Aspiration Pneumonia

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22.1 Overview

Aspiration pneumonia (AP) is one of the common types of pneumonia, which refers to pulmonary inflammation caused by abnormal entry of liquid, exogenous particulate matter, or endogenous secretion into lower respiratory tract. Aspiration pneumonia mostly occurs in the elderly with underlying diseases, often with recurrent and prolonged course, causing a high incidence and mortality in clinical practice. It is generally considered that the risk factors of aspiration pneumonia include advanced age (>70), alcoholism, dysphagia, consciousness disorder, increased gastric content reflux, decreased cough reflex, etc. [1]

The coexistence of multiple risk factors can increase the possibility of aspiration pneumonia.

If after aspiration, irritating cough, shortness of breath, and even asthma immediately occur to the patient, it is called dominant aspiration. If at the time of aspiration (>1 min), the patient has external signs such as cough, irritating cough, shortness of breath, and other symptoms, it is called silent aspiration and often causes missed diagnosis [2]. Silent aspiration refers to repeated aspiration of nasal, pharyngeal, laryngeal, and periodontal secretions for a long time, but without other symptoms such as cough. Silent aspiration is not uncommon but usually asymptomatic and often ignored. At present, silent aspiration is considered to be related to interstitial lung disease, bronchial asthma, bronchiectasis, chronic obstructive pulmonary disease, and chronic cough [3].

The most common clinical syndromes of aspiration pneumonia are chemical pneumonia, bacterial infection, and airway obstruction. Chemical pneumonia (chemical pneumonia) refers to the inhalation of substances toxic to the lower respiratory tract, which is not related to bacterial infection. Clinically, chemical pneumonia caused by inhaling gastric acid is its prototype, also known as Mendelson syndrome. The course of this type of aspiration pneumonia is usually more acute, which can lead to acute respiratory distress syndrome (ARDS). The most common type of aspiration pneumonia is bacterial pneumonia caused by aspiration of bacteria normally existing in upper respiratory tract or stomach. The clinical manifestations of aspiration pneumonia caused by bacteria vary greatly, depending on the infection course of patients, pathogenic bacteria, and host status at the time of visit. The common clinical manifestations include cough, fever, purulent sputum, and dyspnea. The inhaled substances of aspiration pneumonia may also be liquid or particulate matter, which is not toxic to the lungs but can cause airway obstruction or reflective closure of airway.

22.2 Pathological Manifestations

The severity of aspiration pneumonia depends on many factors, such as the amount of aspiration, the nature of inhaled substances, the frequency of aspiration, the virulence of bacteria, and the host's defense ability. For a small amount of aspiration, the lung injury caused by inhalation can be prevented by activating the natural defense function and immune response of the body, usually with clinical symptoms. For a large amount of aspiration or repeated aspiration, or the declined defense function of the host, aspiration pneumonia in different degrees and forms can occur. Histological abnormalities in chemical pneumonia include focal and confluent edema with protein-rich fluid in alveoli, hyaline membrane formation, and alveolar epithelial exposure. Microscopic examination of bacterial pneumonia can show edema, hemorrhage, a large number of neutrophils, and foreign body granuloma in alveolar cavity, centered on bronchioles, which may cause severe bronchiolitis. Pathogenic microorganisms such as bacteria in the inhaled substances can colonize and multiply in lung tissue, produce toxins, further aggravate the

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H. Li et al. (eds.), *Radiology of Infectious and Inflammatory Diseases - Volume 3*,
https://doi.org/10.1007/978-981-99-4614-3_22

inflammatory reaction of lung, may enter blood to cause pulmonary sepsis, and then spread to other parts. If the pulmonary infectious inflammation develops continuously, it can cause the destruction of lung tissue structure, liquefaction, and necrosis and lead to abscess. It can also cause organizing pneumonia, with recurrent and prolonged course. If lipid is inhaled, the alveolar walls and interstitium are filled with a large number of lipid-rich macrophages, causing thicken alveolar walls and interstitium.

