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Cases in Interventional Pulmonary

D. Kyle Hogarth, MD
Professor of Medicine
Director of Bronchoscopy and Interventional Pulmonary
University of Chicago


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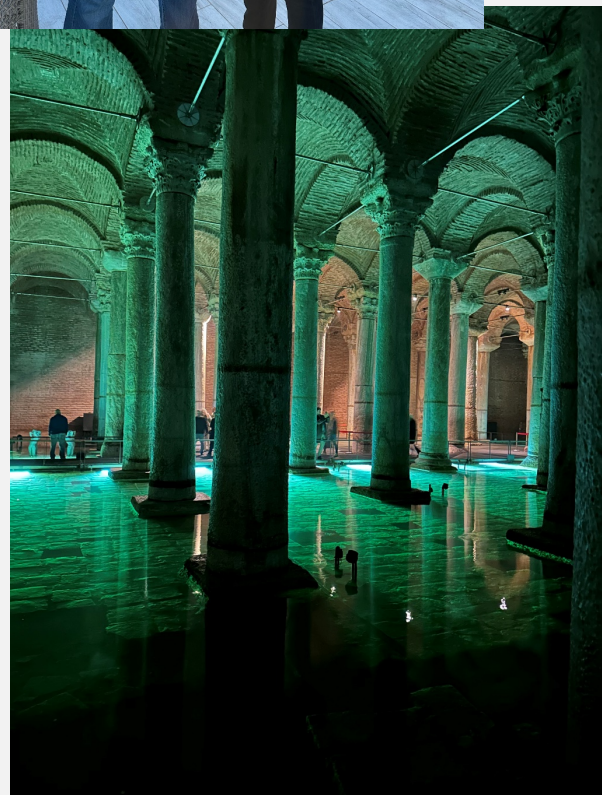
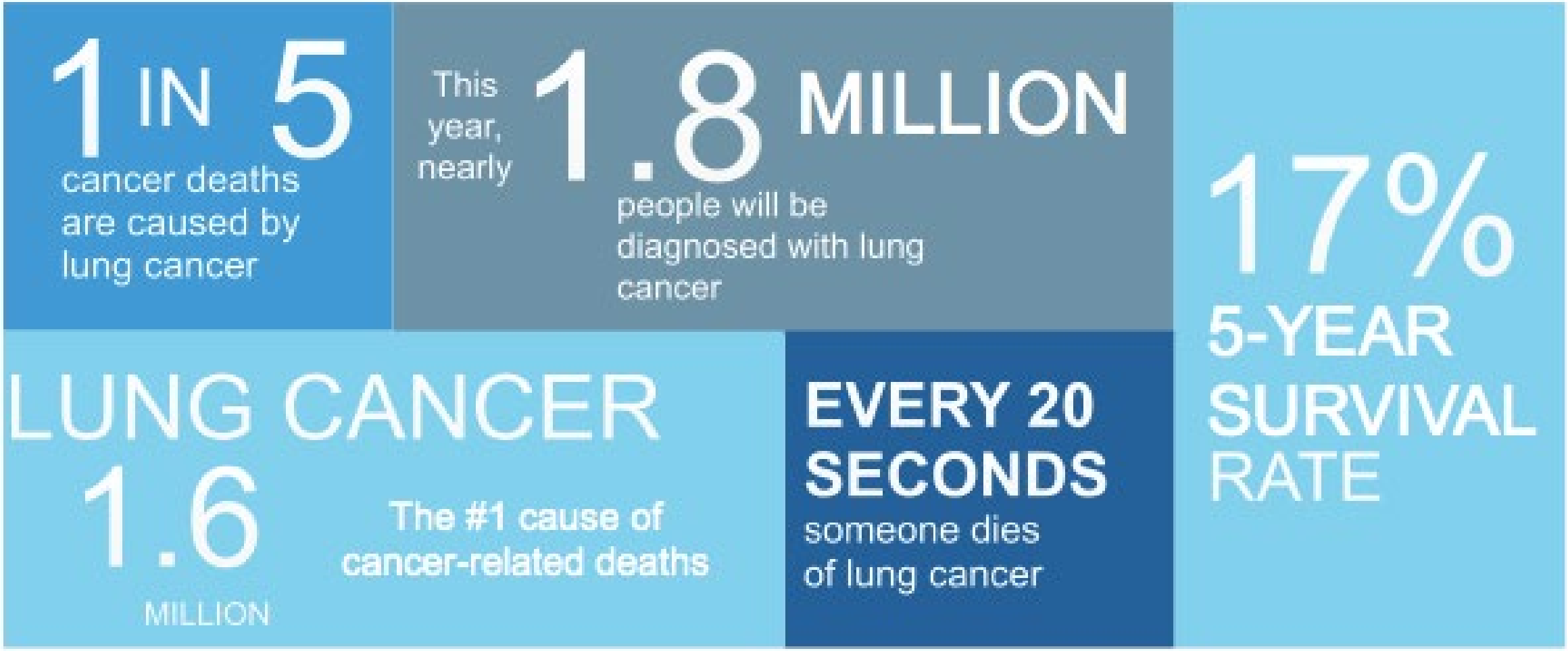


Lung Nodule Evaluation and Peripheral Bronchoscopy

Why worry about nodules? : The risk for Lung Cancer



American Cancer Society 2015
GLOBOCAN (IARC), Section of Cancer Surveillance (16/9/2015)

THE FIVE CAUSES OF LUNG CANCER

Smoking, particularly of cigarettes, is by far the main contributor to lung cancer. Cigarette smoke contains over 60 known carcinogens, including radioisotopes from the radon decay sequence, nitrosamine, and benzopyrene.

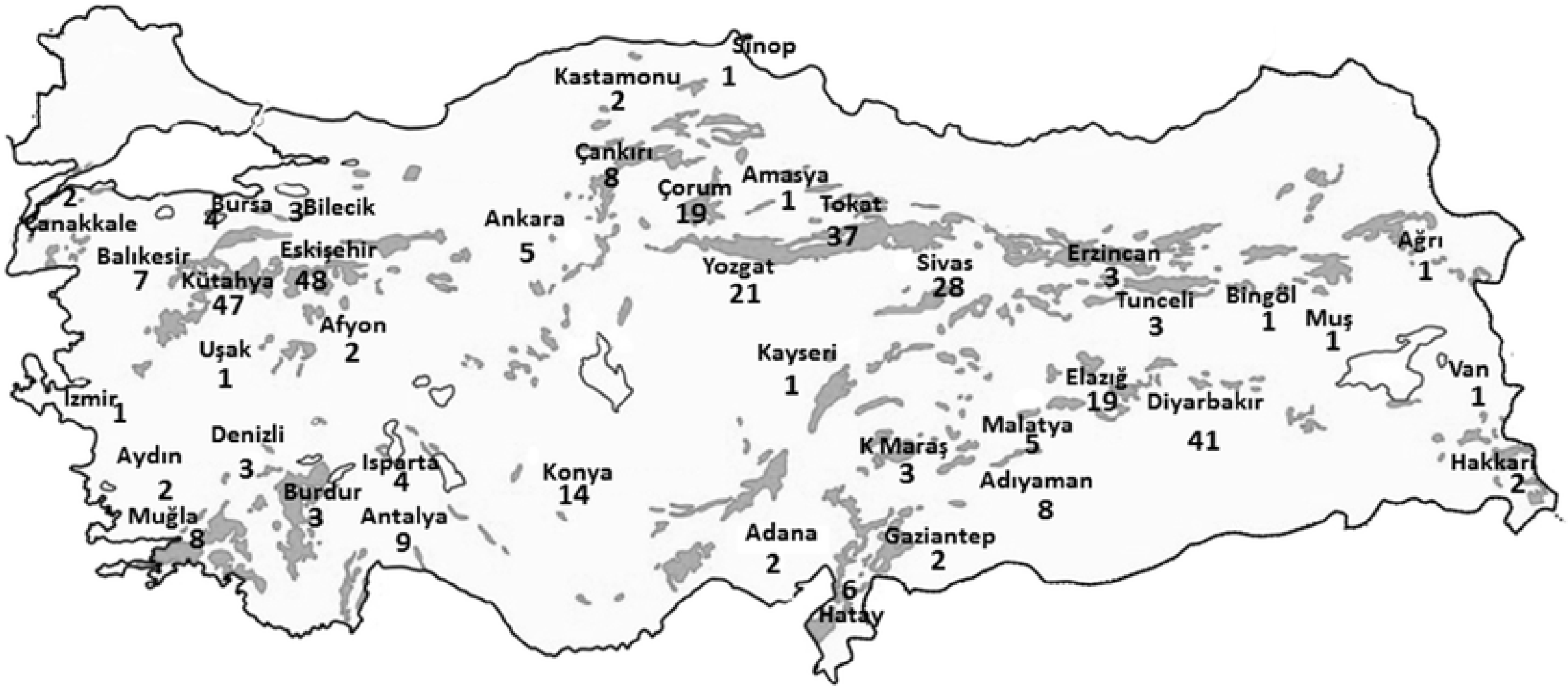
Radon gas, colorless and odorless gas generated by the breakdown of radioactive radium, which in turn is the decay product of uranium, found in the Earth's crust. The radiation decay products ionize genetic material, causing mutations that sometimes turn cancerous.

Asbestos, causes a variety of lung diseases, including lung cancer. Tobacco smoking and asbestos have a synergistic effect on the formation of lung cancer. Asbestos can also cause cancer of the pleura, called mesothelioma.

Air Pollution, outdoor air pollution has a small effect on increasing the risk of lung cancer. Fine particulates and sulfate aerosols, which may be released in traffic exhaust fumes, are associated with slightly increased risk.

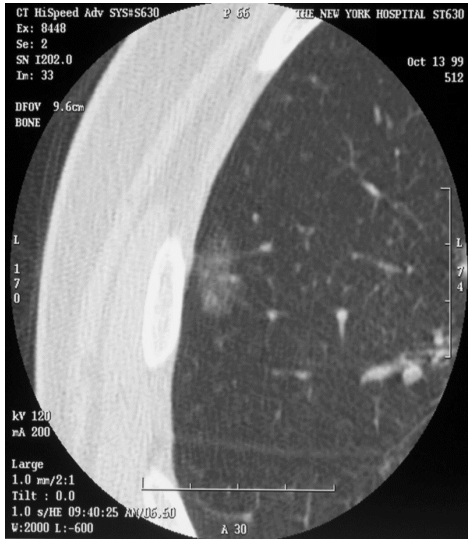
Genetics, It is estimated that 8 to 14% of lung cancer is due to inherited factors. In relatives of people with lung cancer, the risk is increased 2.4 times. This is likely due to a combination of genes.

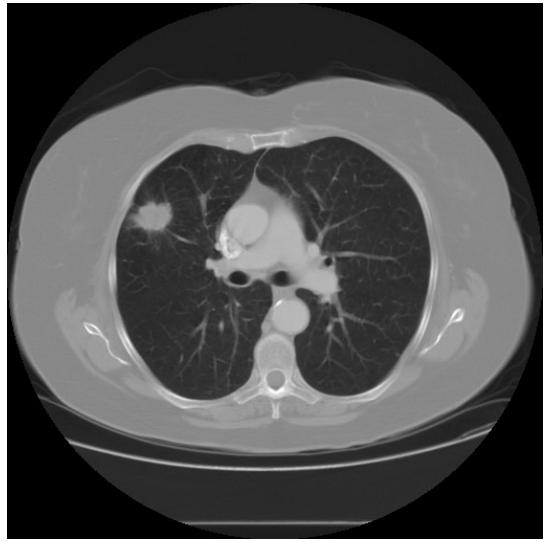
Asbestos areas in Turkey from Soil Sample research



The Single Pulmonary Nodule
The Incidental Pulmonary Nodule
The Lung Nodule

- Lung nodule
- Ground Glass opacity
- Lung mass
- Persistent infiltrate





Lung Nodule Epidemiology

- **Frequent finding on chest CTs in the US**

  Screening LDCT: 10% to 50% (mean ~20%)

  Diagnostic CT: 25% to 30%

Risk of Cancer – Nodule Size

Nodule Size	Confirmed Lung Cancer		PPV (%)
	Yes	No	
4-7 mm	18 (7%)	3642 (53%)	0.5
7-10 mm	35 (13%)	2079 (30%)	1.7
11-20 mm	111 (41%)	821 (12%)	11.9
21-30 mm	58 (22%)	137 (2%)	29.7
> 30 mm	45 (17%)	64 (1%)	41.3

NLST Investigators. NEJM 2013

Case One

- 64 year old male
- 80 pack year history of smoking
- Former smoker, quit in 2016
- PMH: HTN, DM, COPD
- HPI: denies changes in dyspnea, cough, weight loss, hemoptysis
- Undergoes Lung Cancer Screening CT

What should we do?

Next Steps?

1) Surgical Resection
2) Transthoracic Needle Aspiration (TTNA)
3) Bronch with thin scope and REBUS
4) Robotic Endoscopy
5) Bronch with Augmented Fluroscopy (LungVision)
6) Follow up CT scan

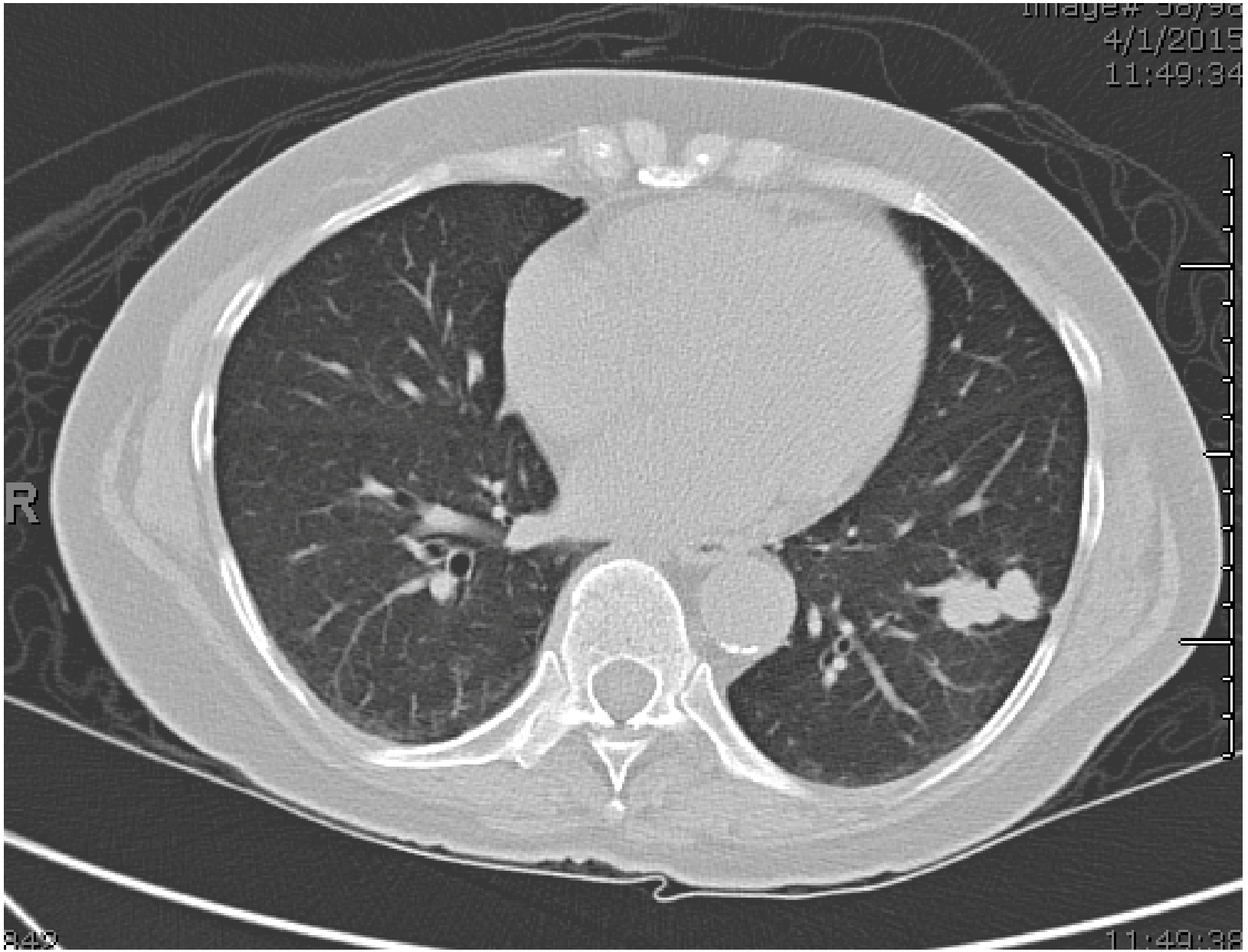
Case Study #1: 3 month follow up

Plan: CT Chest follow up in 3 months
Radiology Interpretation: RUL nodule 9 mm stable in size: follow up 1 year. Stable at 1 year and 2 years.

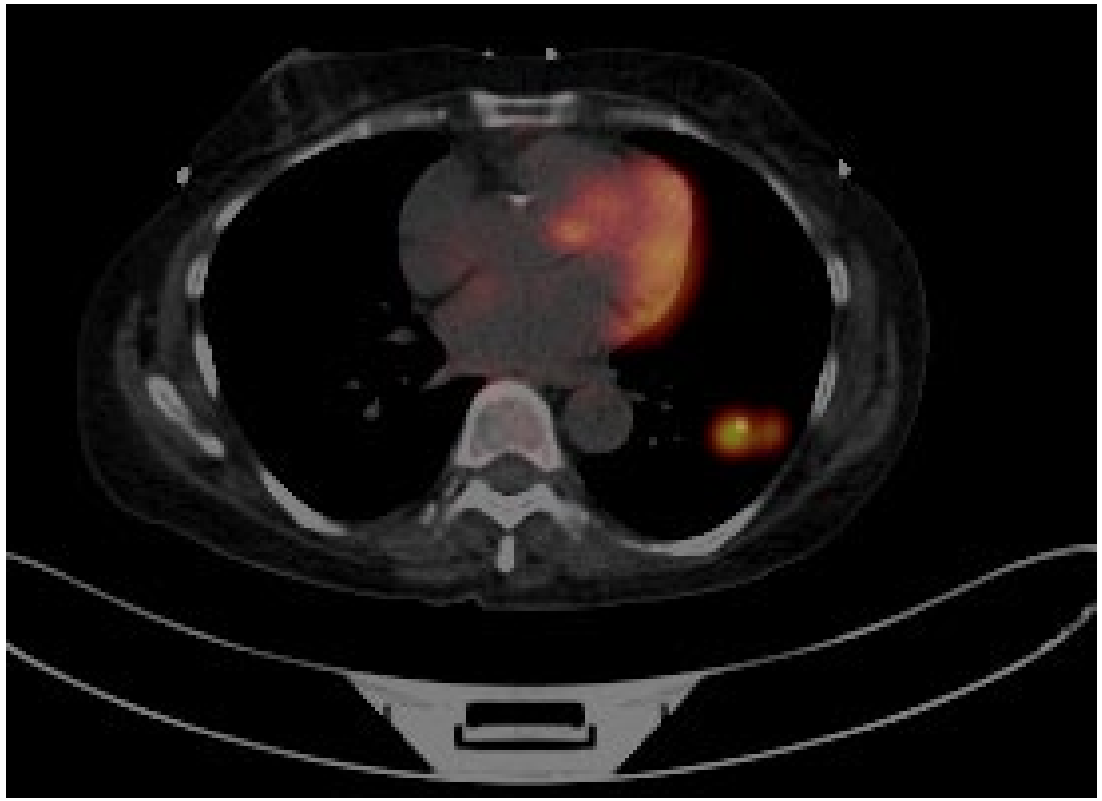
Case Two

- 71 year old female
- 50 pack year smoking history
- Current smoker: 1/2 pack per day
- PMH: HTN, Hep C, osteoarthritis, vision loss
- HPI: denies DOE, cough, weight loss, hemoptysis
- Has a CT scan done for cardiac calcification score

Case Two



Case Two



PET scan: Left lower lobe mass hypermetabolic with SUV 12.5. No other hypermetabolic lesions within the lung or mediastinum. No FDG avid metastatic disease.

Next Steps?

