Learning objectives

The purpose of this exhibit is to differentiate the causes of an opacified hemithorax. The differential diagnosis includes 3 major causes:

• unilateral pulmonary infiltration caused by inflammation or neoplasly
• unilateral pulmonary atelectasis (absorption atelectasis)
• pleural disease (most common large pleural effusion),

plus one

• pneumonectomy

We include images from investigations such as plain film, ultrasound and CT scans.

Background

Opacification of a hemithorax indicates presence of a significant disease (the involved lung is not participating in its physiological functions). A differential diagnosis of opaque hemithorax lists congenital anomalies, inflammatory and neoplastic disorders, and postsurgical causes.

To illustrate the chest pathology that can cause an opaque hemithorax we used a series of 35 patients whose clinical status (cough, haemoptysis, dyspnea, chest pain) determined performing a chest radiograph.

The study was conducted over 4 months (may-august 2012) in the Hospital of Pneumology, Iasi, Romania.

Imaging findings OR Procedure details

The chest radiograph shows the opaque hemithorax. The comparison of the opaque hemithorax to that of the unaffected side can suggest the differential diagnosis:

• An increase in the volume of the hemithorax (large pleural effusion or large intrathoracic mass)
• A decrease in the volume of the hemithorax (restrictive pleural process, pulmonary atelectasis, pulmonary hypoplasia or pneumonectomy)
• A normal volume of the hemithorax may indicate pulmonary consolidation or the association between atelectasis and pleural effusion.
Ultrasound showed the presence of an effusion and allowed image-guided diagnostic aspiration.

CT is the imaging modality of choice because it can characterize pulmonary and mediastinal abnormalities that cause the opaque hemithorax.

1. **Obstructive atelectasis** is lung collapse as a result of airway obstruction by an endobronchial lesion. Airway obstruction prevents the passage of air along the bronchial tree. Air distal to the obstruction is resorbed by the alveoli (obstructive atelectasis is sometimes called resorbtive atelectasis). Studies have demonstrated that atelectasis draws edema fluid into the alveoli- the increased lung opacity seen with atelectasis is a result of both absence of air within the lung parenchyma and also increased fluid within the alveoli (Fig. 1, Fig. 2).

Complete atelectasis of an entire lung is when complete collapse of a lung leads to opacification of the entire hemithorax and an ipsilateral shift of the mediastinum. The mediastinal shift separates atelectasis from massive pleural effusion. A concomitant pleural effusion may restore thoracic symmetry (Fig. 3, Fig. 4, Fig. 5).

On CT images we should inspect the bronchi to identify the cause of the atelectasis.

The most often is a result of a central mass, but occasionally may result from other causes:

- Bronchial obstruction from metastatic neoplasm (e.g. breast or thyroid adenocarcinoma, renal cell carcinoma, melanoma)
- Inflammatory etiology (e.g. tuberculosis, fungal infection)
- Aspirated foreign body
- Mucous plug (Fig. 6, Fig. 7)
- Malpositioned endotracheal tube
- Extrinsic compression of an airway by neoplasm, lymphadenopathy, aortic aneurysm, or cardiac enlargement

2. **Pleural effusions** (Fig. 8, Fig. 9, Fig. 10) are caused by excess formation or insufficient clearance of pleural fluid. Any infectious, neoplastic or traumatic cause can determine unilateral pleural effusion.

Transudative effusions are noninflammatory, they are caused by congestive heart failure and hypoproteinemic states such as liver cirrhosis and nephrotic syndrome. Exudative effusions, caused by pleural inflammation or impaired lymphatic drainage, are most commonly seen with malignancy and infection.

A large pleural effusion can cause complete opacification of the hemithorax. Controlateral shift of the airway and mediastinum is the most useful method to distinguish massive
effusion from unilateral lung atelectasis, that causes complete opacification, but ipsilateral mediastinal shift.

