

# **Pneumothorax Following Lung Biopsy: Facts and Fiction**

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# Percutaneous Lung Biopsy

- **First needle biopsy of the lung, late 1800's**
- **First report of FNAB 1965 (Nordenstrom et al)**
- **Diagnostic rate;**
  - **> 90% for malignancy**
  - **? For benign disease**
- **Better diagnostic rate than bronchoscopy, increase PTX rate**

# Percutaneous Lung Biopsy

## Complications

- Common
  - PTX most common
  - Hemorrhage - rarely fatal
- Rare
  - Air Embolus
  - Needle tract seeding w/ tumor
  - Hemopericardium
  - Death (hemorrhagic complication)
  - Lung torsion

# Percutaneous Lung Biopsy

## Pneumothorax

- PTX rate = 30%, chest tube rate = 10%
- Bronchoscopic techniques - approximately 5% PTX rate
- What is the significance to I.R. service (SFMC)
  - 359 lung biopsies (2001-2002)
  - Chest tube in 37 patients (10.3%)
  - Most common major complication
  - Approximately 40% of all major complications
  - Cost = \$2,016 → bill to pt \$4,202.57

# Percutaneous Lung Biopsy

## Pneumothorax - Related Parameters

- **Pt/Lesion**

- Pulm. disease
- Patient age

- Lesion size
- Lesion depth

- **Bx Technique**

- Needle passes
- Pleural crossing
- Needle tract obliteration

- Needle size
- CT vs Fluoro

- **Post Biopsy Care**

- Post bx position

- 100% O<sub>2</sub>

# Percutaneous Lung Biopsy

- **No change in PTX of C.T. placement rates since 60's**  
**Why?**
- **Maybe PTX rates have improved, but;**
  - CT is more sensitive for ptx, - No (Murphy FB et al , AJR 1990)
  - More aggressive, comfortable w/chest tube the placement
- **Literature review for the facts**
  - Studies w/formal statistical analysis ( $\chi^2$ , *t*- test)
  - Evaluate parameters as single variables
  - Do these parameters correlate w/increased PTX and chest tube placement rate

# Percutaneous Lung Biopsy

## Studies Evaluating Biopsy Parameters Related to PTX Rate

<b>Study (yr)</b>	<b># of bxs</b>	<b># of pt.s</b>
H Saji (2002)	289	289
F Yamagami (2002)	143	143
KM Yeow (2001)	117	117
JP Ko (2001)	150	150
MJ Odell (2000)	117	113
HK Bungay ('99)	88	88
J.E. Cox ('99)	356	346
CL Collings ('99)	423	390
JA Miller ('98)	50	50
JL Swischuk ('98)	651	612
EA Kazerooni ('96)	121	117
P Vitalo ('96)	243	243
F Garcia-Rio ('96)	51	51
T Petsas ('95)	58	58
CLV Anderson ('94)	93	93

# Percutaneous Lung Biopsy

## Studies Evaluating Biopsy Parameters Related to PTX Rate (cont.)

Study (yr)	# of bxs	# of pt.s
PC Hill ('93)	89	89
EH Moore ('91)	55	55
LB Haramati ('91)	131	123
SJ Herman ('90)	93	86
EH Moore ('90)	308	308
KS Miller* ('88)	159	159
GD Fish* ('88)	160	160
R Berger ('88)	182	182
PM Bourgouin ('88)	140	129
D Quon ('88)	138	138
RH Poe ('84)	103	103
Y Cormier ('80)	50	46
W N Sinner ('75)	3799	2726
<b>Totals</b>	<b>8198</b>	<b>7004</b>

\* represent same patient population

# Percutaneous Lung Biopsy

## Studies Evaluating Biopsy Parameters Related to Chest Tube Rate

Study (yr)	# of bxs	# of pt.s
H Saji (2002)	289	289
JP Ko (2001)	150	150
J.E. Cox ('99)	356	46
CL Collins ('99)	423	390
JL Swischuk ('98)	651	612
EA Kazerooni ('96)	121	117
T Petsas ('95)	58	58
CLV Anderson ('94)	93	93
PC Hill ('93)	89	89
EH Moore ('91)	55	55
SJ Herman ('90)	93	86
EH Moore ('90)	308	308
R Berger ('88)	182	182
PM Bourgouin ('88)	140	129
D Quon ('88)	138	138
HS Vine ('81)	100	100
<b>Total</b>	<b>2,957</b>	<b>2,553</b>

