PNEUMOTHORAX

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INTRODUCTION

Pneumothorax refers to the presence of air or gas in the pleural space—the area between the visceral and parietal pleura of the thoracic cavity. This accumulation can disrupt normal lung expansion, impairing ventilation and oxygenation. It may occur spontaneously, due to trauma, or as a complication of medical interventions. Tension pneumothorax is a rapidly progressive and potentially fatal condition in which trapped air accumulates under pressure, leading to severe respiratory distress, mediastinal shift, and hemodynamic instability [1]. This is a rare but potentially serious complication that can occur when performing procedures near the pleura.

TYPICAL PRESENTATION

Case 1

A 76-year-old asthenic woman with a history of migraine and myofascial pain presented to the procedure room for multiple trigger point injections involving the trapezius, levator scapulae, rhomboids, and cervical and upper thoracic paraspinals. She had a history of coronary artery disease (status post coronary artery bypass graft surgery 2 years ago), stable heart failure, hypertension, and chronic obstructive pulmonary disease. She was taking lisinopril, aspirin, and ipratropium nasal spray and had no known allergies. She had a 40-pack-year smoking history. Vitals: weight 45 kg (BMI = 18), BP 140/85, HR 76, RR 18, SpO_2 94% on room air.

Ten cervical and thoracic trigger point injections were performed using 1 mL of 0.25% bupivacaine per site with a 27G 1¼-inch needle. Twenty minutes later, the physician was called to the recovery room. The patient complained of shortness of breath and dizziness and appeared agitated. She subsequently became tachycardic, tachypneic, hypotensive, and her oxygen saturation dropped.

Case 2

An 82-year-old woman with a history of T6 and T7 vertebral body fractures (1 year ago) presented for bilateral T5-7 medial branch radiofrequency neurotomy following successful diagnostic blocks. She had a similar medical history and medication profile to the prior patient, including a 40-pack-year smoking history. Vitals: weight 45 kg (BMI = 18), BP 140/85, HR 76, RR 18, SpO_2 94% on room air.

The procedure was performed using fluoroscopic guidance with 16-gauge, 10-cm needles with 10-mm active tips. Twenty minutes later, she reported chest pain and shortness of breath. She then developed tachycardia, tachypnea, hypotension, and decreased oxygen saturation.

CLINICAL PRESENTATION

The clinical presentations of pneumothorax range from asymptomatic to life-threatening emergencies, depending on factors such as air volume, rate of accumulation, and the patient's underlying respiratory status. The most common symptoms include chest pain and dyspnea, reported in 64% to 85% of cases, respectively [2]. Cough may also occur, but it is less common. Chest pain is typically sudden, unilateral (although rarely bilateral), sharp or stabbing, pleuritic, and possibly radiating to the ipsilateral shoulder or arm.

Physical exam findings depend on the size of the pneumothorax. Small pneumothoraces may have normal findings. Larger pneumothoraces may present with decreased or absent breath sounds, reduced tactile fremitus, and hyperresonant percussion on the affected side. A patient is considered clinically stable if they are able to speak comfortably without signs of respiratory distress, maintain normal blood pressure, have a heart rate between 60–120 beats per minute, a respiratory rate under 24 breaths per minute, and an oxygen saturation above 90% while breathing room air [3].

Tension pneumothorax is a life-threatening emergency resulting in an unstable patient and requiring immediate intervention [4]. It causes the progressive accumulation of air under pressure due to a one-way valve mechanism, resulting in mediastinal shift, compression of the vena cava, and reduced cardiac output. Clinically, tension pneumothorax presents with chest pain, tachypnea, hypotension, hypoxia, tachycardia, tracheal deviation, and jugular venous distension; without prompt treatment, it can result in hemodynamic collapse and death.

DIAGNOSIS

The Society of Critical Care Medicine recommends using ultrasound to complement or replace conventional chest radiography for diagnosing pneumothorax, depending on the clinical context and the need for rapid results [5]. This recommendation is based on evidence that ultrasound has higher sensitivity (exceeding 85%) and specificity (up to 99%) compared to chest radiography, which has a sensitivity of only 30–75% in emergency department (ED) and intensive care unit (ICU) settings [5]. The ultrasound findings suggestive of pneumothorax include the absence of pleural (lung) sliding (*see Figure 1*), the absence of B-lines (comet-tail artifacts) (*see Figure 2*), and the presence of one or more lung points.

