American College of Physicians - Internal Medicine Meeting 2025
New Orleans, LA

Ultrasound-Guided Thoracentesis

Faculty Information

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American College of Physicians
Leading Internal Medicine, Improving Lives

THORACENTESIS

April 3-5, 2025

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Disclosure of Financial Relationships

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OUR TEAM

- Alyssa Burkhart, MD
  - Billings Clinic, Montana
- Alice Gallo de Moraes, MD
  - Mayo Clinic, Rochester
- Emily Gilbert, MD
  - Loyola University Chicago
- Ian Motie, MD
  - Florida State University
- Sophia Raia, MD
  - Maine Medical Center
- Neil Winawer, MD
  - Emory University-Grady Hospital

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Outline

- Relative Contraindications
- Optimal Site & Management
- Complications

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Relative Contraindications

- PT and/or PTT ≥ 2x normal
- Platelet count ≤ 20,000 – 50,000
- Creatinine ≥ 6.0
- Unstable patient
- Infection over insertion site
- Mechanical Ventilation
- If doesn't meet Light's criteria for landmark

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STANDARDS OF PRACTICE

Society of Interventional Radiology Consensus Guidelines for the Periprocedural Management of Thrombotic and Bleeding Risk in Patients Undergoing Percutaneous Image-Guided Interventions—Part II: Recommendations

Endorsed by the Canadian Association for Interventional Radiology and the Cardiovascular and Interventional Radiological Society of Europe

Indravadan J. Patel, MD, Shiraz Rahim, MD, Jon C. Davidson, MD, Sue E. Hanks, MD, Alda L. Tam, MD, T. Gregory Walker, MD, Luke R. Wilkins, MD, Ravi Sarode, MD, and Ido Weinberg, MD

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Coagulation & Hemostasis

- Coags & Platelet counts not routinely indicated
- Lower INR to 2-3 if on warfarin
- Transfuse platelets if less than 20,000
- Don't routinely need to hold DOACS, LMWH, P2Y12 inh
- Caveats:
  1. Observational data
  2. Controversial (other countries recs differ)
  3. Assumes a skilled operator; use of ultrasound
  4. RISK vs BENEFIT
  5. Each patient is an "N of 1"

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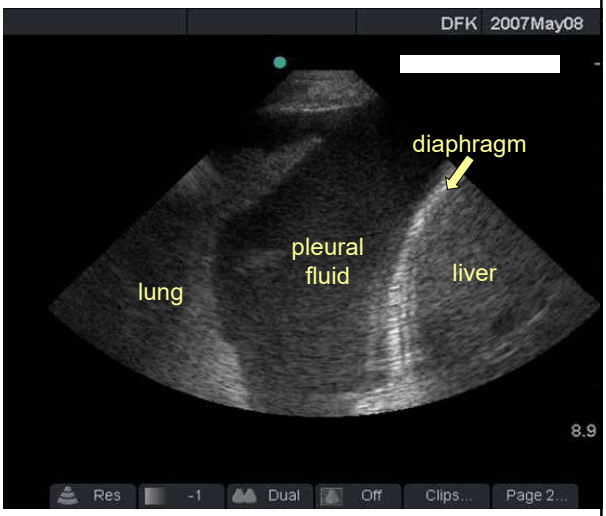
Thoracentesis Procedure

- Besides fluid must identify, diaphragm, inner chest wall and lung
- The lung is seen as an echogenic structure moving with respiration



