WHERE IS THE BUBBLE: ATYPICAL AND UNUSUAL THORACIC AIR

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LEARNING OBJECTIVES

- To review unusual and atypical conditions with presence of air in the thorax.
- To describe the radiological findings that allows diagnosis on chest radiography and multislice CT in these patients.
- To emphasize the importance of diagnosis for management of these patients and its clinical impact.
CONTENT: Location of the thoracic air

MEDIASTINAL: spontaneous (with pneumorrhachis and related to interstitial lung disease), pneumoperitoneum with pneumomediastinum, bronchial or esophageal fistula post-lymph node perforation.

PERICARDIAL: related to progression of lung neoplasm or lung transplantation.

CARDIOVASCULAR: air embolism.

PLEURAL: related to interstitial lung disease, lung neoplasm or mesothelioma, infections, and bilateral pneumothorax post-lung biopsy.

CHEST WALL: intercostal hernias with pulmonary or gastrointestinal content, infections, and subcutaneous emphysema of unusual causes (post-pulmonary biopsy).
# MEDIASTINAL: Pneumomediastinum

## PNEUMOMEDIASTINUM (PM)

### CONCEPT AND PATHOGENESIS:
Free air or gas in mediastinum. Spontaneous PM pathogenesis by “Macklin Effect”: Air ruptures from the alveolus to the perivascular and peribronchial fascial sheath (due to pressure gradient between alveoli and interstitium). Continued insufflation causes air overflow into the retroperitoneum, anterior mediastinum, and subcutaneous tissues of the neck and chest wall.

### ANATOMY:
Communication of mediastinum with:
1. Neck: Submandibular space, retropharyngeal space, and vascular sheaths.
2. Retroperitoneum: Sternocostal attachment of the diaphragm (continuous with flanks and pelvis), and periaortic and periesophageal plane.

### CAUSES:
Spontaneous or secondary.
Potential sources:
1. Intrathoracic: Trachea and main bronchi, esophagus, lung, pleural space, or gas-forming bacteria.
2. Extrathoracic: Head and neck, and intraperitoneum and retroperitoneum.

### DIAGNOSTIC IMAGING:
1. Chest radiograph: Pneumoprecardium, ring around the artery sign (air surrounding right pulmonary artery), tubular artery sign, double bronchial wall sign, continuous diaphragm sign, or extrapleural sign.
2. CT: Specially useful in central airways or esophageal injuries.
# SPECIAL CONDITIONS OF MEDIASTINAL AIR

## SPONTANEOUS PM WITH PNEUMORRHACHIS:
Pneumorrhachis consists on air within spinal canal. Most often from trauma or spine surgery, but also with spontaneous PM (9.5% pediatric patients with spontaneous PM). Extension of the air along the fascial planes of the submandibular and retropharyngeal spaces through the neural foramina into the epidural space. Usually, asymptomatic and self-limited.

## SPONTANEOUS PM RELATED TO INTERSTITIAL LUNG DISEASE:
11.2% of extra-alveolar air in CT (pneumothorax and PM) in one series of patients with idiopathic pulmonary fibrosis. Clinical manifestations from asymptomatic to severe respiratory insufficiency.

## PM WITH PNEUMORETROPERITONEUM:
Dissection of the air into mediastinum from the retroperitoneal space following perforation of a hollow viscus.

## TRACHEAL RUPTURE:
15-27% of all tracheobronchial injury. High morbidity and mortality. Causes: blunt chest trauma or intubation. Diagnosis delayed as a result of rare incidence, and nonspecific clinical and radiologic manifestations. Predominantly, membranous portion of the intrathoracic trachea involved. Diagnostic imaging:
2. CT: Focal defect or circumferential absence of tracheal wall, contour deformity, abnormal communication with other mediastinal structures, overdistention of the endotracheal tube balloon or herniation of endotracheal tube balloon, and extraluminal position of endotracheal tube.
MEDIASTINAL: Spontaneous PM with pneumorrhachis