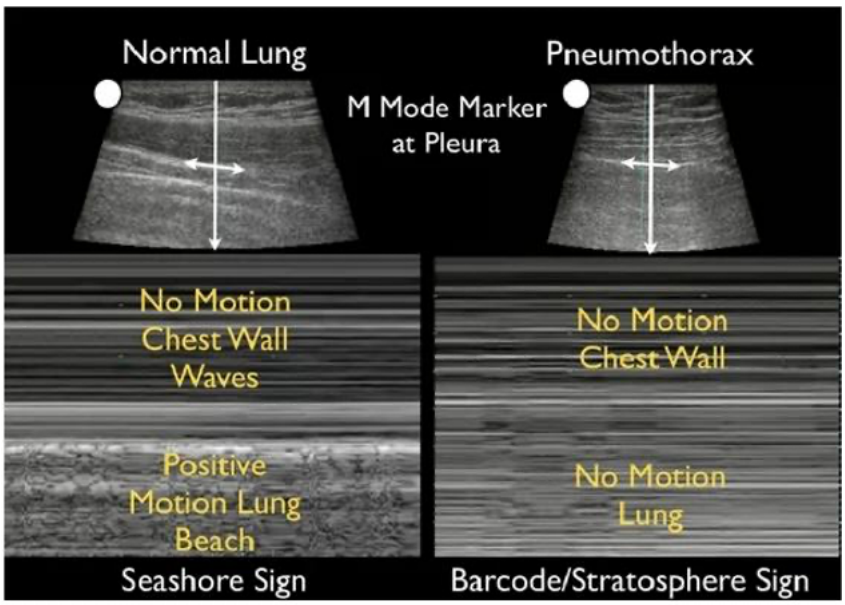

Figure 1. Seashore Sign and Stratosphere Sign.
Seif D, Perera P, Mailhot T, Riley D, Mandavia D. Bedside ultrasound in resuscitation and the rapid ultrasound in shock protocol. Crit Care Res Pract. 2012;2012:503254. doi: 10.1155/2012/503254. Epub 2012 Oct 24. PMID: 23133747; PMCID: PMC3485910.
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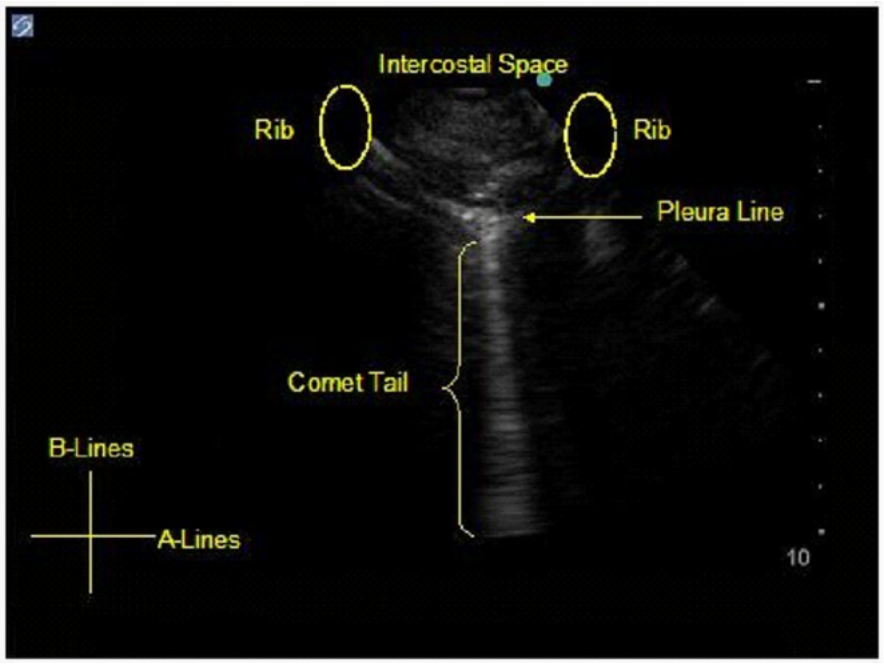


Figure 2. Comet Tail B-Lines.
Summerfield DT, Johnson BD. Lung ultrasound comet tails – technique and clinical significance. Hot Topics in Echocardiography. 2013. InTech. Doi: 10.5772/56198.
(Available at: **https://www.intechopen.com/chapters/44070**)

While not appropriate for unstable patients, a CT scan is the criterion standard for detailed imaging, especially for small or loculated pneumothoraces.

