Between The Ribs: What's New In Thoracic Surgery

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I have no disclosures

Objectives

- Discuss the options available for managing the solitary pulmonary nodule
- Develop a strategy for staging the patient with a non-small cell lung cancer
- Assess the current recommendations for sublobar lung resections
- Recognize options for advanced surgical resections

Introduction

- Lung cancer is the number one cause of cancer death in women
- In 2014 it is estimated that 159,260 men and women will die of lung cancer
- In Nebraska 1,220 new lung cancer cases with 900 deaths
- Lung cancer will be responsible for over one million deaths this year alone

Epidemiology

- Approximately 224,210 new cases of lung cancer will be diagnosed in 2014
- 90% of these cases are related to tobacco abuse and 10% to radon and other environmental causes
- Smokers have a 20-fold increase in lung cancer risk compared to never-smokers
- Tripling the number of cigarettes smoked triples the risk of developing lung cancer but tripling of the duration of smoking has been estimated to increase the lung cancer risk 100-fold

Histopathology

- Non-small cell lung cancers comprise almost 85% of all lung cancers
- The mechanisms leading to the development of the different types of tumors is still unclear
- Smoking causes all of the histologic types of cancer, but the dose-response relationship with the number of cigarettes smoked is steepest with small cell

Histopathology(cont)

- Adenocarcinoma is now the most common histology
- In women, the incidence rates of SCCA, large cell and small cell have flattened but the rate of adenocarcinoma is rising
- The change is thought to be related to increase in puff volume which deposits tobacco smoke in peripheral airways, and increase in the level of nitrates which enhances combustion. This decreases polycyclic aromatic hydrocarbons but increases tobacco specific nitrosamine NKK

Solitary Pulmonary Nodule

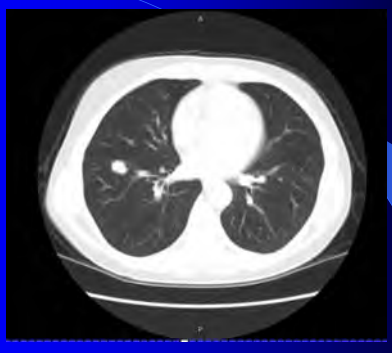
- More than 150,000 nodules are identified each year in the US (SNP defined as <3cm in size with no atelectasis or adenopathy)
- Primary malignancy identified in 35% and solitary metastasis in 23%
- Rate of failure to diagnose lung cancer ranges from 25-90% on plain CXR
- In study by Quekel et al, lesions missed were smaller(16mm), more superimposed structures and had less distinct borders. The delay in diagnosis was 472 days. 43% of lesions increased from T1 to T2

Incidence Of Malignancy In Solitary Pulmonary Nodules Related To Age

Age (Years)	Malignant(%)
35-44	15
45-49	26
50-59	41
60-69	50
70-79	70
Over 80	Almost 100

Diagnosis Of SNP

- Spiral CT with IV contrast is imaging modality of choice. MRI provides no additional benefit
- 84-90% of spiculated nodules are malignant
- Under 2cm in size, about 50% of SPN's are cancer.The majority of nodules >2cm in size are malignant. At >3cm in size the incidence is so high that all nodules should be resected.



PET and the SPN

- PET has an overall sensitivity of 96.8% and specificity of 77.8% for malignant nodules, and a 96% sensitivity and 88% specificity for benign nodules
- For low risk patients, a negative PET has a posttest likelihood of malignancy of 1%, but the high risk patient with a negative PET the chance of malignancy is still 14%
- Because of limits of resolution, not recommended for lesions smaller than 1cm