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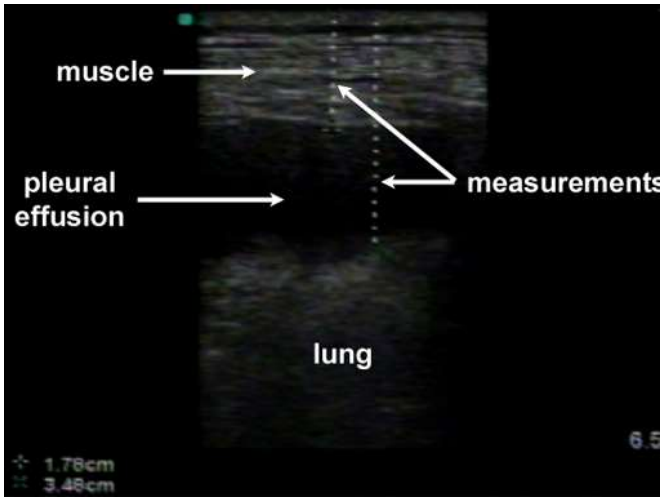
Thoracentesis Procedure

- Look for the deepest pocket of fluid superficial to the lung
- Measure to determine needle depth



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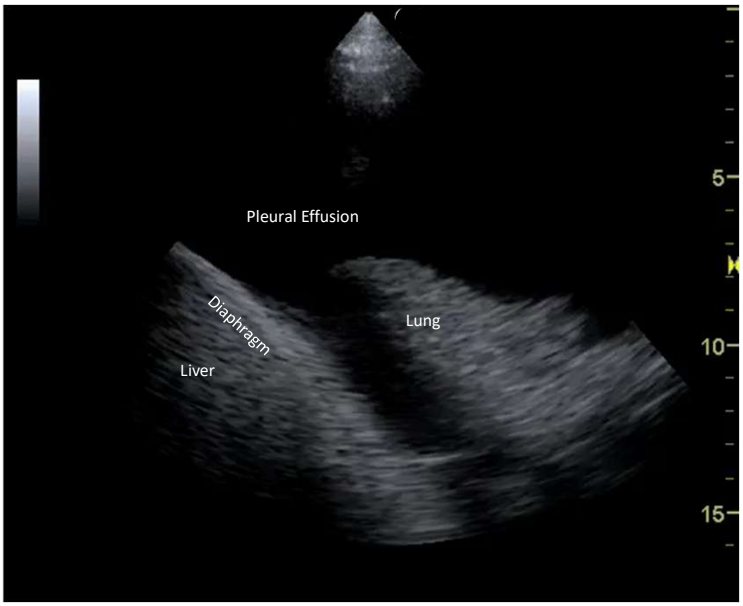
Anechoic Pleural Effusion



