Surgical Technique

Minimally invasive lobectomy: The First Affiliated Hospital of Chongqing Medical University experience

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Clinical vignette

A 52-year-old male presented with a history of cough without sputum for one week on admission. An enhanced computed tomography (CT) scan of the chest demonstrated a large mass in the right upper lung lobe in length by 4×5 cm. He then had a fiberoptic bronchoscopy that demonstrated left main bronchial stenosis but no abnormality in the other bronchus. Cancer cells were not found in the branchofiberscope biopsy and lavage fluid. On July 24th, 2017, an ultrasound-guided bronchoscopy with a transbronchial needle aspiration biopsy (EBUS-TBNA) did not find any cancer cells. ECT, abdominal color doppler flow imaging and plain cranial CT scan all demonstrated normal. He was staged as at least a clinical T3Nx lesion. We proceeded onto surgical resection and intraoperative frozen diagnosis.

Surgical techniques

Preparation

The patient was given a clear liquid diet 24 hours pre-operatively. According to the principle of enhanced recovery after surgery (ERAS), we did not give a formal bowel preparation and drink water two hours before operation.

Exposition

The patient's surgery was a minimally invasive lobectomy in the left lateral position. A fold position was utilized to decrease body obstacles when the surgical assistant controlled the thoracoscopy. The thoracoscopic access was selected in the middle seventh sides of the armpit line, about 1.5 cm. The main operating hole was centered at the 3 cm axillary line, and the upper lobe was removed at the third rib. The assist operating hole was placed at the posterior intercostal line, which was about 2 cm long at the ninth rib.

Operation (Figure 1)

The endoscopic ring forceps gripped and rolled back the right upper lung lobe from the assist operating hole, and exposed the front of the hilum. The electrocoagulation hook was used to remove the vessel sheath of right superior pulmonary vein from the main operating hole. Then the right superior pulmonary vein was dissociated with the conventional right-angle forceps, and the suction tip assisted in dissociation from the assist operating hole. The stapler disconnected the right superior pulmonary vein from the assist operating hole. The right pulmonary artery was exposed at that moment, and the first branch of the right pulmonary artery vessel sheath was dissociated along the main trunk. Then the stapler disconnected the first branch of the right upper lung from the assist operating hole. The right upper lobe bronchus was exposed at that moment. The right upper lobe bronchus was dissociated and disconnected by stapler. The remaining branches of the pulmonary artery were exposed after disconnecting the bronchus, and were ligated by 4$^{\#}$ silk thread and biosynthesis of clips and disconnected by ultrasonic scalpel from the main operating hole. After removing the lymph nodes (LNs) at the root of the right upper lobe, the stapler disconnected the fissure. One 7.5 glove was used to remove specimens from the right upper lobe. Intraoperative frozen result suggested a malignant tumor in the right upper lobe. The conclusion was that systematic nodal dissection should be carried out.

Figure 1 Minimally invasive lobectomy (1).
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The ring clamp forceps gripped and rolled the right lower lobe upward, and the electrocoagulation hook dissociated the inferior pulmonary ligament to remove the eighth and ninth groups of LNs. Then the endoscopic ring clamp forceps gripped and clamped the right lower lung lobe near the hilum, and made the lung move forward, exposing the posterior of the hilum and the posterior mediastinum. The electrocoagulation hook dissociated the posterior mediastinum below the azygos vein, and the carina was exposed. The ring clamp forceps was used to clamp the subcarinal lymph nodes (SCN). The LNs were resected by electrocoagulation hook and ultrasonic scalpel. The right upper lung lobe was then gripped and rolled downward, exposing the hilum. The electrocoagulation hook dissociated the upper mediastinum pleura and the 4th group of LNs were pushed upward by suction tip. Along the superior vena cava, the electrocoagulation hook dissociated the upper mediastinum pleura up to the subclavian vein and down to the azygos vein. The suction tip pushed the superior vena cava to the anteromedial aspect from the main operating hole, and the azygos vein was pulled downward. The ring forceps gripped the soft tissue behind the superior vena cava and the electrocoagulation hook dissociated the mediastinal soft tissue along the posterior superior vena cava and the front of the trachea. The electrocoagulation hook and ultrasonic scalpel removed mediastinal soft tissue and the 2nd and 4th group of LNs. At last, the thoracic cavity was checked using sterile water and no bleeding or air leakage was found.