Methods Of Investigating Solitary Pulmonary Nodules

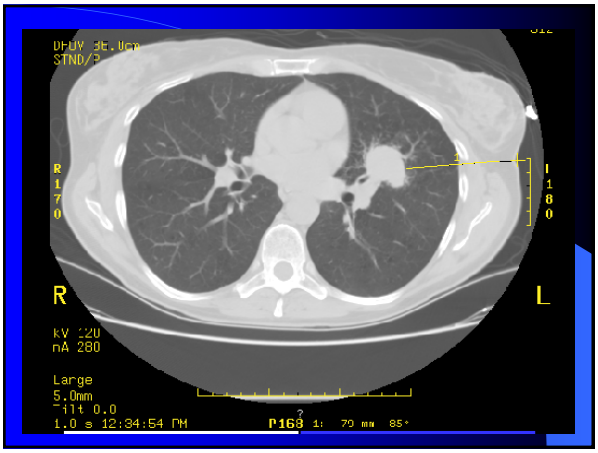
- Sputum cytology
- Flexible Bronchoscopy
- Electromagnetic navigational bronchoscopy
- Percutaneous needle biopsy
- VATS biopsy

Efficacy Of Bronchoscopic Diagnosis Of SPN

- Bronchoscopy has a yield of >90% when there is endobronchial disease present
- The diagnostic yield decreases to a range of 18-62% when the bronchus is clear
- The yield is lowest when the lesion is in the apical or basilar segments and when the lesion is less than 2cm in size (33-62%)

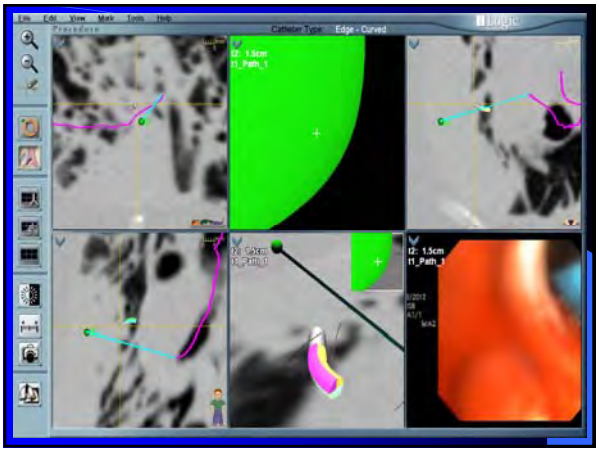
Percutaneous Needle Biopsy

- Fine-needle aspiration biopsy reported to have up to a 95% sensitivity for detecting malignant lesions
- Significantly less reliable for lesions <1cm in size
- Diagnostic yield for benign lesions is in the range of 5-20%



Electromagnetic Navigational Bronchoscopy

- Novel technology which allows the localization of lung nodules and mediastinal lymph nodes
- Extended working channel and guide
- Can perform biopsy, needle biopsy, brush biopsy and BAL for cytology



The Problem

Stage	Incidence	Survival
Stage I	15%	70%
Stage II	10%	40%
Stage III	25%	5%
Stage IV	50%	<1%

Recommendations

- Pt's with known or suspected lung cancer should have a CT scan
- If the mediastinal nodes are >1cm further biopsy should be performed
- Where available a PET scan should be performed to stage the mediastinum
- Pt's with a "positive" scan require further biopsy
- All recommendations graded B

Noninvasive Staging

- Chest X-ray
- CT scan- chest, abdomen, pelvis
- CT scan- head
- MRI
- PET scan
- Bone Scan

Mediastinal Staging- CT

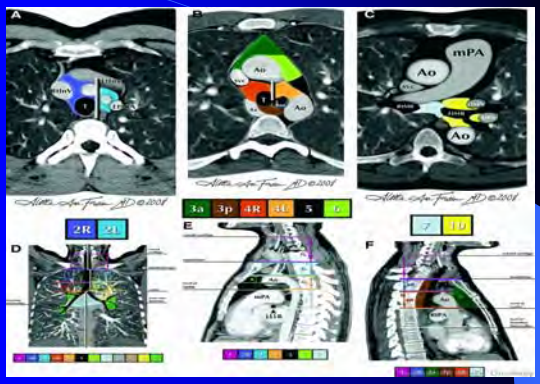
- Twenty studies with 3,438 patients
- Most studies use >10mm short-axis diameter as criteria for positivity
- Pooled sensitivity was .57 and pooled specificity was .82
- The positive predictive value was .56, negative predictive value .83