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ICU 6TH
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Gen THI
S MB
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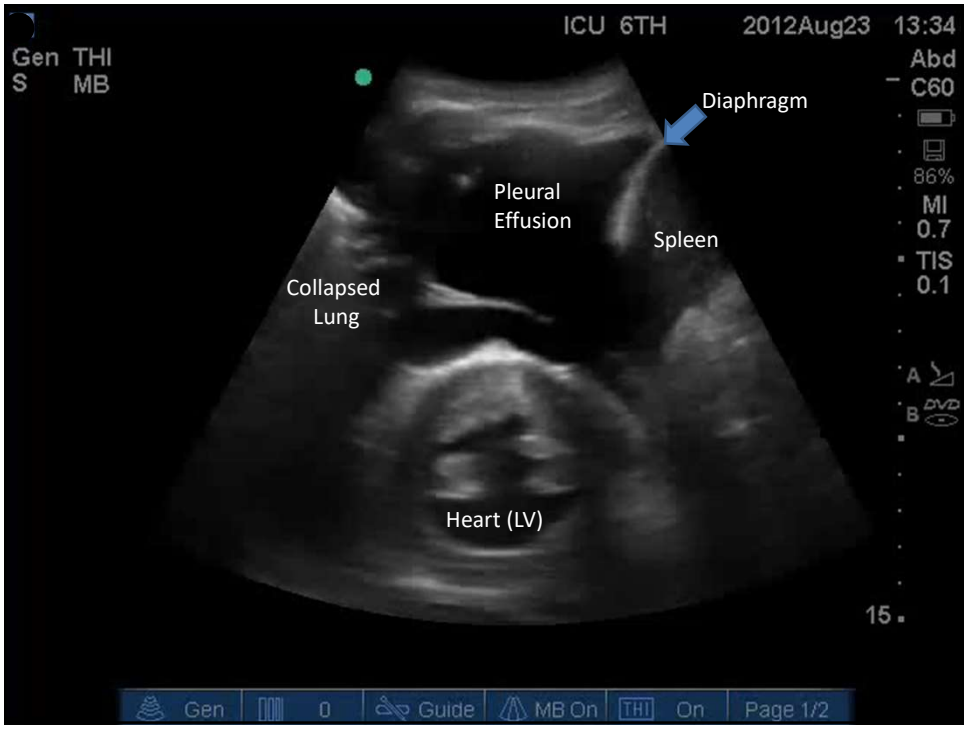
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Diaphragm
Pleural
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Spleen
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86%
MI
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Gen
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THI
On
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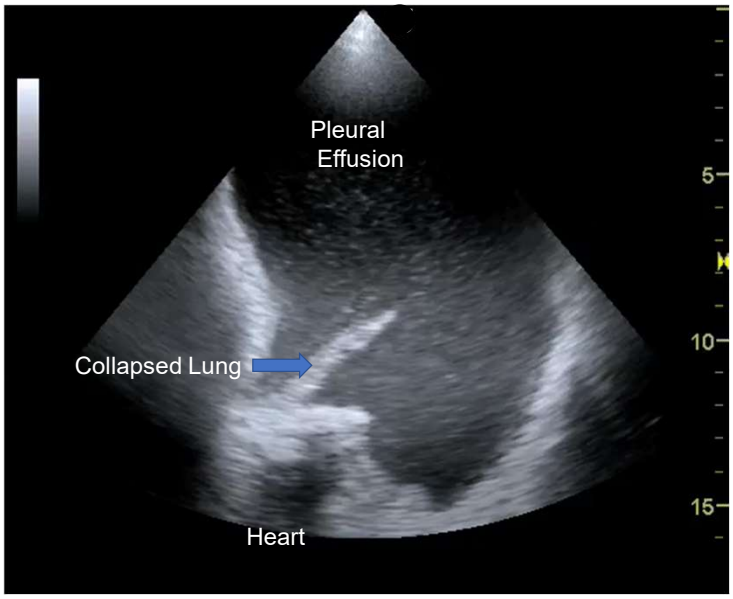
Plankton sign



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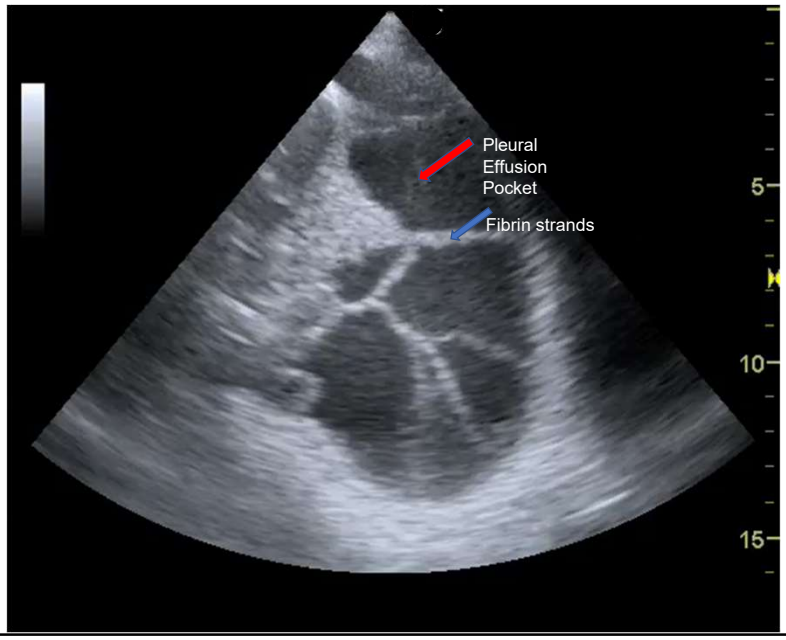
Loculated Pleural effusion