3. Pleural thickening and fibrothorax (Fig. 11, Fig. 12)

Fibrothorax is defined as fibrosis within the pleural space, and occurs secondary to the inflammatory response to one of a number of events:

- tuberculosis - particularly as a late sequelae
- thoracic empyema
- asbestos related pleural disease
- rheumatoid arthritis
- haemorthorax

Fibrothorax can cause restrictive impairment of lung function. A fibrothorax is characterised by relatively smooth pleural thickening that may be calcified. The mediastinal pleura is usually spared. There is usually marked volume loss in the affected hemithorax.

4. Pneumonia - it is a rare cause of the opaque hemithorax because usually the pneumonic infiltration doesn't involve the entire lung.

The radiographic features are characteristic, with homogeneous opacification of the lung. Patent bronchi within homogeneous consolidation appear as linear branching lucencies or, when seen end on, as rounded lucencies (air bronchogram). Parapneumonic effusions are common (Fig. 13, Fig. 14).

CT is not recommended for the initial evaluation of patients with pneumonia, but it is a valuable adjunct to conventional radiography in patients with irrelevant or nondiagnostic imaging findings. It includes homogeneous consolidation with air bronchograms.

The diagnosis is supported by clinical and paraclinical findings. Chest pain, dyspnea, hemoptysis, decreased exercise tolerance, and abdominal pain from pleuritis are highly indicative of a pulmonary process. The presence of cough, particularly cough productive of sputum, is the most consistent presenting symptom. Leukocytosis with a left shift may be observed. The causative organism can be identified in sputum samples or in blood cultures.

5. Pneumonectomy (Fig. 15, Fig.16, Fig. 17, Fig. 18) is a condition that causes unilateral complete opaque hemithorax that can easily be detected from the patient's
history of surgery and also by the presence of post operative skin scar over patient’s chest.

After pneumonectomy, the empty space is filled with air. This space gradually accumulates with fluid over weeks to months. Complete opacification on chest radiograph occurs in most patients; a small number of patients will have residual air. In addition to the gradual accumulation of fluid, the post-pneumonectomy space shrinks, resulting in the elevation of the ipsilateral hemidiaphragm, shifting of the mediastinum towards the post-pneumonectomy space and hyperinflation and encroachment of the remaining lung into the post-pneumonectomy space (Fig. 19).

6. Thoracic scoliosis and chest wall deformity (Fig. 20, Fig. 21, Fig. 22)

Extreme scoliosis and thoracic deformity can mimic an opaque hemithorax. This appearance may be accentuated by the ventilatory restriction and pulmonary underexpansion seen in some of these cases.

7. Massive tumours (pleural metastasis) (Fig. 23) filling major volume of a hemithorax may compress the lung to such an extent, so that the chest radiograph seems as completely opaque hemithorax.

8. Pulmonary aplasia and agenesis

The thoracic imaging appearance of pulmonary agenesis or aplasia consists of complete opacification of one hemithorax with severe volume loss evidenced by extensive shift of the cardimediastinal structures toward the affected side.

Pulmonary underdevelopment has been classified into three groups by Schneider and Schwalbe. In group 1, bronchus and lung are absent (agenesis); in group 2, a rudimentary bronchus is present and limited to a blind-end pouch without lung tissue (aplasia); and in group 3, there is bronchial hypoplasia with variable reduction of lung tissue (hypoplasia).

Pulmonary agenesis is defined as a complete absence of carina, main bronchus, lung parenchyma and pulmonary vasculature. Pulmonary aplasia is similar except that a blind-ending rudimentary bronchus is present.

Pulmonary hypoplasia is defined as deficient or incomplete development of the lungs. It is characterized by the presence of both bronchi and alveoli in an underdeveloped lobe.
In this study, out of 35 patients 9 were found to have pleural effusion, 3 had destroyed lung, 4 had lung consolidation, 11 had collapse, 5 had pneumonectomy and 2 had thoracic scoliosis and 1 had large pleural mass. Other rarer causes seen as differential diagnoses for opaque hemithorax could not be found in patients in our study.