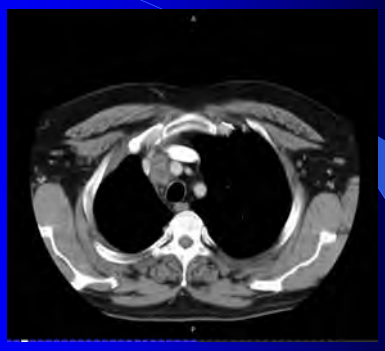
Mediastinal Staging- PET

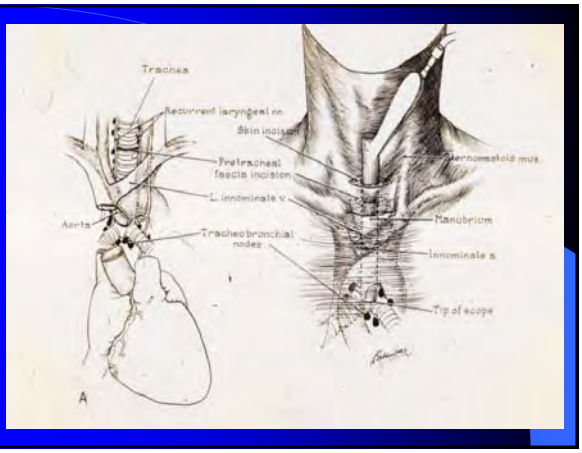
- Eighteen studies with 1,045 patients
- The pooled sensitivity was .84 and the specificity .89
- PPV .79 and NPV .93
- Only three studies with combined CT/PET- 152 pts
- PPV .83-.93 and NPV .88-.95

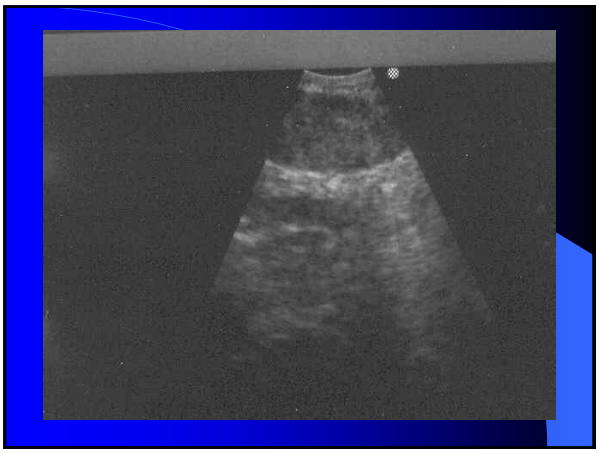
Invasive Staging

- Bronchoscopy- TBNA
- Endobronchial ultrasound (EBUS)- TBNA
- Esophageal ultrasound (EUS)- NA
- Transthoracic needle aspiration
- Mediastinoscopy/Mediastinotomy
- Thoracoscopy







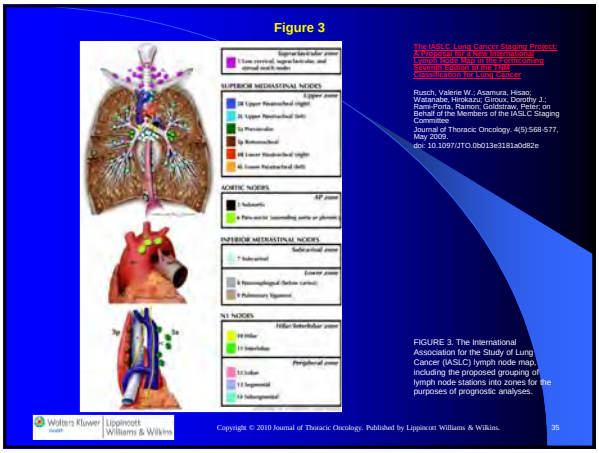


Surgical Resection

- Wedge resection
- Segmentectomy
- Lobectomy
- Bilobectomy
- Pneumonectomy
- Sleeve lobectomy/pneumonectomy
- Extended resections

