



The visceral response to thoracentesis: Predicting pleural apposition after thoracentesis with terminal pleural manometry

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Article:

Association between terminal pleural elastance and radiographic lung re-expansion after therapeutic thoracentesis in patients with symptomatic pleural effusion: a post-hoc analysis of a randomized trial

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The clinical question

Does a normal visceral pleural recoil (VPR), defined as terminal pleural elastance < 14.5 H₂O/L over the final 200 mL of pleural fluid aspirated, correlate with radiographic lung re-expansion on chest radiograph and by ultrasound?

AABIP take home message

This post hoc analysis of a previous randomized controlled trial including both malignant and nonmalignant effusions suggests that measurement of terminal pleural elastance does not correlate with a lenient definition of pleural apposition on chest radiograph nor with lung re-expansion on ultrasound. Radiographic lung re-expansion does not necessarily indicate normal pleural physiology. Prior studies have demonstrated poor pleurodesis success rates with both sclerosing agents and indwelling pleural catheters. There is speculation that this may be because radiographic lung expansion and subjective symptomatic improvement were used to enroll patients. There is some evidence to suggest that pleural elastance may be a better predictor of pleurodesis success, though further studies are required to investigate the relationship between VPR and pleurodesis success.

Background

Durable treatment response in the form of pleurodesis is often sought for symptomatic, recurrent malignant pleural effusions to decrease symptomatic burden and reduce hospitalizations. Pleural apposition is required to achieve this desired effect. Unfortunately, lung re-expansion as determined by chest radiography and ultrasound have not led to high

rates of pleurodesis success. This has been demonstrated in the ASAP trial in which daily indwelling pleural catheter drainage showed improvement over every other day drainage at 47 vs 24% and in the IPC-PLUS trial in which IPC plus talc demonstrated improvement over IPC drainage alone at 43 vs 23% pleurodesis at day 35. Both studies demonstrated below 50% pleurodesis success rates, and both used radiographic lung re-expansion as their inclusion criteria.

This is as opposed to the results of Lan et al published in Annals of Internal Medicine in 1997 where pleural elastance >19 cm H₂O/L was associated with a higher incidence of trapped lung (11 of 14 patients) and pleural elastance <19 cm H₂O/L was associated with a lower incidence of trapped lung (3 of 51 patients) after 500 mL of malignant pleural fluid aspiration. The discordance between chest radiograph and pleural elastance has been previously observed. Chopra et al in their study in Chest 2020 showed that 28% of patients with lung re-expansion on post thoracentesis chest radiograph ($>90\%$ apposition) had an elevated pleural elastance (>14.5 cm H₂O/L) and 34% of patients who had incomplete lung expansion on chest radiograph had a normal pleural elastance.

The authors of our study set out to evaluate further the relationship between terminal pleural elastance and lung re-expansion on both chest radiograph and ultrasound.

Study Design

Study Design

- Retrospective analysis of a previous prospective randomized trial at two university hospitals in the United States.
 - Pleural pressure was measured using a single-use digital manometer just after thoracentesis catheter placement, after every 100 mL aspirated for the first liter and then after every 200 mL thereafter.
 - Pleural pressure was recorded at the end of expiration.
 - Procedure was stopped when no further fluid could be aspirated, persistent cough or chest discomfort developed or when pleural pressure became lower than -20 cm H₂O.
 - Bedside thoracic ultrasound was performed for all patients and a post procedure chest radiograph for all patients who reported.
 - Lungs were considered re-expanded by chest radiography if there was $\geq 75\%$ pleural apposition on assessment by two investigators and by ultrasound if no more than scant pleural fluid remained assessed by the operator and confirmed by a second investigator on saved post-procedure images.
 - Terminal pleural elastance, termed visceral pleural recoil (VPR), was documented as the pleural elastance over the final 200 mL.
 - The last measurement was discarded if no pleural fluid was present on ultrasound to avoid interference by local pleural deformation forces.
 - VPR greater than 14.5 cm H₂O/L was considered abnormally elevated

Primary outcome:

- Concordance of radiographic re-expansion of lung by chest radiograph and thoracic ultrasound with a normal VPR (< 14.5 cmH₂O/L)

Secondary Outcomes:

- Mean VPR in those with and without radiographic re-expansion
- Sensitivity, specificity, and PPV of radiographic re-expansion for normal VPR

Intervention(s):

- Post-hoc analysis of a prospective randomized controlled trial.

Population

Inclusion criteria

- Patients 18 years of age with pleural effusion of any cause undergoing therapeutic thoracentesis
- Estimated pleural effusion volume of at least 500 mL based on radiography

Exclusion criteria

- Effusions deemed unlikely to be free-flowing
- Patients unable to maintain a seated position
- Coagulopathy
- Hemodynamic instability
- Patients deemed high risk by the operator
- Patients unable to provide informed consent

Baseline Characteristics

- 61 patients undergoing large volume thoracentesis for any cause
- Age 66.7 (SD 11.8)
- Male 32 (52%)
- Setting:
 - Outpatient 38 (62%)
 - ED 1 (2%)
 - Inpatient ward 21 (34%)
 - Inpatient ICU 1 (2%)
- Prior thoracentesis 24 (39%)
- Previously known effusion etiology
 - Malignant 18 (29%)
 - Chylous 1 (2%)
 - Fibrinopleuritis with entrapment 1 (2%)
 - Non-specific pleuritis 1 (2%)
- Comorbidities
 - Malignancy 39 (64%)
 - Heart Failure 4 (6%)
 - CKD 3 (5%)

Outcomes

Primary outcomes:

- There was no significant difference in VPR in expandable vs non-expandable lungs by CXR (28.6 ± 21.6 cm H₂O/L vs 34.1 ± 34.4 , $p=0.49$) or by ultrasound (34.4 ± 29.2 vs 33.4 ± 36.9 , $p=0.91$)

Secondary outcomes:

- Lung re-expansion occurred in 34 of 61 patients (55.7% by ultrasound) and 35 of 51 (68.6%) by chest radiograph with a concordance of 86% (44 of 51 patients who obtained both ultrasound and radiograph)
- VPR was abnormally elevated in 44 of 61 patients (70.4%) overall
- VPR was elevated in 25 of 35 (71.4%) of those with expandable lung by radiograph vs 11 of 16 (68%) of those not expandable ($p=0.85$)
- VPR was elevated in 26 of 34 (76%) expandable by ultrasound vs 17 of 27 (63%) of those not expandable ($p=0.25$)
- The sensitivity, specificity, and PPV of radiographic lung re-expansion for normal VPR were 44.4%, 39.5% and 23.5%, respectively

Adverse events:

- No adverse events were related to the post-hoc analysis
- In the initial study there were no serious complications reported. There were 6 of 62 patients in the control group with asymptomatic pneumothorax ex vacuo in the control group (without manometry) vs 0 in the manometry group in that study.

Commentary

In this study retrospectively examining the relationship between terminal pleural elastance (VPR) and lung re-expansion on both chest radiography and ultrasound, there was no significant correlation found. This study was the first study to examine this relationship in both malignant and nonmalignant effusions as well as through ultrasound evaluation. This has wide reaching implications for both clinical practice and clinical trial enrollment.

Prior studies have shown poor correlation of radiographic findings with successful pleurodesis rates. There is also evolving literature demonstrating that pleural elastance may correlate better with lung re-expansion and successful pleurodesis rates. Further evaluation through randomized controlled trials will need to be performed to evaluate if terminal pleural elastance indeed predicts pleurodesis success.

Funding

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- Proprietor of the inline single-use digital manometer used in the trial

Suggested Reading

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Article citation

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