



# Uniportal S<sup>10</sup> segmentectomy by transfissural intersegmental tunneling

Amaya Ojanguren<sup>1</sup>, Marc-Olivier Sauvain<sup>2</sup>, Céline Forster<sup>1</sup>, Michel Gonzalez<sup>1</sup>

<sup>1</sup>Service of Thoracic Surgery, Centre Hospitalier Universitaire Vaudois/University Hospital of Lausanne, Lausanne, Switzerland; <sup>2</sup>Service of Surgery, Réseau Hospitalier Neuchâtelois, Neuchâtel, Switzerland

*Correspondence to:* Michel Gonzalez, MD. Service of Thoracic Surgery, University Hospital of Lausanne, Rue du Bugnon 46, 1011 Lausanne, Switzerland. Email: michel.gonzalez@chuv.ch.

**Abstract:** Pulmonary segmentectomy is a parenchyma-sparing technique that is currently proposed for diagnosis of centrally located nodules or definitive treatment of metastases or early stage non-small cell lung cancer. However, pulmonary segmentectomy is a technically more challenging procedure than lobectomy that requires individual dissection of segmental broncho-vascular structures and identification of the intersegmental plane to prevent incomplete resection and post-operative complications. Segmentectomy is now performed through the use of video-assisted thoracic surgery (VATS). Segmentectomies can be classified into simple and complex based on the difficulty to separate several intersegmental planes. Segmentectomies of the lower lobes are technically feasible by VATS but remain challenging, especially since standardization reports are still lacking. However, this procedure is interesting because the greatest part of pulmonary perfusion and function is located in the lower lobe. Although the posterior basal (S<sup>10</sup>) is recognized as one of the most challenging anatomical segmentectomies, it could be safely performed by uniportal VATS. Our approach consists in opening first the intersegmental between S<sup>6</sup> and S<sup>10</sup> by using an intersegmental tunneling technique. This technique permits the accurate identification of the bronchovascular structures of the segment S<sup>10</sup>. Intra-operative assistance with indocyanine green (ICG) near-infrared angiography may help surgeons identify the intersegmental plane during these complex segmentectomies.

**Keywords:** Uniportal; segmentectomy; video-assisted thoracic surgery (VATS)

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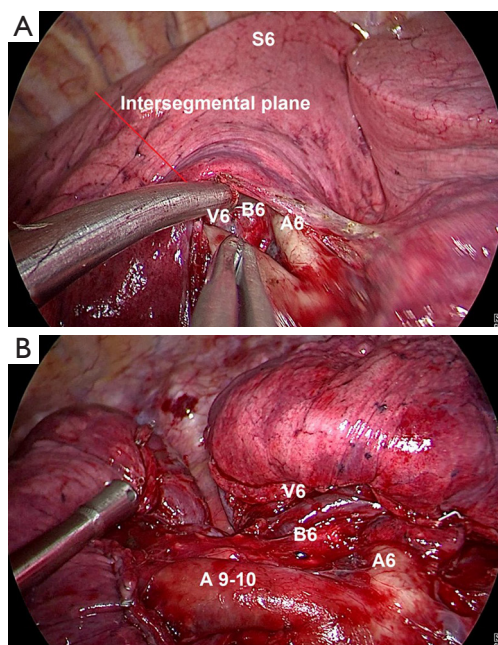
## Introduction

Isolated resection of the posterior basal segment (S<sup>10</sup>) is infrequent and considered of the most challenging anatomical segmentectomy when done by uniportal approach. First, the basal pulmonary artery branches are deeply located in the lung parenchyma making the identification of the segmental artery difficult, and division of two intersegmental planes is required. Furthermore, anatomical variations are very common in this region. Incorrect identification of vascular or bronchial structures and of the intersegmental plane may lead to potentially catastrophic complications or insufficient margins. The intersegmental tunneling method allows the early division

of the intersegmental plane between S<sup>6</sup> and S<sup>10</sup> and the subsequent accurate identification of the segmental artery S<sup>10</sup> and the dominant vein to S<sup>10</sup>. In this article, we describe the uniportal procedure for the right S<sup>10</sup> segmentectomy by intersegmental tunneling.