Images for this section:

**Fig. 1**: Posteroanterior chest radiograph. Complete atelectasis of the left lung. Mediastinal displacement, opacification, and loss of volume are present in the left hemithorax.
Fig. 2: Right lateral intercostal echo transmission (the same patient)-dilated bronchi that are filled with secretions
Fig. 3: Anteroposterior chest radiograph. Opaque hemithorax on the right side
Fig. 4: Right lateral intercostal echo transmission shows a homogenous lung consolidation with a mild pleural effusion as in the presence of obstructive atelectasis
Fig. 5: Computed tomography (CT) scan (mediastinal window). Right pulmonary atelectasis- collapsed parenchyma with heterogeneous structure (hypodense areas caused by exudate retention or necrosis) and significant enhancement. Pleural effusion around atelectatic process with a thickness of ~ 2cm
Fig. 6: Anteroposterior chest radiograph- dorsal decubitus. Left lung mucous plugging with atelectasis
Fig. 7: Anteroposterior chest radiograph. After bronchoscopy
Fig. 8: Posteroanterior chest radiograph. Left pleural effusion
Fig. 9: Right-lateral intercostal echo transmission - pleural effusion with a wedge-shaped hypoechoic transformation of parts of the lower lobe of the lung as in the presence of atelectasis
Fig. 10: Computed tomography (CT) scan (mediastinal window). Large pleural effusion occupying the entire right hemithorax. Pleural effusion is associated with passive atelectasis of the right lung.
**Fig. 11:** Posteroanterior chest radiograph. Volume loss in right chest with diffuse pleural thickening
Fig. 12: Computed tomography (CT) scan (mediastinal window). Pulmonary fibrosis affecting entire left lung. The left hemithorax is shrunken, condensed, in the condensing unit are present cavities, traction bronchiectasis, areas of atelectasis. Lung changes are associated with pleural thickening.
Fig. 13: Anteroposterior chest radiograph- dorsal decubitus. Patient known with aortic coarctation. Alveolar consolidation involving the right lung. The patient was suspected of aspiration pneumonia vs. ARDS
Fig. 14: Anteroposterior chest radiograph. Patient with left lung pneumonia and parapneumonic effusion
Fig. 15: Posteroanterior chest radiograph. Left pneumonectomy
Fig. 16: Posteroanterior chest radiograph. Elloesser flap. Patient with post-pneumonectomy empyema with bronchopleural fistula
Fig. 17: CT scan and CT reconstruction (mediastinal window). Reduced volume in the left hemithorax (pneumonectomy and thoracoplasty C4-C8)
Fig. 18: CT reconstruction. Left thoracoplasty
**Fig. 19:** CT scan and CT reconstruction (mediastinal window). Right post-pneumonectomy space filled with dense fluid (caused by residual liquid) showing no enhancement after contrast administration, pointed, linear and irregular pleural calcifications, thickened pleura with variable thickness up to 12 mm maximum. Right hemithorax volume loss with intercostal space reduction, attraction of the trachea, esophagus, heart, mediastinum to the right, ascension of the right hemidiaphragm with right / left difference of ~ 10 cm
Fig. 20: Posteroanterior chest radiograph. Thoracic scoliosis
Fig. 22: Major thoracic deformity with thoracic Kyphoscoliosis. Major change in position of the mediastinal vessels. Right lower lobe atelectasis (extrinsic compression caused by the descending aorta and spine - under the bifurcation of the trachea these two structures show a horizontal trajectory and cause a significant reduction in volume of the right lung)
Fig. 21: Computed tomography (CT) scan (mediastinal window). Thoracic Kyphoscoliosis. Major change in position of the mediastinal vessels. Right lower lobe atelectasis.
Fig. 23: CT scan and CT reconstruction (mediastinal window). The left hemithorax is occupied by large expansive masses with hypervascular septa, areas of necrosis and contrast enhancement exercising significant compression on the left bronchial tree and controlateral lung mass effect -pleural metastasis
Conclusion

The role of the radiologist in diagnosis of the opaque hemithorax is crucial because he can limit the differential considerations, make a specific diagnosis, or suggest potential management options.

References


Personal Information