Node Dissection

- Usually attempt to remove the hilar nodes en-bloc with the specimen
- On the right side will perform a lymph node dissection to include levels 2R, 4R, 7,8,9 and 10R
- On the left will remove 5,6,7,8,9 and 10L



VATS

- To be considered a viable alternative must adhere to the same oncologic principles as open lobectomy
  - Individual vessel ligation
  - Complete anatomic resection with negative margins
  - Complete hilar node dissection
  - Appropriate management of the mediastinal nodes

Advantages

- Less postoperative pain
- Shorter hospital stay
- Decreased morbidity and mortality
- Improved survival in patients undergoing resection for lung cancer
- Increased immunologic benefit- decreased CRP and IL-6
- Decreased cost

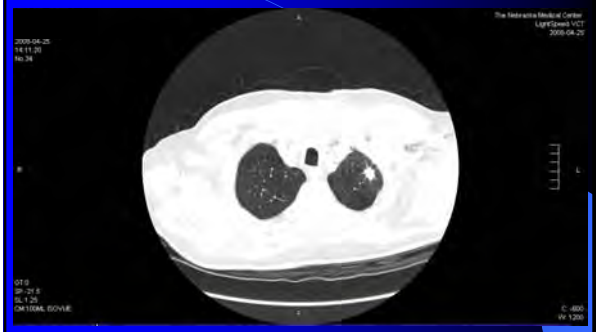
Clinical Advantages

- Decreasing the extent of resection lowers the operative mortality
- In a study of 2200 lung resections mortality following pneumonectomy was 6.2%, lobectomy 2.9% and sublobar resections 1.4%
- Sublobar resection preserves pulmonary function which improves morbidity and mortality

Ginsberg et al. J Thorac Cardiovasc Surg 1983;86:654-8.

Sublobar Resection

- Wedge resection- is a non-anatomic resection of a pulmonary nodule/mass
- Segmentectomy- entails the division of the segmental pulmonary artery, vein and bronchus supplying the anatomic segment



Favorable Criteria

- Peripheral tumors
- Tumors <2cm
- At least a 1cm margin
- No endobronchial tumor
- Age >75
- Absence of nodal disease
- Ground glass opacity
- Adenocarcinoma with purely lepidic pattern (BAC) histology

Current Era

- In 1987, the Japanese implemented a national lung cancer screening program
- This resulted in the detection of smaller, earlier stage lung cancers
- Enthusiasm for more limited resections resurfaced in the setting of these more favorable tumors

Modifications

- Focused more on anatomic resections than wedge resections
- Included the use of extended segmentectomies
- Systematic lymph node evaluation
- Histologic examination of stapled margins

Results

- Okada et al reported their results of extended segmentectomy vs lobectomy for tumors <2cm
- There were no local recurrences in either group
- 5 year survival was 87.1% for segmentectomies vs 87.8% for lobectomy

Okada et al. Ann Thorac Surg 2001; 71:956-60.

Results (cont.)

- Bando et al reported their results performing segmentectomies for tumors <2cm
- The 5 year survival was 82% and the local recurrence rate was 1.9%
- In 2005, Martin-Ucar et al compared segmentectomy vs lobectomy in a group of patients with impaired pulmonary function (FEV1 <40%)
- No difference in 5 year survival and local recurrence rate was similar at 18%

Bando et al. Eur J Cardiothorac Surg 2002;21:894-99.
Martin-Ucar et al. Eur J Cardiothorac Surg 2005;27:675-79.

