Robotic Assisted Left Lower Lobe Basilar Segmentectomy

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Disclosure Statement:
Drs Soukiasian and Brownlee are Proctors for Intuitive

Funding Statement:
This study received no funding

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Central Message: The described steps demonstrate a safe and reproducible approach to robotic assisted basilar segmentectomy.

Central Picture Legend: Robotic assisted left lower lobe basilar segmentectomy

Introduction
The role of segmentectomy in the treatment of lung cancer is continually being refined and has gained renewed attention recently with the completion of two randomized controlled trials. In the JCOG0802, Saji and colleagues compared lobectomy to anatomic segmentectomy in patients with clinical stage IA tumors with tumor size less than 2cm. After 7 years follow-up, anatomic segmentectomy was superior to lobectomy for overall survival. More recently Altorki and colleagues showed that for similar sized tumors (<2cm), sublobar resection (wedge or segment) was non-inferior to lobectomy for disease free and overall survival after 7 years follow-up.

Basilar segmentectomy was performed in a 52-year-old female patient with remote history of tobacco abuse. She was referred for surgical evaluation and treatment of a left lower lobe basilar segment 1.8cm lesion first noted on CT chest. The patient underwent a robotic navigational bronchoscopy with biopsy consistent with an invasive lung adenocarcinoma with acinar and lepidic patterns. Her pulmonary function tests were within normal limits. She underwent a flexible bronchoscopy with left robotic lower lobe basilar segmentectomy with mediastinal lymph node dissection. Final pathology showed a pT1aN0 adenocarcinoma, measuring 1.8cm with a 0.8cm invasive component. The margin was measured as 6.5 cm.

This study was approved by our institutional review board. In addition, the patient consented to deidentified pictures and videos collected during this procedure; Cedars Sinai Medical Center is a teaching hospital, and this practice is standard and included in procedure consent, which was obtained prior to surgery.

Robotic approach to basilar segmentectomy is described in 11 steps with accompanying videos 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. 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.

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 a 8mm robotic port is used with optical entry 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 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 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: Takedown of Inferior Pulmonary Ligament/ Posterior dissection - Video 2
The lung is retracted anteriorly and apically with a cigar and the tip up forceps from port #1 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. The dissection is carried more distal than a formal lobectomy to isolate and identify the basilar and superior segmental veins and any other aberrant venous anatomy, if present.

Anterior retraction of the lung is maintained to facilitate the posterior hilar dissection as it is carried above the inferior pulmonary vein. Care is taken to stay at the edge of the lung parenchyma where the hilar pleura is opened the entire length of the posterior mediastinum, to help parachute the structures up into the operative field. Level 10 lymph nodes are harvested just above the inferior pulmonary vein. 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 preserved during exposure of the level 7 lymph node packet. Level 7 lymph nodes are harvested to expose the entire carina, left mainstem bronchus as well as right mainstem bronchus. Retraction is moved superiorly to focus exposure between the left mainstem bronchus and main pulmonary artery.

Step 3: Interlobar Lymph Node Dissection/Posterior Pulmonary Artery- Video 3
The level 11 interlobar nodes between segment 2 and segment 6 lies between the main pulmonary artery and the mainstem bronchus. This lymph node packet is dissected free. Careful excision of this nodal packet allows for identification of the posterior aspect of the superior segmental arterial branch (A6) as well as the proximal portion of the main PA and if present the posterior ascending artery (A2). This dissection will later aid and make for a safer exposure of the posterior aspect of the major fissure. Dissection is carried onto the main PA, and distally to expose the superior aspect of the superior segmental artery and basilar segments. Emphasis is placed on dissecting the peri-areolar adventitial tissue off the artery to identify the correct plane. This opens the posterior aspect of the major fissure and aids in completion of the fissure in subsequent steps. A cigar is placed over the pulmonary artery at this point which helps mark the endpoint during the fissure dissection.
Step 4: Anterior Hilar Dissection
The lung is reflected posteriorly to expose the anterior hilum and the superior and inferior pulmonary veins. Identification and careful dissection is carried from inferior to superior making sure to identify and preserve the phrenic nerve. An emphasis is placed on excising hilar lymph nodes and dissection on the peri-areolar plane of the vein. Dissection should continue out toward the lung parenchyma to identify the division between superior segmental vein and basilar veins.