## Patient selection and work up

Posterior basal segmentectomy (S<sup>10</sup>) can be indicated in case of central metastases or non-solid tumors with ground glass opacity suggesting non-invasive lung cancer (1). However, saving lung parenchyma by a less invasive resection is related to a technically challenging procedure. Therefore, articles focused on thoracoscopic posterior basal segmentectomy



**Figure 1** Intra-operative view. (A) Creation of the tunnel between  $S^6$  and  $S^{10}$ , (B) intra-operative view after division of the intersegmental plane between  $S^6$  and  $S^{10}$ .

are scarce (2-7). Perfect knowledge of anatomy is crucial for planning such complex segmentectomy and a thin slice Chest CT-scan with contrast product should be performed to identify anatomical variation. The trans-fissure technique requires an extensive dissection through the fissure to first individualize the lower lobe segmental arteries and then transect the bronchus and the veins. This technique could be indicated in NSCLC patients where extensive removal of all lymph nodes 12 and 13 can be realized. When the fissure is incomplete, the operation may be difficult and increase the risk of post-operative air leak.

### Peri-operative setting

The general anesthesia is managed with a left double-lumen tube. The patient is positioned on lateral side and the table is flexed to increase the distance between the ribs. A 3-cm incision is performed in the 5<sup>th</sup> intercostal space between the tip of the scapula and the breast in the anterior axillary line. The wound is protected by a plastic soft tissue retractor (Alexis® Retractor Applied Medical USA).

The surgeon and the assistant are positioned on the anterior side of the patient whereas the scrub nurse stands at the back. A 10-mm 30° thoracoscope is used in order

to optimize the visualization of the pleural cavity and all mediastinal structures. A dissector (Scanlan®, USA), a hook monopolar cautery and an Ultracision Harmonic scalpel (Ethicon®, Johnson & Johnson, USA) are used for dissection and coagulation respectively. All vessels are divided by endoscopic staplers (Golden Stapler®, DACH Medical Group, Germany). As mediastinal lymph node dissection is generic to all oncologic pulmonary resections, it is not described in this tutorial.

### Procedure

Dissection starts in the middle portion of the major fissure where the artery is approached (*Video 1*). The basilar arterial trunk is exposed. All branches must be carefully dissected on a sufficient length to avoid misidentification. At this point, interlobar lymph nodes are totally removed.

The common trunk for  $A^{9+10}$  and  $A^6$  (posteriorly) are clearly identified. Then, dissection proceeds between  $A^{9+10}$  and  $A^6$  along the intersegmental plane until  $V^6$  is exposed. The pulmonary ligament is incised up to the inferior pulmonary vein. The vein is cleared from surrounding tissue until  $V^6$  and the common basal vein are identified. The most important point is to clearly expose  $V^6$  keeping in mind that a tunnel will be created to separate  $S^6$  and  $S^{10}$ .

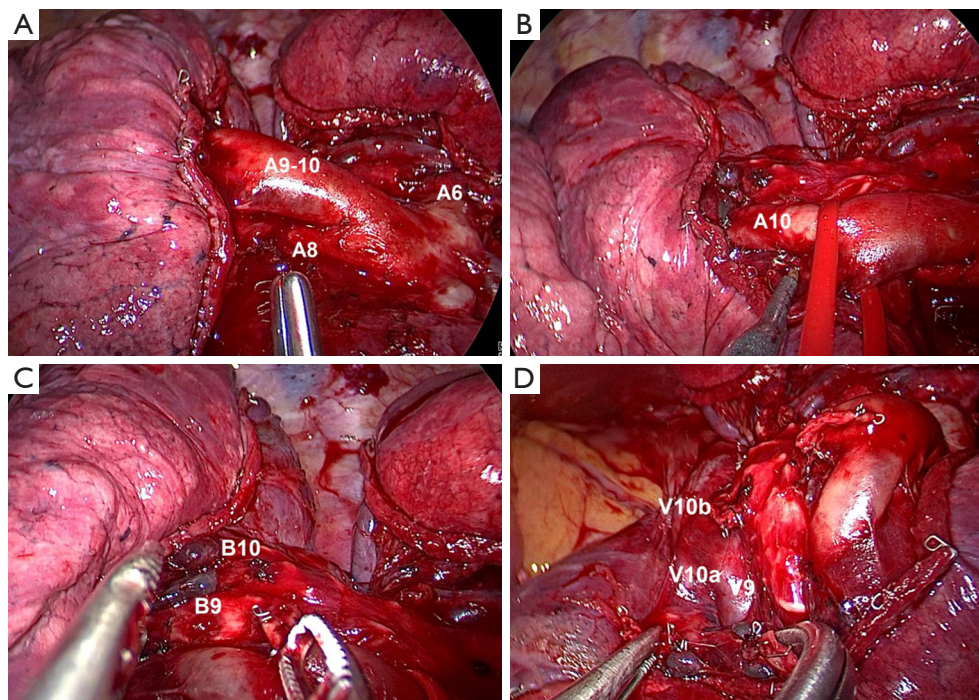
The dissection continues in the fissure and the intersegmental plane between  $S^6$  and  $S^{10}$  is progressively made thinner. The intersegmental plane between  $S^6$  and  $S^{10}$  is initially divided by an endoscopic stapler to delimitate the superior and basal segments (*Figure 1*). Thus, a tunnel is created that first, connects the fissure with the posterior mediastinum, and second, that separates  $S^6$  and  $S^{10}$ . The tunnel is divided by successive application of endoscopic staplers.

