Robotic Assisted Left Pneumonectomy

Harmik J. Soukiasian MD, Andrew R. Brownlee MD

1 Cedars Sinai Medical Center Los Angeles, Department of Surgery, Division of Thoracic Surgery, Los Angeles, CA

Disclosure Statement:
Drs Soukiasian and Brownlee are Proctors for Intuitive

Funding Statement:
This study received no funding

Corresponding Author:
Harmik Soukiasian MD
Cedars-Sinai Medical Center
Thoracic Surgery
8631 W 3rd St # 240E, Los Angeles, CA 90048
Email: soukiasianh@cshs.org
Telephone: (310) 423-2640
Mediastinal Anatomy

**Central Message:** The described steps demonstrate a safe and reproducible approach to a robotic assisted left pneumonectomy.

**Introduction**

Pneumonectomy carries high morbidity and mortality rates ranging from 5-8%. Utilization of the robotic approach in major thoracic procedures continues to increase nationally\(^1\). Robotic pneumonectomy has been shown to be safe and effective with similar long and short-term oncologic outcomes compared to open and video assisted approaches\(^2,3\). Pneumonectomy is indicated in primary lung malignancies when R0 resection cannot be obtained with lobectomy, bilobectomy or sleeve resection. Pneumonectomy in patients with N2 disease is controversial\(^4,5\).

Robotic pneumonectomy was performed on a 32-year-old female, never smoker, who presented with a long-standing history of cough with hemoptysis. Ultimately a CT Chest demonstrated complete left lower lobe collapse, with air trapping of the left upper lobe and nodular extension from the left lower lobe airway into the left mainstem bronchus. She then underwent bronchoscopy and endobronchial ultrasound. During this procedure, the mass biopsied and debrided. The pathology demonstrated an atypical carcinoid tumor, with negative mediastinal lymph nodes. DOTATATE scan showed no evidence metastatic disease. Given the location and size of the lesion, R0 resection could not be obtained without pneumonectomy. A discussion was had with the patient and she elected to proceed with pneumonectomy.

IRB approval was not required; the patient consented to publication of deidentified pictures and videos collected during this procedure.

**Materials and Methods**

Robotic approach to pneumonectomy is described in 8 steps with accompanying video from a single operation. The specific steps are described based on the authors experience and how the operation is performed at our institution. Three robotic instruments are used in this procedure; 1) Long bipolar, used for all the dissection with an energy setting of 8mw and 120watts, 2) Force bipolar, used for manipulating and positioning for exposure to assist dissection and stapling and 3) Tip-up grasper, used for retraction of the lung. The 30-degree robotic camera is utilized.

**Operative Technique:**

Step 1: Port Placement/Chest Exploration - Video 1
The patient is placed in right lateral decubitus position, prepped and draped. A Veres needle is used to insufflate to 8-10mmHg and optical entry is used with the 8mm robotic port to access the chest.
Three ports are placed in the 9th interspace approximately 8cm apart. The most posterior port - #1 is placed 3-4cm lateral to the spine. Port #2 is placed 8cm lateral to port #1, followed by port #3 8cm lateral to port #2 which is at or just posterior to the posterior axillary line.

One anterior 12mm robotic port - #4 is placed in the sub-pectoral line as medial and inferior as possible, usually in the 7th interspace. Care is taken to ensure a distance of 8cm from the camera port #3. Next the 12mm robotic assistant port is triangulated inferior to the camera port #3 and next closest posterior port #2 entering just above the diaphragmatic insertion.* After this, the robot is docked and the camera is centered in the working space. Airseal is activated and the chest cavity and lung are then thoroughly inspected for possible metastatic disease.

Step 2: Posterior hilar dissection / Takedown of Inferior Pulmonary Ligament - Video 2
The lung is retracted anteriorly and apically with a cigar and the tip up forceps from port #4 to expose the inferior pulmonary ligament as well as the sub-carinal space. The inferior pulmonary ligament is dissected using the Long Bipolar instrument to expose the inferior pulmonary vein using a combination of bipolar cautery and blunt dissection. Level 8 & 9 lymph nodes are harvested as they are encountered. Anterior retraction of the lung is maintained to facilitate the posterior hilar and mediastinal dissection as it is carried above the inferior pulmonary vein. The hilar pleura is opened the entire length of the posterior mediastinum along the edge of the lung. This parachutes the structures up into the operative field. Level 10 lymph nodes are harvested just above the inferior pulmonary vein.