Differential diagnosis of acute chest pain and/or dyspnea:

- Asthma/COPD Exacerbation: Bilateral wheezing, prolonged expiratory phase
- Myocardial Infarction/Angina: Crushing, non-pleuritic chest pain; radiation to arm/jaw; diaphoresis
- Pneumonia: Fever, cough, sputum production, localized crackles
- Pulmonary Embolism: Sudden dyspnea, pleuritic chest pain, hemoptysis, risk factors [surgery, deep vein thrombosis (DVT), immobility]
- Anxiety/Panic Attack: Normal physical exam and imaging
- Local Anesthetic Systemic Toxicity (LAST): Peri-oral numbness, tinnitus, seizures, or arrhythmias following an excessive dose of local anesthetic or injection into the carotid/vertebral artery or highly-perfused area

EMERGENCY PROTOCOL

For stable patients with a small pneumothorax:

- Administer supplemental oxygen (10–15 L/min via face mask)
- Transfer to a higher level of care for at least 6 hours of observation

For suspected tension pneumothorax (unstable patients) [6]:

- Activate emergency medical services (EMS) immediately (call 911 or local equivalent)
- Oxygen: 100% via a non-rebreather
- Needle Decompression [7]: Consider needle aspiration or transfer to an appropriate medical center for potential decompression of the pleural space or chest tube placement [3].
  - Avoid positive-pressure ventilation before decompression, as it can worsen a pneumothorax.
- Transport: Arrange immediate transfer to a hospital for monitoring and definitive management (*e.g.*, chest tube placement).

Follow-up

- Notify the patient's emergency contact or family.
- Debrief the team and review procedures to prevent future occurrences.