Tumor Size

- Okada et al analyzed 1272 consecutive lung resections to help further stratify suitability for sublobar resection
- Four groups with primary tumor size ≤10mm, 11-20mm,21-30mm and ≥31mm
- Cancer specific survival was 100, 83.5, 76.5, and 57.9%
- Sublobar resection was performed in 52% of tumors <20mm and 16% of tumors >20mm

Survival

- 5 year cancer specific survival for pts with Stage I disease having tumors <20mm and 21-30mm was 92.4 and 87.4% after lobectomy
- After segmentectomy 96.7 and 84.6%
- After wedge resection 85.7 and 39.4%
- When tumors were >30mm survival was 81.3, 62.9 and 0% respectively

Okada et al. J Thorac Cardiovasc Surg 2005;129:87-93

Concerns

- The studies highlight the differences in results between segmentectomy and lobectomy pertaining to rates of local recurrence in the Western and Japanese literature

Strategies To Reduce Local Recurrence

- It has been known since the late 1980's that external beam radiation decreases local recurrence
- A small Phase II CALGB study of sublobar resection followed by RT (56 Gy) in 58 pts failed to show a benefit
- Even though no benefit was seen in this study, the use of adjuvant therapy was deemed promising

Miller et al. Ann Thorac Surg 1987;44:340-43.
Shenib et al. J Thorac Cardiovasc Surg 2005;129:813-18.

Intraoperative Brachytherapy

- In 1998, D'Amato et al described the use of ^{125}I impregnated vicryl mesh applied to the staple line
- This was done in a group of 14 high risk patients and showed no adverse effects
- In a group of 101 pts undergoing sublobar resection with ^{125}I seeds embedded in the staple line, Santos et al reduced local recurrence to 2% compared to18.6% for historical controls

D'Amato et al. Chest 1998;114:1112-5.
Santos et al. Surgery 2003;134:691-7.

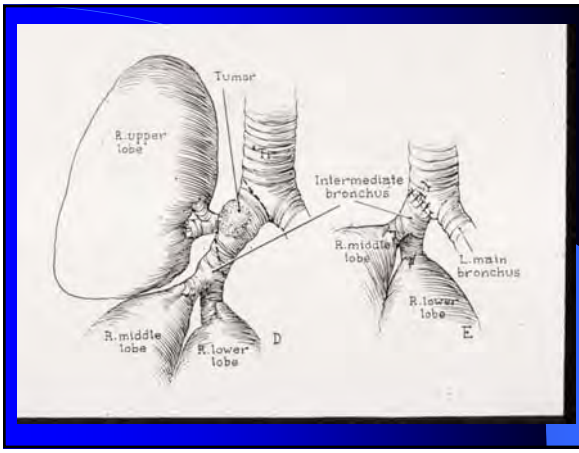
Recommendations

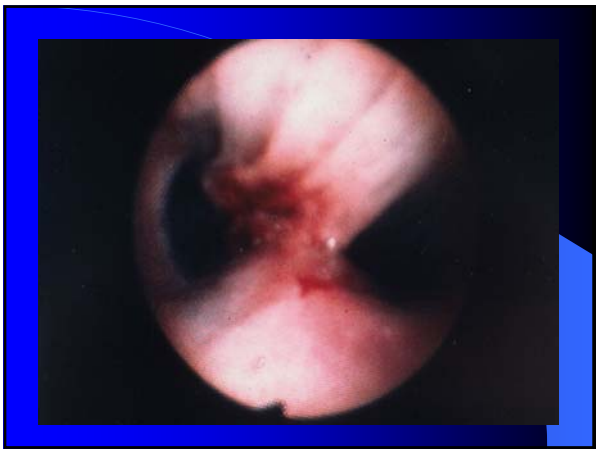
- Clinical Stage I <2cm
- FEV1 <60%
- DLCO <60%
- PA systolic pressure >40 mm Hg
- Oxygen requirement
- Congestive heart failure
- LV ejection fraction <40%
- Resection should be a segmentectomy