Fig. 1. 63 y.o. woman with dyspnoea. Chest radiograph showed air delimiting the aortic knob and subcutaneous emphysema in frontal projection (white arrows). Lateral projection of the chest radiograph demonstrated air outlining the anterior wall of the intrathoracic trachea and bronchi and the anterior cardiac border (pneumoprecardium) (white arrows). CT clearly depicts the extension of air into the spinal canal (black arrows). This patient was diagnosed of spontaneous PM with pneumorrhachis. Follow-up CT demonstrated resolution of all of these radiological findings.
MEDIASTINAL: PM related to interstitial lung disease

Fig. 2. 68 y.o. woman with UIP (Usual Interstitial Pneumonia) diagnosis 5 years ago. Worsening of respiratory symptoms with small efforts dyspnoea. Spontaneous pneumomediastinum (black arrows) and increase in the extension of ground glass opacities in relation to interstitial pneumonia progression with respect to previous CT 2 months ago.
MEDIASTINAL: PM related of perforation of sigma

Fig. 3. 70 y.o. man with fever and abdominal pain on the left flank. CT showed bilateral pulmonary nodules and PM (black arrows). Multiplanar reconstruction on sagital and coronal planes clearly demonstrated the passage of intra-abdominal air through the esophageal hiatus (white arrows). CT also demonstrated pneumoperitoneum caused by sigma perforation probably related to diverticulitis (white arrows).
Fig 4. 36 y.o. woman. Autolysis attempt with benzodiazepines intake. Acute respiratory insufficiency with progressive respiratory deterioration and chest and cervicofacial subcutaneous emphysema after intubation. Chest radiograph showed massive subcutaneous emphysema, endotracheal tube balloon overdistention (white arrows) with distal end located into proximal segment of the left main bronchus (black arrow). CT showed bilateral pneumothorax, endotracheal tube balloon overdistention (white arrow) and posterior tracheal wall deformity due to tracheal rupture, specially evident on MinIP reformatted images (black arrow). Treatment consisted in double chest tube insertion for bilateral pneumothorax and selective intubation of right main bronchus with succesful extubation after 36 hours.
MEDIASTINAL

SPECIAL CONDITIONS OF MEDIASTINAL AIR

DEHISCENCE OF BRONCHIAL ANASTOMOSIS IN LUNG TRANSPLANTATION:
Risks factors of bronchial anastomatic complications (overall prevalence approx. 15%): donor bronchus ischemia caused by disruption of the native bronchial circulation, recurrent infection, and rejection. First month after lung transplantation. CT findings: bronchial wall defect, bronchial narrowing, bronchial wall irregularity, extraluminal air, PM, pneumothorax, and ipsilateral lung volume loss. Bronchoscopy may identify mucosal necrosis, the earliest sign and a useful predictor of this complication. Clinical evolution: no sequelae, stricture that requires stent, or fatal.

INTRAMUCOSAL ESOPHAGEAL DISSECTION (IED):
Separation of mucosa and/or submucosa from deeper muscular layers due to abrupt increases in intraesophageal pressure. Causes: Spontaneous (women in their 7th or 8th decade, often with anticoagulation), iatrogenic (endoscopy), foreign body, and repeated episodes of retching or vomiting. Diagnosis: esophagography, CT (submucosal air and no extravasation of oral contrast in contained perforation; subcutaneous emphysema and PM in perforation), endoscopic ultrasound and/or standard endoscopy. Conservative management.