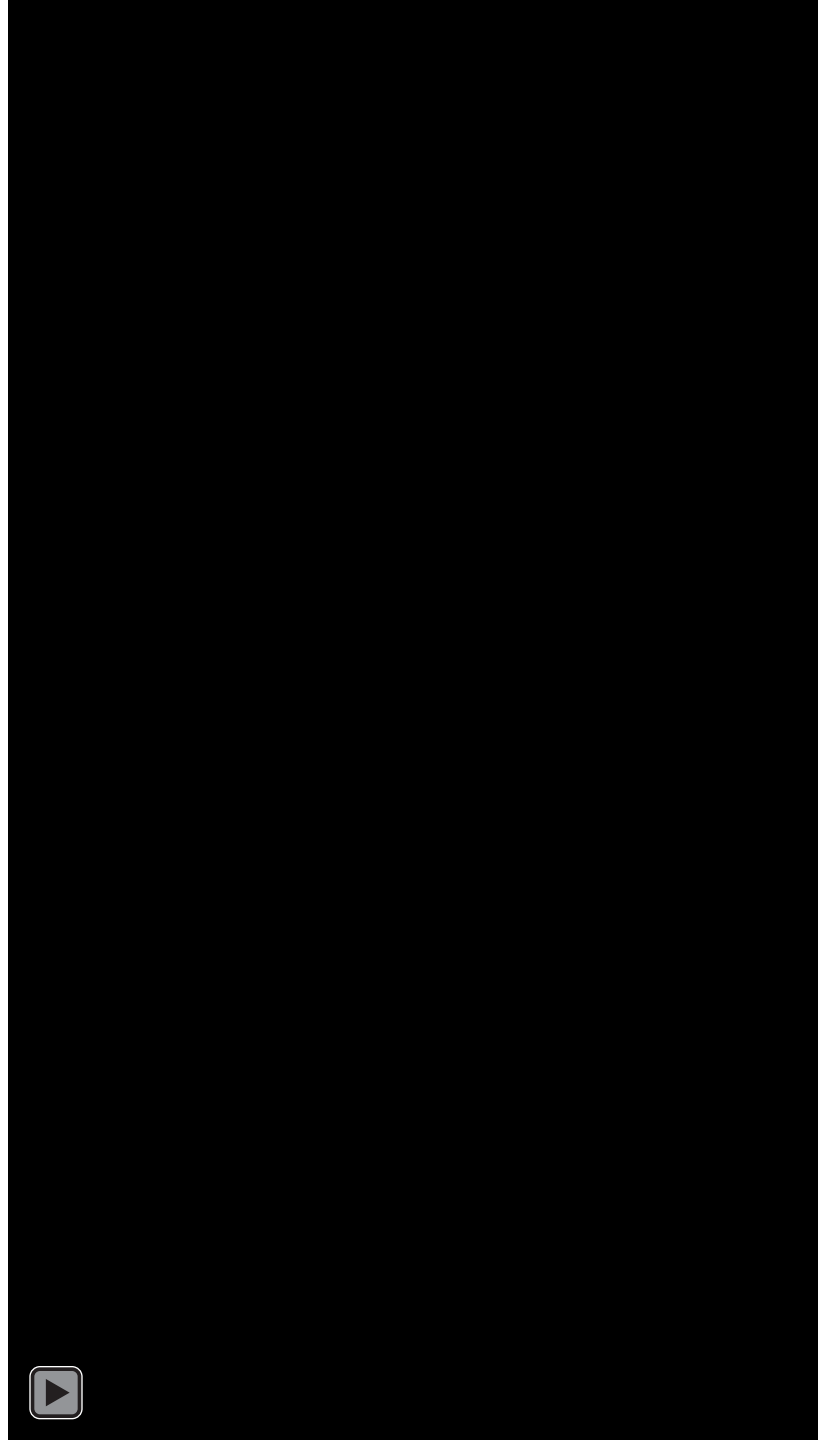
1) Surgical Resection
2) Transthoracic Needle Aspiration (TTNA)
3) Bronch with thin scope and REBUS
4) Robotic Endoscopy
5) Bronch with Augmented Fluroscopy (LungVision)
6) Follow up CT scan

Case Two

- Underwent bronchial branch tracing mapping with augmented fluoroscopy via LungVision : ROSE consistent with adenoCA. EBUS staging of mediastinum negative. Referred to VATS for stage 1b disease
- Pathology: Adenocarcinoma
- Staged T1bN0M0
- Smoking cessation: quit smoking prior to surgery with Buproprion

Case Three

- 84 year old female with follow up CT scan for incidental noted GGO
- Former smoker, but quit 35 years ago
- Excellent performance status and normal PFTs



Next Steps?

1) Surgical Resection
2) Transthoracic Needle Aspiration (TTNA)
3) Bronch with thin scope and REBUS
4) Robotic Endoscopy
5) Bronch with Augmented Fluroscopy (LungVision)
6) Follow up CT scan

Case Three

- Underwent robotic navigation with Noah Galaxy to the RUL. ROSE consistent with adenoCA. EBUS staging of mediastinum negative. Referred to VATS for stage 1 disease.
- Pathology: Adenocarcinoma
- Staged T1aN0M0

Sampling the SPN

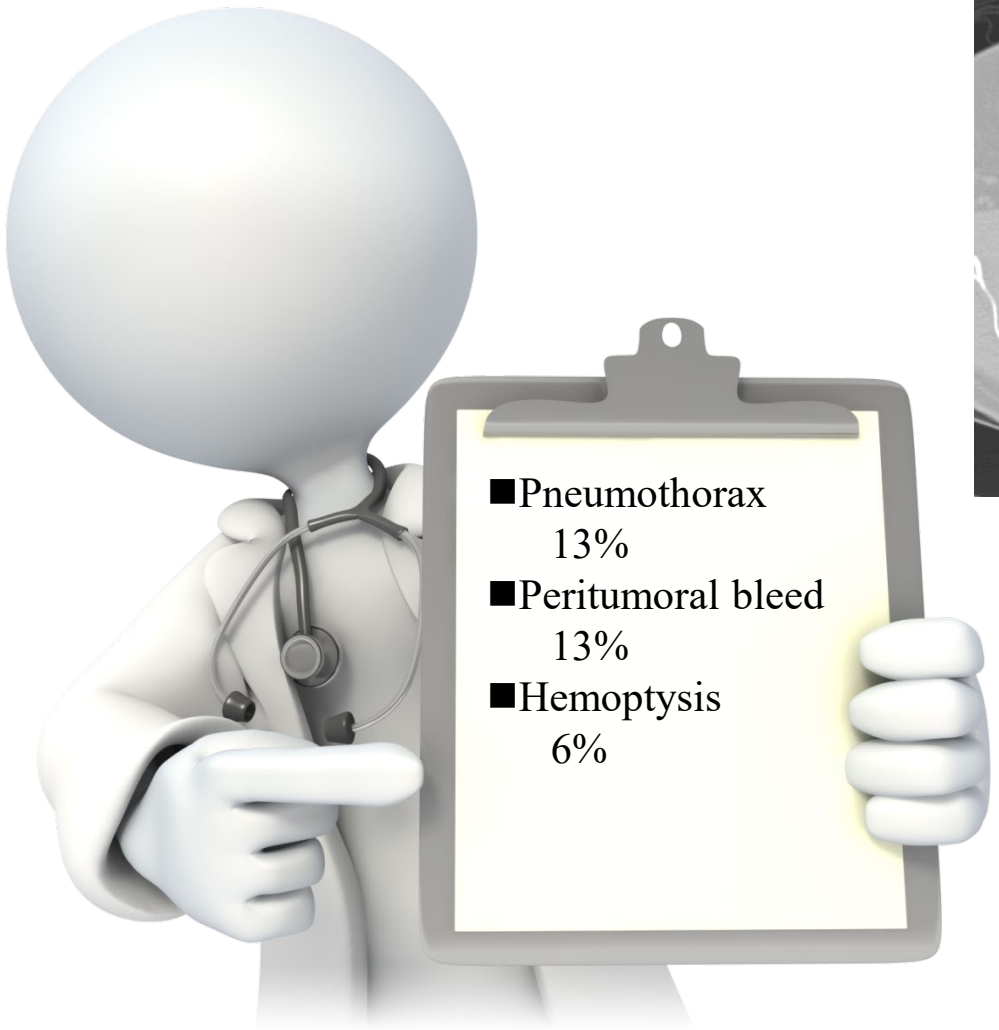
- So Many choices…..

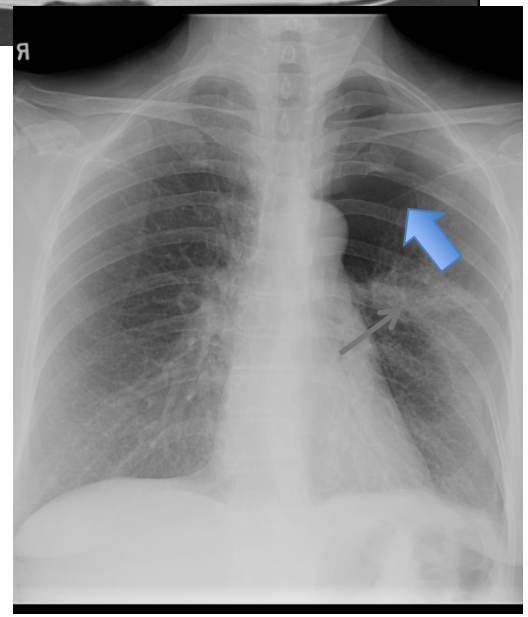
CT-Guided Fine Needle Aspiration

- Cannot be used in all cases due to co-morbidities
- Not suitable for all lesion locations [1]
- Sensitivity rate 75-95%[2,3]
- Specificity rate 50-88%[2]
- False negative rate: 3-29%[2]

1.Lawrence Shulman et al. Curr Opin Pulm Med 2007;13:271-277.
2 . David Ost et al. N ENGL J MED 2003;348:2535-42.
3. Veritas trial: presented at ATS 2024 in SanDiego, CA. Publication pending.

Serious Complications Can Occur: and there is no staging





Navigation is preferred to TTNA due to the following

- Higher safety
- Similar yields
- Better tissue acquisition
- Need for molecular markers (and future studies)
- Ease of marker placement at time of biopsy
- Staging can also occur at the same time!

AMERICAN COLLEGE OF CHEST PHYSICIANS

Why is Peripheral Bronchoscopy Challenging?

Periferik Bronkoskopi Neden Zorludur?

- Complex anatomy
- CT to body divergence
- Atelectasis
- Mucous plugs
- Breathing
- Airway distortion.

- Karmaşık anatomi
- CT'den vücut sapmasına
- Atelektazi
- Mukoza tıkaçları
- Nefes alma
- Hava yolu distorsiyonu.

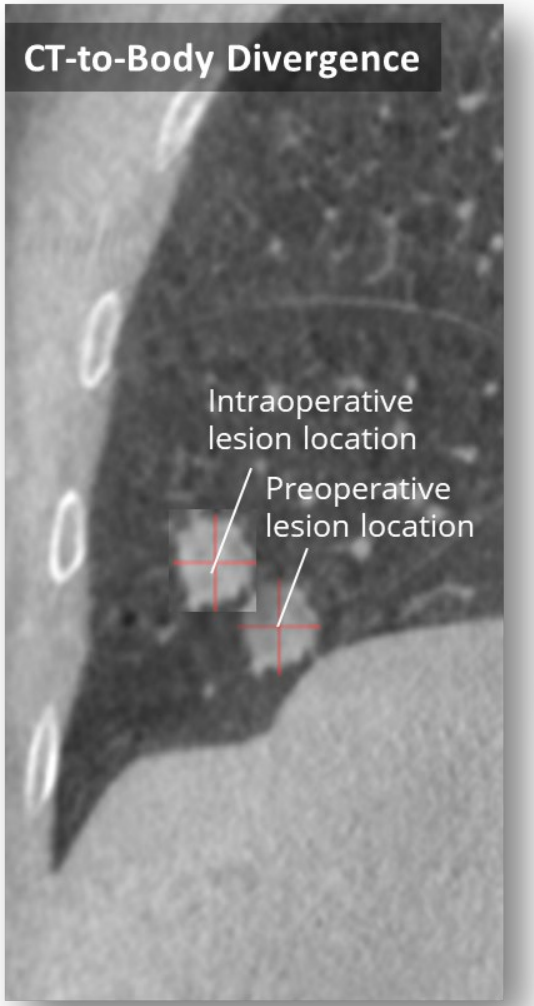
Current Challenges in Peripheral Bronchoscopy

CT-to-Body Divergence

- All navigation platforms – including ENB and robotics – rely on preoperative CT for setting navigation target.
- Difference between preoperative CT and actual lesion location is 14.1 ± 9.9 mm on average, with up to 37mm.[1]

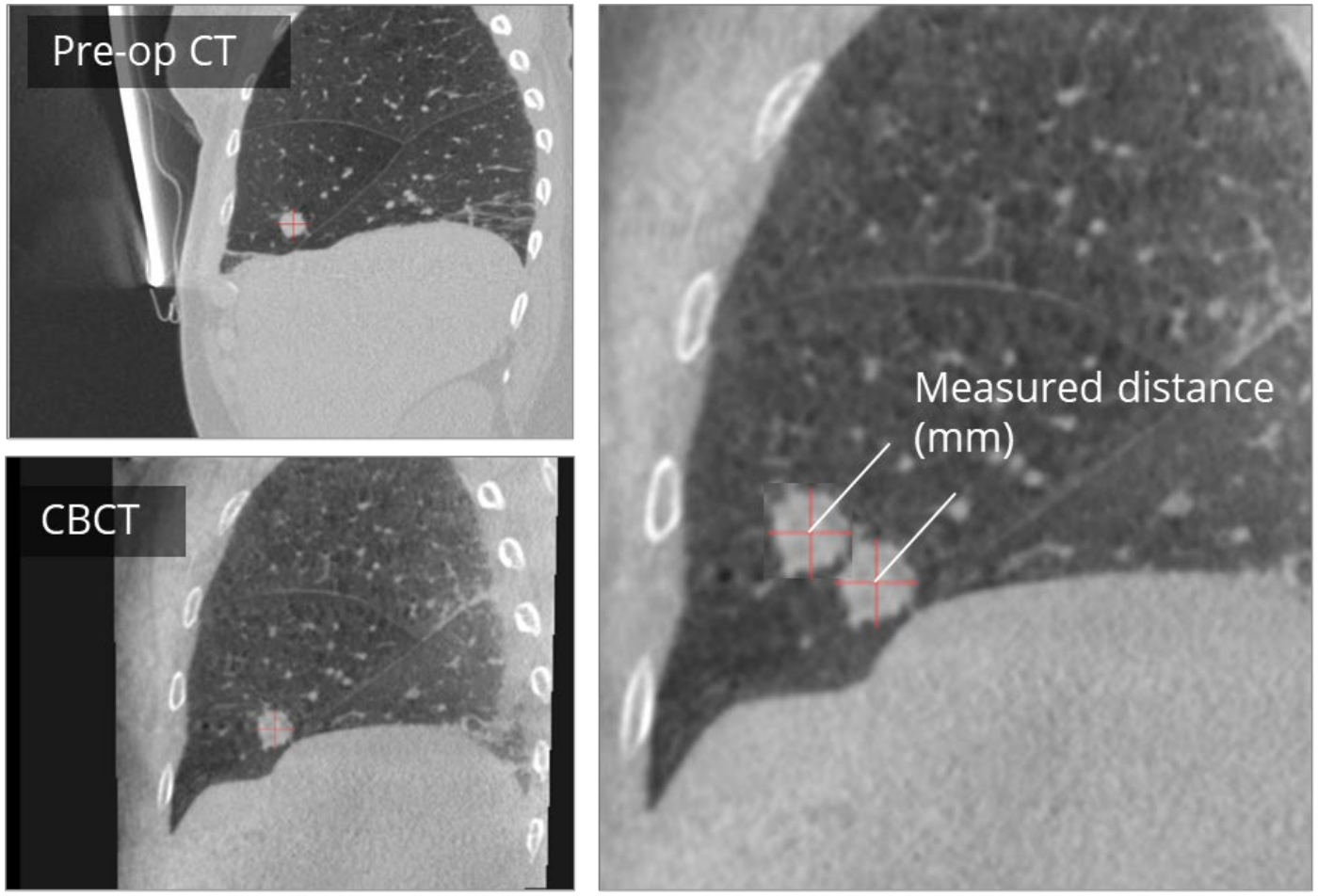
Lack of Tool-in-Lesion Confirmation

- Trans-thoracic needle aspiration (TTNA) can achieve 92.1% diagnostic yield[2] due to CT-guidance that enables visual confirmation of tool-in-lesion prior to biopsy.



[1]Pritchett MA. MA13.10 Comparison of Pulmonary Nodule Location Between Preprocedural CT and Intra-Procedural Cone-Beam CT During Guided Bronchoscopy. Journal of Thoracic Oncology. 2018 Oct; Supplement (Oct):S403, [2]DiBardino DM, Yarmus LB, Semaan RW. Transthoracic needle biopsy of the lung. J Thorac Dis. 2015 Dec;7(Suppl 4):S304-16.

Quantifying CT-to-Body Divergence



Study comparing pre-operative CT to intraoperative Cone-Beam CT (CBCT) showed CT-to-body divergence to be 14.1 ± 9.9 mm on average, with greater divergence in lower lobes.*

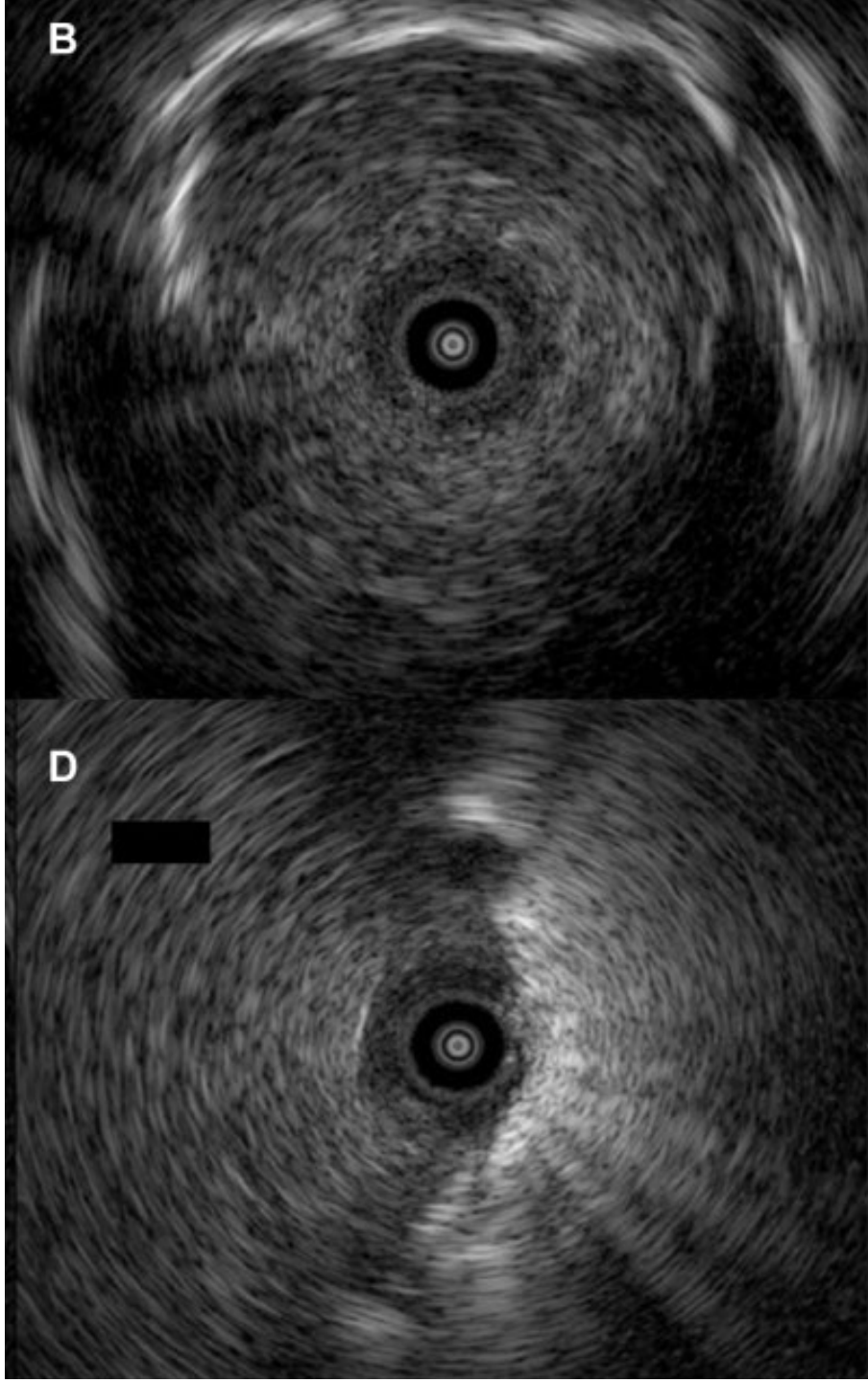
- 23 Nodules in 21 Patients
- Compared pre-op CT with intraop CBCT
- Average divergence = 14.1 ± 9.9 mm

Lobes	Divergence (mm) Avg. (Max)
Upper lobes	12.6 (35.9)
Non-upper lobes	18.4 (28.89)

*Pritchett MA. MA13.10 Comparison of Pulmonary Nodule Location Between Preprocedural CT and Intra-Procedural Cone-Beam CT During Guided Bronchoscopy. Journal of Thoracic Oncology. 2018 Oct; Supplement (Oct):S403

Radial probe localization

REBUS studies with high sensitivity are likely due to publication bias and should be interpreted with caution.