Step 5: Fissure Dissection/Pulmonary Artery and Segmental Lymph Node Dissection - Video 4
The lung is retracted posteriorly and the 4th robotic arm helps provide gentle traction to expose the fissure. The fissure is dissected in the avascular plane down to the pulmonary artery and is carried along the plane of Leriche to expose the pulmonary artery along its extent. The dissection is carried posteriorly to meet the prior posterior hilar dissection. If the fissure is more thick (more than just thin connective tissue), a yellow vessel loop is placed around the tissue to elevate the parenchyma away from the pulmonary artery and it then divided with a robotic stapler. Lower lobe arterial branches including the superior segment and basilar arteries are dissected. This is achieved by performing a thorough lymph node dissection.

Step 6: Division of Basilar Pulmonary Artery- Video 6
A red vessel loop is placed around the basilar segmental artery. The robotic stapler is then passed beneath the basilar segmental artery. The red vessel loop is removed, and the artery is divided with a vascular (white) load making sure to preserve the superior segmental artery.

Step 7: Division of Basilar Pulmonary Vein- Video 7
The basilar segmental vein is encircled with a blue vessel loop making sure to identify the superior segmental vein and preserve it. A robotic stapler is then passed around the basilar segmental vein. The blue vessel loop is removed, and the vein is divided with a vascular load making sure to protect the superior segmental vein.

Step 8: Basilar Bronchus Dissection/Test Inflation of Superior Segment with ICG/Mak Parenchymal Margin- Video 8
At this point dissection is carried out to isolate and expose the basilar bronchus and identify and preserve the superior segmental bronchus. Intravenous ICG is administered, and the intersegmental plane is marked. This can also be augmented with a test inflation of the superior segment with the robotic stapler clamped across the basilar bronchus to utilize both modalities to identify the optimal parenchymal line of transection prior to division of the bronchus.

Step 9: Division of Basilar Bronchus- Video 9
A robotic stapler is clamped over the basilar segmental bronchus. Care is taken to ensure the line of transection leaves a flush staple line and no blind bronchial stump. The yellow vessel loop is removed, and the basilar bronchus is divided.

Step 10: Division of Parenchyma- Video 10
The parenchyma is then divided with multiple firings of the robotic stapler (usually green load, with black load used if the parenchyma is thick) making sure to identify and preserve the bronchovascular structures to the superior segment.

Step 11: Complete Lymph Node Dissection/Remove Specimen - Video 11
The rest of the lymph node dissection is then completed including level 5/6 if the dissection is on the left side and 2/4 if operating on the right side and removed. The chest is inspected for hemostasis and any air leaks. The anchor bag is then inserted through the assistant port and placed in the apex with the sac opening towards the lateral chest wall. The lung specimen is then placed in the sack and removed. Often the 12mm assistant port has to be enlarged slightly to remove the specimen.

*The accompanying videos demonstrate 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: Takedown of Inferior Pulmonary Ligament/ Posterior dissection
Video 3: Step 3: Interlobar Lymph Node Dissection/Posterior Pulmonary Artery
Video 4: Step 4: Anterior Hilar Dissection
Video 5: Step 5: Fissure Dissection/Pulmonary Artery and Segmental Lymph Node Dissection
Video 6: Step 6: Division of Basilar Pulmonary Artery
Video 7: Step 7: Division of Basilar Pulmonary Vein
Video 8: Step 8: Basilar Bronchus Dissection/Test Inflation of Superior Segment with ICG/Mark Parenchymal Margin
Video 9: Step 9: Division of Basilar Bronchus
Video 10: Step 10: Division of Parenchyma
Video 11: Step 11: Complete Lymph Node Dissection/Remove Specimen
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