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Complications

- Pneumothorax
- Reexpansion pulmonary edema
- Intercostal artery laceration
- Bleeding
- Infection
- Vagal reaction

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REVIEW ARTICLE

Pneumothorax Following Thoracentesis

A Systematic Review and Meta-analysis

Craig E. Gordon, MD, MS; David Feller-Kopman, MD; Ethan M. Balk, MD, MPH; Gerald W. Smetana, MD

Background: Little is known about the factors related to the development of pneumothorax following thoracentesis. We aimed to determine the mean pneumothorax rate following thoracentesis and to identify risk factors for pneumothorax through a systematic review and meta-analysis.

Methods: We reviewed MEDLINE-indexed studies from January 1, 1966, through April 1, 2009, and included studies of any design with at least 10 patients that reported the pneumothorax rate following thoracentesis. Two investigators independently extracted data on the pneumothorax rate, risk factors for pneumothorax, and study methodological quality.

Results: Twenty-four studies reported pneumothorax rates following 6605 thoracenteses. The overall pneumothorax rate was 6.0% (95% confidence interval [CI], 4.6%-7.8%), and 34.1% of pneumothoraces required chest tube insertion. Ultrasonography use was associated with significantly lower risk of pneumothorax (odds ratio [OR], 0.3; 95% CI, 0.2-0.7). Lower pneumothorax rates were observed with experienced operators (3.9% vs 8.5%, $P = .04$), but this was nonsignificant within studies directly comparing this factor (OR, 0.7; 95% CI, 0.2-2.3). Pneumothorax was more likely following therapeutic thoracentesis (OR, 2.6; 95% CI, 1.8-3.8), in conjunction with periprocedural symptoms (OR, 26.6; 95% CI, 2.7-262.5), and in association with, although nonsignificantly, mechanical ventilation (OR, 4.0; 95% CI, 0.95-16.8). Two or more needle passes conferred a nonsignificant increased risk of pneumothorax (OR, 2.5; 95% CI, 0.3-20.1).

Conclusions: Iatrogenic pneumothorax is a common complication of thoracentesis and frequently requires chest tube insertion. Real-time ultrasonography use is a modifiable factor that reduces the pneumothorax rate. Performance of thoracentesis for therapeutic purposes and in patients undergoing mechanical ventilation confers a higher likelihood of pneumothorax. Experienced operators may have lower pneumothorax rates. Patient safety may be improved by changes in clinical practice in accord with these findings.

Arch Intern Med. 2010;170(4):332-339

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Complication Rate

Table 1 Complication rates of pleural aspiration by operator and image guidance

Ultrasound guidance	Operator	Frequency of post-procedure pneumothorax	Frequency that a chest drain was required post procedure	Frequency of dry tap/procedure failure
Yes	Radiologist in training	2.7%	1.8%	2.7%
Yes	Senior physician	3.6%	0.9%	3.2%
Yes	Radiologist	2.7%	0.5%	
No	Physician in training	15.0%	4.7%	12.9%
No	Senior physician	5.7%	1.4%	1.6%

The calculations and references used in this table are shown in appendix 1 in the online supplement.[132–134]

Thorax 2010;**65**(Suppl 2):ii61–ii76. doi:10.1136/thx.2010.137026

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Tension Pneumothorax

- Chest pain, hypotension, tachycardia
- Emergent needle decompression
- Use no smaller than 3.25 inch 14 gauge needle
- Smaller needle size associated with high failure rate
- 2nd intercostal space; mid-clavicular line

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2010 British Thoracic Society Guidelines

- Follow Up CXR?
- A chest x-ray after a simple pleural aspiration is not required unless air is withdrawn, the procedure is difficult, multiple attempts are required or the patient becomes symptomatic. (C)