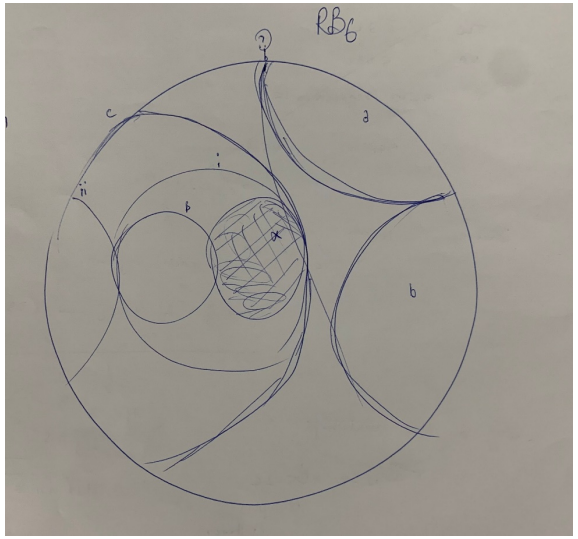


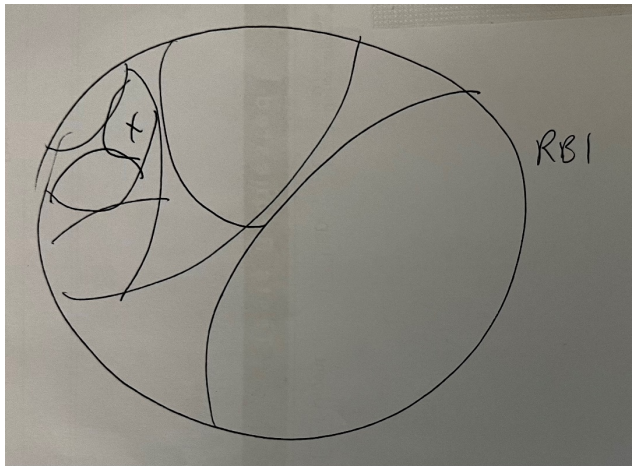
1. Sainz Zuñiga PV, Vakil E, Molina S, Bassett RL Jr, Ost DE. Sensitivity of Radial Endobronchial Ultrasound-Guided Bronchoscopy for Lung Cancer in Patients With Peripheral Pulmonary Lesions: An Updated Meta-analysis. Chest. 2020 Apr;157(4):994-1011. doi: 10.1016/j.chest.2019.10.042. Epub 2019 Nov 15. PMID: 31738928.
2. Sagar AS, Sabath BF, Eapen GA, Song J, Marcoux M, Sarkiss M, Arain MH, Grosu HB, Ost DE, Jimenez CA, Casal RF. Incidence and Location of Atelectasis Developed During Bronchoscopy Under General Anesthesia: The I-LOCATE Trial. Chest. 2020 Dec;158(6):2658-2666. doi: 10.1016/j.chest.2020.05.565. Epub 2020 Jun 17. PMID: 32561439; PMCID: PMC8173777.

Solutions for the peripheral nodule

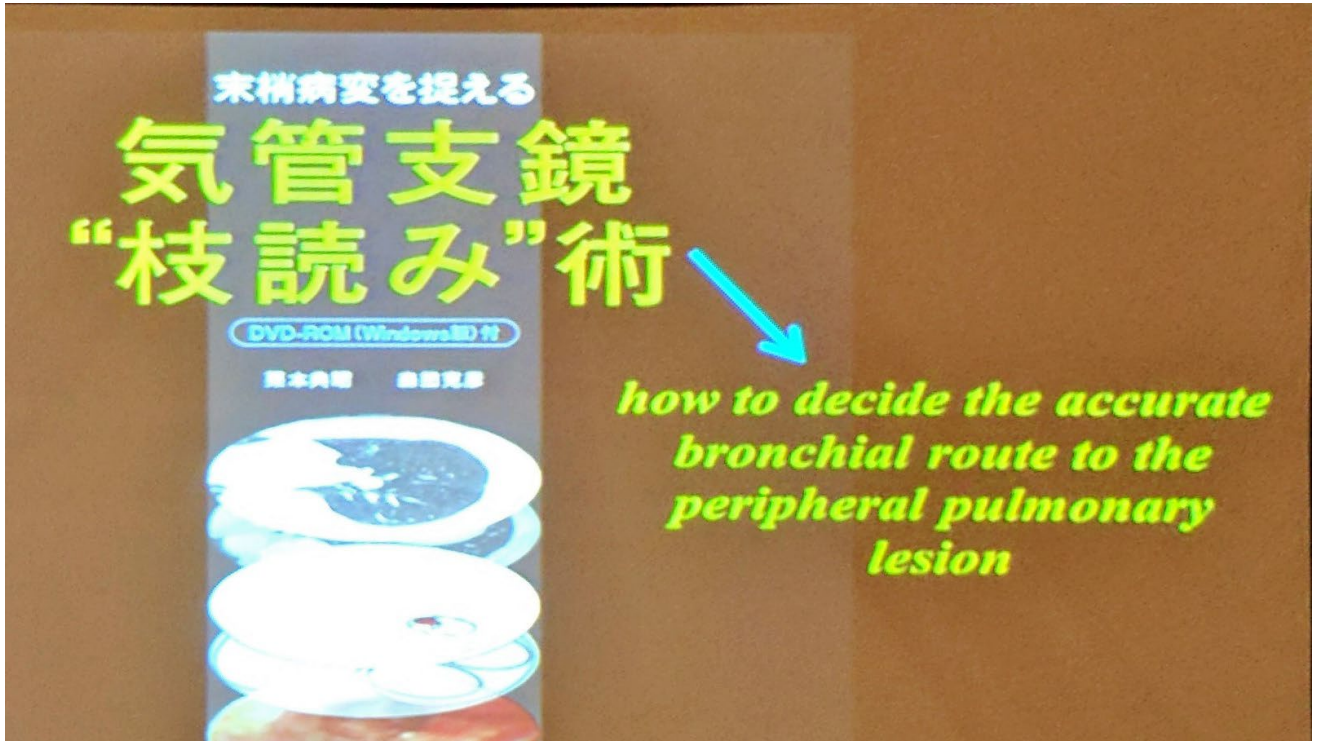
Getting there with a Scope and your Brain

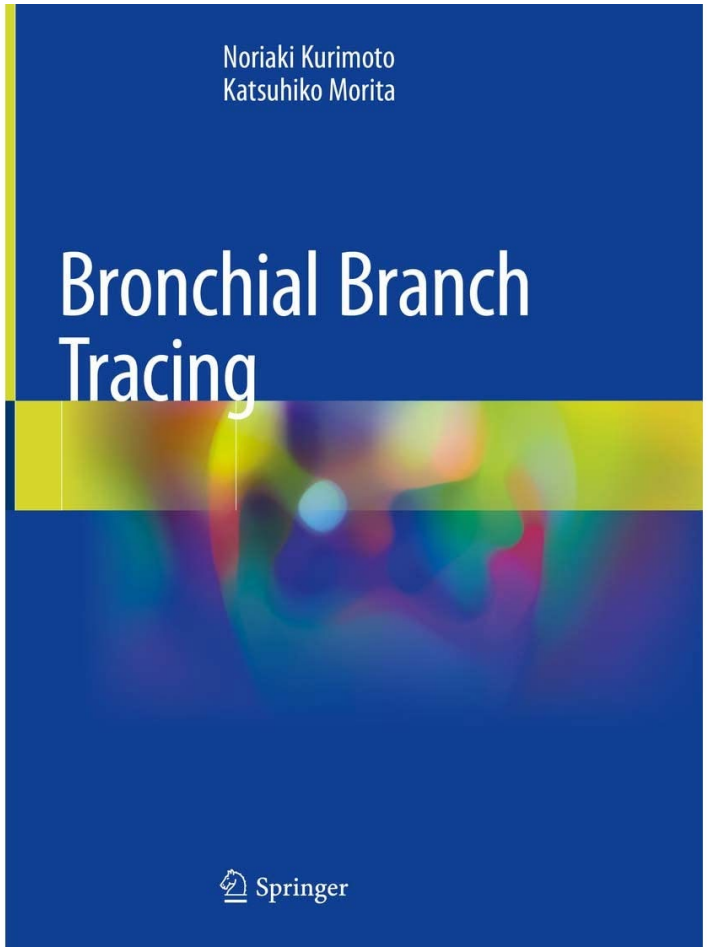
- Studying the CT scan
- Mapping the airway using the Kurimoto Method
- Trust your knowledge of anatomy