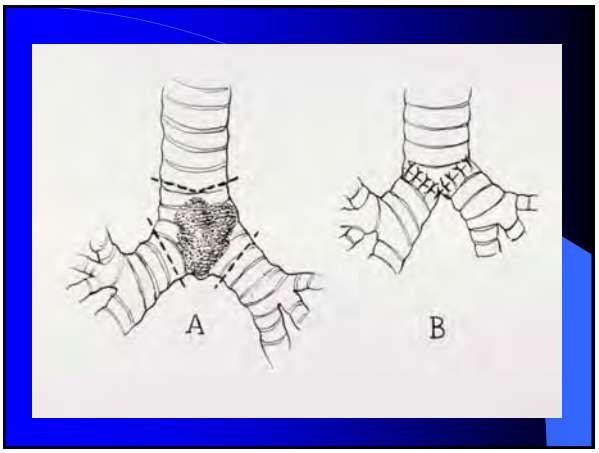
ACOSOG Z4032

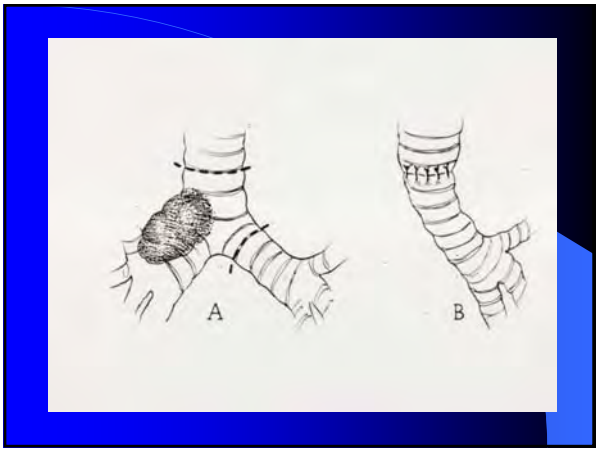
Conclusions

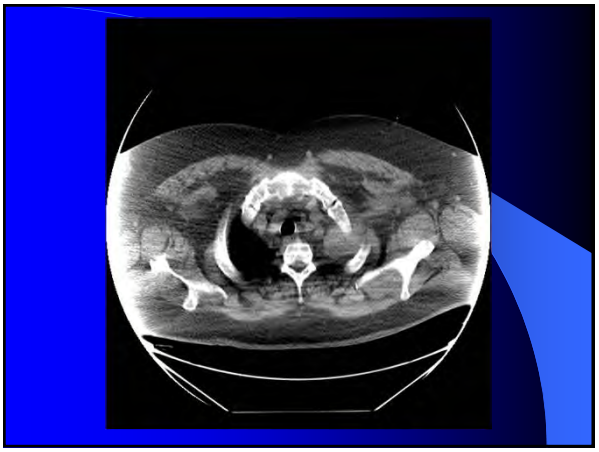
- Segmentectomy remains an option in the management of NSCLC
- Consideration should be given to those pts with tumors <2cm
- Lobectomy should still be considered the procedure of choice in those with adequate cardiopulmonary reserve
- External beam RT and intraoperative brachytherapy are options for decreasing local recurrence and potentially improving long term survival