Clinical results

Two thoracic drainage tubes were placed in the middle seventh sides of the armpit line and at the 9th sides of the posterior intercostal line. The port sites were closed in standard fashion. The patient was observed for 24 hours in the ICU for transitioning over to our step-down unit. We followed the principle of ERAS, and thoracic tubes were removed when volume of drainage was below 200 mL. The patient recovered well and was discharged three days postoperatively.

Comments

Video-assisted thoracoscopic surgery was introduced in the early 1990s, and its use in the treatment of lung cancer has subsequently spread to China. In 2001, the First Affiliated Hospital of Chongqing Medical Division of Thoracic Surgery began to perform minimally invasive lobectomy (2). In 2001, we also carried out our initial video-assisted mini-thoracotomy. In 2006 we began to use more minimally invasive techniques and started a total thoracoscopic surgery with the 4-hole-assisted approach to lobectomy (2). In 2009, we introduced the 3-hole-assisted single-direction thoracoscopic lobectomy for lung cancer. The single-direction thoracoscopic lobectomy was used to do thoracoscopic lobectomy in patients with lung cancer in the middle 2000s. The single-direction thoracoscopic lobectomy was characterized by incisions convenient for the placement of instruments and the lobectomy proceeded progressively in a single direction from superficial to deep structures. Our approach is that the upper and middle lobectomy are in a single direction, from forward to backward. On the other hand, the lower lobectomy is done in a single direction, from downward to upward. For the specific structure of the hilar, the dissociation and disconnection procedure is as follows: pulmonary vein, bronchus, pulmonary artery and pulmonary fissure. In addition, the dissociation of hilar structure is done mainly by the electrocoagulation hook and assisted by suction tip (3). From May 2009 and to July 2013, 853 patients underwent a 3-hole single-direction thoracoscopic lobectomy approach. Within the 3-hole single-direction thoracoscopic group, 10% of patients received neoadjuvant chemoradiotherapy followed by surgery. The 30-day mortality for the entire cohort was 0.3%, and the 90-day mortality was 0.5%. There was no difference in complications in those who had neoadjuvant chemoradiotherapy compared to those who had primary surgical resection. The rates of pneumothorax, hemothorax, pulmonary infection, and respiratory failure all showed no specific difference.

In around 2014, we started uniportal video-assisted thoracoscopic lobectomy for lung cancer. In 2016, we contributed a report to the Journal of Thoracic Disease, illustrating the operative techniques (4,5), which consisted of the results of our initial 150 patients undergoing uniportal video-assisted thoracoscopic lobectomy. Thirty-day and in-hospital mortality was 0.6%. Pneumothorax occurred in 15% of patients; however, within the last 53 patients, following a change in technique, the rate was down to 7%. About 9% of patients developed pulmonary infection, 3% had hemothorax, and 0.5% developed respiratory failure. The average length of stay was 7 days.

In 2016 we began our robotic lobectomy program utilizing the DaVinci robot for lung cancer. Our initial experience of 20 patients demonstrated a 0% 90-day mortality. An R0 resection was seen in 93% of patients. Rate of conversion was 0. Morbidity was seen in 45% of patients, mostly from pulmonary infection at 15%. The average length of stay was 5 days, and 85% of the patients were discharged to home. Overall operative time was long at 115 minutes, but this may be related to the learning curve.

Currently, the vast majority of lobectomies performed at The First Affiliated Hospital of Chongqing Medical University are performed in a minimally invasive fashion. There is a diversity in approaches from a 4 -hole-assisted thoracoscopic lobectomy approach to a 3-hole-assisted single-direction thoracoscopic lobectomy, uniportal video-assisted thoracoscopic lobectomy and a robotic-assisted minimally invasive lobectomy. The transition from the open technique to these minimally invasive techniques has given rise to a decreased length of stay, decreased morbidity, and improved patient outcomes and satisfaction. This transition occurred with practicing established thoracic surgeons who were used to the open approach. The fact is that patients benefited from these surgeons adapting new minimally invasive techniques and using established expertise.

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Footnote

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

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