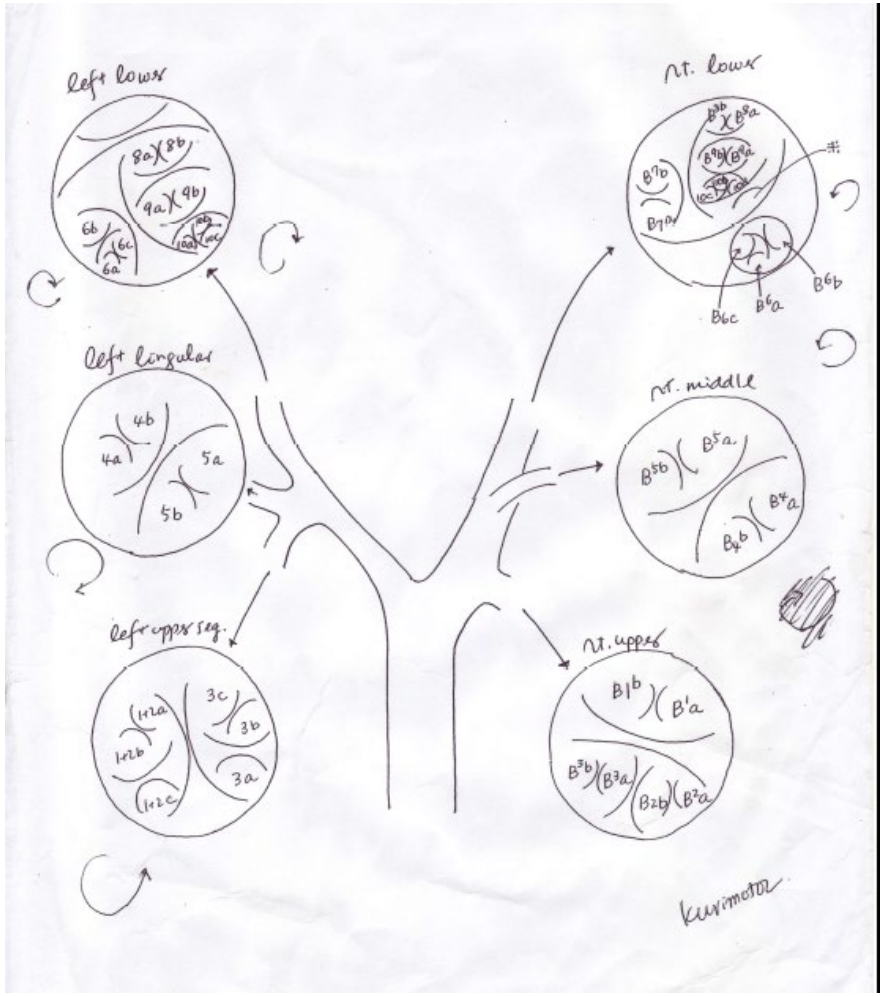


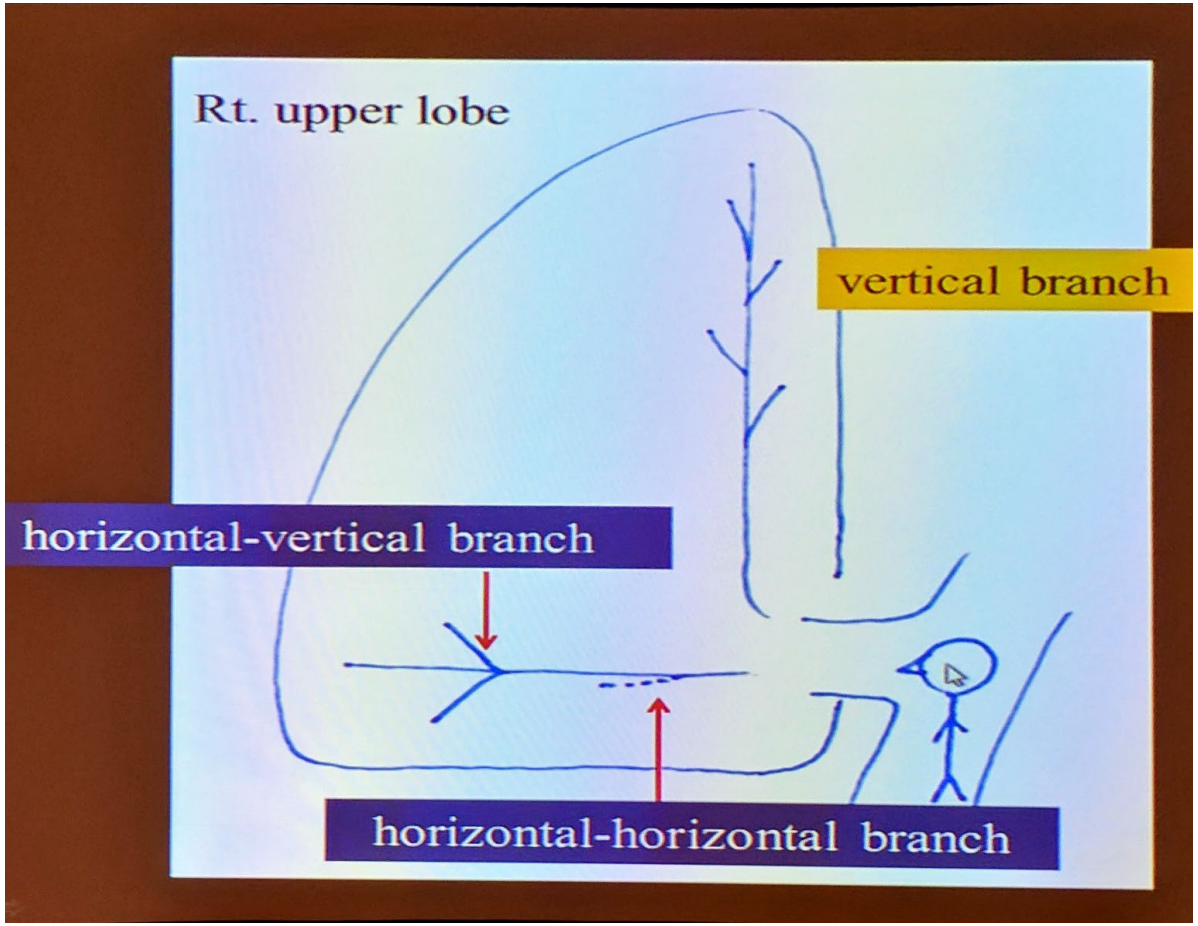
Kurimoto Method





Kurimoto Method





Kurimoto Method

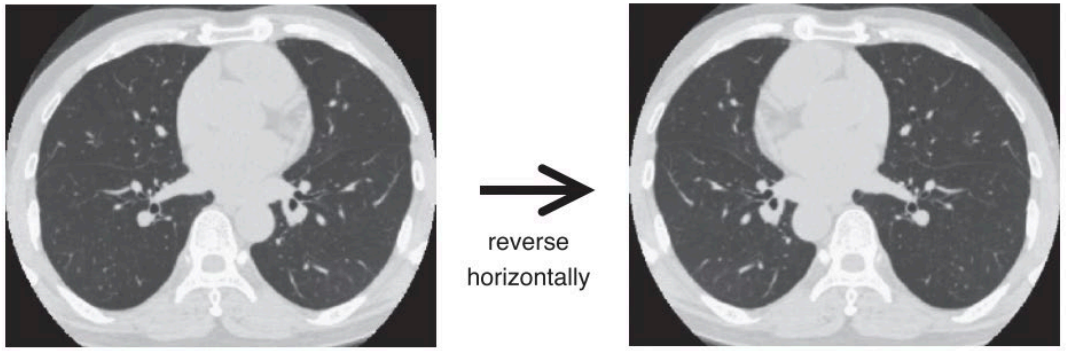


Fig. 1.5 To reverse CT images

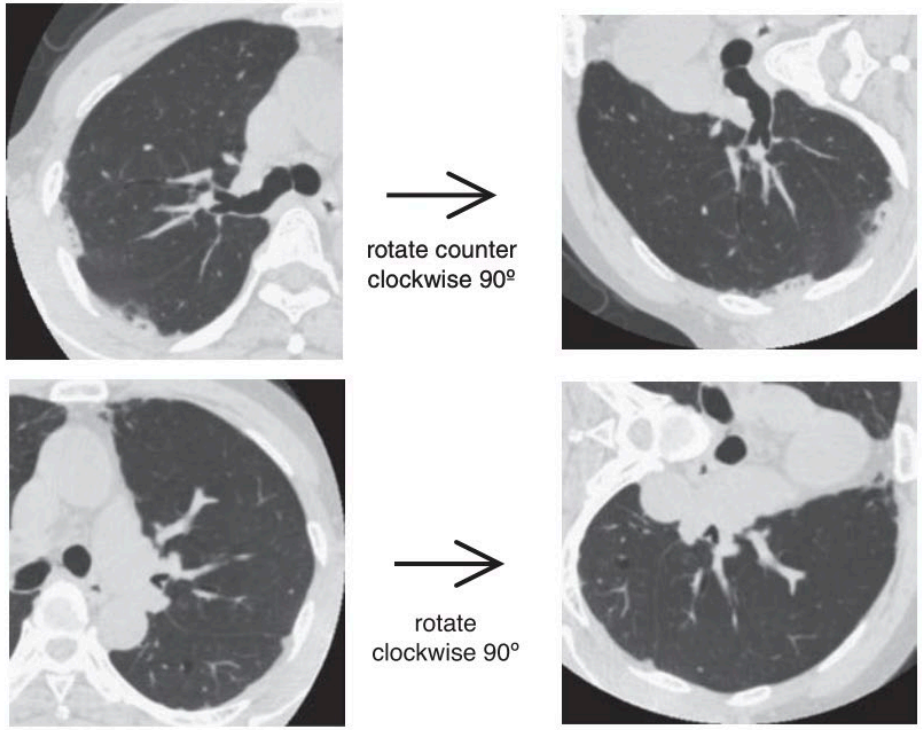


Fig. 1.6 To rotate CT images

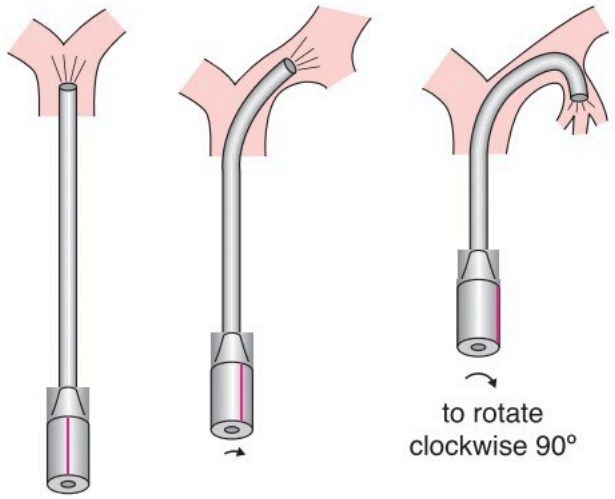


Fig. 1.7 Rotation of the bronchoscope

Kurimoto Method

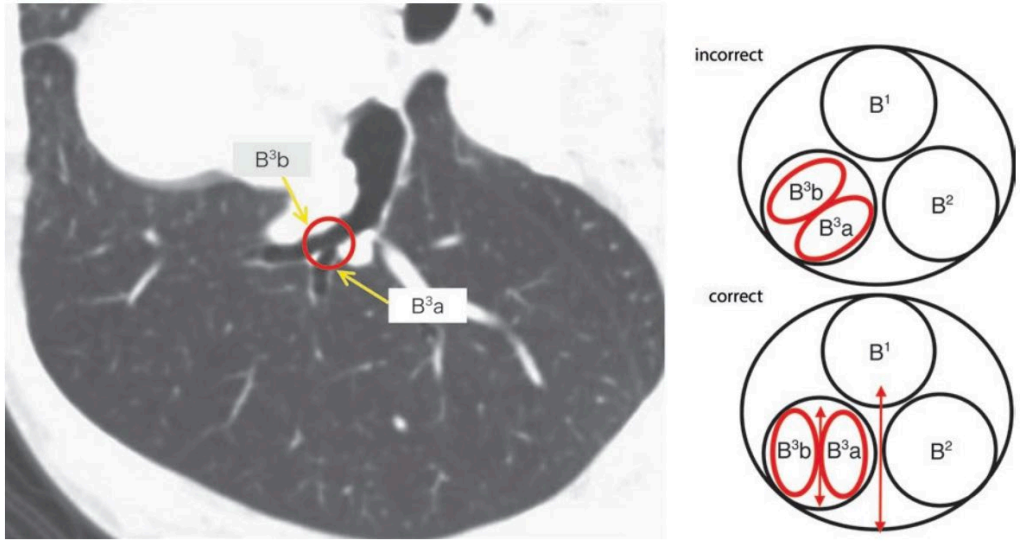


Fig. 1.14 Horizontal–horizontal pattern at the spur of right B³a and B³b

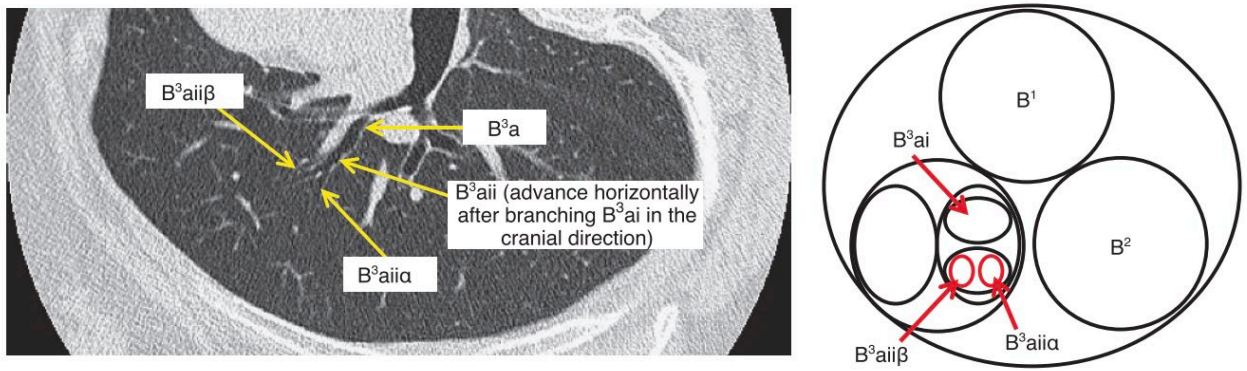


Fig. 1.15 Horizontal–horizontal pattern at the spur of right B³aiiα and B³aiiβ

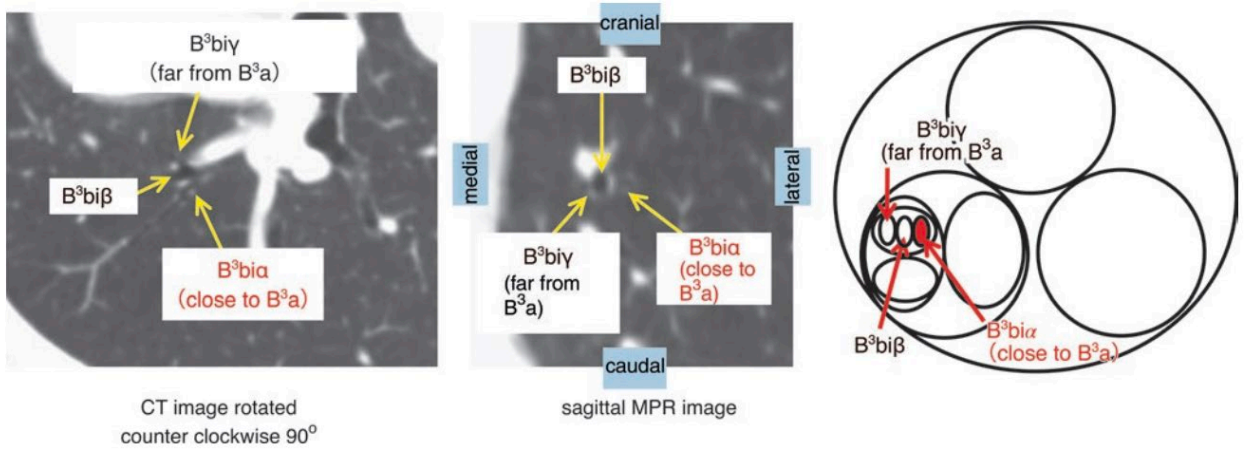


Fig. 1.16 Horizontal–horizontal pattern at the spur of right B³biα, B³biβ, and B³biγ

Why is the Yield with this method limited?

- Learning curve
- Atelectasis
- Lack of real time imaging

Augmented Fluorsocopy for Real-Time, Image-Guided Biopsy

Augmented fluoroscopy enables true real-time, image-guided biopsy.

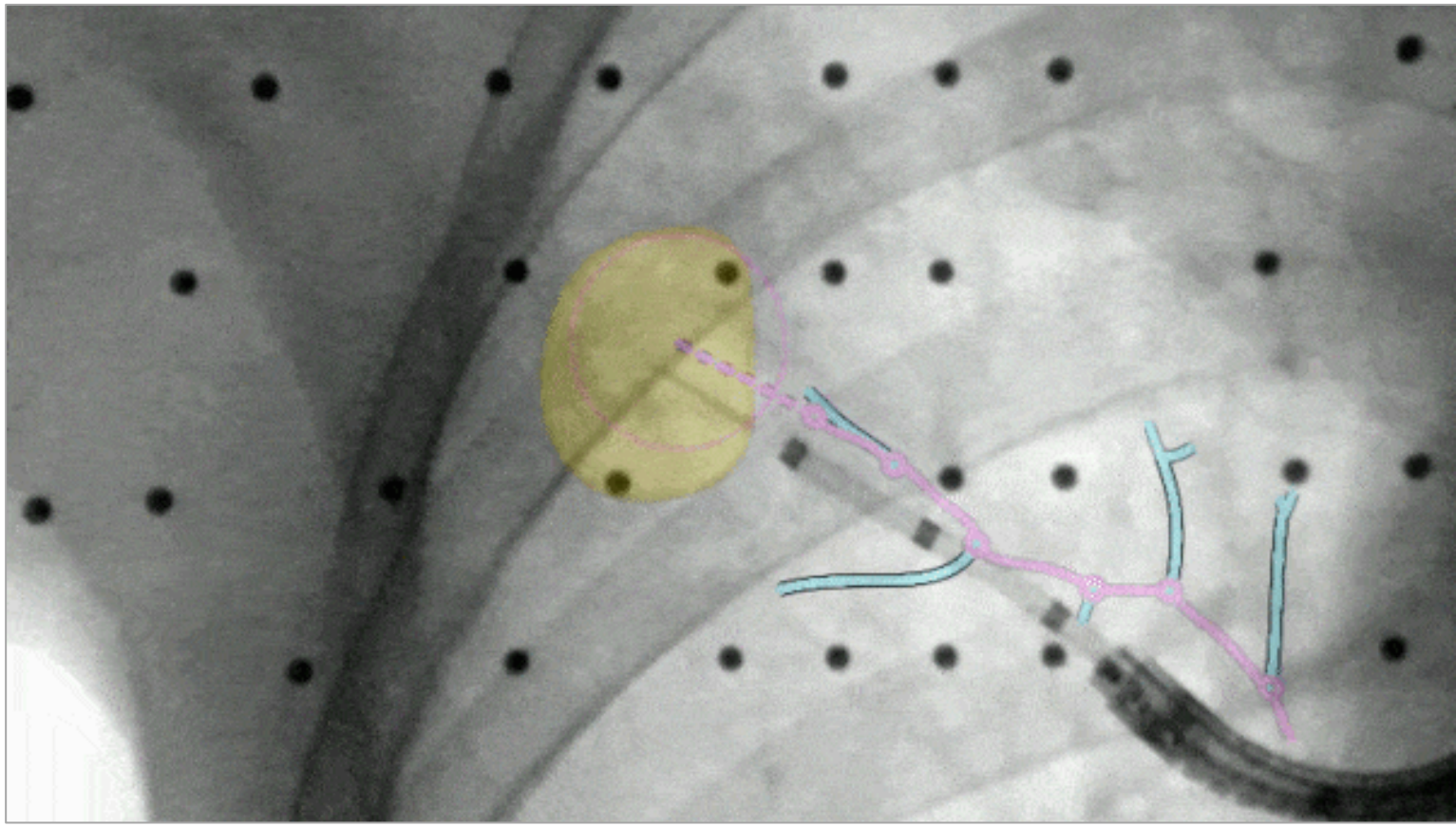
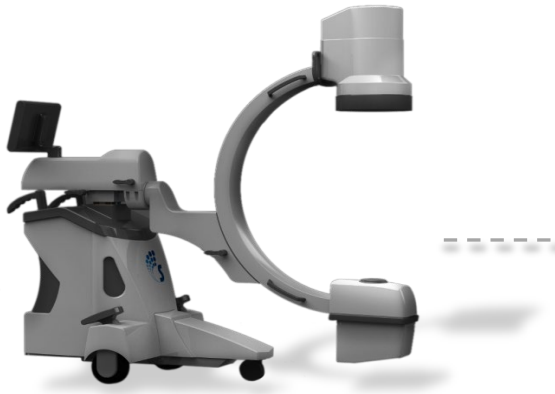


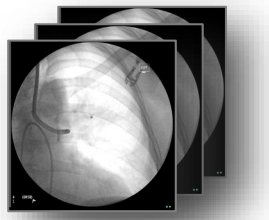
Image courtesy of Dr. Joseph Cicenia, Cleveland Clinic.

How LungVision Works

Proprietary artificial intelligence (AI)-driven imaging algorithm transforms series of 2D X-ray images from any C-arm into real-time, intraoperative CT scans.



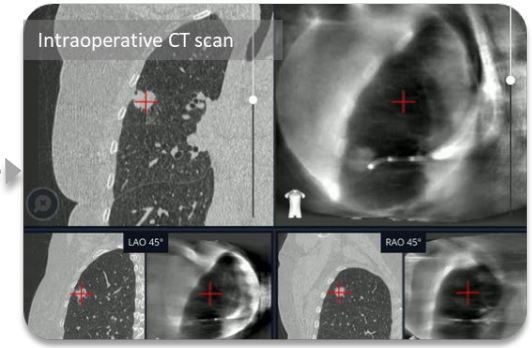
C-Arm

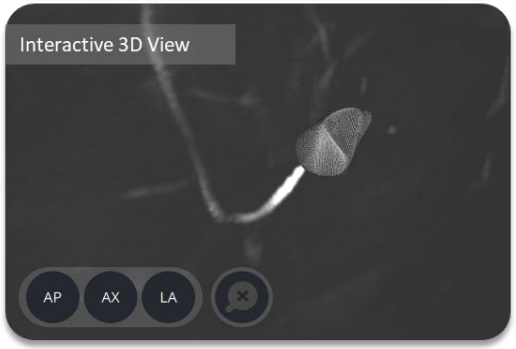


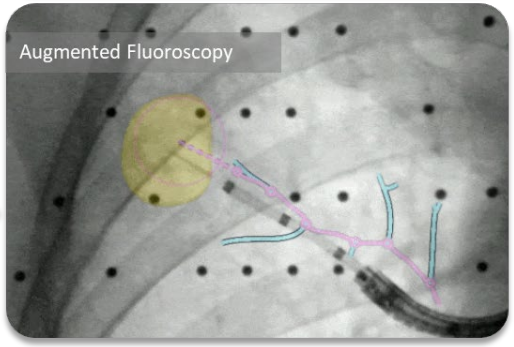
2D X-ray images

AI-Driven Imaging Algorithm

Body Vision Main Unit







Intraoperative CT Imaging for Tool-In-Lesion Confirmation

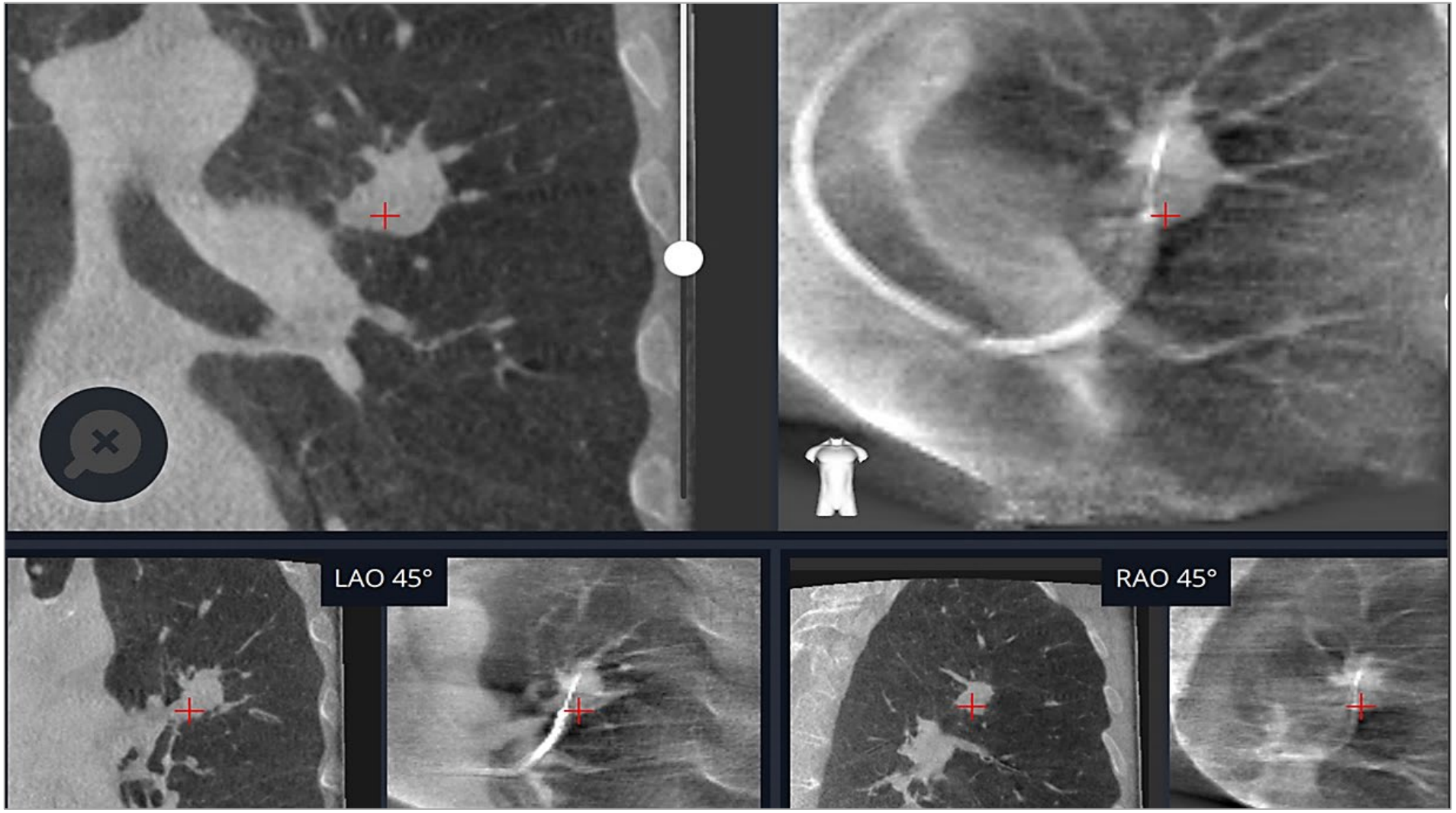


Image courtesy of Dr. Michael Pritchett at FirstHealth Moore Regional Hospital & Pinehurst Medical Clinic.

Interactive 3D View

Image courtesy of Dr. Michael Pritchett at FirstHealth Moore Regional Hospital & Pinehurst Medical Clinic.
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Impact of Body Vision Image Guided Biopsy on Diagnostic Yield

58 consecutive biopsies with Body Vision and manual bronchoscope at a high-volume academic site with 6 clinicians:

88%*

Overall
Diagnostic Yield

45 consecutive biopsies with Body Vision and robotic bronchoscope at a high-volume academic site with single clinician:

91%*

Diagnostic Yield with
Long-Term Follow-Up

Cicenia J, Bhadra K, Sethi S, Nader DA, Whitten P, Hogarth DK. Augmented Fluoroscopy: A New and Novel Navigation Platform for Peripheral Bronchoscopy. J Bronchology Interv Pulmonol. 2021 Apr 1;28(2):116-123. doi: 10.1097/LBR.0000000000000722. PMID: 33105419.

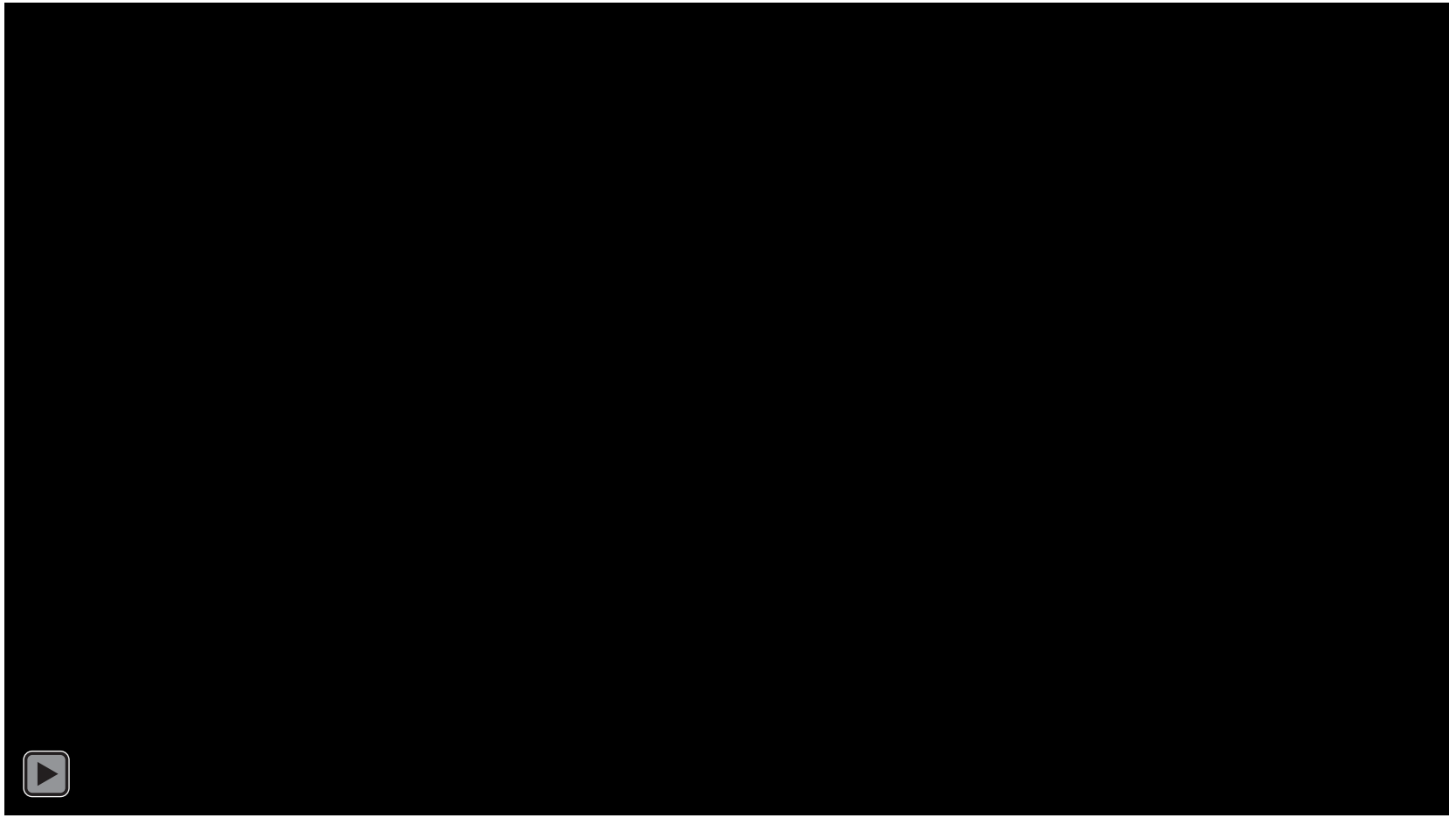
Case 1: 8mm RUL

Body Vision Intraoperative 3D Imaging showing tool-in-lesion

- No direct airway
- Bracketed by 2 blood vessels
- Diagnosed as metastatic renal cell carcinoma on 1st needle pass