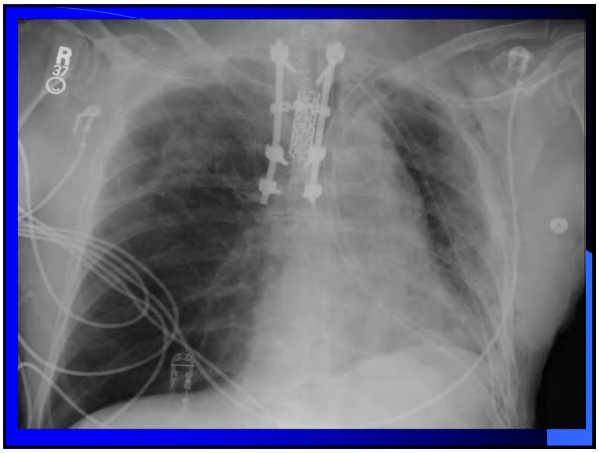












NSCLC Treatment Outcomes

Stage	Clinical 5-Year Survival	Pathologic 5-Year Survival
IA	50%	73%
IB	43%	58%
IIA	36%	46%
IIB	25%	38%
IIIA	19%	24%
IIIB	7%	9%
IV	2%	13%

Goldstraw P, et al. *J Thorac Oncol.* 2007;2(8):706-714.
www.iaslc.org

Conclusions

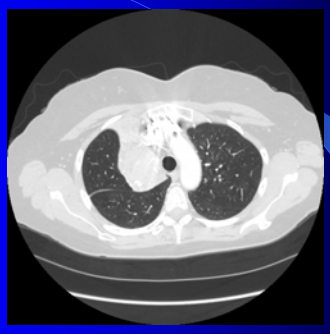
- Surgery remains the most effective option for the management of patients with early stage lung cancer
- The role of surgery in patients with more advanced stages of disease continues to evolve
- Limited resection may be as effective as lobectomy for small tumors

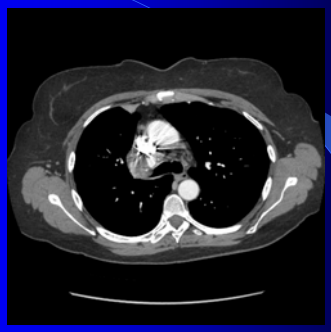
Case #1

- 68 year old female presents with complaints of chills, low grade temperature, body aches and fatigue
- Reports a 10 pound weight loss over the past month
- History significant for a 25 pack/year history of tobacco abuse

Case #1

- Chest X-ray is obtained which demonstrates collapse of the right upper lobe
- A CT scan is obtained which confirms collapse of the upper lobe and reveals a right hilar mass obstructing the right upper lobe bronchus
- There is an 11mm right paratracheal lymph node





Clinical Decision #1

- Are additional imaging studies required?
  - CT scan/MRI brain
  - Bone scan
  - PET scan

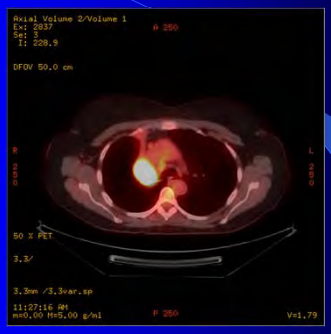
Non-Invasive Staging

- Patients clinically Stage IB-IIIA being treated with curative intent should undergo a PET scan if available
- All patients should have a complete clinical evaluation and only those with a site specific symptom should undergo further imaging studies

Silvestri G, et al. CHEST 2007;132:178S-201S

Case #1

- History and physical exam reveal no musculoskeletal nor neurologic complaints or findings
- A PET scan confirms a right hilar mass with an SUV 32.4
- The right paratracheal node has an SUV 3.1
- No other areas of increased uptake are noted



Clinical Decision #2

- Based on the PET scan should the patient be considered to have Stage IIIA disease or is tissue confirmation required prior to making a treatment recommendation?

PET Scans

- A positive mediastinal PET scan should be confirmed by some type of biopsy as studies have shown a false positive rate as high as 20%
- Conversely, patients with enlarged mediastinal nodes but a negative PET scan may also warrant a biopsy especially if a tissue diagnosis is required

Detterbeck, F et al. CHEST 2004;125:2300-2308.