After the division of the intersegmental plane between  $S^6$  and  $S^{10}$ , the branches of the pulmonary artery are easily recognized in the fissure (*Video 2*).  $A^{10}$  can be easily identified and divided using an endoscopic vascular stapler.

Once the segmental artery is cut, the bronchial branch  $B^{9+10}$  is identified posterior and cranial to the  $A^{10}$  stump. The posterior basal segmental bronchus ( $B^{10}$ ) is isolated and cut (*Figure 2*).

$V^{10}$  is clearly identified once  $B^{10}$  has been divided. When the venous anatomy is not clear, it is preferable to divide only its lowermost tributary. As shown in the video,  $V^9$  is identified and kept, and then  $V^{10a}$  and  $V^{10b}$  are cut separately.

The division of the intersegmental plane is the most difficult as the intersegmental plane is tridimensional



**Figure 2** Intra-operative view: (A,B) the segmental S<sup>10</sup> artery, (C) segmental S<sup>10</sup> bronchus and (D) segmental S<sup>10</sup> vein.

(*Video 3*). However, the tunneling technique facilitates completion of the intersegmental plane as S<sup>6</sup> and S<sup>10</sup> are already divided. The intersegmental plane is identified by using the systemic injection of indocyanine green with near-infrared imaging-system after transection of the segmental arteries. We use fluorescence with near infrared imaging (Karl Storz®, Germany). A total of 3 mL (2.5 mg/mL) of indocyanine green is injected through a peripheral venous line and demarcation line is promptly visualized between vascularized and devascularized lung parenchyma. Demarcation line (between the green enhanced parenchyma and normal parenchyma) is marked by electrocautery and the intersegmental plane between S<sup>10</sup> and S<sup>9</sup> is divided by successive application of endoscopic staplers. During this maneuver, it is important to include bronchovascular stumps in the specimen and to follow the division of the parenchyma in the direction of the segmental hilum.

The specimen is retrieved in a bag. Thereafter, a systematic lymph node dissection is performed. Finally, an intercostal block with local anesthesia (bupivacaine 0.5%) is applied between the 2<sup>nd</sup> and 8<sup>th</sup> intercostal space. A 28 French chest tube is introduced and the lung is re-expanded under direct vision.

### Post-operative management

After initial transfer to the recovery room for 2 hours, the patient is transferred to the ward. The chest tube is removed in the absence of air leak and a 24-h serous output of less than 400 mL. In this patient, the chest tube was removed on postoperative day 1 and the patient was discharged on day 3.

### Tips, tricks and pitfalls

Steps to intersegmental tunneling:

- ❖ Dissection of the major fissure;
- ❖ Identification of the common trunk for A<sup>9+10</sup> and A<sup>6</sup>;
- ❖ Identification of V<sup>6</sup> which delimitates the intersegmental plane between S<sup>6</sup> and S<sup>10</sup>;
- ❖ Dissection of lymph node facilitates the exposure of the segmental bronchus;
- ❖ Division of A<sup>10</sup>, followed by B<sup>10</sup> and V<sup>10</sup>;
- ❖ Systemic injection of indocyanine green with near-infrared imaging system more appropriate to identify the intersegmental plane between S<sup>10</sup> and S<sup>9</sup>.



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## Footnote

*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/vats-20-41>). The authors have no 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). Written informed consent was obtained from the patient for publication of this manuscript and any accompanying images.

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