Case 1: 8mm RUL

Body Vision augmented fluoroscopy showing navigation and biopsy

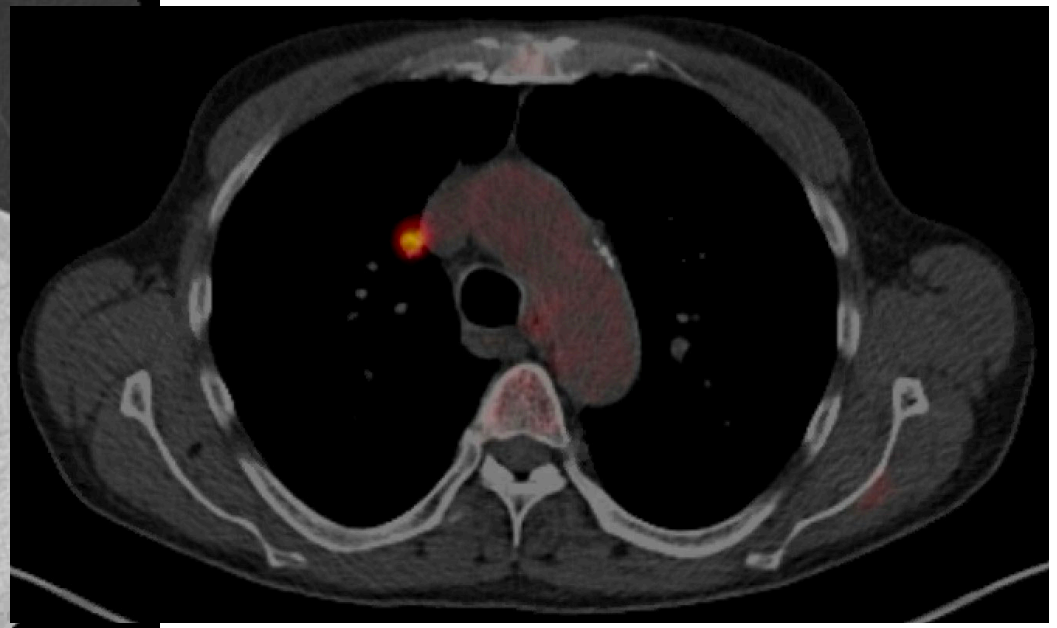


- Diagnosed as metastatic renal cell carcinoma on 1st needle pass

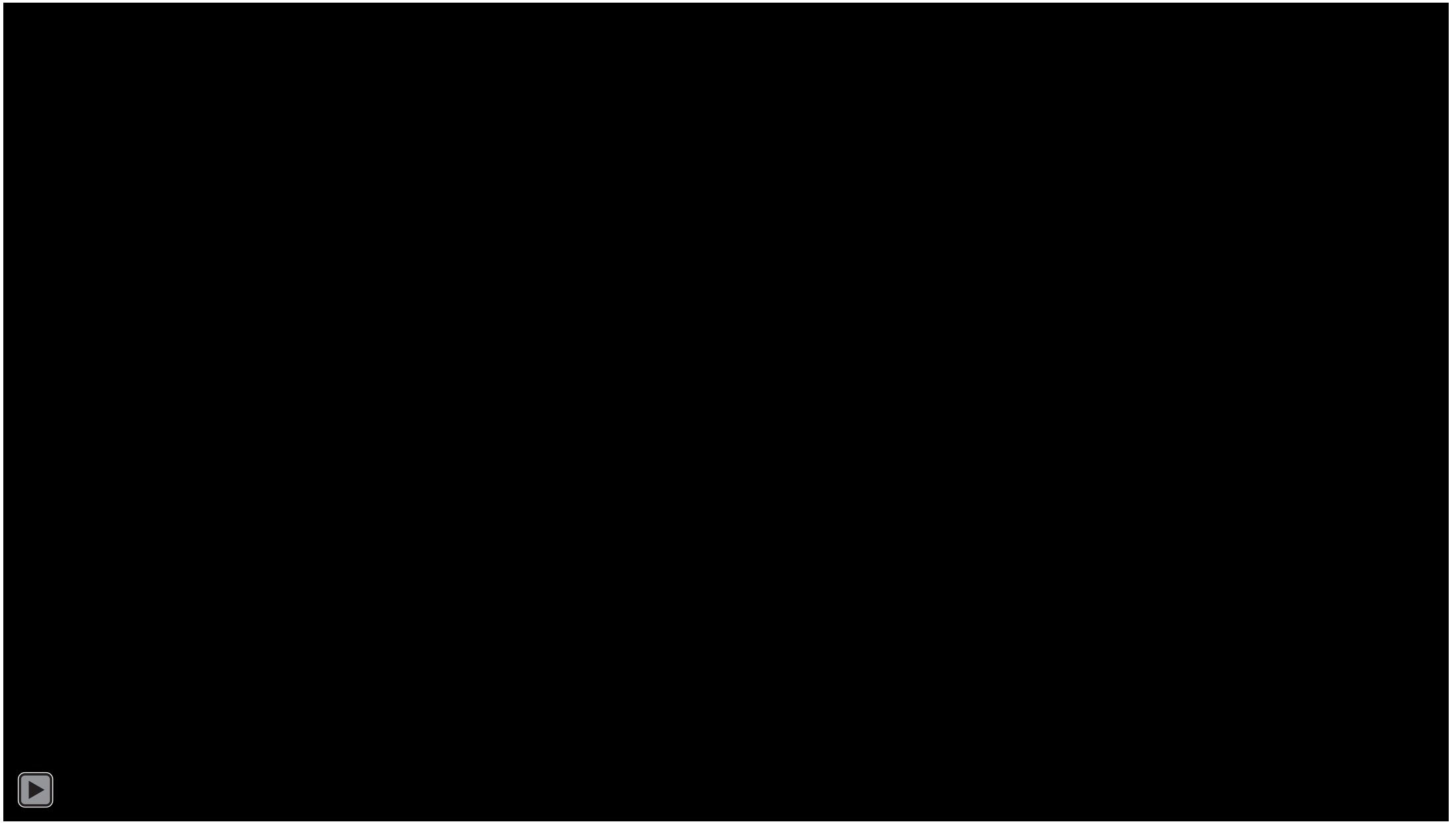
Robotics

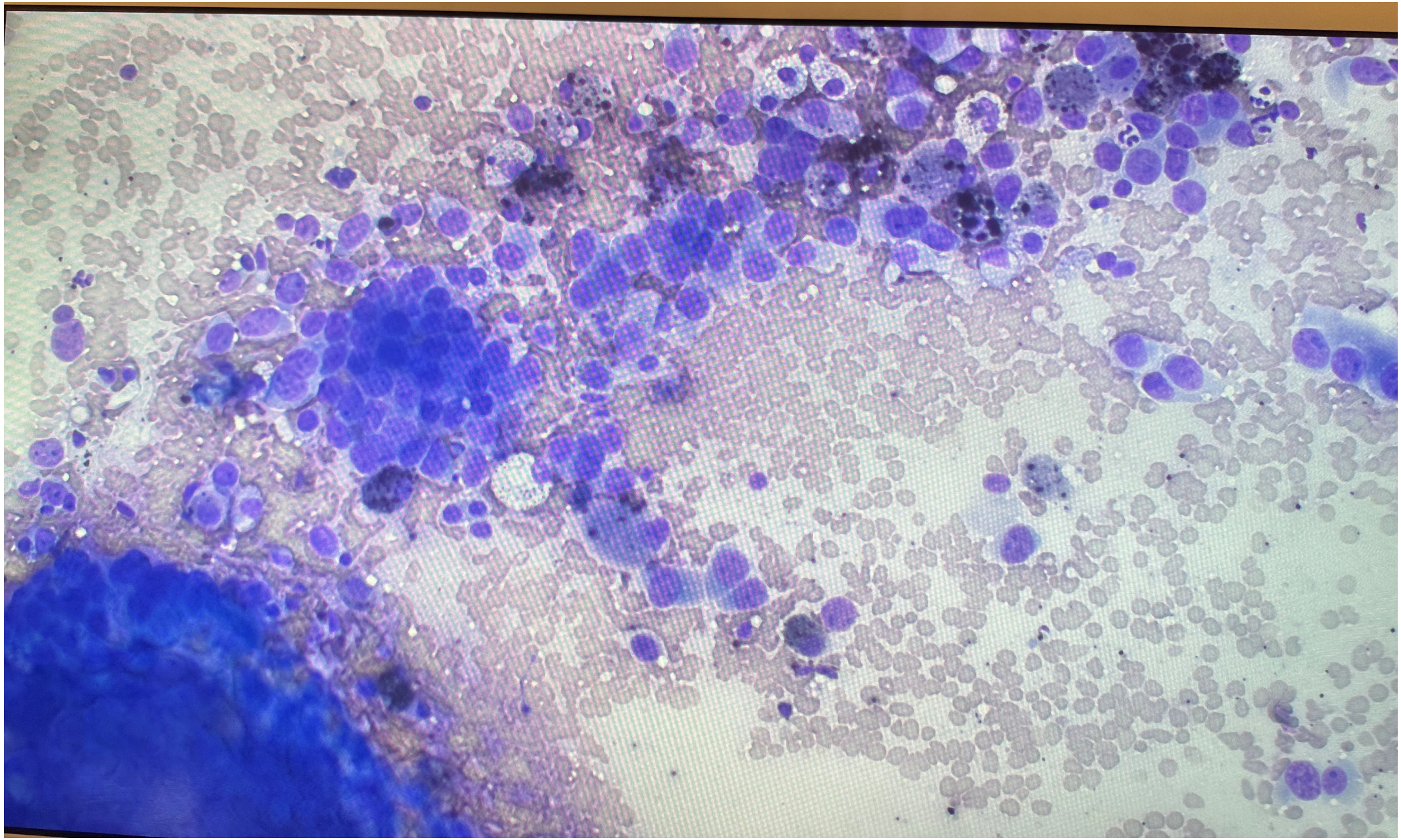
Case done 8/22/23

- 67 y.o. smoker with CT scan showing 9mm RUL nodule on the medial surface surrounded by emphysema. PET positive. Poor performance status.

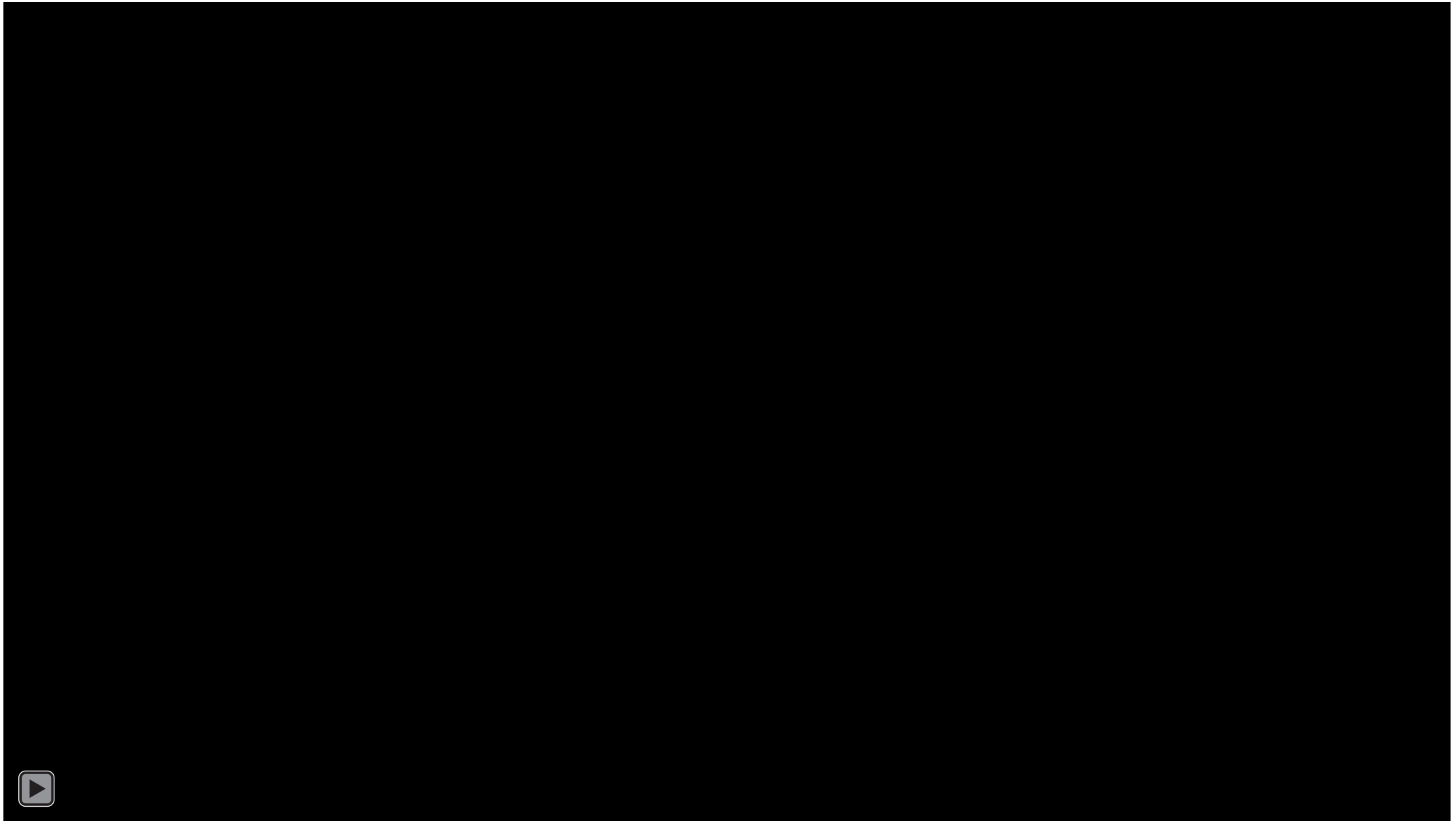


1st Pass of forceps: (total case was 12 minutes)





Case Three (the GGO)

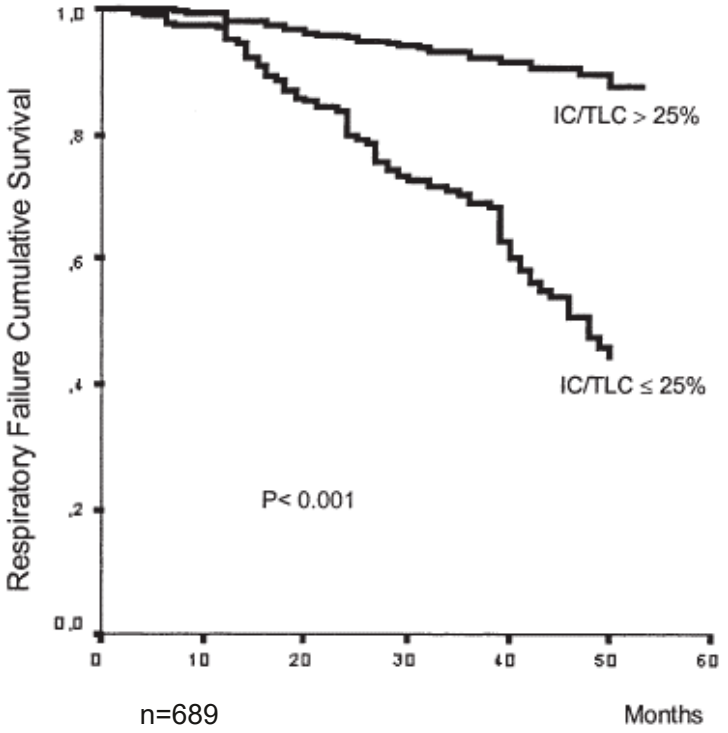


Advanced Emphysema Management

Disease Progression

- Emphysema patients suffer significant breathlessness and inability to conduct daily life activities such as walking, showering, and playing with grandchildren
- Many require supplementary oxygen, which can be poorly tolerated by patients and often lose effectiveness with time
- Patients with severe emphysema have high mortality risk[1]
- Quality of life of a severe emphysema patient is generally worse than a patient with lung cancer[2]

Mortality Risk of Hyperinflation[1]



[1] Casanova et al (2005): Inspiratory-to-Total Lung Capacity Ratio Predicts Mortality in Patients with Chronic Obstructive Pulmonary Disease. Am J Respir Crit Care Med Vol 171. pp 591 - 597.
[2] Gore et. al Thorax 2000; 55 1000-1006.

Spectrum of Treatment Options

Medical Management

Non-invasive

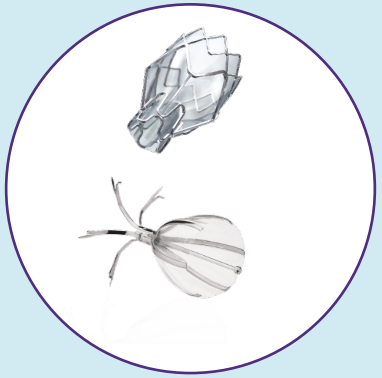
Limited effect in severe patients

Pulmonary Rehabilitation

Non-invasive

Difficult to sustain benefits

Bronch LVR



Designed to Provide Benefits Similar to Surgery with Broader Eligibility

Minimally Invasive

Fully Removable

Lung Volume Reduction Surgery

Invasive
Effective
>5% risk of death

Not an option for most patients

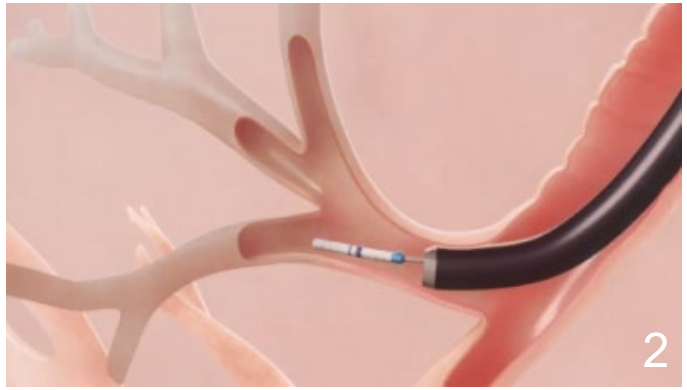
Lung Transplant

Invasive
Effective
5-15% risk of death

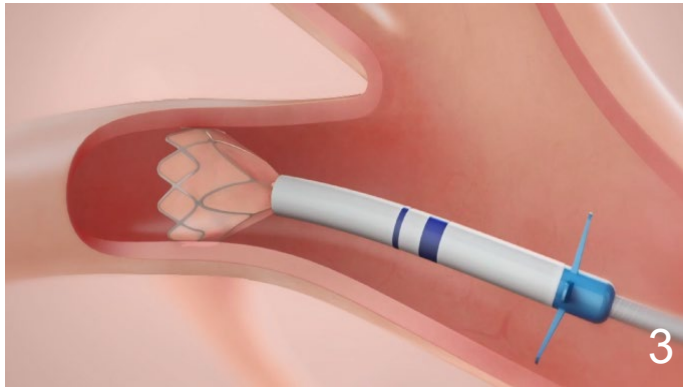
Not an option for most patients

How Valves Work

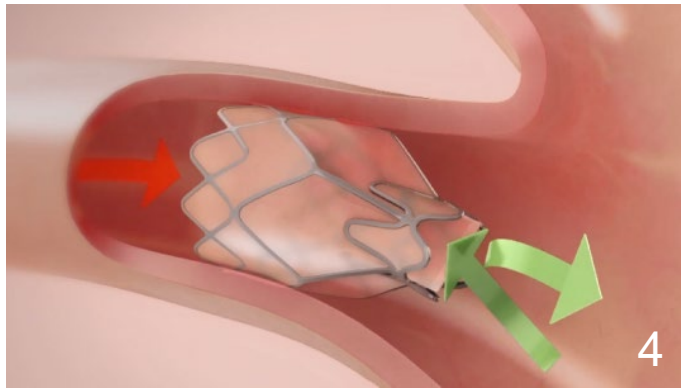
Bronchoscope introduced into lungs
of patient with diseased, hyperinflated lobe



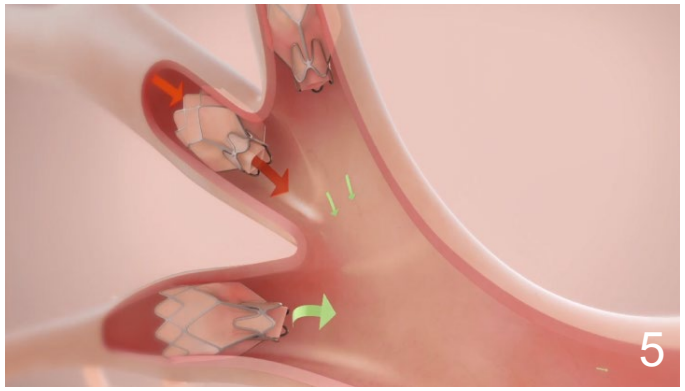
Delivery catheter advanced into
target lobe through bronchoscope



Valve size chosen in one step procedure
and delivered to seal target airway



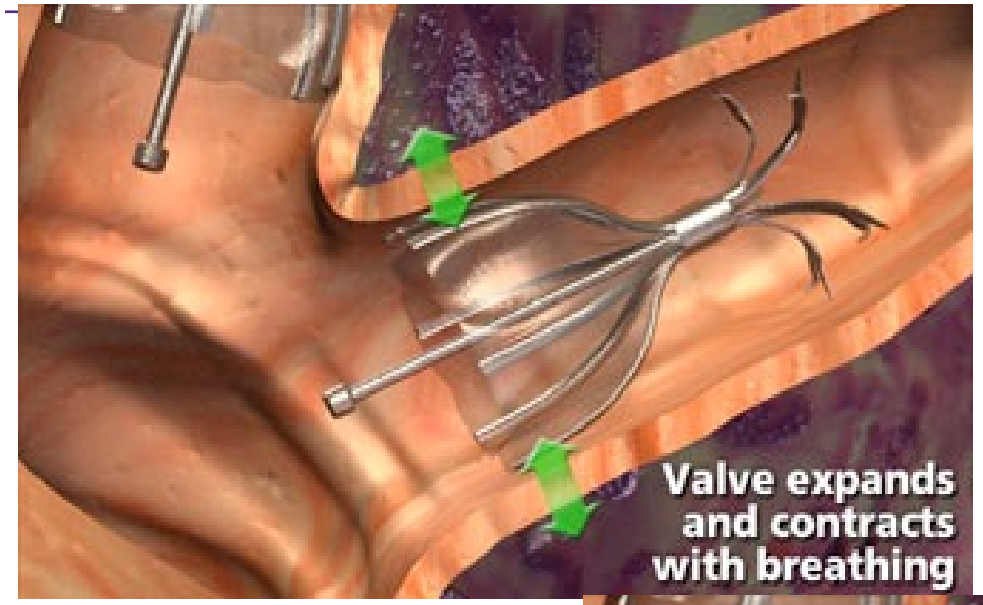
Valve allows trapped
air to escape but not to re-enter