Clinical Decision #3

- Which procedure would you recommend next?
  - Endobronchial ultrasound with biopsy
  - Cervical mediastinoscopy with biopsy
  - VATS biopsy
  - No biopsy proceed directly to surgery

Invasive Staging

- Any of the invasive techniques- EUS-NA, EBUS-NA, TBNA, TTNA are considered appropriate ways to sample the mediastinal nodes
- It is suggested that a non-malignant biopsy result be confirmed by mediastinoscopy

Detterbeck F, et al. CHEST 2007;132:202S-220S.

Pre-Operative Evaluation

- FEV1 1.82liters(88% predicted)
- DLCO 65% predicted
- PaO2 84mmHg
- PaCO2 34mmHg

Clinical Decision #4

- Based on the data presented are the pulmonary functions adequate to perform a right pneumonectomy if required?

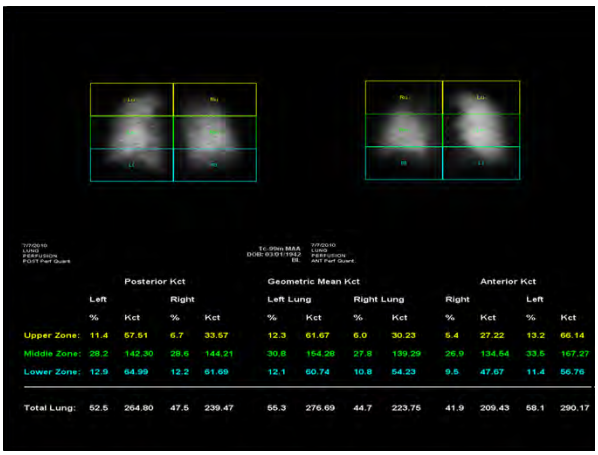
Pulmonary Function Tests

- DLCO has been demonstrated to be an independent predictor of postoperative mortality and pulmonary morbidity
- Mortality is increased in patients with a DLCO <60% of normal
- A value of ppoDLCO <40% is used to distinguish higher risk patients

Ferguson, M et al. J Thorac Cardiovasc Surg 1988;96:894-900.
Ferguson, M et al. J Thorac Cardiovasc Surg 1995;109:275-83.
Brunelli, A et al. Eur J Cardiothorac Surg 2006;29:567-70.

Case #1

- A quantitative perfusion scan is performed and the results show the right lung 45% and the left lung 55%
- The right upper zone receives 6% of the perfusion



	Posterior Kct				Geometric Mean Kct				Anterior Kct			
	Left		Right		Left Lung		Right Lung		Right		Left	
	%	Kct	%	Kct	%	Kct	%	Kct	%	Kct	%	Kct
Upper Zone:	11.4	67.51	6.7	33.57	12.3	61.67	6.0	30.23	5.4	27.22	13.2	66.14
Middle Zone:	28.2	142.30	28.6	144.21	30.8	154.26	27.8	139.29	26.9	134.64	33.5	167.27
Lower Zone:	12.9	64.99	12.2	61.69	12.1	60.74	10.8	54.23	9.5	47.67	11.4	56.76
Total Lung:	52.5	264.80	47.5	239.47	55.3	276.69	44.7	223.75	41.9	209.43	58.1	290.17

Case #1

- The patient is taken to the operating room where bronchoscopy confirms tumor occluding the right upper lobe bronchus
- Frozen section analysis reveals a squamous cell carcinoma
- EBUS is performed and intra-operative cytology is negative for malignancy

Surgical Treatment

- The procedure continues with a diagnostic VATS which shows no evidence of disease within the pleural space
- A right upper lobe sleeve lobectomy and mediastinal node dissection is performed
- The patient does well postoperatively and is discharged home on POD#5

Case #1

- Final pathology shows a squamous cell carcinoma 3.7cm in size
- All lymph nodes are negative for malignancy
- Final pathologic stage is T2N0M0 Stage IB