Step 3: Posterior Sub-Carinal/Mediastinal Dissection - Video 3
The dissection is carried along the pericardium making sure to identify the inferior aspect of the bronchus, which is superior to the vein. The vagus nerve is identified and mobilized off of the hilar structures. The esophagus is mobilized off the posterior pericardium and the subcarinal space is opened. The level 7 lymph node packet is fully excised to expose the entire carina, left mainstem bronchus and right mainstem bronchus. Retraction is moved superiorly to focus exposure between the left mainstem bronchus and main pulmonary artery. A thorough mobilization of the left mainstem bronchus and carina off the left main pulmonary artery is performed. The level 10 lymph nodes between the left mainstem and left main PA are excised and this facilitates visualization of the anterior cartilaginous portion of the left bronchus and allows for more mobility of the airway. Once this step is complete the surgeon should have a clear view of the carina from both a posterior view and an anterior view. This will facilitate the safe retraction of the bronchus away from the main PA when passing the stapler across the main PA.

Technical pearl: Using a right sided double lumen tube allows for more facile dissection around the left mainstem. This also avoids the need to retract the ET tube prior to bronchial transection. A left sided bronchial balloon can also be misconstrued for a subcarinal lymph node resulting in airway injury.
Step 4: Anterior Hilar Dissection/Dissection of Pulmonary Veins - Video 4
The lung is reflected posteriorly and laterally to expose the anterior hilum and the superior and inferior pulmonary veins. Dissection is carried from inferior to superior with care taken to identify and preserve the phrenic nerve. An emphasis is placed on excising anterior hilar lymph nodes and dissection on the peri-areolar plane of the vein. Once the tissue is dissected between the inferior and superior pulmonary veins the subcarinal space will be clearly visible from an anterior perspective as well, due to the prior complete dissection of the subcarinal space posteriorly. This will facilitate the safe division of the inferior pulmonary vein.

The same technique is then used to develop the plane between the superior pulmonary vein and the main pulmonary artery. Retraction and manipulation of the superior pulmonary vein is used to expose and develop the plane between the vein and the main PA.

Step 5: Division of Pulmonary Veins - Video 5
The inferior pulmonary vein is divided first. A blue vessel loop is used to encircle the vein and retracted it to create a generous window to pass a stapler and transect the artery. The lung is then retracted towards the apex of the chest, exposing the inferior aspect of the left mainstem bronchus and the main PA. This plane is developed further with dissection of the adventitial tissue and excision of lymph nodes on the inferior aspect of both structures. This dissection was started when the posterior dissection was performed and the lymph node removed, hence facilitating the current dissection of completing the safe and well visualized separation of the bronchus from the PA. The superior pulmonary vein is then encircled and divided.

Step 6: Division of Pulmonary Artery - Video 6
A red vessel loop is placed around the pulmonary artery twice. This serves to assist in retraction but also can be used as a Rummel-like tourniquets. If additional control is need, an additional vessel loop can be placed more distally on the artery. The yellow vessel loop is passed around the left mainstem bronchus. The red vessel loop is removed and the artery is divided with a vascular (white) load.

Step 7: Division of Bronchus - Video 7
The bronchus is retracted posterior and inferior. Appropriate tension on the vessel loop is placed in order to deliver the carina out of the mediastinum so the stapler can be passed flush to the base of the left mainstem bronchus without encroaching on the left main PA stump. Bronchoscopy is performed concurrently to ensure that no blind bronchial stump remains prior to transection. Generally, a black stapler load is used.

Step 8: Leak Test/Hemostasis/Removal of Specimen - Video 8
The bronchial stump is immersed with warm water. A leak test is performed up to a pressure of 30mmHg. Hemostasis is confirmed. Intercostal nerve blocks are performed. The specimen is extracted with a 15mm bag. A single 20 French chest tube is placed.
*This video demonstrates the use of a 15mm disposable assistant port, not a 12mm robotic port as describe in the aforementioned steps. This change transition was implemented at the time of writing this article.


Video Legends
Video 1: Step 1: Port Placement/Chest Exploration
Video 2: Step 2: Posterior hilar dissection / Takedown of Inferior Pulmonary Ligament
Video 3: Step 3: Posterior Sub-Carinal/Mediastinal Dissection
Video 4: Step 4: Anterior Hilar Dissection/Dissection of Pulmonary Veins
Video 5: Step 5: Division of Pulmonary Veins
Video 6: Step 6: Division of Pulmonary Artery
Video 7: Step 7: Division of Bronchus
Video 8: Step 8: Leak Test/Hemostasis/Removal of Specimen
Robotic Assisted Left Pneumonectomy