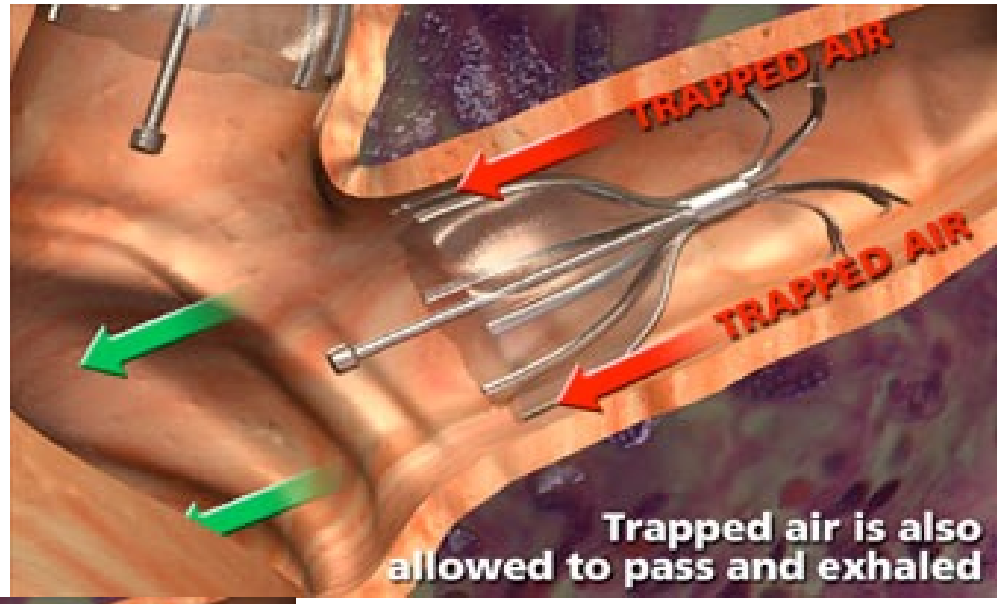


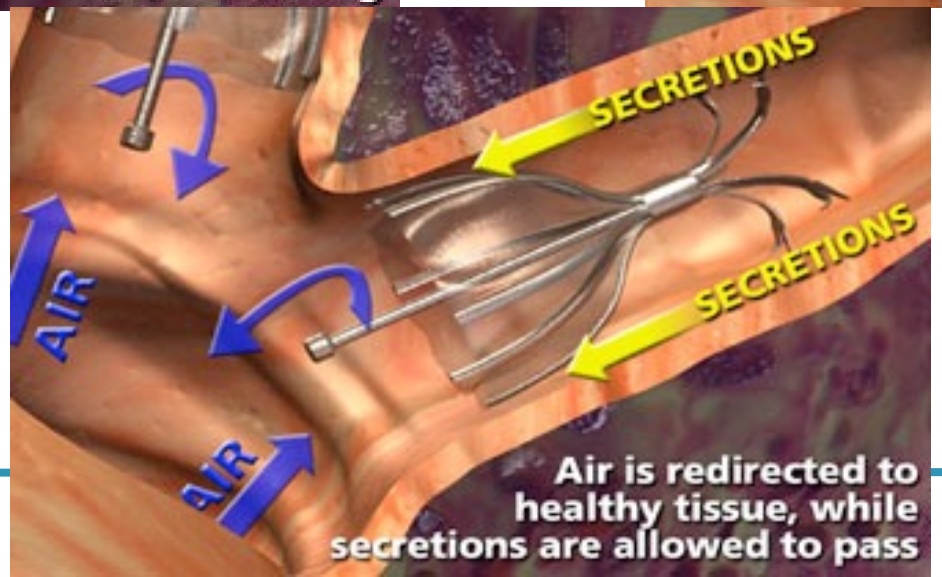
An average of 5 Valves
delivered to fully occlude diseased lobe

Hyperinflation in target lobe is reduced,
improving lung function and breathlessness

How Valves Work







Typical Work Up for Valve Eligibility

- ❑ Medical history
  - ❑ Diagnosis of emphysema
  - ❑ BMI < 35 kg/m^2
  - ❑ Stable with ≤ 20mg prednisone (or equivalent) daily
  - ❑ Non-smoking
  - ❑ Collect any available imaging and lung function studies from the past

- ❑ Pulmonary Function Tests (post-bronchodilator)
  - ❑ Spirometry (FEV_1 15-45% predicted)
  - ❑ Body Plethysmography (RV ≥ 150%, TLC ≥ 100%)
  - ❑ DLCO greater than 20

- ❑ Arterial Blood Gas Levels collected on room air (if needed)
  - ❑ Rule out severe hypercapnia PaCO2 ≥50 mm Hg
  - ❑ Rule out severe hypoxemia PaO2 ≤45 mm Hg

- ❑ 6MWD (100m-500m)

- ❑ Imaging
  - ❑ High Resolution CT (≤ 1.5mm slice thickness, TLC view)
  - ❑ Upload to StratX/SeleCT softwares
  - ❑ Perfusion Scan (Optional)

- ❑ Echocardiogram
  - ❑ Rule out congestive heart failure, LVEF <45%
  - ❑ Rule out uncontrolled pulmonary hypertension, sPAP >45mm Hg

Case One

- Patient is a 62 year old woman former 30 pack year smoker, quit in 2007
- Hx of advanced COPD who presents for eval of BLVR.
- At baseline, she notes significant SOB when climbing stairs: 3 steps before she needs to take a break
- Able to walk on level ground but with limitations.
- On 2 L of oxygen on exertion and at bedtime. No significant cough or sputum production.

		1200	feet
Heart Rate:	60	96	
Dyspnea BORG Scale:	0.5	3	
Fatigue	1	3	
O2 Sat.	98	88	

Stopped or paused before 6 min: n Reason:

Post Test Comments:

	Pre-Drug			Post-Drug		
	Actual	**Pred**	**%Pred**	**Actual**	**%Pred**	**%Chng**
--- PLETHYSMOGRAPHY ---						
TLC (Pleth) (L)	7.02	5.06	138			
FRC (L)	4.94	2.88	171			
RV (Pleth) (L)	4.61	1.92	239			
---- SPIROMETRY ----						
FVC (L)	2.43	3.13	77	2.42	77	+0
FEV1 (L)	*1.08	2.30	*46	*1.09	*47	+1
FEV1/FVC (%)	44	73	60	45	61	+1
FEF 25-75% (L/sec)	*0.30	2.59	*11	*0.32	*12	+6
FEF Max (L/sec)	2.61	5.96	43	3.13	52	+19
---- SLOW VITAL CAPACITY						
SVC (L)	2.41	3.13	76			
IC (L)	2.09	2.17	95			
ERV (L)	0.33	0.96	33			
---- AIRWAYS RESISTANCE -						
Raw (cmH2O/L/s)	2.47	1.86	132			
sGaw (1/cmH2O*s)	*0.08	0.20	*38			
---- DIFFUSION ----						

	Pre-Drug		
	Actual	**Pred**	**%Pred**
---- DIFFUSION ----			
DLCOunc (ml/min/mmHg)	10.41	18.93	54
DLCOcor (ml/min/mmHg)		18.93	
TLC (SB) (L)	3.76	5.06	74
RV (SB) (L)	1.49	1.92	77

StratX™ Lung Report

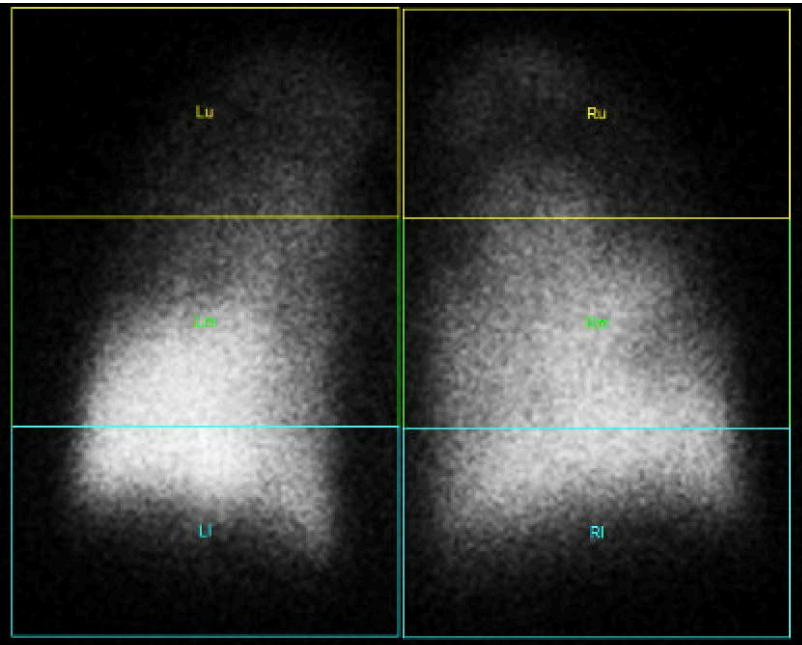
pulmonX

SUMMARY

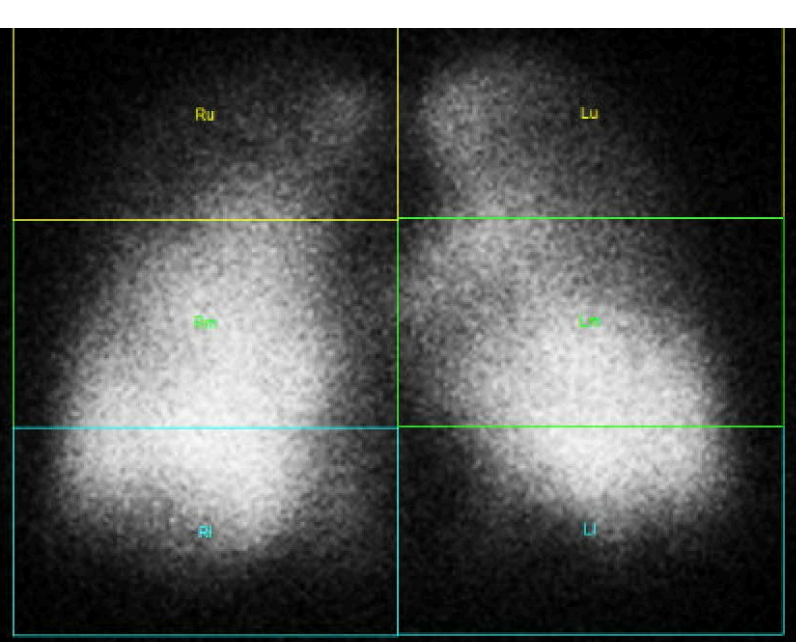
KEY

RESULTS

	RIGHT LUNG				LEFT LUNG	
	95	95	95	95	95	95
	76	72	46	37	71	26
	54	48	8	12	47	9
	1457	1687	230	1333	1612	953



4/4/2024
UC LUNG SUPINE
AP PERF
POST Perf Quant.



4/4/2024
UC LUNG SUPINE
AP PERF
ANT Perf Quant.

	Posterior Kct				Geometric Mean Kct				Anterior Kct			
	Left		Right		Left Lung		Right Lung		Right		Left	
	%	Kct	%	Kct	%	Kct	%	Kct	%	Kct	%	Kct
Upper Zone:	5.0	29.87	5.8	34.32	6.4	37.54	6.3	37.24	6.9	40.41	8.0	47.18
Middle Zone:	25.2	150.16	27.6	164.42	25.3	149.41	27.7	163.40	27.6	162.39	25.2	148.67
Lower Zone:	18.7	111.54	17.8	105.94	16.2	95.54	18.2	107.30	18.4	108.68	13.9	81.84
Total Lung:	48.9	291.56	51.1	304.67	47.8	282.49	52.2	307.94	52.9	311.48	47.1	277.69

Where is your Target?

1) RUL
2) RUL/RML
3) RLL
4) LUL
5) LLL

72 y.o. with emphysema on 2L.
Per patient, he is able to walk about 40 minutes on a treadmill at 3 mph with elevation of 1 for the last few months and He has participated in multiple rehab-pulmonary rehab in the past few months. (on 6MWT he did 800 feet)
He quit smoking about 8 years ago since the diagnosis of COPD/emphysema.
Wants more activity. Limited with simple activities.

Was told he had PAHTN: RHC was normal

	Pre-Drug			Post-Drug		
	Actual	Pred	%Pred	Actual	%Pred	%Chng
--- PLETHYSMOGRAPHY ---						
TLC (Pleth) (L)	9.92	6.59	150			
FRC (L)	8.05	3.75	214			
RV (Pleth) (L)	7.25	2.52	287			
---- SPIROMETRY ----						
FVC (L)	*2.20	4.07	*54	*2.47	*60	+12
FEV1 (L)	*0.51	2.71	*18	*0.65	*24	+27
FEV1/FVC (%)	23	66	34	26	39	+14
FEF 25-75% (L/sec)	*0.16	2.45	*6	*0.25	*10	+57
FEF Max (L/sec)	2.09	8.33	25	2.39	28	+14
---- SLOW VITAL CAPACITY						
SVC (L)	*2.67	4.07	*65			
IC (L)	1.67	2.85	58			
ERV (L)	0.80	1.22	65			
---- AIRWAYS RESISTANCE -						
Raw (cmH2O/L/s)	*6.91	1.45	*476			
sGaw (1/cmH2O*s)	*0.02	0.20	*8			

DLCO is 22% predicted

StratX™ Lung Report

pulmonX

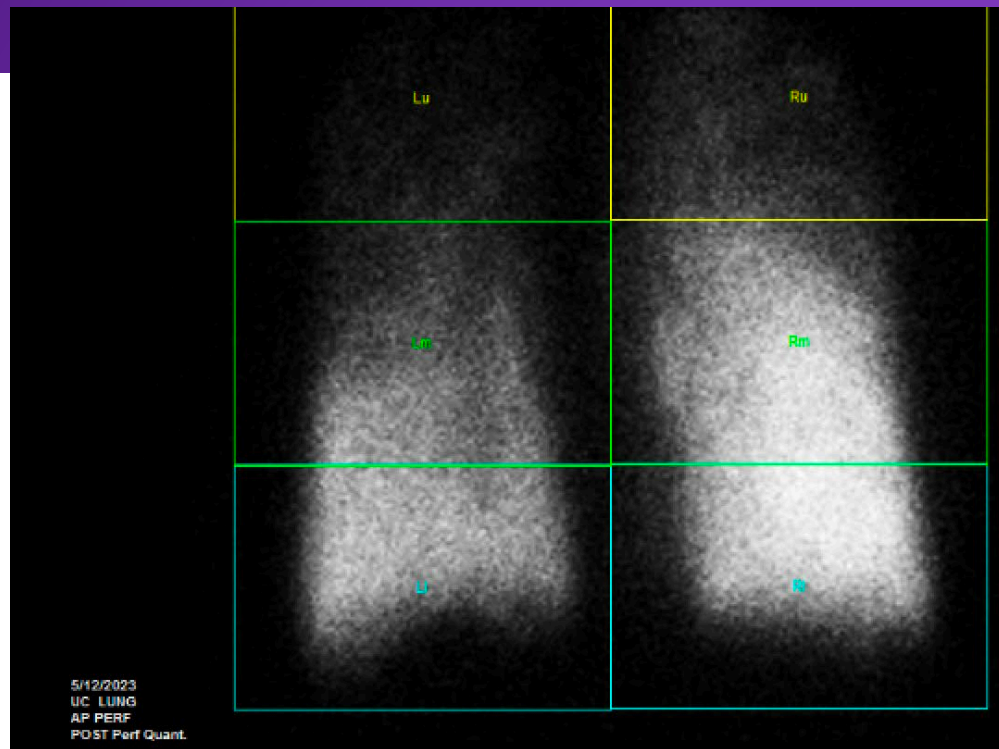
SUMMARY

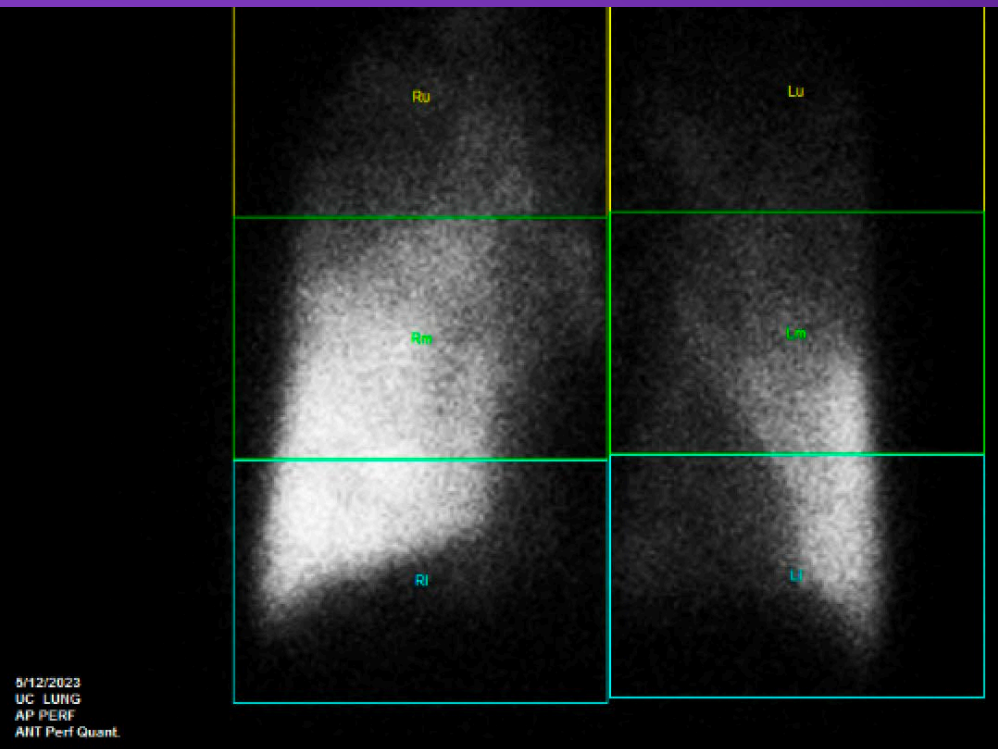
KEY

RESULTS

	RIGHT LUNG				LEFT LUNG	
	42	71	48	71	89	89
	77	74	64	51	77	39
	56	51	33	24	57	16
	2218	2890	672	2088	2360	1631

Perfusion





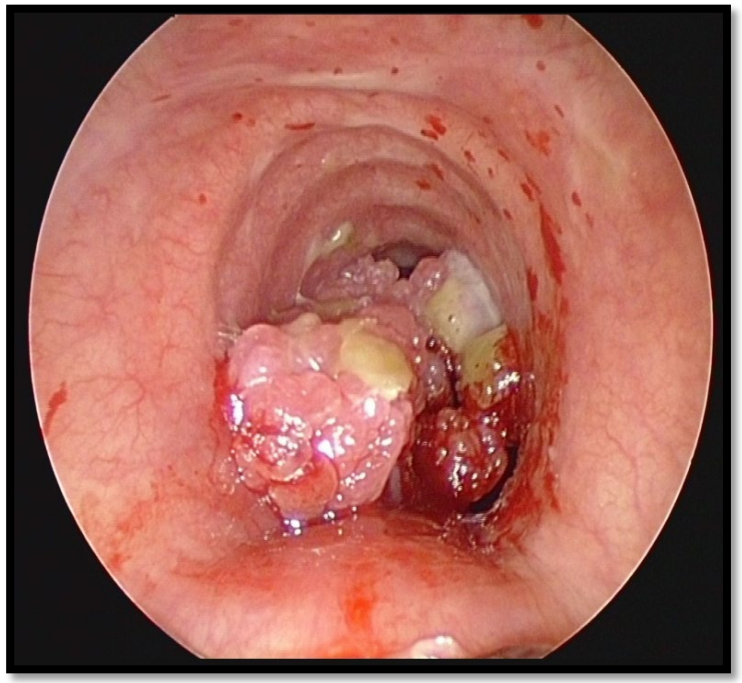
	Posterior Kct				Geometric Mean Kct				Anterior Kct		
	Left		Right		Left Lung		Right Lung		Right	Left	
	%	Kct	%	Kct	%	Kct	%	Kct	%	Kct	%	Kct
Upper Zone:	2.7	16.40	5.6	33.67	3.0	17.78	6.5	38.75	7.4	44.58	3.2	19.29
Middle Zone:	15.1	90.61	30.7	184.91	15.0	89.37	33.7	201.64	36.6	219.89	14.7	88.14
Lower Zone:	19.7	118.51	26.2	157.58	16.0	95.86	25.8	154.36	25.2	151.21	12.9	77.54
Total Lung:	37.5	225.52	62.5	376.16	34.0	203.01	66.0	394.75	69.2	415.68	30.8	184.97

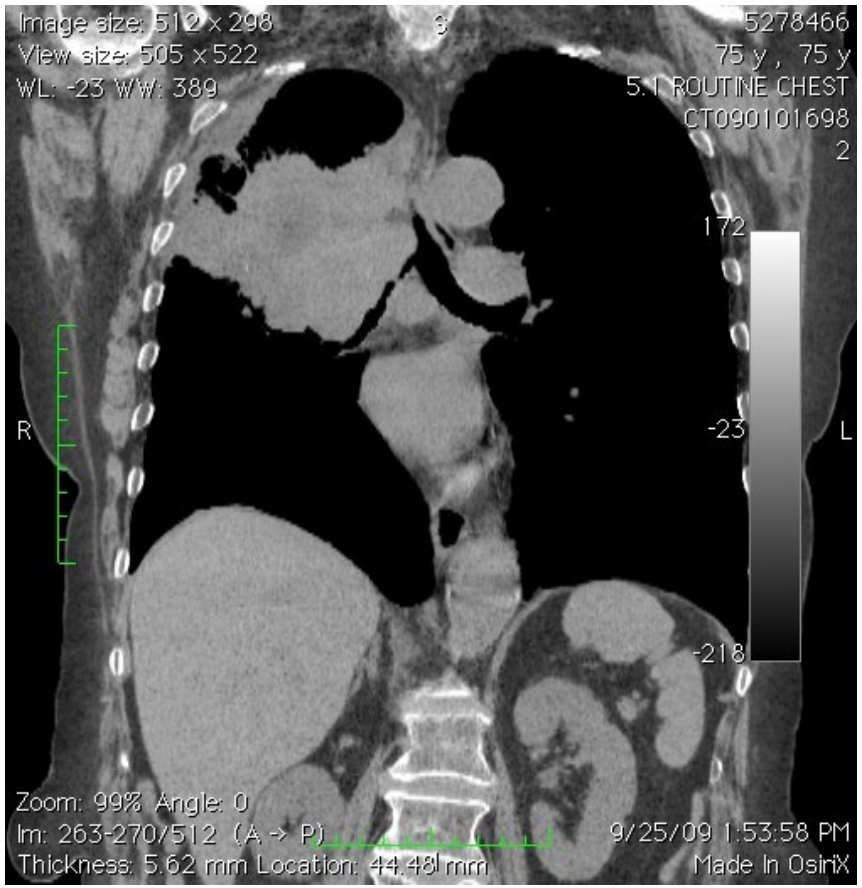
Where is your Target?