BOERHAAVE SYNDROME:
Complete transmural laceration of the esophagus from violent straining or vomiting (increase in intraesophageal pressure). High mortality and morbidity. Middle-aged men with history of alcoholism (50%). Mackler triad of symptoms: vomiting, sudden chest pain, and subcutaneous emphysema. Location: left posterior wall of the lower one-third of the esophagus, about 2 m long and 3-6 cm above the diaphragm. Chest radiograph: widening of mediastinum, PM, subcutaneous emphysema, pleural effusion (left side), hydropneumothorax, and patchy pulmonary opacities. Esophagography: extravasation of contrast. CT: esophageal wall thickening, periesophageal air, PM, and esophagopelural fistula (left side). Treatment: conservative, endoscopic or surgical.
Fig 5. 67 y.o. man with right lung transplantation. Coronal MinIP reformatted images revealed mediastinal air in the vicinity of bronchial anastomosis probably due to surgical suture failure (white arrows) and right pneumothorax. Treatment consisted in right main bronchus endoprosthesis placement.

MEDIASTINAL: Intramucosal esophageal dissection

Fig 7. 20 y.o. man with previous endoscopy to assess esophageal alimentary impaction. CT showed pneumomediastinum and air images probably within the submucosal esophageal layer (white arrows) along with pneumoperitoneum and pneumoretroperitoneum (black arrows). After administration of oral contrast, CT did not demonstrate contrast leaking, localized in submucosa (black arrows). Esophagography showed no oral contrast leaking. Conservative management was carried out with complete resolution of the radiological findings on follow-up.
MEDIASTINAL: Boerhaave Syndrome

Fig. 8. 36 y.o. woman presenting with abdominal pain after vomiting. CT reveals pneumomediastinum and right pneumothorax (black arrows). After oral contrast intake, leaking of the contrast material to right pleural cavity is demonstrated, secondary to esophageal wall disruption (white arrows). Surgical reparation of the esophageal tear was required.
# MEDIASTINAL

## SPECIAL CONDITIONS OF MEDIASTINAL AIR

### TRACHEOESOPHAGEAL FISTULA DUE TO ESOPHAGEAL NEOPLASM:
Esophagorespiratory fistulas in 5-10% of advanced esophageal cancer. Risk increased after radiotherapy. Clinical features: cough when swallowing liquids, dryness of mouth, neck and chest pain, and sputum with particles of food. Chest radiograph: recurrent pulmonary consolidation secondary to aspiration, lung abscesses, pleural effusion, and radiopaque foreign bodies. Esophagography demonstrates the passage of oral contrast to the trachea. Endoscopy may be used. CT determinates the extent of the fistulous tract and involvement of lung parenchyma.

### BRONCHIAL AND ESOPHAGEAL FISTULA POST-LYMPH NODE PERFORATION:
Rupture of casseous lymph-nodes into esophagus or bronchii. Causes: M. tuberculosis, Histoplasma, and Actinomyces. Also described bronchial perforation due to malignant subcarinal lymphadenopathy. CT may demonstrate bronchial and/or esophageal perforation. Diagnosis of bronchial perforation with bronchoscopy.

### DESCENDING NECROTIZING MEDIASTINITIS:
Infection of the mediastinum that spreads fromcervical and odontogenic infection. Mortality 30-50%. Three potential routes for the spread of infections from the neck to mediastinum: pretracheal (anterior mediastinum), lateral pharyngeal (middle mediastinum), and retropharyngeal-retrovisceral space or “danger space” (posterior mediastinum). Chest radiograph findings: subcutaneous emphysema, pneumomediastinum, and widening of the superior mediastinum. CT findings: mediastinal air, fluid collections, pleural or pericardial effusions, and lymphadenopathies.
MEDIASTINAL: Tracheoesophageal fistula due to esophageal neoplasm

Fig. 9. 58 y.o. man presenting with fever and dysphagia. Esophageal wall thickening on CT images (white asterisk) and fistulous tract connecting esophagus and intrathoracic trachea. This communication is more clearly demonstrated by the oral contrast material leaking through this fistula (white arrows). Lung consolidation on RUL (black asterisk). Radiological findings were consistent with esophageal neoplasia with tracheoesophageal fistula and RUL aspiration pneumonia. An esophageal endoprosthesis was placed with significant clinical improvement.
MEDIASTINAL: Bronchial and esophageal fistula post-lymph-node perforation

Fig 10. 75 y.o. man with fever and dysphagia. CT showed paramediastinal RUL lung consolidation (black asterisk) and hypodense mediastinal lymph nodes (white arrows). Follow-up CT (upper row) showed a right paratracheal lineal air tract from the esophagus to the right paratracheal adenopathy (white and black arrows). Diagnosis was right paratracheal lymph node perforation with esophageal fistula secondary to tuberculosis.