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CHEST Original Research

PULMONARY PROCEDURES

Diagnosis of Pneumothorax by Radiography and Ultrasonography

A Meta-analysis

Wu Ding, MM; Yuehong Shen, MM; Jianxin Yang, MM; Xiaojun He, MM; and Mao Zhang, MD

Conclusions: "bedside ultrasound performed by clinicians had a higher sensitivity and similar specificity compared to CXR for the diagnosis of pneumothorax, but the accuracy of ultrasound depended on the skill of the operators."

Chest 2011; 140(4):859-866

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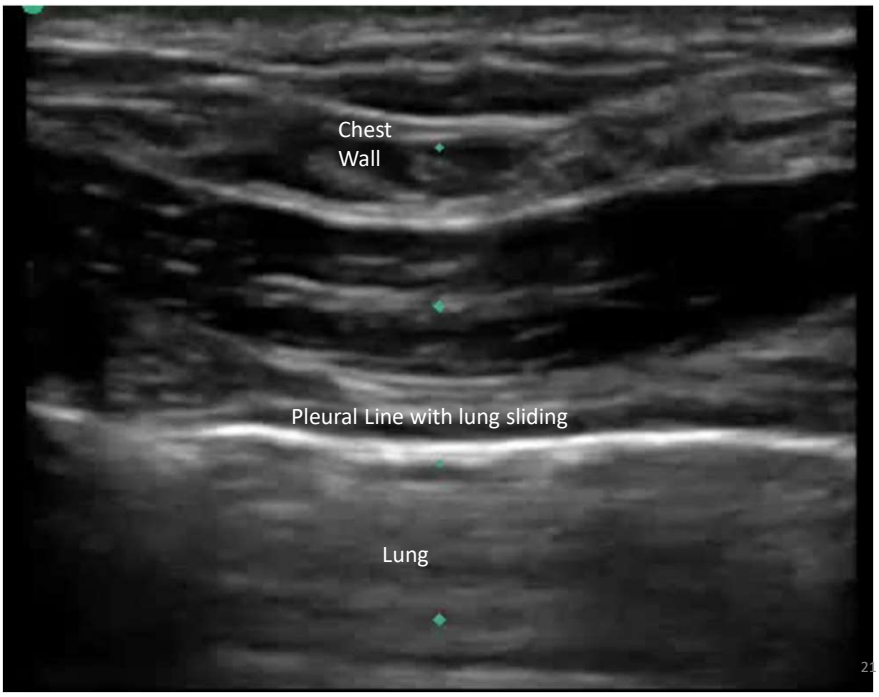

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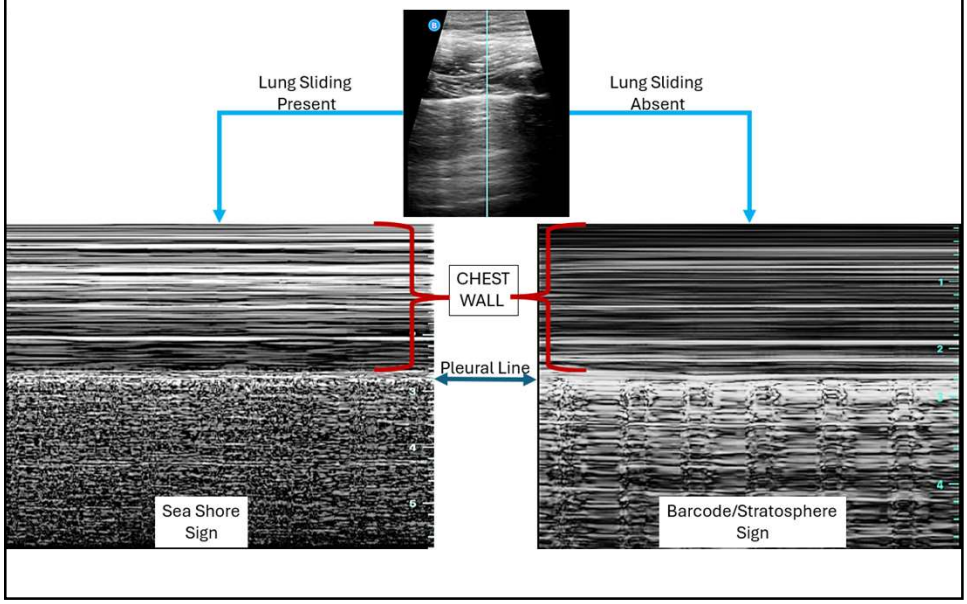
M-Mode at the Pleural Line