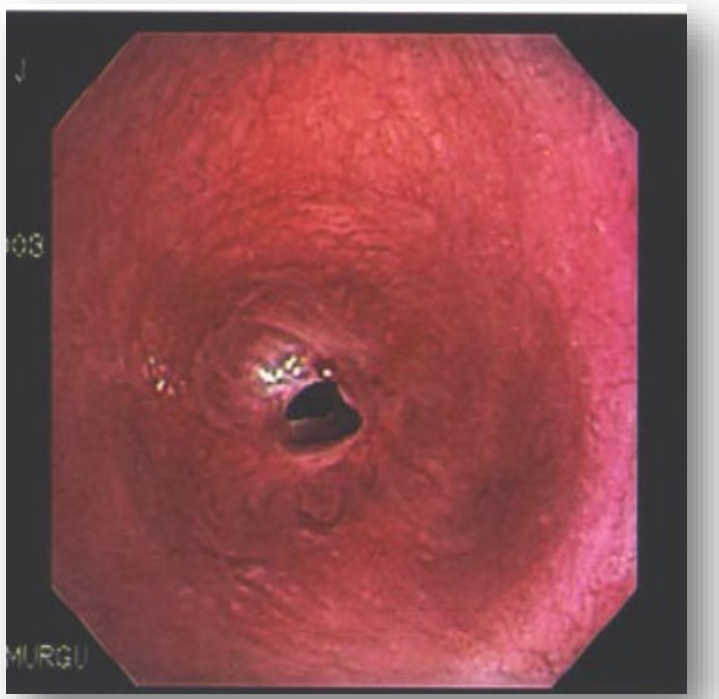
1) RUL
2) RUL/RML
3) RLL
4) LUL
5) LLL

Central Airway Obstruction

Comes in Many Flavors…







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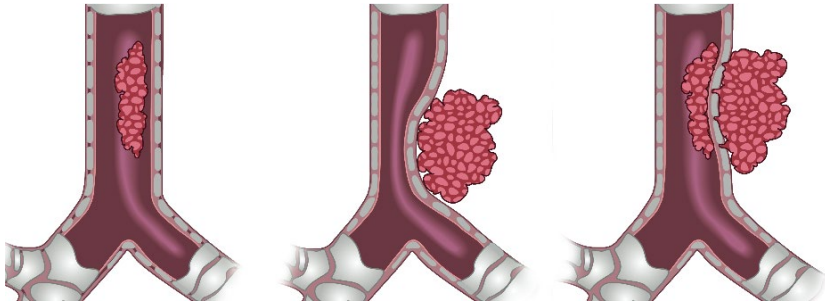
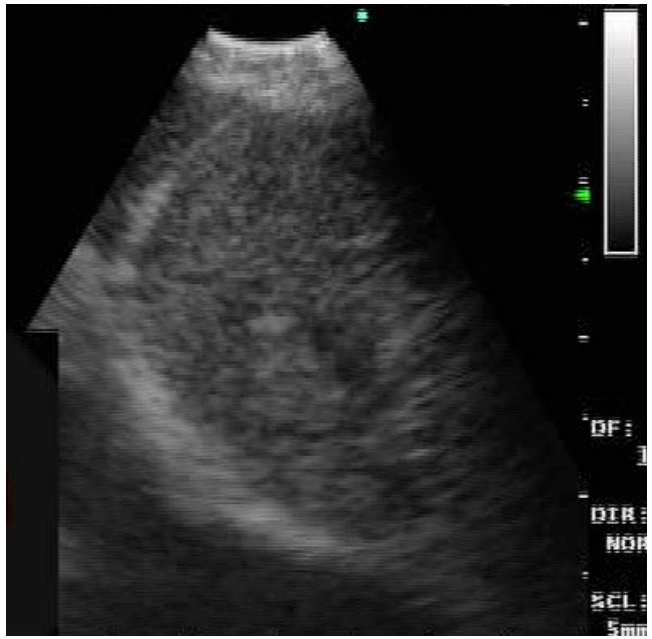
Bronchoscopic Evaluation

- ✓ Determine/confirm type of lesion
  - Extrinsic, intrinsic, or mixed
- ✓ Diagnose
  - Take a biopsy
- ✓ Use EBUS to determine:
  - Extension of obstruction
  - Degree of invasion





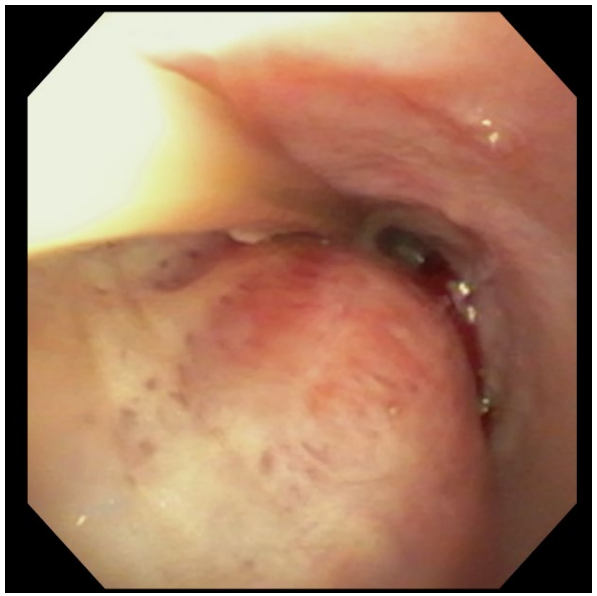
Evaluation of CAO with EBUS

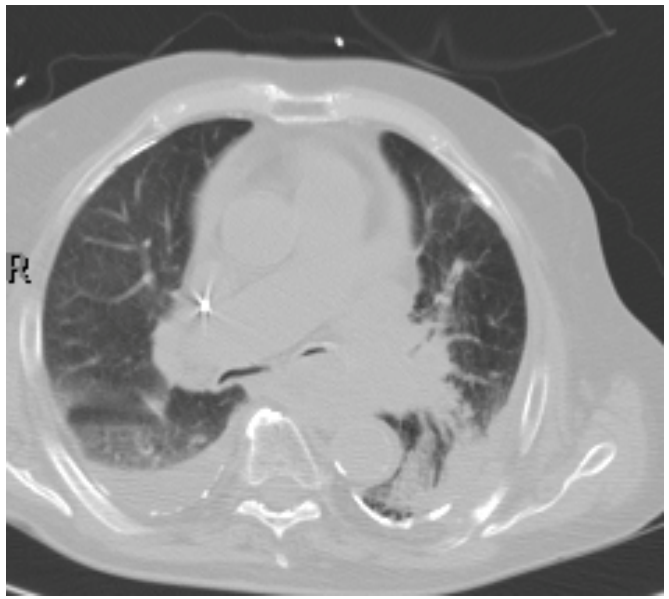
THE UNIVERSITY OF CHICAGO

CASE PRESENTATION-CAO

Q. This patient with recently diagnosed stage IV lung adenocarcinoma has respiratory failure, post obstructive pneumonia and critical left mainstem bronchial obstruction. Which of the following should be offered next?

1) Stent insertion
2) Laser debulking
3) Comfort care
4) Palliative radiotherapy





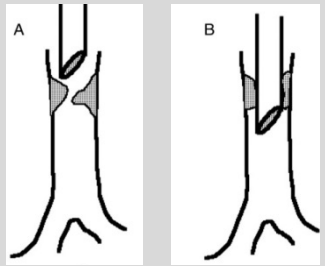
Treatment/Palliation Options

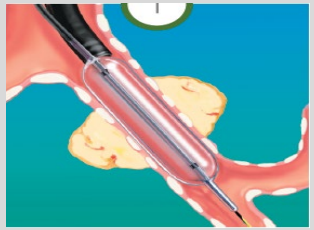
Rigid

Allows for simultaneous dilatation, resection, ventilation and aspiration. Necessary for placement of silicone stents.

Bronchoplasty

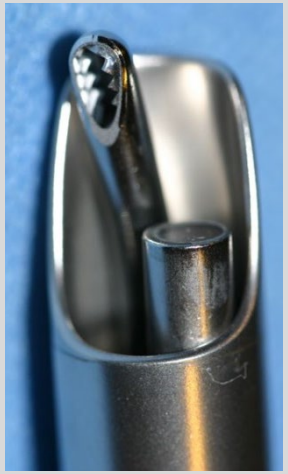
Create luminal patency through dilation using a rigid scope or dilators (balloons, Jackson dilators, etc.)





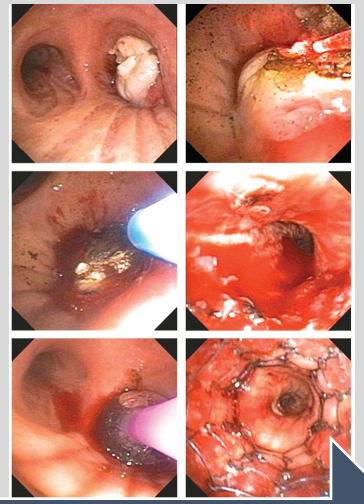
Mechanical Debridement

For intrinsic and mixed lesions, remove tumor with forceps, rigid bronchscope, or a microdebrider.



Thermal Ablation

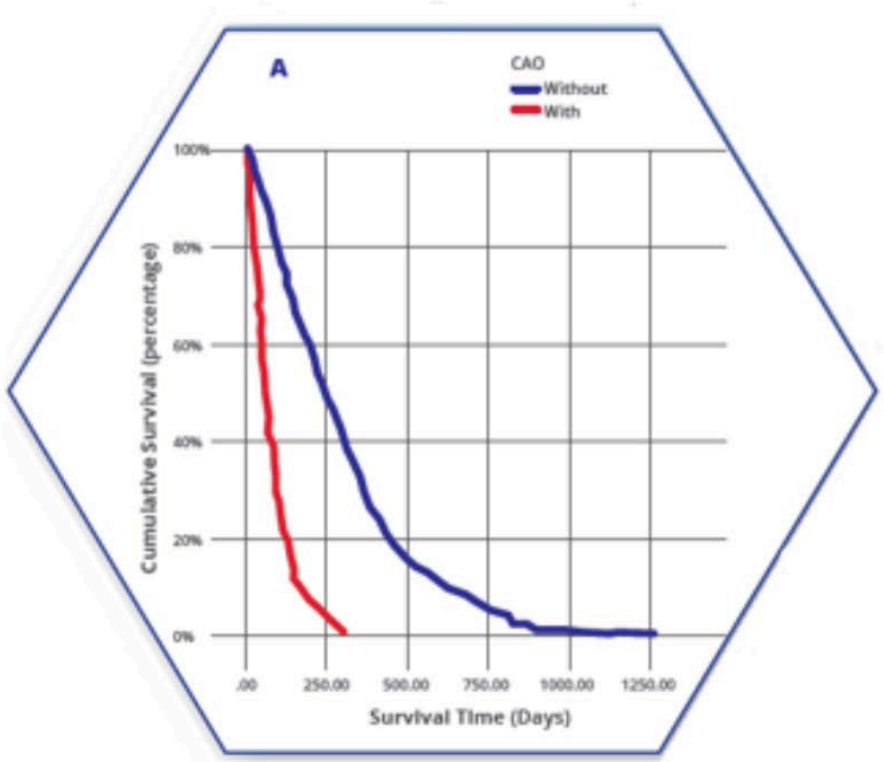
Destroy lesion and achieve hemostasis with laser, cautery, cryo or APC. Effective but carries risk of airway ignition.



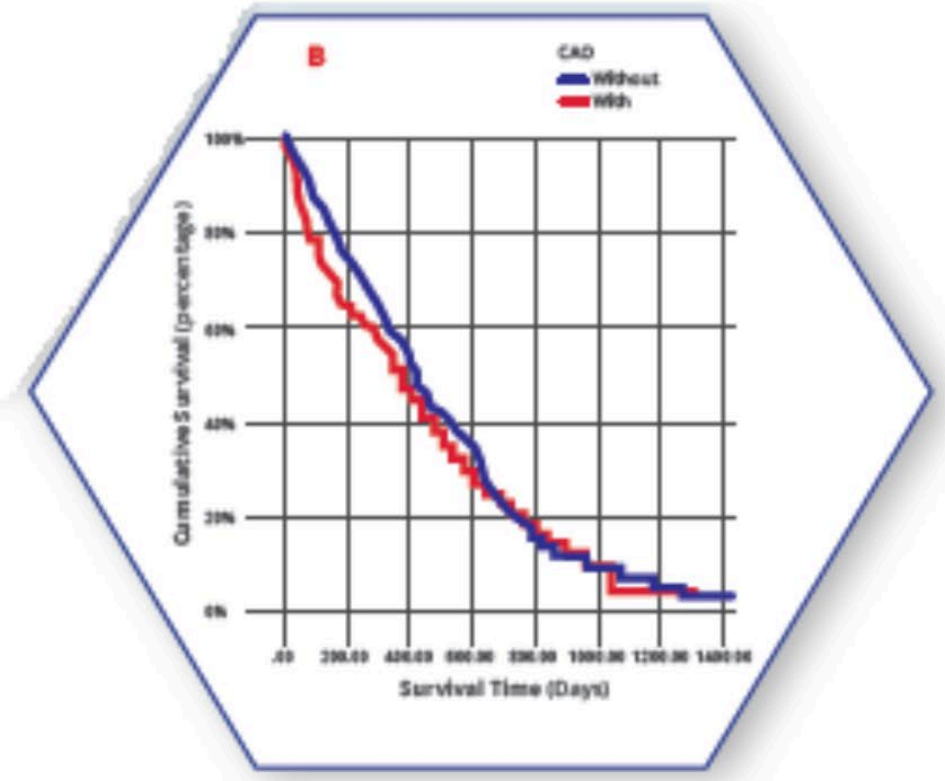
Multimodality therapy

Central Airway Obstruction (CAO) Impact Upon Survival

Kaplan–Meier survival curve of patients with and those without CAO

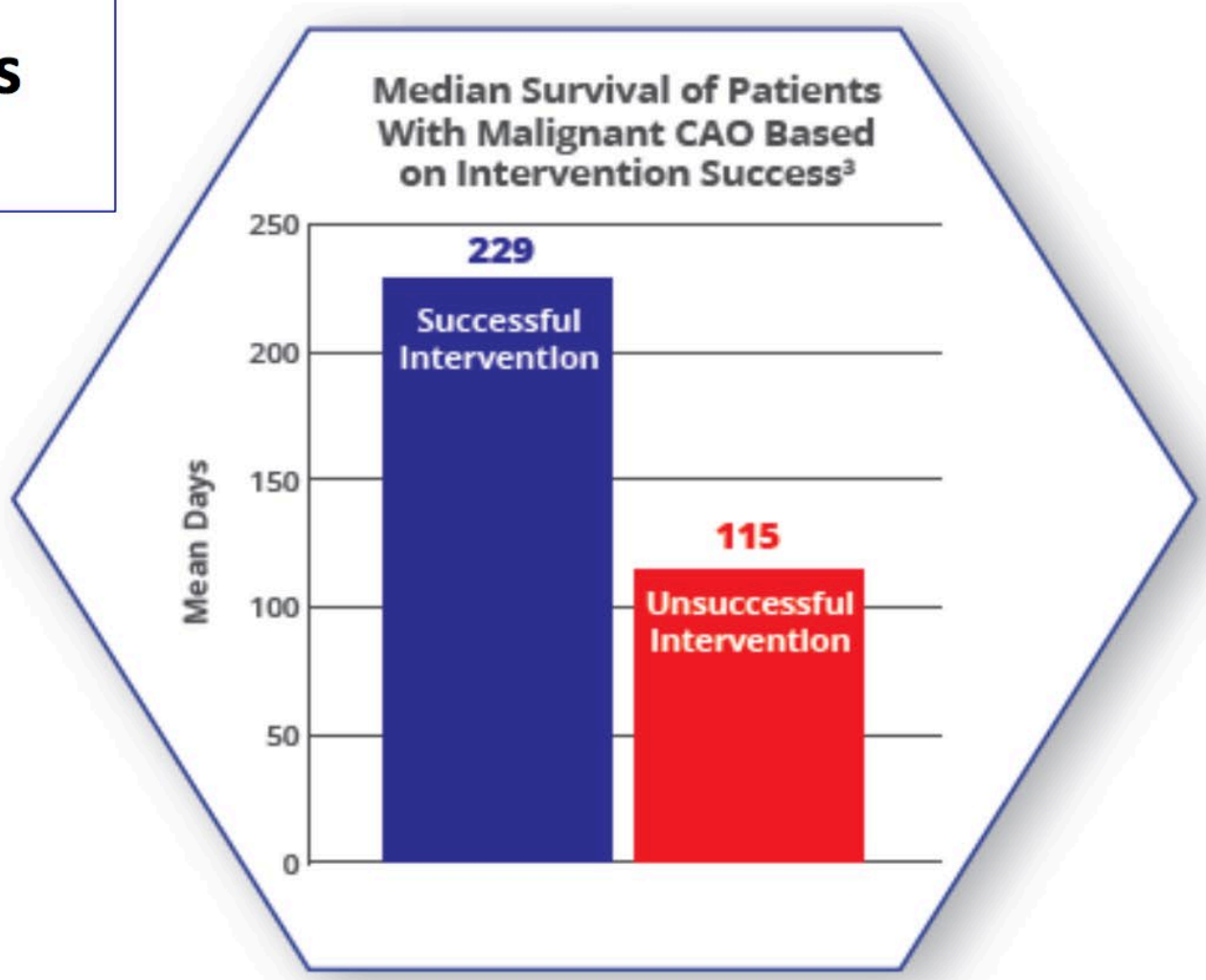


Kaplan–Meier survival curve of patients without CAO and with CAO treated with interventional bronchoscopy



Chen CH, Wu BR, Cheng WC, et al. Interventional pulmonology for patients with central airway obstruction: an 8-year institutional experience. *Medicine (Baltimore)*. 2017;96(2):e5612.

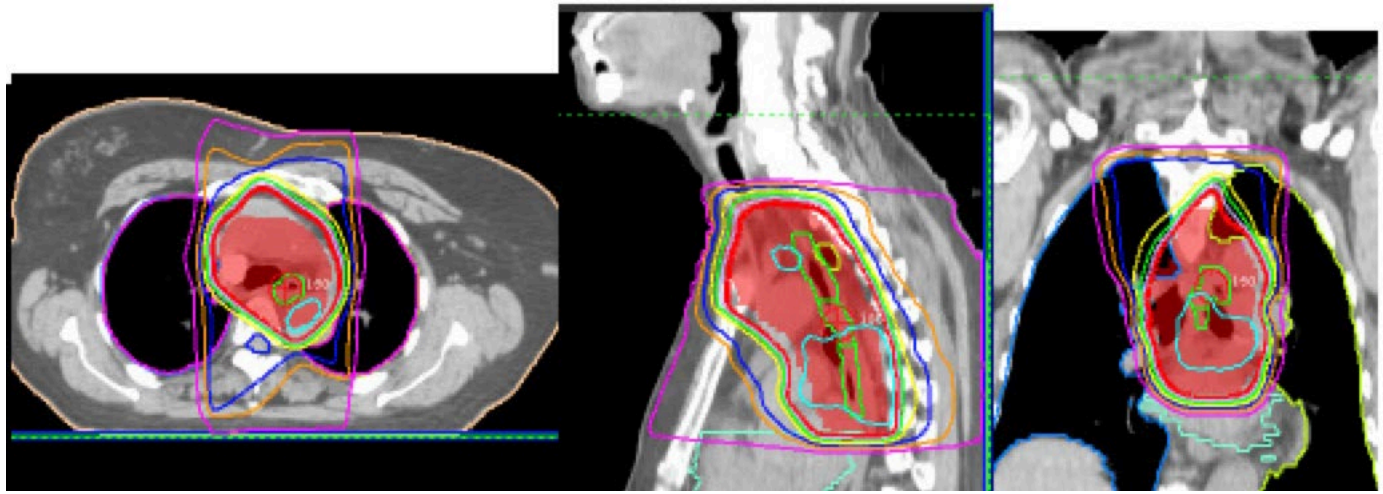
Survival Impact of Successful Treatment Intervention in Patients with CAO



Mahmood K, Wahidi MM, Thomas S, et al. Therapeutic bronchoscopy improves spirometry, quality of life, and survival in central airway obstruction. *Respiration*. 2015;89(5):404-413.