# Percutaneous Lung Biopsy

## Significance of Lesion Size

Study	Technique	PTX%	Chest Tube%	PTX		Chest Tube	
				P<.05	NS	P<.05	NS
H Saji (2002)	CT	26.6	14.2	289	---	289	---
F Yamagami (2002)	CT	34.3	2.2	143	---	---	---
KM Yeow (2001)	CT	12.0	0.0	---	117	---	---
MJ Odell ('99)	?	54.7	20.5	117	---	---	---
J. E. Cox ('99)	CT, Fluoro	40.4	7.0	356	---	---	---
JA Miller ('98)	CT	14.0	2.0	---	50	---	---
EA Kazerooni ('96)	CT	44.0	14.9	121	---	---	121
P. Vitalo ('96)	CT	21.0	2.1	---	243	---	---
F. Garcia-Rio ('96)	CT	19.0	3.9	51	---	---	---
CLV Anderson ('94)	CT	35.0	17.0	93	---	---	93
KS Miller/GD Fish(88)	CT, Fluoro	34.0	11.0	160	---	---	---
RH Poe ('84) †	Fluoro	37.0	13.0	---	103	---	---
<b>Total # of bxs</b>				<b>1330</b>	<b>513</b>	<b>289</b>	<b>214</b>

† = prospective

# Percutaneous Lung Biopsy

## PTX - Lesion Size

- Smaller lesions have
  - + Correlation with PTX
  - ? Correlation with C.T. placement
- Smaller lesion → more difficult biopsy → longer procedure → increase PTX / C.T. rates

# Percutaneous Lung Biopsy

## Significance of Lesion Depth

Study	Technique	PTX%	Chest Tube %	PTX		Chest Tube		Comment
				P<.05	NS	P<.05	NS	
H Saji	CT	26.6	14.2	289	---	289	---	
F Yamagami (2002)	CT	34.2	2.2	143	---	---	---	
MJ Odell ('99)	?	54.7	20.5	117	---	---	---	
HK Bungay ('99)	CT	47.0	0.0	88	---	---	---	
J. E. Cox ('99)	CT, Fluoro	40.4	7.0	356	---	---	---	PI. based vs nonpl. based
EA Kazerooni ('96)	CT	44.0	14.9	121	---	---	121	≤ 2cm vs ≥ 2cm
P Vitalo ('96)	CT	21.0	2.1	243	---	---	---	
CLV Anderson ('94)	CT	35.0	17.0	---	93	---	---	
LB Haramati ('91)	CT	27.4	4.6	131	---	---	---	Aerated vs nonaerated lung
KS Miller/GD Fish ('88)	CT, Fluoro	34.0	11.0	160	---	---	---	
RH Poe ('84) †	Fluoro	37.0	13.0	103	---	---	---	
WN Sinner ('75)	Fluoro	27.2	7.7	?	---	---	---	
<b>Total # bxs</b>				<b>1,751</b>	<b>93</b>	<b>289</b>	<b>121</b>	

† = prospective

# Percutaneous Lung Biopsy

## PTX - Lesion Depth

- **Deeper lesions have;**
  - ++ correlation with PTX
  - ? correlation with C.T. placement
- **Single study** (Yeow et al 2001) **shows + correlation between PTX and superficial lesions**
- **Deeper lesions → more difficult biopsy → longer procedure → increase PTX/C.T. rates**

# Percutaneous Lung Biopsy

## Significance of Pulmonary Disease

Study	Technique	PTX%	Chest Tube %	PTX		Chest Tube		Comment
				P<.05	NS	P<.05	NS	
H Saji	CT	26.6	14.2	289	---	---	289	PFT
F Yamagami (2002)	CT	34.3	2.2	---	143	---	---	CT
KM Yeow (2001)	CT	12.0	0.0	---	117	---	---	CT
JP Ko (2001)	CT	39.0	5.0	150	---	150	---	PFT
J.E. Cox ('99)	CT, Fluoro	40.4	7.0	356	---	356	---	CT
CL Collings ('99) †	CT, Fluoro	28.0	4.0	---	423	423	---	CT
JA Miller ('98)	CT	14.0	2.0	50	---	---	---	CT
EA Kazerooni ('96)	CT	44.0	14.9	---	121	121	---	PFT
P Vitalo ('96)	CT	21.0	2.1	243	---	---	---	PFT
F Garcia-Rio ('96)	CT	19.0	3.9	51	---	---	---	PFT
CLV Anderson ('94)	CT	35.0	17.0	---	93	93	---	PFT
PC Hill ('93)	CT, Fluoro	20.0	---	---	89	---	89	PFT
KS Miller/GD Fish('88)	CT, Fluoro	34.0	11.0	160	---	---	---	PFT, CXR
D Quon ('88)	?	29.7	8.0	138	---	138	---	PFT, pO <sup>2</sup>
RH Poe ('84) †	Fluoro	37.0	13.0	103	---	---	---	CXR
HS Vine ('81)	Fluoro	23.0	9.0	---	---	100	---	CXR
WN Sinner ('75)	Fluoro	27.2	7.7	?	---	---	---	?
<b>Total # of bx.s</b>				<b>1,940</b>	<b>986</b>	<b>1,381</b>	<b>378</b>	