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Reexpansion Pulmonary Edema

- Very rare complication; mechanism unknown
- Dyspnea, tachypnea, cough, fever, tachycardia
- Unilateral pulmonary edema in lung that rapidly reexpands; can be bilateral
- Lung has typically been collapsed for ≥ 3 days
- Usually occurs within 3 hours of procedure; almost all by 24hrs
- May last 2-5 days
- "Rule of 3's"

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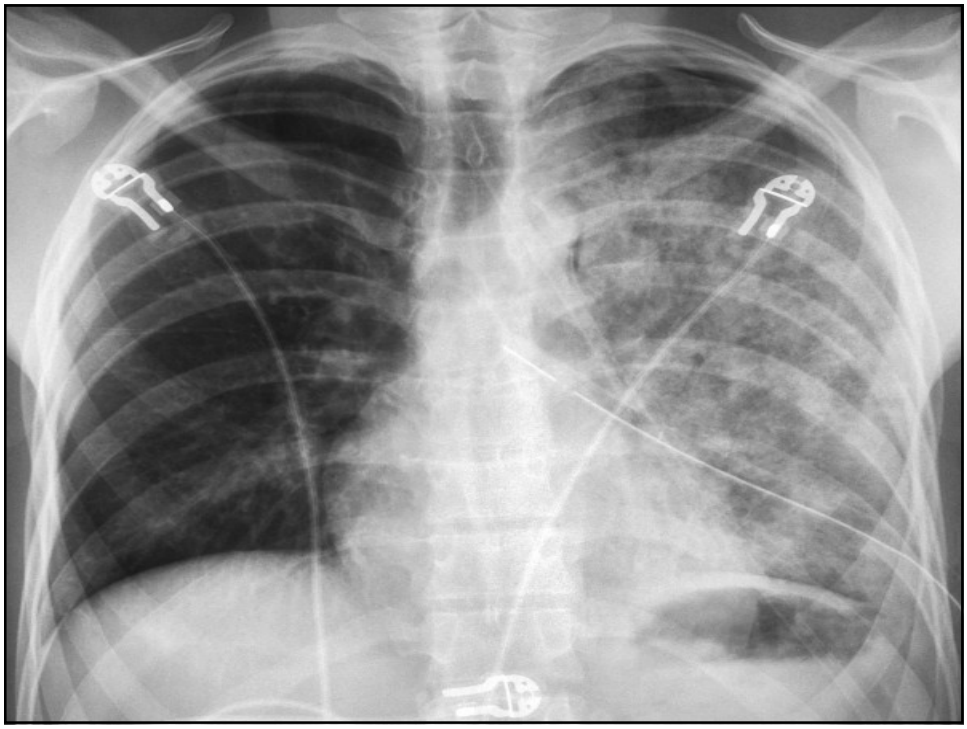

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Reexpansion Pulmonary Edema

Treatment

- Supportive care (oxygen, mechanical ventilation)
- Diuretics not routinely recommended

Prevention

- Limit fluid removal to 1-1.5 liters (myth)
- Keep pleural pressure > than -20 cm H20
- Chest tightness/discomfort correlates

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Large-Volume Thoracentesis and the Risk of Reexpansion Pulmonary Edema

David Feller-Kopman, MD, David Berkowitz, MD, Phillip Boiselle, MD, and Armin Ernst, MD

Departments of Interventional Pulmonology and Radiology, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts

Background. To avoid reexpansion pulmonary edema (RPE), thoracenteses are often limited to draining no more than 1 L. There are, however, significant clinical benefits to removing more than 1 L of fluid. The purpose of this study was to define the incidence of RPE among patients undergoing large-volume (≥1 L) thoracentesis.

