Surgical Technique

Trans-inferior-pulmonary-ligament VATS basal segmentectomy: application of single-direction strategy in segmentectomy of left S9+10

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Introduction

With the extensive application of low-dose computed tomography (CT) screening in lung cancer diagnosis, the detection of early stage lung cancer has increased remarkably (1). Although full lobe resection is the mainstream treatment of early-stage non-small cell lung cancer (NSCLC), limited resection, such as anatomic segmentectomy, plays an important role in the treatment of patients with both stage IA NSCLC and those unable to tolerate lobectomy because of compromised medical conditions (2-7). The intentional use of anatomic segmentectomy for the treatment of small peripheral lung cancers was first described by Jensik *et al.* in 1973 (8). Despite the rapid development in video-assisted thoracic surgery (VATS) in the past two decades, the VATS segmentectomy still poses a few technical challenges. For our thoracoscopic segmentectomy practice, we adopted the strategy of single-direction thoracoscopic lobectomy that was designed by Liu *et al.* (9). Taking the left basal S9+10 segmentectomy as an example, we described the technical characteristics of single-direction segmentectomy through an inferior pulmonary ligament approach (*Figure 1*).

Operative techniques

The surgical procedure was performed under general anesthesia with double-lumen intubation. The patient was placed in a full lateral decubitus position. The thoracoscopic port (1 cm) was made in the seventh intercostal space (ICS) on the midaxillary line. The utility incision (2.5 cm) was made on the anterior axillary line in the fourth ICS, and the assistant incision (2 cm) was made in the ninth ICS behind the posterior axillary line.

After the location of the tumor was confirmed by finger palpation, we marked it with a suture. The tumor can also be located preoperatively by a hook-wire puncture if necessary. The utility incision was protected with a silicone rubber wound protector. An endoscopic ring clamp was inserted to grip the left lower lobe cranially. Then, the dissection was initiated from the inferior pulmonary ligament rather than the interlobar fissure. An electrocautery hook and a suction were introduced in the dissection of the inferior pulmonary ligament and the inferior pulmonary vein. After a careful dissection, the branches of the inferior pulmonary vein to the affected segments were skeletonized. The veins to the lateral and posterior basal segments were identified and sectioned with an endo stapler. The segmental veins were located on the intersegmental plane and collected the venous blood of the adjacent segments and were preserved during operation. Then, the segmental bronchus became visible after the dissection of the segmental veins, and the lymph nodes around the segmental bronchus were carefully removed and sent for frozen-section examination. All the branches of the lower lobe bronchus, especially the superior bronchi, need to be revealed for the identification of the right bronchi of the target segments. After the segmental lymph nodes were confirmed to be negative for cancer, the lateral and posterior basal segmental bronchus was clamped, and the participating lobe was inflated. The purpose of this was to confirm that the marked tumor was located in the target segments. Next, the target bronchus was transected

Figure 1 The video depicts a single-direction VATS left S9+10 segmentectomy. The operation was carried out with the single-direction strategy by approaching the inferior pulmonary ligament. The most superficial segmental vein was transected first, followed by the deep bronchi and deeper segmental artery, and the intersegmental fissure was treated last (10). VATS, video-assisted thoracic surgery.

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with the cutting stapler. The distal bronchial stump of the target segment was lifted cranially, and, after similarly careful identification, the deeper segmental arteries were dissected and transected with the endo stapler. The contour of the target segment was demarcated by segmental lung inflation and deflation. Finally, the endoscopic stapler was used for cutting the segmental plane. The segmental specimen was placed in a glove and removed through utility incision. The resection of this pulmonary segment proceeded from the caudal to the cranial direction. The most superficial segmental vein was transected first, along with the deep bronchus and deeper segmental artery, and finally the intersegmental plane in turn. The subsequent hilar and mediastinal lymph node sampling was performed.

Comments

Identifying the segmental bronchus and vessels that are involved in complicated anatomical variations is technically meticulous. Preoperative three-dimensional CT bronchography and angiography (3D-CTBA) can reveal anatomical structures and variations and can thus improve the accuracy of operation (11-13). In cases when identifying a targeted segmental structure by high-resolution CT proves difficult, we implemented 3D-CTBA to identify the targeted vessels, bronchus, and surgical margin preoperatively. Using the identification of the adjacent structures with less anatomic variation as a reference point, such as the dorsal segmental vein, and dorsal segmental bronchus, is another way of identifying a target structure during operation.

Basilar segmentectomy usually starts from the opening of the oblique fissure for the isolation of the superior and basilar branches of the lower lobe artery. However, the oblique fissure may be severely hypoplastic. By approaching the inferior pulmonary ligament, basal segmental structures can be reached more freely for dissection.

Due to there being no actual fissures among the segments, another difficulty of thoracoscopic segmentectomy is the dissection of the segmental vessels and bronchi which are located deep in the parenchyma. In our opinion, segmentectomy can be considered as a lobectomy with completely fused fissures. Therefore, the single-direction strategy which prevents the difficulty of a hypoplastic lung fissure is a suitable method for segmentectomy. The resection procedures at the hilum are carried out in a mining-like fashion, with the segmental vessels and bronchus being managed one by one, layer by layer. Additionally, it is easy to divide the intersegmental plane with a stapler as the last step since the segmental vessels and bronchus have already been transected.

In summary, VATS S9+10 segmentectomy could be successfully implemented with the strategy of single-direction through inferior pulmonary ligament approach.

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Footnote

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

Informed Consent: Written informed consent was obtained from the patient for publication of this manuscript and any accompanying images.

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