† = prospective

# Percutaneous Lung Biopsy

## PTX - Pulmonary Disease

- **Pulmonary disease (COPD) has;**
  - + correlation w/ PTX
  - ++ Correlation w/ C.T. placement
- **COPD more likely to produce symptoms b/c;**
  - Inability of lung to seal itself
  - Lack of pulmonary reserve (C.T. needed for smaller PTX)
  - Decreased rate of PTX resorption

# Percutaneous Lung Biopsy

## Significance of Age of Patient

Study (yr)	Technique	PTX%	Chest Tube %	PTX		Chest Tube	
				P<.05	NS	P<.05	NS
H Saji	CT	26.6	14.2	---	289	---	289
F Yamagami (2002)	CT	34.3	2.2	---	143	---	---
KM Yeow (2001)	CT	12.0	0.0	---	117	---	---
MJ Odell ('99)		54.7	20.5	---	117	---	---
JA Miller ('98)		14.0	2.0	---	50	---	---
EA Kazerooni ('96)	CT	44.0	14.9	---	121	---	121
P. Vitalo ('96)	CT	21.0	2.1	---	243	---	---
F. Garcia-Rio ('96)	CT	19.0	3.9	---	50	---	---
CLV Anderson ('94)	CT	35.0	17.0	---	93	---	93
KS Miller/CD Fish('88)	CT, Fluoro	34.0	11.0	---	160	---	---
<b>Total # of bx.s</b>				<b>0</b>	<b>1383</b>	<b>0</b>	<b>503</b>

# **Percutaneous Lung Biopsy**

## **PTX - Patient Age**

- No correlation between age and incidence of PTX or chest tube placement**

# Percutaneous Lung Biopsy

## Significance of Number of Needle Passes

Study	Technique	PTX%	Chest Tube %	PTX		Chest Tube	
				P<.05	NS	P<.05	NS
F Yamagami (2002)	CT	34.3	2.2	---	143	---	---
HK Bungay ('99)	CT	42.0	0.0	---	88	---	---
J.E. Cox ('99)	CT, Fluoro	40.4	7.0	--	356	---	---
JL Swischuk ('98)	CT, Fluoro	26.9	9.2	---	651	---	651
EA Kazerooni (96)	CT	44.0	14.9	---	121	---	121
P Vitalo (96)	CT	21.0	2.1	---	243	---	---
EH Moore (91) †	CT	36.0	9.0	---	55	---	55
KS Miller/GD Fish(88)	CT, Fluoro	34.0	11.0	---	160	---	160
RH Poe (84) †	Fluoro	37.0	13.0	---	103	---	---
WN Sinner (75)	Fluoro	27.2	7.7	≥2000	---	---	---
<b>Total # of Bx.s</b>				<b>?</b>	<b>1,920</b>	<b>0</b>	<b>987</b>

† = prospective

# **Percutaneous Lung Biopsy**

## **PTX - Number of Needle Passes**

- **Questionable correlation between number of needle passes and PTX**
- **No correlation between number of needle passes and C.T. placement**

# Percutaneous Lung Biopsy

## PTX - Needle Size

- Early study (WN Sinner '75) and recent study of 356 bx.s (J.E. Cox '99) show no correlation between needle diameter and PTX
- Recent study of 651 bx.s (JL Swischuk '98) shows significant correlation between smaller diameter needle and PTX (possibly C.T. placement also)
- Smaller needles primarily used to prevent hemorrhage

# Percutaneous Lung Biopsy

## PTX - Pleural Crossings

### Percutaneous Needle Biopsy of Lung Lesions

To the Editor:

We would like to congratulate Poe et al for the excellent article, "Predicting risk of pneumothorax in needle biopsy of the lung" (*Chest* 1984; 85:232-35). Their reported incidence of pneumothorax (37 percent) with 30 percent requiring tube thoracostomy is an acceptable and realistic risk of the procedure and closely approximates our experience with over 700 percutaneous needle biopsies of the lung.

to traverse additional pleural surfaces and hence increase likelihood of a pneumothorax developing. This is of significant planning one's approach to these lesions is that an anterior or posterior approach to a central lesion may be associated with greater or lesser number of pleural surface punctures. The appropriate route should translate into a lower incidence of pneumothorax.

An additional significant factor is the production of this complication, which was not mentioned, is the degree of patient cooperation during the procedure. It is our impression that patient tension, such as deep inspiration, coughing or other types of turbulent motion during the procedure, increase the likelihood of producing significant pleural tear. These features may be reduced by careful patient preparation, combined with mild sedation.