Methods. One hundred eighty-five patients undergoing large-volume thoracentesis were included in this study. The volume of fluid removed, absolute pleural pressure, pleural elastance, and symptoms during thoracentesis were compared in patients who did and did not experience RPE.

Results. Of the 185 patients, 98 (53%) had between 1 L and 1.5 L withdrawn, 40 (22%) had between 1.5 L and 2 L withdrawn, 38 (20%) had between 2 L and 3 L withdrawn, and 9 (5%) had more than 3 L withdrawn. Only 1 patient (0.5%, 95% confidence interval: 0.01% to 3%) experienced clinical RPE. Four patients (2.2%, 95% confidence interval: 0.06% to 5.4%) had radiographic RPE (diagnosed only on postprocedure imaging without clinical symptoms). The incidence of RPE was not associated with the absolute change in pleural pressure, pleural elastance, or symptoms during thoracentesis.

Conclusions. Clinical and radiographic RPE after large-volume thoracentesis is rare and independent of the volume of fluid removed, pleural pressures, and pleural elastance. The recommendation to terminate thoracentesis after removing 1 L of fluid needs to be reconsidered: large effusions can, and should, be drained completely as long as chest discomfort or end-expiratory pleural pressure less than −20 cm H_2O does not develop.

(Ann Thorac Surg 2007;84:1656–62)

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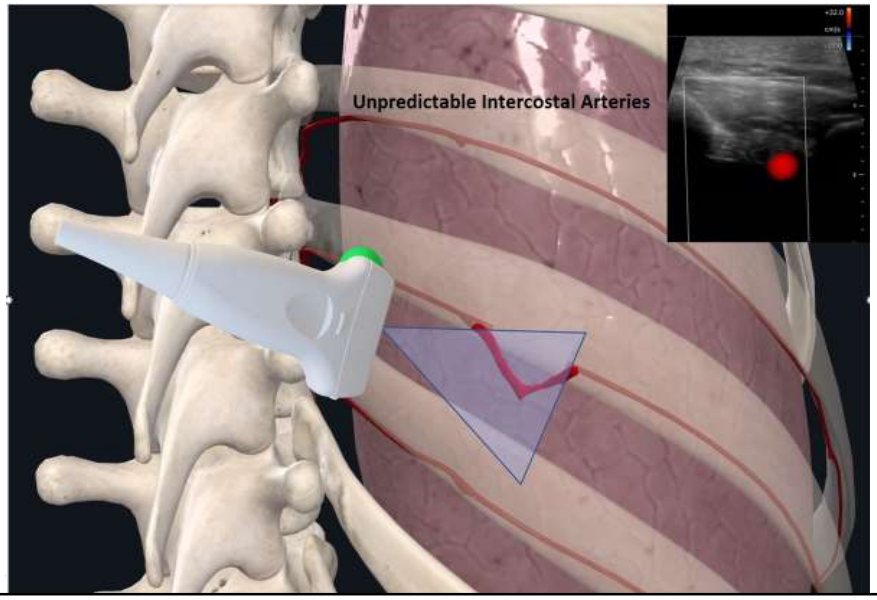
Intercostal Artery Laceration