Fig. 11. 48 y.o. man with lung cancer treated with surgery and chemotherapy. Follow-up CTs showed subcarinal lymph node (black asterisks) which became perforated and developed a complex fistulous connection with bronchus (black arrow) and esophagus (white asterisk). The findings are better depicted with MinIP reformatted images. RLL consolidation due to aspiration pneumonia is also shown.
MEDIASTINAL: Descending necrotizing mediastinitis

Fig. 12. 18 y.o. man presenting with oral cavity pain, edema, right submandibular zone swelling and cervical crepitation. Neck and chest CT showed right submandibular air-containing fluid collection (white arrows). Air bubbles were also depicted in superior mediastinum at the retrosternal space probably secondary to mediastinitis (black arrows). Treatment consisted in surgical debridement of the cervical and mediastinal collections and removal of the tooth causing the infection.
PERICARDIUM: Pneumopericardium

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<th>PNEUMOPERICARDIUM (PC)</th>
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<td><strong>CLINICAL FINDINGS:</strong></td>
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<td>Important differential diagnosis of chest pain. Also, dyspnoea and palpitations. Important accumulation of pericardial air may result in pericardial tamponade.</td>
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| **CAUSES:** |
| 1. Iatrogenic: thoracocentesis, post-sternal bone marrow biopsy, intubation... |
| 2. Penetrating and blunt chest trauma. |
| 4. Fistula between pericardium and air containing structures: bronchial tree, gastrointestinal tract, and pleural or peritoneal spaces. |

| **DIAGNOSTIC IMAGING:** |
| 1. Chest radiograph: Air surrounding heart, limited superiorly by the lower border of the aortic arch. No extension along trachea or bronchi, or into neck. Change in distribution with change in patient position. |
| 2. CT: Confirmation of the diagnosis and potential cause. |

| **PC IN LUNG NEOPLASM:** |
| 3 ways: |
| 1. Bronchopericardial fistula formed by a necrotic tumor which invades the pericardium. |
| 2. Trauma caused by bronchoscopy or thoracocentesis. |
| 3. Rupture of a bulla into the pericardium through a necrotic focus. |
PERICARDIAL: PC related to progression of lung neoplasm

Fig. 13. 53 y.o man with squamous lung carcinoma presenting with chest pain, fever and productive cough. Chest radiograph reveals LUL pulmonary mass (black asterisk) and pneumopericardium (white arrows). Chest CT showed progression of the lung mass with cavitation development (black asterisk) and pneumopericardium probably secondary to direct extension to the pericardium (white arrows).
PERICARDIUM: PC related to lung transplantation

Fig. 14. 58 y.o. man with bilateral lung transplantation. Chest CT showed right pneumothorax, pneumomediastinum and pneumopericardium with visible pericardial defect (black arrows). Coronal MinIP reformatted images depict air in the vicinity of bronchial anastomosis due to surgical suture failure (black arrow) treated with bronchial endoprosthesis placement (white arrows).
CARDIOVASCULAR: Air embolism

AIR EMBOLISM

**INCIDENCE:**
Reported after intravenous administration of contrast at CT in 11.7%-23%.

**PATHOGENESIS:**
Visualization on unenhanced CT suggests origin in the insertion of the cannula, small amounts of air between the cannula and the plastic tube of the injector, or both. Another source, microbubbles in the contrast material. Also in many other nonradiologic intravenous administrations of drugs or fluid.