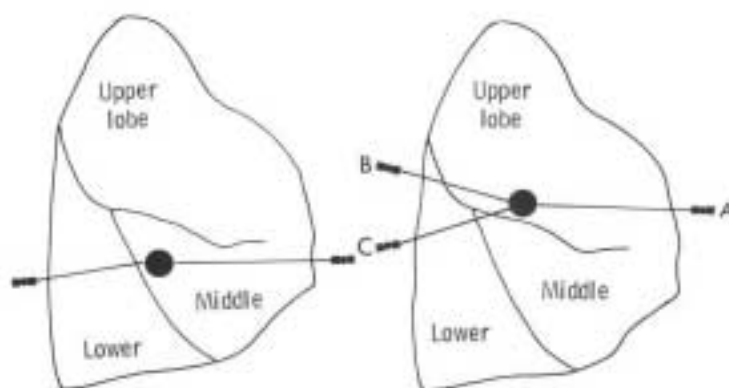


FIGURE 1a (left). Middle lobe lesion. The posterior approach involves crossing an additional pleural surface. b (right). Right upper lobe lesion. The anterior approach (A) crosses fewer pleural surfaces than other posterior approaches (B and C).

Explanation for findings of Poe et al ('84) that depth of lesion is single dominant variable predicting PTX

# Percutaneous Lung Biopsy

## PTX - Pleural Crossings

- **St. Louis et al ('84)**
  - No statistics
  - No data
  - Speculation
  - Good drawings
- **Two studies** (E.A. Kazerooni '96, J.P. Ko 2001) **shows no correlation between pl. crossings and PTX or C.T. placement**
- **Risk of pleural crossings remains unsubstantiated**

# Percutaneous Lung Biopsy

## PTX - CT vs Fluoro

- Speculation that C.T. increase risk of PTX
- 2° to increased procedure times
- Single report of 410 bx.s (Collings et al; '99) shows no increase incidence of PTX or C.T. placement with use of C.T. vs fluoro
- Single report of 88 Bx.s (Bungay et al; 1999) shows more likely to detect PTX with CT ( $p < 0.001$ )

# Percutaneous Lung Biopsy

## Significance of Needle Tract Obliteration

Study	Technique	PTX%	Chest Tube %	PTX		Chest Tube		Comment
				P<.05	NS	P<.05	NS	
T. Petsas ('95) †‡	CT	31.0	12.1	---	58	58	---	Fibrin glue
S.J. Herman ('90) †‡	Fluoro	27.0	2.2	---	93	---	93	Blood
P.M. Bourgouin ('88) †‡	Fluoro	32.1	8.6	---	140	---	140	Blood
<b>Total # bxs</b>					<b>291</b>	<b>58</b>	<b>233</b>	

† = prospective

‡ = randomized

# Percutaneous Lung Biopsy

## PTX - Needle Tract Obliteration

- Little value in preventing PTX
- ? Prevention of chest tube
- Has not received much acceptance b/c;
  - Questionable effectiveness
  - Additional procedure
  - Requires guiding needle

# Percutaneous Lung Biopsy

## Significance of Post Bx Position

Study	Technique	PTX%	Chest Tube %	PTX		Chest Tube		Comment
				P<.05	NS	P<.05	NS	
KM Yeow (2001)	CT	12.0	0.0	---	117	---	---	
CH Collings ('99) †,‡	CT, Fluoro	28.0	4.0	---	423	---	423	Bx site down vs up
EH Moore ('91) †,‡	Fluoro	36.0	9.0	---	55	55	---	Bx site down vs up
EH Moore (90) †	Fluoro	25.0	1.6	262	---	262	---	
<b>Total # of bxs</b>				<b>262</b>	<b>777</b>	<b>317</b>	<b>605</b>	

† = prospective  
 ‡ = randomized

# **Percutaneous Lung Biopsy**

## **PTX - Post Biopsy Position**

- **Limited evidence proving preventative value of post biopsy position**

# **Percutaneous Lung Biopsy**

## **PTX - 100% O<sub>2</sub>**

- **Single report of 50 bx.s (Y. Cormier, '80) showing significant decrease in PTX rate w/peri-procedural 100% oxygen**
- **Requires cumbersome mask or mouth piece**
- **Not simply oxygen by N.C.**

# Percutaneous Lung Biopsy

## PTX - Facts

- **COPD (especially for chest tube)**
- **Decrease lesion size**
- **Increase lesion depth**

# Percutaneous Lung Biopsy

## PTX - Fiction

- Age
- Number of needle passes
- Needle size
- Pleural crossings
- CT vs Fluoro
- Needle tract obliteration
- Post biopsy position
- 100% O<sub>2</sub>

# Percutaneous Lung Biopsy

## PTX - Conclusion

- **Who cares? Does this information help?**
  - Better patient preparation, informed consent
  - Better procedure planning
  - Appropriate referral
  - Don't let technical factors keep you from obtaining the diagnosis