RISK MITIGATION/PREVENTION

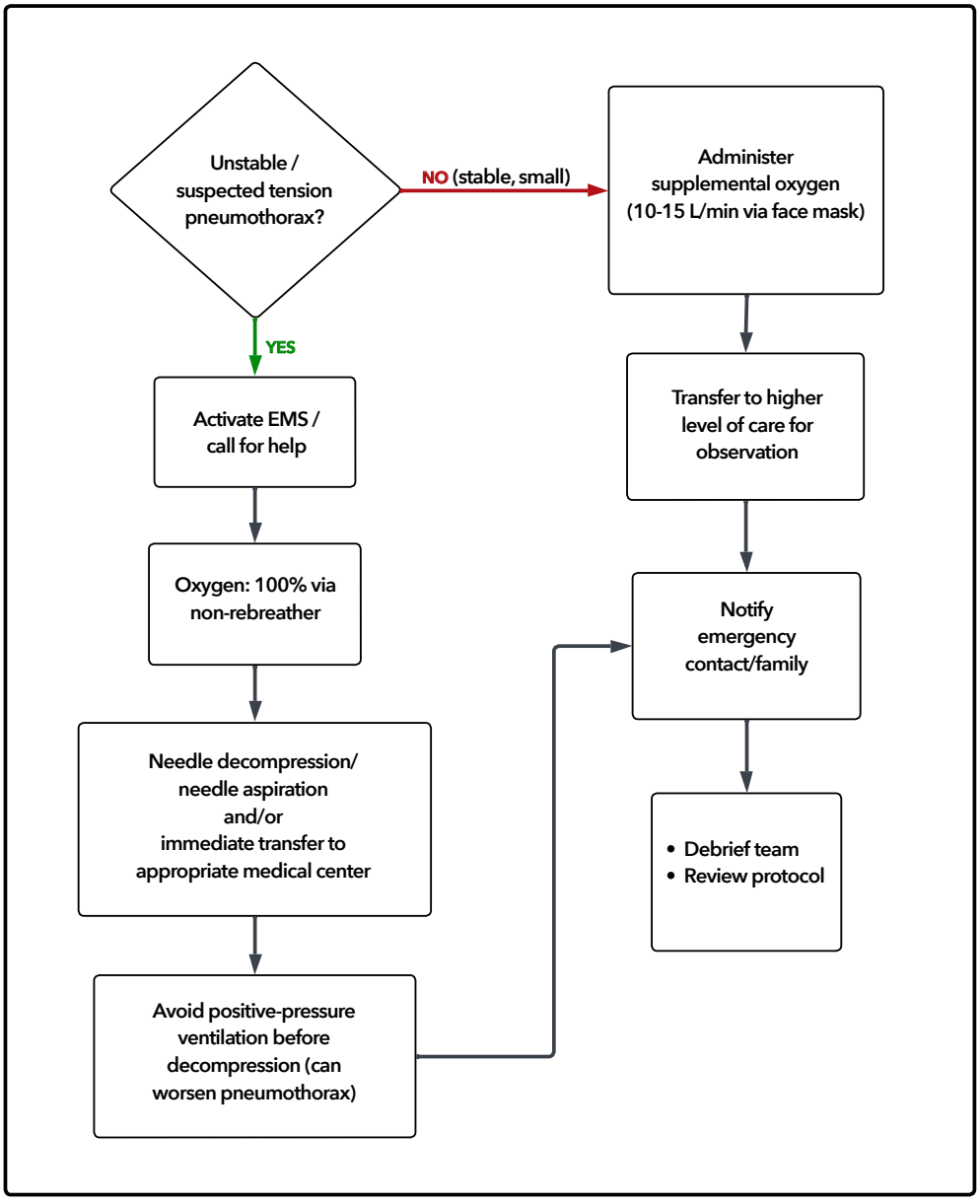
- Use appropriate needle depth and anatomical landmarks.
  - In Case 1, performing myofascial blocks over the chest cavity introduces the risk of pneumothorax, especially if using a > 1-inch needle in an asthenic woman. A risk/benefit analysis and informed consent should be performed.
- When applicable, consider using ultrasound guidance to identify and avoid the pleura. If ultrasound is not suitable, consider alternative imaging methods such as fluoroscopy or CT [8].
  - In Case 2, poor radiofrequency cannula placement technique directly led to the pneumothorax. Using careful fluoroscopic technique would have prevented this emergency and complication [3].
- Recognize high-risk patient factors:
  - Underlying lung disease [e.g., chronic obstructive pulmonary disease (COPD), asthma, interstitial lung disease (ILD), cystic lung disease)
  - Thin body habitus (less soft tissue protection)
  - Advanced age (fragile tissue)
  - Smoking history (presence of blebs or bullae)

  Each of the patients had these risk factors, increasing their susceptibility to iatrogenic pneumothorax.
- Regardless of the service site, the facility should be appropriately equipped to manage emergencies (see ***Advance Preparation for Emergencies*** [9]).

KEY CONSIDERATIONS/TAKEAWAYS

- Pneumothorax refers to air in the pleural space, which can result in lung collapse.
- Cardinal symptoms of pneumothorax include sudden pleuritic chest pain and dyspnea.
- Tension pneumothorax is a medical emergency resulting in tachycardia, tachypnea, hypoxia, and hypotension. Physical exam findings include decreased breath sounds unilaterally (rarely bilateral), hyperresonance, decreased tactile fremitus, jugular venous distention (JVD), and tracheal deviation.
- Imaging:
  - Ultrasound: absence of pleural sliding, B-lines, and presence of lung points
  - Chest X-ray (CXR): shows pleural line without lung markings
  - Point-of-care Ultrasound (POCUS): higher sensitivity than CXR
  - CT: most accurate, but not for unstable patients
- Management:
  - Small/stable: provide oxygen and observe
  - Large/symptomatic: requires needle aspiration or chest tube
  - Tension: requires immediate decompression

SUSPECTED PNEUMOTHORAX



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