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**BRIEF ANSWERS
TO SPECIFIC
CLINICAL
QUESTIONS**

Q: Is chest radiography routinely needed after thoracentesis?

A: No. After thoracentesis, chest radiography or another lung imaging study should be done only if pneumothorax is suspected, if thoracentesis requires more than 1 attempt, if the patient is on mechanical ventilation or has pre-existing lung disease, or if a large volume ($> 1,500$ mL) of fluid is removed. Radiography is also usually not necessary after diagnostic thoracentesis in a patient breathing spontaneously. In most cases, pneumothorax found incidentally after thoracentesis does not require decompression and can be managed supportively.

■ WHAT ARE THE RISKS OF THORACENTESIS?

Thoracentesis is a minimally invasive procedure usually performed at the bedside that involves insertion of a needle into the pleural cavity for drainage of fluid.¹ Diagnostic thoracentesis should be done in most cases of a new pleural effusion unless the effusion is small and with a clear diagnosis, or in cases of typical heart failure.

Therapeutic thoracentesis, often called large-volume thoracentesis, aims to improve symptoms such as dyspnea attributed to the pleural effusion by removing at least 1 L of pleural fluid. The presence of active respiratory symptoms and suspicion of infected pleural effusion should lead to thoracentesis as soon as possible.

Complications of thoracentesis may be benign, such as pain and anxiety associated with the procedure and external bleeding at the site of needle insertion. Pneumothorax is the most common serious procedural complication and the principal reason to order postprocedural chest radiography.¹ Less common complications

include hemothorax, re-expansion pulmonary edema, infection, subdiaphragmatic organ puncture, and procedure-related death. Bleeding complications and hemothorax are rare even in patients with underlying coagulopathy.²

Point-of-care pleural ultrasonography is now considered the standard of care to guide optimal needle location for the procedure and to exclude other conditions that can mimic pleural effusion on chest radiography, such as lung consolidation and atelectasis.³ High proficiency in the use of preprocedural point-of-care ultrasonography reduces the rate of procedural complications, though it does not eliminate the risk entirely.^{3,4}

Factors associated with higher rates of complications include lack of operator proficiency, poor understanding of the anatomy, poor patient positioning, poor patient cooperation with the procedure, lack of availability of bedside ultrasonography, and drainage of more than 1,500 mL of fluid. Addressing these factors has been shown to decrease the risk of pneumothorax and infection.¹⁻⁵

■ HOW OFTEN DOES PNEUMOTHORAX OCCUR AFTER THORACENTESIS?

Several early studies have examined the incidence of pneumothorax after thoracentesis. Lack of ultrasonography use likely explains a higher incidence of complications in early studies: rates of pneumothorax after thoracentesis without ultrasonographic guidance ranged from 5.2% to 26%.^{6,7}

Gervais et al⁸ analyzed thoracentesis with ultrasonographic guidance in 434 patients, 92 of whom were intubated, and reported that pneumothorax occurred in 10 patients, of whom 6 were intubated. Two of the intubated patients required chest tubes. Other studies

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have confirmed the low incidence of pneumothorax in patients undergoing thoracentesis, with rates such as 0.61%,¹ 5%,⁹ and 4%.¹⁰

The major predictor of postprocedural pneumothorax was the presence of symptoms such as chest pain and dyspnea. No intervention was necessary for most cases of pneumothorax in asymptomatic patients. The more widespread use of procedural ultrasonography may explain some discrepancies between the early^{5,6} and more recent studies.^{1,8-10}

Several studies have demonstrated that postprocedural radiography is unnecessary unless a complication is suspected based on the patient's symptoms or the need to demonstrate lung re-expansion.^{1,4,9,10} Clinical suspicion and the patient's symptoms are the major predictors of procedure-related pneumothorax requiring treatment with a chest tube. Otherwise, incidentally discovered pneumothorax can usually be observed and managed supportively.

■ WHAT MECHANISMS UNDERLIE POSTPROCEDURAL PNEUMOTHORAX?

Major causes of pneumothorax in patients undergoing thoracentesis are direct puncture during needle or catheter insertion, the introduction of air through the needle or catheter into the pleural cavity, and the inability of the ipsilateral lung to fully expand after drainage of a large volume of fluid, known as pneumothorax ex vacuo.⁵

Pneumothorax ex vacuo may be seen in patients with medical conditions such as endobronchial obstruction, pleural scarring from long-standing pleural effusion, and lung malignancy, all of which can impair the lung's ability to expand after removal of a large volume of pleural fluid. It is believed that transient parenchymal pleural fistulae form if the lung cannot expand, causing air leakage into the pleural cavity.^{5,8,9} Pleural manometry to monitor changes in pleural pressure and elastance can decrease the rates of pneumothorax ex vacuo in patients with the above risk factors.⁵

■ WHEN IS RADIOGRAPHY INDICATED AFTER THORACENTESIS?