**LOCATION (Fig. 15):**

Fig. 15. Most frequent locations of air embolism (black circles). AA: Ascending aorta. SVC: Superior vena cava. MPA: Main pulmonary artery. RPA: Right pulmonary artery. LPA: Left pulmonary artery. RV: Right ventricle. RA: Right atrium. LA: Left atrium.

**CLINICAL SIGNIFICANCE AND MANAGEMENT:**
Usually minor and subclinical. Rapid injection of 100-200 mL considered fatal. With slow injection much higher volumes of air may be tolerated. Treatment of large air emboli: left lateral position of the patient and 100% oxygen. Extreme caution with right-to-left shunts (high risk of arterial embolism leading to neurologic deficits or myocardial ischemia.
CARDIOVASCULAR: Air embolism after intravenous administration of contrast

Fig. 16. 58 y.o. man presenting with left lower limb pain and swelling. AngioCT showed bilateral pulmonary embolism and tiny air bubbles located into the main pulmonary artery and right ventricle related to air embolism (white arrows). The patient received anticoagulation therapy with no further symptomatology.
# PLEURAL: Broncopleural fistulas

## BRONCOPLEURAL FISTULAS (BPF)

### CONCEPT:
Direct communication between pleural cavity and bronchial tree (true BPF) or lung parenchyma.

### CAUSES:
1. Central: Fistulous connection between pleura and trachea or main and segmental bronchi. After total or partial lung resection or lung transplantation, or blunt and penetrating trauma. Dehiscence of bronchial stump, the most common cause of BPF.
2. Peripheral: Fistulous connection between pleura and airway distal to segmental bronchi or lung parenchyma. After necrotizing pneumonia, empyema, malignancies, radiotherapy, bulla or cyst rupture, thoracic interventional procedures, tuberculosis, aspergillosis, granulomatosis with polyangiitis and pulmonary sarcoidosis. Most common cause, pulmonary infections or iatrogenic.

### DIAGNOSTIC IMAGING:
1. Chest radiograph: Usually, hydropleumothorax. Suspicion of BPF when new intrathoracic air or increase in intrathoracic air with displacement of mediastinum away from the resected side.
2. CT: Direct visualization of the fistulous tract between the lung or airway and pleural space (large BPF), extraluminal air bubbles adjacent to bronchial stump (small BPF) or change in pre-existing pleural air-fluid level. Frequently allows identification of the etiology of the BPF. Also, allows assessment of the anatomic relationship of adjacent vasculature and mediastinal structures.

### MANAGEMENT AND TREATMENT:
If pleural infection, prompt drainage, early initiation of broad-spectrum antibiotics and aggressive nutritional supplementation. When possible, early central BPF requires a surgical approach. Peripheral BPF are treated according to underlying disease and patient’s clinical condition.
Fig. 17. 81 y.o. man with dyspnoea, cough and yellowish sputum. Tuberculosis history with partially completed treatment. Chest radiograph showed right pleural calcifications with air of probably pleural origin (black asterisk). CT showed calcified right pleural thickening with air within the pleural space (black arrows). MinIP images revealed the existence of a bronchopleural fistula (white arrows). The patient died a few days after hospital admittance.
## SPECIAL CONDITIONS OF PLEURAL AIR

### SPONTANEOUS PNEUMOTHORAX (PMT) IN MALIGNANT PLEURAL MESOTHELIOMA (MPM):
Very rare presenting feature of MPM. Reported in 2% of total MPM in one series. More frequent in patients over 40 y.o. Bilateral spontaneous PMT also reported. Three mechanisms: rupture of necrotic tumor nodules; periphery tumor nodules that cause ball-like valve action leading to over-distention of that part of lung with formation of subpleural bullae; and tumor invasion into the lung parenchyma. Usually, chest drainage not successful.