22.3 Imaging Manifestations

1. Inhalation bacterial pneumonia: Chest radiographs typically show unilateral or bilateral patchy or fused consolidation of cavities mainly involving pulmonary hypostatic part. In supine position, diffuse consolidation is located in the posterior segment of upper lobe and dorsal segment of lower lobe, while in the upright position, consolidation is mainly found in the basal segment of lower lobe. CT findings are similar to those of chest radiographs and usually include unilateral or bilateral patchy or fused consolidation and ground-glass opacity foci mainly involving pulmonary hypostatic part (Fig. 22.1). Other common manifestations include centrilobular nodules with blurred edges, which reflect bronchiolitis and peribronchiolitis, and fluid and debris in the airway of the hypostatic part.
2. Inhalation chemical pneumonia: Chest X-ray radiographs show bilateral, peripheral distribution of cavity consolidation with blurred edges. CT findings include consolidation and ground-glass opacity foci in the pulmonary hypostatic part, often accompanied by centrilobular nodules with blurred edges. Inhalation of large amounts of gastric acid results in extensive ground-glass opacity foci, thickened lobules, and intralobular septa (Fig. 22.2).
3. Inhalation of water: Chest X-ray radiographs and CT show alveolar edema, with extensive lesions with blurred edges in both lungs, varying from normal to subsegmental or segmental irregular fusion, mainly distributed around the hilum and less distributed in the periphery.