Current literature suggests that imaging to evaluate for postprocedural complications should be done if there is suspicion

of a complication, if thoracentesis required multiple attempts, if the procedure caused aspiration of air, if the patient has advanced lung disease, if the patient is scheduled to undergo thoracic radiation, if the patient is on mechanical ventilation, and after therapeutic thoracentesis if a large volume of fluid is removed.¹⁻¹⁰ Routine chest radiography after thoracentesis is not supported in the literature in the absence of these risk factors.

Some practitioners order chest imaging after therapeutic thoracentesis to assess for residual pleural fluid and for visualization of other abnormalities previously hidden by pleural effusion, rather than simply to exclude postprocedural pneumothorax. Alternatively, postprocedural bedside pleural ultrasonography with recording of images can be done to assess for complications and residual pleural fluid volume without exposing the patient to radiation.¹¹

Needle decompression and chest tube insertion should be considered in patients with tension pneumothorax, large pneumothorax (distance from the chest wall to the visceral pleural line of at least 2 cm), mechanical ventilation, progressing pneumothorax, and symptoms.

■ KEY POINTS

- Pneumothorax is a rare complication of thoracentesis when performed by a skilled operator using ultrasonographic guidance.
- Mechanisms behind the occurrence of pneumothorax are direct lung puncture, introduction of air into the pleural cavity, and pneumothorax ex vacuo.
- In asymptomatic patients, pneumothorax after thoracentesis rarely requires intervention beyond supportive care and close observation.
- Factors such as multiple thoracentesis attempts, symptoms, clinical suspicion, air aspiration during thoracentesis, presence of previous lung disease, and removal of a large volume of fluid may require postprocedural lung imaging (eg, bedside ultrasonography, radiography).

REFERENCES

1. Ault MJ, Rosen BT, Scher J, Feinglass J, Barsuk JH. Thoracentesis outcomes: a 12-year experience. *Thorax* 2015; 70(2):127–132. doi:10.1136/thoraxjnl-2014-206114
2. Hibbert RM, Atwell TD, Lekah A, et al. Safety of ultrasound-guided thoracentesis in patients with abnormal preprocedural coagulation parameters. *Chest* 2013; 144(2):456–463. doi:10.1378/chest.12-2374
3. Barnes TW, Morgenthaler TI, Olson EJ, Hesley GK, Decker PA, Ryu JH. Sonographically guided thoracentesis and rate of pneumothorax. *J Clin Ultrasound* 2005; 33(9):442–446. doi:10.1002/jcu.20163
4. Gordon CE, Feller-Kopman D, Balk EM, Smetana GW. Pneumothorax following thoracentesis: a systematic review and meta-analysis. *Arch Intern Med* 2010; 170(4):332–339. doi:10.1001/archinternmed.2009.548
5. Heidecker J, Huggins JT, Sahn SA, Doelken P. Pathophysiology of pneumothorax following ultrasound-guided thoracentesis. *Chest* 2006; 130(4):1173–1184. doi: 10.1016/S0012-3692(15)51155-0
6. Brandstetter RD, Karetzky M, Rastogi R, Lolis JD. Pneumothorax after thoracentesis in chronic obstructive pulmonary disease. *Heart Lung* 1994; 23(1):67–70. pmid:8150647
7. Doyle JJ, Hnatiuk OW, Torrington KG, Slade AR, Howard RS. Necessity of routine chest roentgenography after thoracentesis. *Ann Intern Med* 1996; 124(9):816–820. pmid:8610950
8. Gervais DA, Petersein A, Lee MJ, Hahn PF, Saini S, Mueller PR. US-guided thoracentesis: requirement for postprocedure chest radiography in patients who receive mechanical ventilation versus patients who breathe spontaneously. *Radiology* 1997; 204(2):503–506. doi:10.1148/radiology.204.2.9240544
9. Capizzi SA, Prakash UB. Chest roentgenography after outpatient thoracentesis. *Mayo Clin Proc* 1998; 73(10):948–950. doi:10.4065/73.10.948
10. Alemán C, Alegre J, Armadans L, et al. The value of chest roentgenography in the diagnosis of pneumothorax after thoracentesis. *Am J Med* 1999; 107(4):340–343. pmid:10527035
11. Lichtenstein D. Lung ultrasound in the critically ill. *Curr Opin Crit Care* 2014; 20(3):315–322. doi:10.1097/MCC.0000000000000096

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