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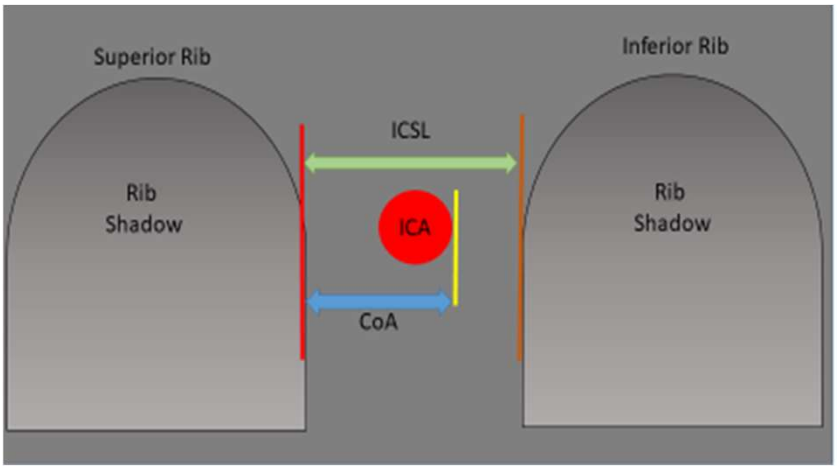
Intercostal Artery Laceration



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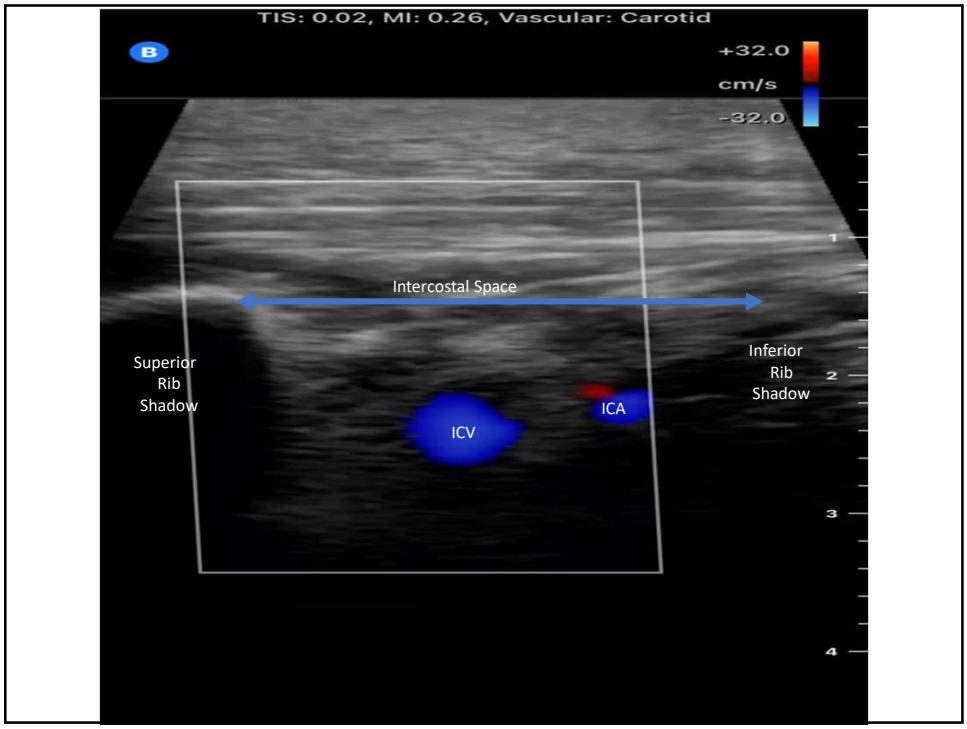
B
+32.0
cm/s
-32.0
Superior
Rib
Shadow
Intercostal Space
Inferior
Rib
Shadow
ICA
1
2
3

29


TIS: 0.02, MI: 0.26, Vascular: Carotid
B
+32.0
cm/s
-32.0
Intercostal Space
Superior
Rib
Shadow
Inferior
Rib
Shadow
ICA
ICV
1
2
3
4

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Thank You!

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