Malignant CAO- key points on external beam radiotherapy

- When lung cancer causes severe airway obstruction resulting in **atelectasis**: the **response rate to RT alone is only about 20%**
- **Especially if the treatment is initiated > 2 weeks after the development of atelectasis**

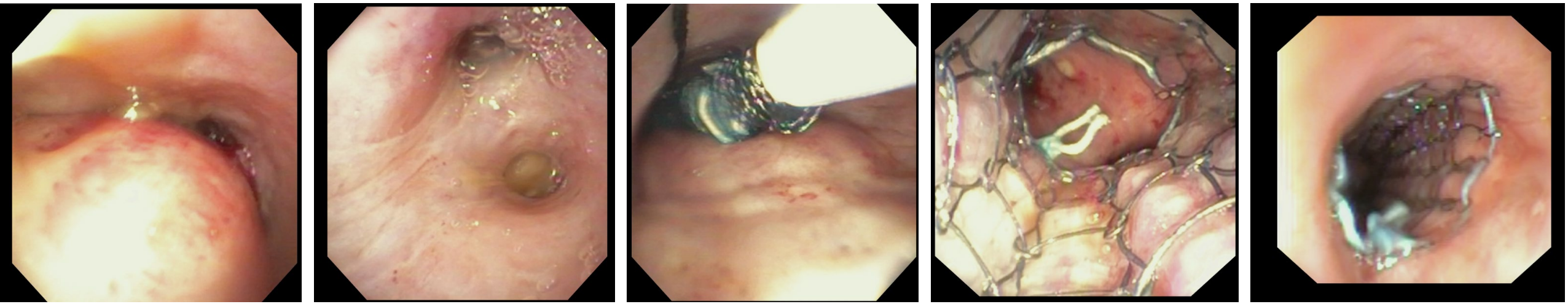


Chetty KG, Moran EM, Sassoon CS, Viravathana T, Light RW. Effect of radiation therapy on bronchial obstruction due to bronchogenic carcinoma. *Chest.* 1989;95(3):582-584.

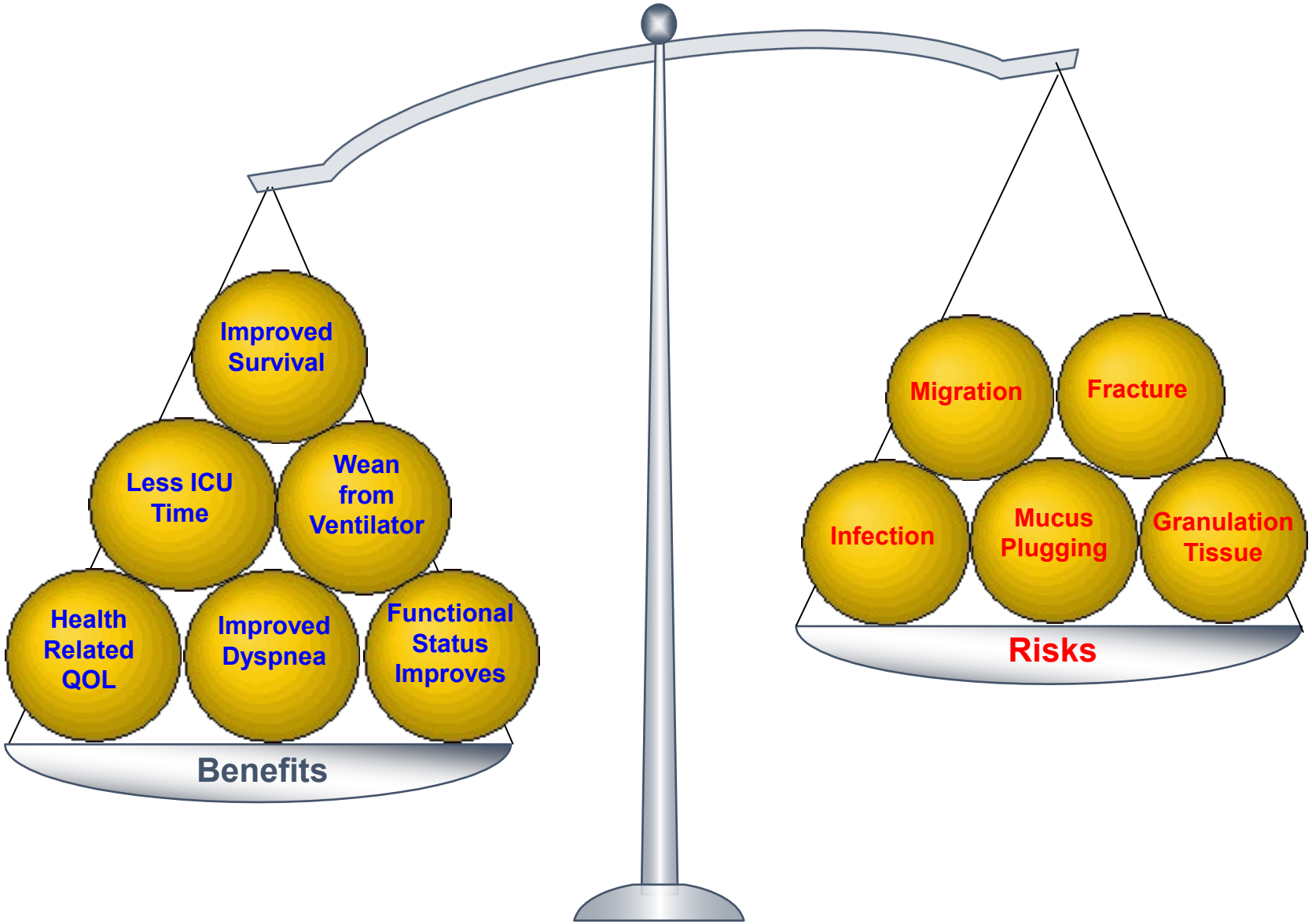
Slawson RG, Scott RM. Radiation therapy in bronchogenic carcinoma. *Radiology.* 1979;132(1):175-176.

Reddy SP1, Marks JE. Total atelectasis of the lung secondary to malignant airway obstruction Response to radiation therapy. *Am J Clin Oncol.* 1990;13(5):394-400.

Case resolution….



Balance the Risks vs. Benefits

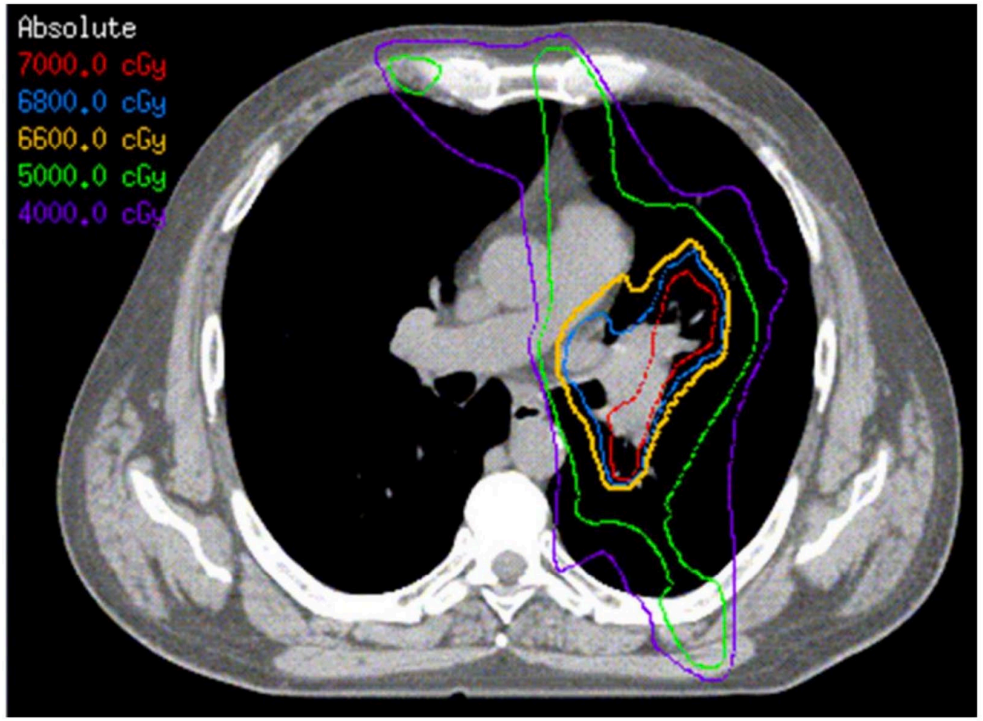


Peripheral Tumor Ablation

- Energy
- Cryo: same idea as energy: just colder.
- Chemotherapy directly into tumors
- Electroporation
- PDT
- Brachytherapy
- Viral Vectors
- Nanoparticles
- Steam

Intratumor chemo injection

66M w/ recurrent NSCLC obstructing part of the LUL



-Completed radiation

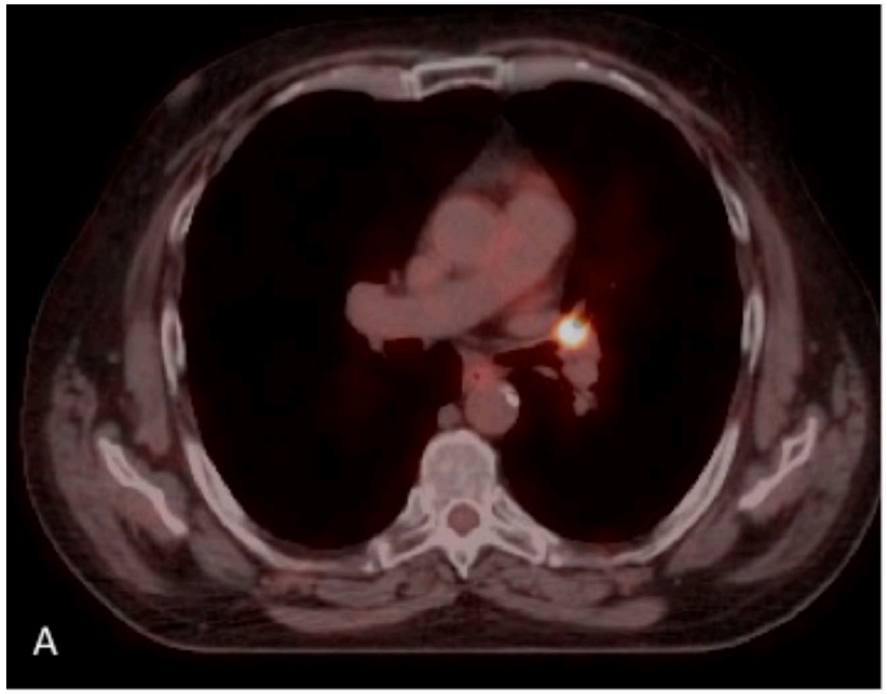
-Receives consolidation chemotherapy, c/b intolerance

Slide courtesy of C. Matt Kinsey, MD

THE University of Vermont CANCER CENTER

Recurrent NSCLC in the Radiation Field

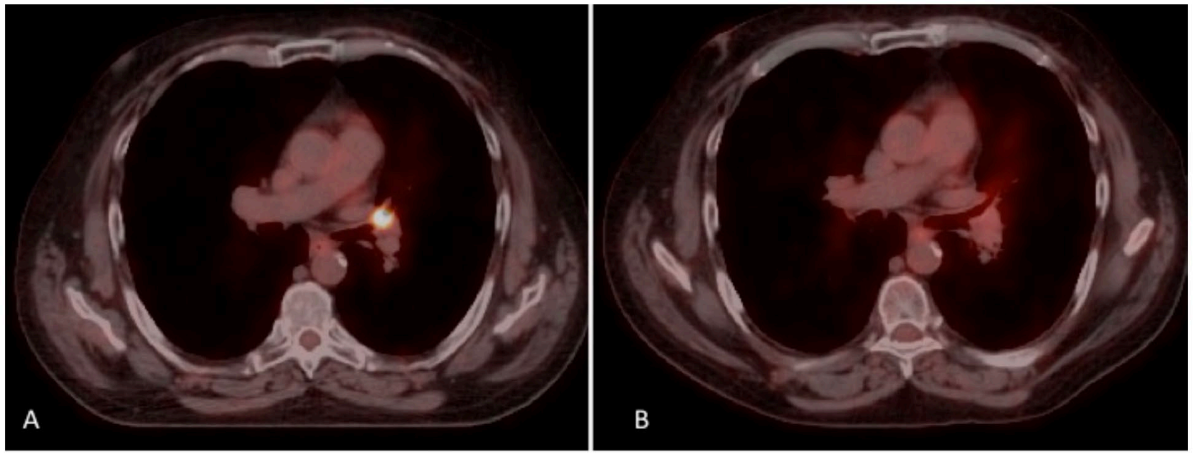
- -Recurrence in region of prior radiation
- -Median OS w/ single agent chemotx: 5 months
- -Patient refuses chemotherapy



Slide courtesy of C. Matt Kinsey, MD

Endobronchial Ultrasound-Guided Transbronchial Injection of Cisplatin

-Completes 4, weekly, injections of intratumoral cisplatin
-PET-CT 5 weeks after completion of the EBUS-TBNI course
-Patient passed away of pneumonia 2.5 yrs later
-First published account in the US



Khan, F., Anker, C. J., Garrison, G., Kinsey, CM. (2015). Endobronchial ultrasound-guided transbronchial needle injection for local control of recurrent non-small cell lung cancer. *Annals of the American Thoracic Society*, *12*(1), 101–104

Slide courtesy of C. Matt Kinsey, MD

Why intratumoral?

IV Cisplatin Accumulation in the Lung is *Greater* than in The Tumor

Table 5 Cisplatin concentration in perfusate, lung tissue, and tumor tissue in rats

Animals	Tumor	Route	Dose or initial conc.	Lung (µg/g)	Tumor (µg/g)	Reference
Rat	Sarcoma	ILuP	0.1 mg/mL		6.67 (1.64)	[46]
		IV	1 mg		2.51 (0.60)	
Rat	Sarcoma	ILuP	25 µg/mL	~4	4.76 (0.60)[a]	[48]
		ILuP	50 µg/mL	~11	4.95 (0.80)[a]	
		ILuP	100 µg/mL	~21	4.84 (0.74)[a]	

Data are presented as means and SD. *ILuP* isolated lung perfusion, *IV* intravenous infusion

[a]Concentration at 60 min of ILuP

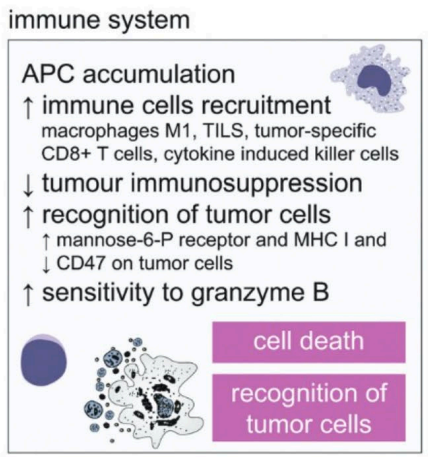
Perfusate (via cardiopulmonary bypass) was previously attempted to address this problem, c/b lung toxicity

http://www.accessdata.fda.gov, accessed 1/3/14

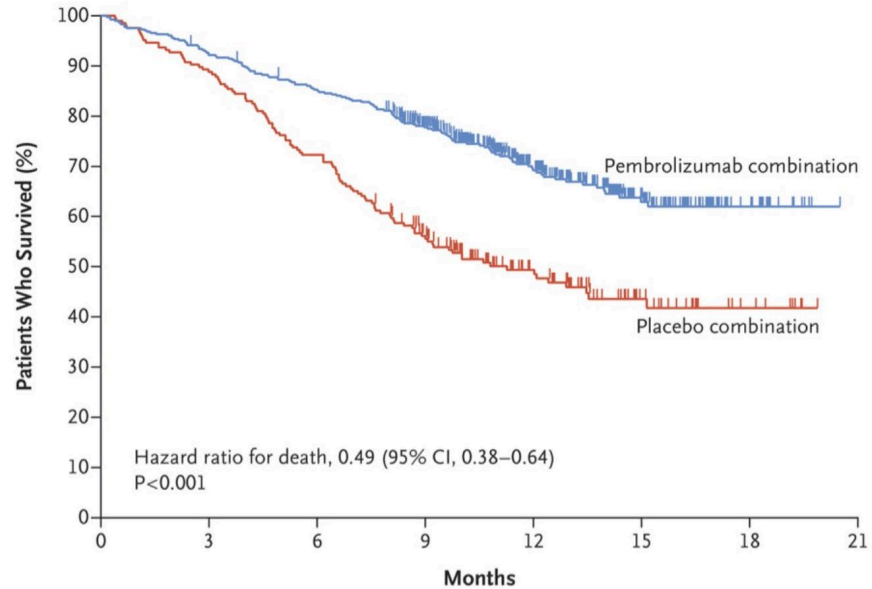
Rudek M et al. Handbook of Anticancer Pharmocokinetics and Pharmacodynamics, Springer 2014

Slide courtesy of C. Matt Kinsey, MD

Can Intratumoral Cisplatin Augment Immunotherapy?



Metallomics, 2019, **11**, 1182–1199



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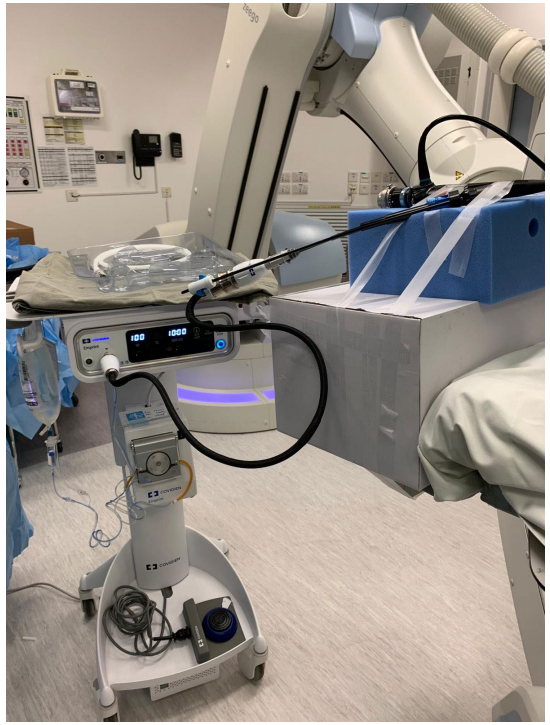
Microwave Ablation by Endobronchial Route



Slide courtesy of Mike Pritchett, DO – Pinehurst, NC. USA

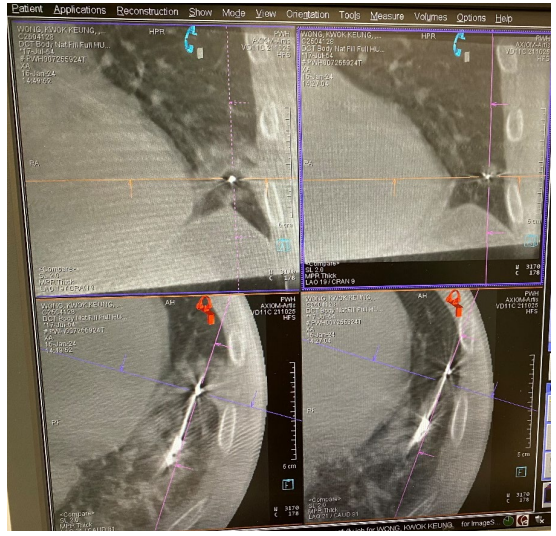
Microwave catheters

CBCT showed Emprint microwave catheter deployed into the nodule.

Slide courtesy of Calvin Ng, MD – Hong Kong

5100W 10 mins microwave energy applied and CBCT showing good post-ablation changes.

CBCT images comparing pre-ablation (right) to post-ablation CBCT (left), minimal margin >5mm (not taking into consideration tissue contraction)



Slide courtesy of Calvin Ng, MD – Hong Kong

Thank You!

D. Kyle Hogarth, MD, FCCP

dhogarth@uchicago.edu

+1-773-991-5812

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