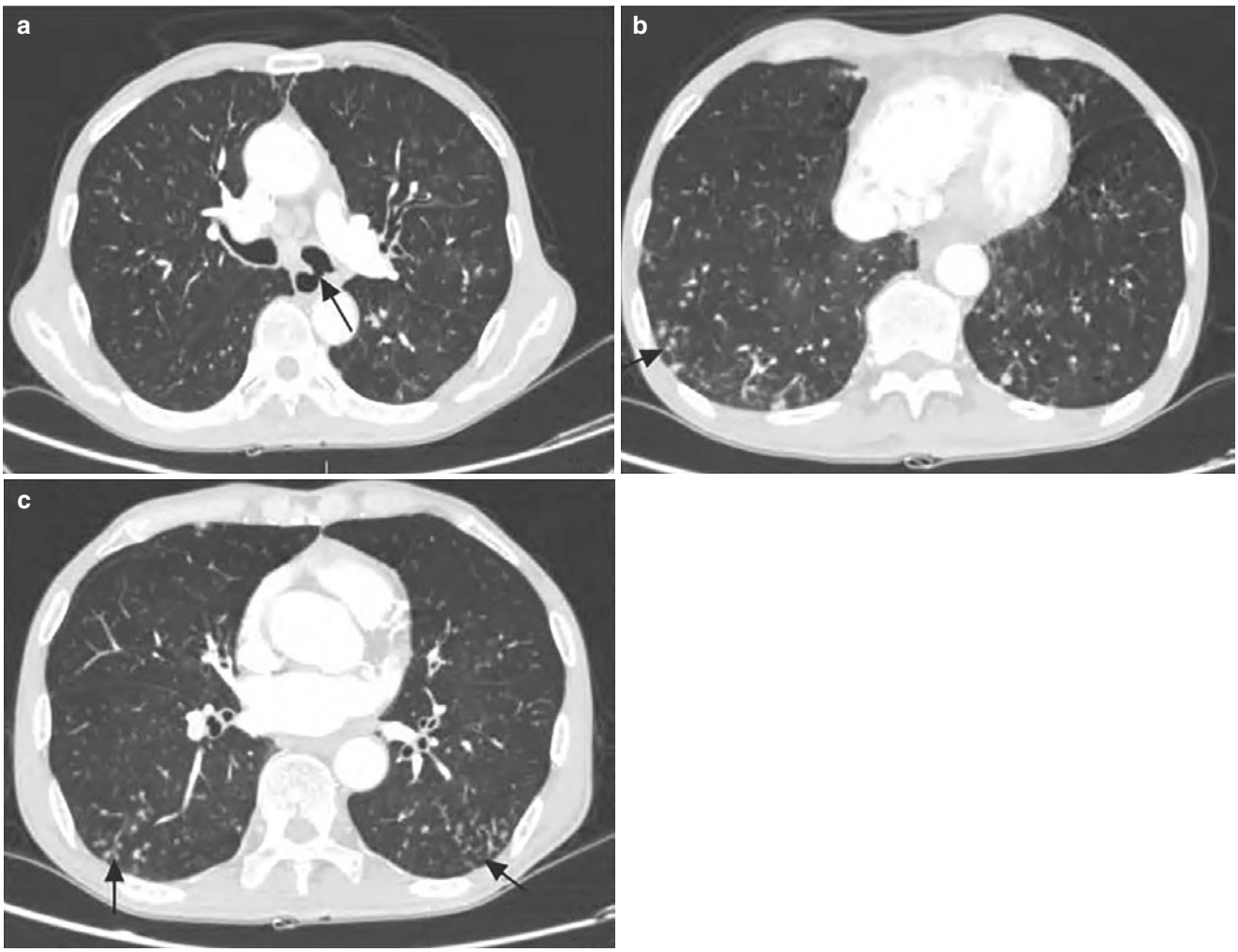

Fig. 22.1 Bilateral aspiration pneumonia. After radiotherapy for esophageal cancer. (**a**) CT lung window showed esophageal—left main bronchial fistula (arrow); (**b**) multiple patchy ground-glass opacities in the lower lobes of both lungs (arrow); and (**b** and **c**) centrilobular nodules (arrow)