### SPONTANEOUS PMT IN LUNG NEOPLASM:
Incidence of spontaneous PMT in patients with primary lung cancer between 0.03 and 0.05%. In metastases, especially from sarcoma, incidence of spontaneous PMT higher. Predominance in men (90%). First manifestation of lung cancer (78.3% of PMT in lung neoplasm). At advanced stage of disease. Suspicion of lung cancer in patients with spontaneous PMT in less than 40 y.o. with recurrent spontaneous PMT and in more than 40 y.o. with history of heavy smoking, chronic bronchitis or emphysema, incomplete lung expansion or suspicious chest radiograph after chest drainage.

### SPONTANEOUS PMT IN LYMPHANGIOLEIOMYOMATOSIS (LAM):
Dyspnea in LAM due to spontaneous PMT in 40%. Lifetime incidence of PMT in LAM: 39-81%. Chemical or surgical pleurodesis to prevent recurrent pneumothorax, but potential pleural adhesions and increased risk of perioperative bleeding may complicate future lung transplantation.

### BILATERAL PMT AFTER UNILATERAL BIOPSY OF LUNG NODULE:
1.3% of spontaneous bilateral PMT. Iatrogenic bilateral PMT after unilateral transthoracic lung puncture due to pleuro-pleural communication caused by previous mediastinal procedures (heart or heart-lung transplantation or resection of thymoma) or congenital pleuro-pleural communication. Fusion of bilateral pleural spaces in anterior junctional line may form a pleuro-pleural communication resulting in a single pleural cavity (“buffalo chest”). Persistent pleural connections after heart and heart-lung transplantation in 33-40%. Treatment with unilateral drainage.
**PLEURAL: Spontaneous PMT in thoracic neoplasms**

**Fig 18.** 57 y.o. man with disseminated lung cancer under chemotherapy treatment. Chest radiograph revealed a right pulmonary mass with a right pleural air-fluid level in relation to hydropneumothorax (black arrows) and left pulmonary nodules. CT showed progression of the right pulmonary mass and the contralateral nodules. The patient died a few days later.

**Fig 19.** 69 y.o. man with progressive dyspnoea and chest pain. Chest radiograph showed a right air-fluid level secondary to hydropneumothorax (black arrows). Pleural drainage and videothoracoscopy were performed revealing multiple right parietal pleural nodules. Follow-up CT showed right pleural effusion with pleural nodular thickening (white arrows). Biopsy of the pleural nodules was positive for pleural mesothelioma.
PLEURAL: Spontaneous PMT in LAM

Fig. 20. 43 y.o. woman with chest pain. Chest radiograph showed diffuse bilateral interstitial lung pattern with hyperlucency of left hemithorax and blunting of the right costophrenic angle on frontal projection (black arrow). A line corresponding to the visceral pleura is seen on the lateral projection secondary to the presence of localized right pneumothorax (white arrows). Chest CT revealed a diffuse cystic pattern in both lungs with right pneumothorax (white asterisks). Lymphangioleiomyomatosis was the final diagnosis and talc pleurodesis was performed.
PLEURAL: Bilateral pneumothorax, pneumomediastinum and subcutaneous emphysema post-biopsy of a lung nodule

Fig. 21. 72 y.o. man with solitary RUL lung nodule biopsied with fine needle and diagnosis of non-small cell lung carcinoma. Chest radiograph 72 hours after the procedure revealed pneumomediastinum with severe subcutaneous emphysema. CT confirmed the presence of pneumomediastinum, subcutaneous emphysema and bilateral pneumothorax with left predominance. Right chest incision was performed in order to drain subcutaneous emphysema. During right upper lobectomy multiple pleural adherences were observed. The explanation for this rare complication is the presence of a congenital communication between both pleural cavities through the anterior junction line (black arrows) giving way to the contralateral pneumothorax after right lung biopsy as long as no previous chest surgery history existed.
### CHEST WALL

