dissection, followed by division by using a vascular stapler. We dissect and expose the superior segmental bronchus and it was stapled in the same way as mentioned for the vein. The last step is to divide the intersegmental plane and remove the segment using a protective bag.

Right lower lobe basilar segmentectomy (S7-S8-S9-S10)

Removal of four segments in the right lower lobe (S7-S8-S9-S10) while sparing the apical segment (S6) is called basal segmentectomy. These segments are usually removed together since they are dependent on a single bronchus.

After identification of the artery in the fissure, a stapler was placed above to better expose the artery. The anterior portion of the fissure is stapled, which allowed division of the basilar artery using a stapler.

The next step is dissection of the basilar segmental vein. The direct view provided by the single incision approach allows excellent visualization of the plane between the superior segmental vein and basilar vein. The basal vein was divided with a stapler. Once the inferior segmental vein has been divided, the lower lobe basilar segmental bronchus is exposed, dissected and divided from its inferior aspect to its bifurcation with the middle lobe bronchus on the right side or the upper lobe bronchus on the left side. Dissection of the bronchus with development of the plane between the bronchus and artery is performed with visualization of the artery. We recommend the removal of the interbronchial

lymph nodes to better define the anatomy. The intersegmental plane is completed last. The lung is inflated to confirm an adequate ventilation of the superior segment of the lower lobe.

Anatomic lingulectomy using vascular clips (S4-S5)

The next video shows two different ways to perform an anatomic lingulectomy. In the first video we used vascular clips for vessels. The lingula is retracted laterally and posteriorly and the pleura overlying the LV is incised. In this particular case, the tumor was involving part of the lower lobe in the fissure, so the first step was to divide the anterior portion of the fissure from an anterior view.

The identification of the LV, lower lobe vein (LLV) and the artery indicates the location to place the stapler to divide the anterior portion of major fissure. The anvil of the stapler is placed between the LLV and LV, and above the upper part of the artery, and the parenchyma is retracted into the jaws of the stapler.

This maneuver facilitates the dissection of the LV. A ring forceps is then placed while holding the lingula for traction, exposing the small recurrent lingular artery which is then divided with clips. Once this small vessel is divided, the lingular bronchus is exposed. In this particular case there was no angle for the stapler, so the bronchus was transected using scissors and the stump was closed using a stapler at the end of the procedure. Subsequently the main lingular artery is exposed and divided by using vascular clips.

Finally the intersegmental plane is divided and the stump of the bronchus with is closed with an endostapler at the end of the procedure.

Anatomic lingulectomy using staplers (S4-S5)

The last segment of this video shows a non-edited lingulectomy using endostaplers. The fissure is complete so the lingular artery is easily exposed, dissected and divided in the fissure by using a vascular stapler. The LV is dissected and divided by using a 30 mm vascular stapler. Once the vein is divided, the lingular bronchus is exposed and transected using endostaplers. The last step is to divide the intersegmental plane.

Comments

Uniportal VATS segmentectomies are usually more difficult than lobectomies. From June 2010 to February 2014, we have performed 28 uniportal VATS anatomic segmentectomies. The mean surgical time was 89.5±3 minutes (range, 40-150 minutes). The mean number of nodal stations explored was 4.1±1 (range, 0-5) with a mean of 11.5±1.8 (range, 7-25) lymph node resections. The mean tumor size was 2.24±1 cm (range, 1-4 cm). The median chest tube duration was 2 days (range, 1-6 days) and the median length of stay was 2 days (range, 1-6 days).

None of these segmentectomy cases required conversion, which may be attributed to experience in uniportal lobectomy, including vascular dissection, the management of fissures, as well as experience in more complex cases (lobectomy after induction therapy, hilar calcification, and pneumonectomy) (7).

Comparing segmentectomies by thoracotomy with uniportal thoracoscopic segmentectomies, the latter was associated with a shorter length of stay and with equivalent morbidity and mortality (8).

The advantage of using the camera in coordination with the instruments is that the vision is directed to the target tissue, addressing the target lesion from a straight perspective and thus obtaining a similar angle of view as with open surgery. In standard three-ports VATS, the geometric configuration of a parallelogram generates interference with the optical source, creating a plane with a torsion angle not favorable on the flat two-dimensional vision of currently available monitors (9).

Another potential advantage of this approach could be a reduction in postoperative pain, although this has not yet been demonstrated. There could be several explanations for this issue: only one intercostal space is involved and avoiding the use of a trocar could minimize the risk of intercostal nerve injury. During instrumentation, force is applied only over the superior aspect of the inferior rib through the utility incision.

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