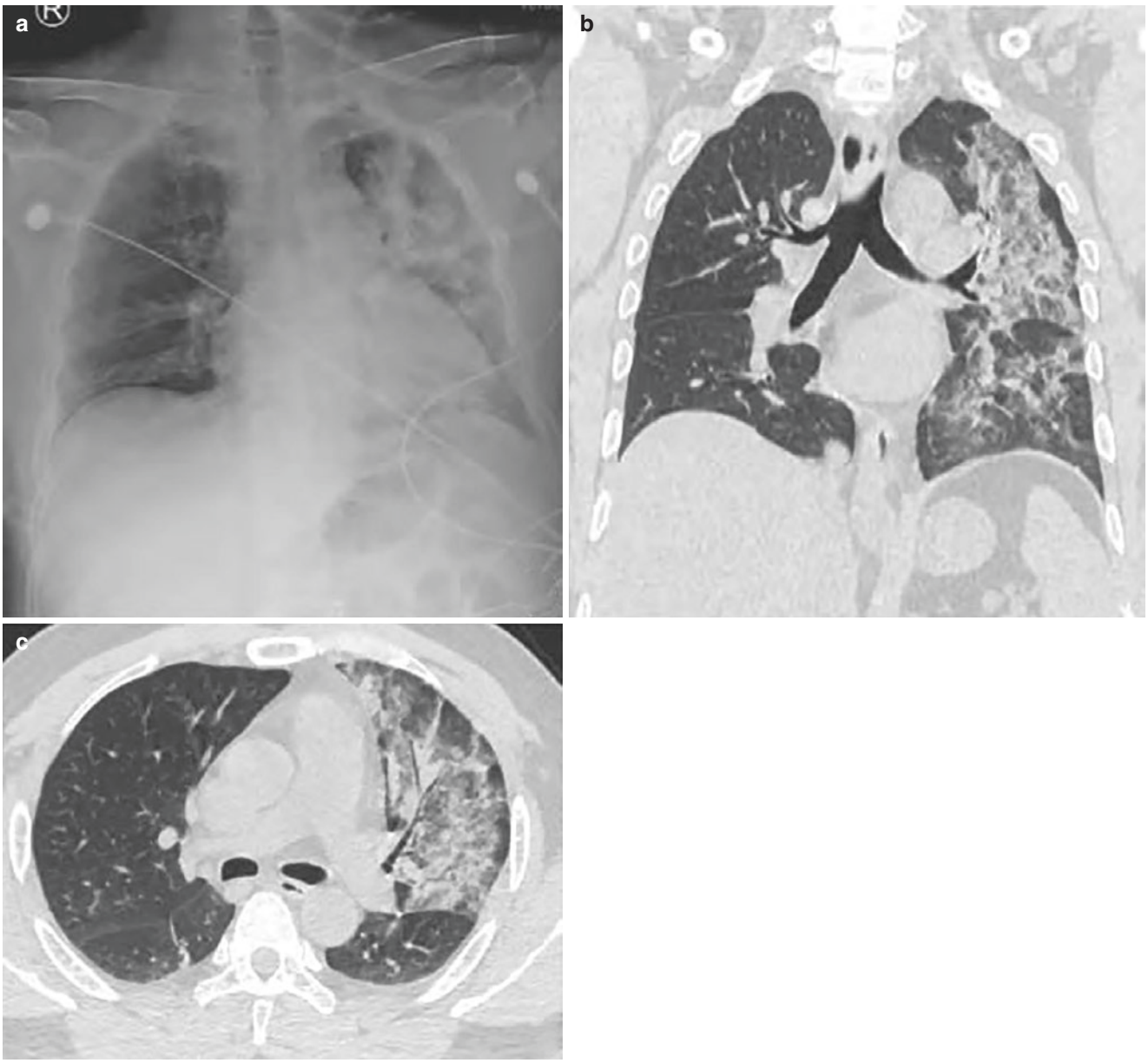

Fig. 22.2 Left-side aspiration pneumonia. Aspiration occurred during gastroscopy under general anesthesia in the left lateral position. (**a**) Bedside chest radiograph showed large consolidation of left lung; and (**b** and **c**) CT lung window showed large patchy consolidation and ground-glass opacities in the left lung

4. Inhalation of lipids: Chest radiographs show no specificity, including single or multiple consolidation areas. Focal fat opacity areas (−30 to 120 HU) can often be found on CT. The lesions show gravity-dependent distribution; the initial stage features central lobular (less aspiration) distribution or the whole lobular (more aspiration) distribution of ground-glass opacity lesions. Within 1 week, obvious consolidation can be found in the lung segment of aspiration. After 2–4 weeks, the density of solid lesions is decreased and recovered to ground-glass opacity. Pulmonary fibrosis occurs when the ground-glass opacity foci progress for 2–4 months, and volume reduction is common.
5. Inhalation of foreign bodies: Foreign bodies can often be displayed directly but may be ignored. Distal lobe atelectasis or focal air cavity consolidation should be traced to the proximal airway.

22.4 Diagnostic Key Points

1. Patients have a history of aspiration and risk factors.

2. Imaging findings show typical gravity-dependent patchy consolidation foci, found in the posterior segment of the upper lobe or the dorsal segment of the lower lobe in supine position, more common on the right side than on the left side (the right main bronchus is more vertical).
3. Opaque objects can be found in the airway cavity.

22.5 Differential Diagnosis

1. Pulmonary embolism: The typical imaging manifestations are wedge-shaped or conical consolidation with the bottom facing the pleura and the tip pointing to the hilum. CT pulmonary artery angiography (CTPA) can show filling defect in pulmonary artery.
2. Cardiogenic pulmonary edema: It has the corresponding clinical manifestations of basic cardiac diseases, with cardiac enlargement.
3. Hyaline membrane disease: It is common in premature infants, and its clinical manifestations include progressive dyspnea, inspiratory three-concave sign, and cyanosis. Typical imaging manifestations are decreased transparency of two lung fields, dotted opacities, and reticular opacities of uniform fine particles, manifested as "white lung" in severe cases.

22.6 Research Status and Progress

Anaerobic bacteria are the main microorganisms in the upper respiratory tract. Previous scholars thought that anaerobic bacteria were the main pathogenic bacteria of aspiration pneumonia, mainly including Bacteroides, Prevotella, Clostridium, and Streptococcus. Recent studies have found that the etiology of aspiration pneumonia has undergone tremendous changes. With the improvement of laboratory examination methods, researchers have found that Gram-negative bacteria, *Staphylococcus aureus*, and aerobic bacteria are also common pathogenic bacteria of aspiration pneumonia, which are similar to hospital-acquired pneumonia [1, 4].

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