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<th>SPECIFIC CONDITIONS OF AIR IN THE CHEST WALL</th>
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<td><strong>INFECTIONS:</strong> Uncommon and potentially life-threatening conditions. The most common causative organisms in pyogenic infections of the chest wall: <em>S. aureus</em> and <em>P. aeruginosa</em>. Other microorganisms: <em>Klebsiella</em>, <em>Actinomyces</em>, <em>Blastomyces</em>, <em>Nocardia</em>, <em>Aspergillus</em> and <em>M. tuberculosis</em>. Outcome depends on early diagnosis, immunosuppression, offending microorganism, and extent of the infection. Spectrum of the disease: cellulitis, pyomyositis, abscess, or necrotizing fasciitis. Chest radiograph: chest wall or extrapleural mass, adjacent pulmonary opacities, rib erosion or sclerosis and pleural effusions (in chronic chest wall infections), skin fistulas, associated empyemas, and air-fluid levels within subcutaneous tissues. CT: lower attenuation than muscle collections with or without air in soft tissues, and bone destruction. MRI: high-signal-intensity collections on T2-weighted or STIR images.</td>
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<td><strong>INTERCOSTAL LUNG HERNIAS (ILH):</strong> Protrusion of pulmonary tissue beyond the normal confines of the thoracic cage. Lung hernias classified according to location (cervical, thoracic, or diaphragmatic) and cause (congenital or acquired). Spontaneously or acquired weakness of the intercostal space from chest trauma, surgery or infection. Predisposing conditions: chronic obstructive pulmonary disease (CPOD), and inflammatory or neoplastic processes. The most frequent cause of acquired ILH is trauma. Clinical presentation as chest wall lump with expansion during Valsalve manoeuvre (cough). Chest radiograph: “lung beyond the rib” sign and (if hernia seen in profile) and “lucent lung” sign (if hernia seen in face). CT demonstrates the ILH through the chest wall and splaying of ribs with widening of intercostal space. Asymptomatic ILH do not require surgical treatment. Surgical treatment in any sign of incarceration or for cosmetical reasons.</td>
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<td><strong>TRANSDIAPHRAGMATIC INTERCOSTAL HERNIAS (TIH):</strong> Herniation of abdominal content through a diaphragmatic and chest wall defects. Usually following trauma, but also after minor events (massage, cough...). Predisposing factors: CPOD, asthma, diabetes or steroids. Palpable and reducible mass in chest wall. Chest radiograph and CT: rib fractures with separation of the ribs and bowel loops in the chest wall. Treatment with surgery for reparation of diaphragmatic and chest wall defects.</td>
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CHEST WALL: Infection

Fig. 22. 29 y.o. man with previous surgery of pectus excavatum correction presenting with left chest wall swelling and spontaneous purulent material outflow from the surgical wound. CT showed a presternal fluid collection within the subcutaneous tissue with air bubbles corresponding to abscess. The collection was surgically debrided (left bottom image).
CHEST WALL: ILH

Fig. 23. 64 y.o. man with left lung transplantation. Follow-up chest radiograph showed lucent lesion beyond the rib cage on frontal projection (black arrows), and with an anterior location on lateral projection (white arrows). CT MinIP reformatted images better depicted the presence of an anterior intercostal lung hernia (white arrows).
CHEST WALL: TIH with gastrointestinal content

**Fig. 24.** 55 y.o. man presenting with long standing (more than two years) right chest wall mass. CT showed right intercostal hernia containing colon (with air) and abdominal fat (white arrows) in association with diaphragmatic defect (white asterisk). 3D reformatted images revealed eighth and ninth right rib fractures (white arrows) with intercostal space widening (white asterisk).
CONCLUSIONS

- Localization of the abnormal thoracic air is important for the correct differential diagnosis of the causing diseases.

- Chest radiograph and CT are the most useful imaging techniques in the diagnosis of these patients.

- A correct diagnosis of the diseases presenting with abnormal thoracic air has a potential impact on the therapeutic management of these patients.
RELEVANT REFERENCES


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