Clinico-radiological features of aspiration-related lung disease: a retrospective observational clinical study

Lina Wang
Peking University First Hospital
Shuai Ma
Peking University First Hospital
Jianxing Qiu
Peking University First Hospital
Yan Xiong
Peking University First Hospital
Mingwei Shi
Peking University First Hospital
Lianjun Lin
Peking University First Hospital
Xinmin Liu (lxm2128@163.com)
Peking University First Hospital

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Abstract

Background

Aspiration-related lung disease may mimick a variety of pulmonary disorders. Complex clinical presentations, non-specific radiologic characteristics, lack of aspiration history and difficulties in obtaining lung biopsy make diagnosis challenging.

Methods

This retrospective observational study reviewed all patients of aspiration pneumonia identified on lung pathology in Peking university first hospital from January 1, 2010 to December 31, 2021.Clinical information including risk factors, symptoms, bronchoscopic examinations, chest imaging findings and outcomes on discharge were analyzed.

Results

A total of 20 inpatients with aspiration-related lung disease were included. Median age was 64 years (interquartile range: 55 to 67.75) and 14 (70%) were male patients. Aspiration-related lung disease was confirmed by lung biopsy (histologic presence of foreign body or other particulate matter) or cytologic pathology in BALF. Of these,19(95%) lung specimens included 6 (30%) surgical biopsy, 12 (60%) bronchoscopic biopsy and 1 CT-guided lung aspiration biopsy. One patient was identified by cytologic examination of BAL fluid. Recurrent cough was the most common symptom (70%). Four patients (20%) were asymptomatic and were discovered pulmonary nodules incidentally. Fourteen patients (70%) had one or more risk factors for aspiration, with dysphagia or choking the most common one (10 cases, 50%). Only 7 patients (35%) were clinically suspected of aspiration prior to biopsy. Twelve patients (66.7%) showed at least 2 lung lobes involved. Chest CT imaging revealed a variety of abnormalities, including mass in 9 patients (50%), ground glass opacity in 8 patients (44.4%), consolidation in 7 patients (38.9%), bronchiolitis in 5 patients (27.8%). The proportion of neutrophils in BALF cytological classification increased significantly during all 7 patients who underwent bronchoalveolar lavage. Five patients occurred respiratory failure and one patient needed endotracheal intubation for auxiliary ventilation.

Conclusions

Our study confirmed the atypical clinical manifestations of aspiration-related disease, which should be considered in the differentiation of pulmonary lesions even without risk factors or respiratory symptoms.

Introduction

Aspiration is the pathologic passage of fluid or substances below the level of the vocal cords into the lower airways that can cause various pulmonary disorders[1]. At present, the diagnosis of aspiration-related disease depends on clinical history (witnessed macro-aspiration), risk factors, and compatible findings on chest radiography[2]. However, we may not be aware of the occurrence of aspiration in most cases resulting in delayed diagnosis. The lack of clear diagnostic criteria limits further study to clinical practice.

Volume, frequency, chemical characteristics, and size of aspirated particles factor into the development of aspiration pneumonia, pneumonitis, and airway obstruction, which results in a wide spectrum of disease with various presentations[3]. The tomographic findings in patients with aspiration-related disease were varied, including bronchiectasis, bronchial wall thickening, pulmonary nodules, consolidations, pleural effusion, ground-glass attenuation and atelectasis[4]. Ryu AJ et al. described the atypical radiologic presentations related to aspiration such as mass that suspected to be malignant[5]. The broad spectrum of imaging findings also increases the difficulty of diagnosis.

A few studies have found that the lung tissue after aspiration can show a variety of pathological manifestations, such as acute and chronic bronchiolitis, consolidation, mass-like lesion with fibrosis and chronic inflammatory infiltrates[5]. Aspiration confirmed by pathology may be used as a point of penetration for the study of aspiration-related disease. Thus, we can better understand the clinico-radiologic characteristics of patients with aspiration-related disease.

Materials And Methods

We reviewed all pathology data records at the Peking university first hospital between January 1, 2010, and December 31, 2021, and included patients who were diagnosed with aspiration -related disease according to pathologic examination of lung biopsy specimen or BALF. This search was conducted by using a computer-assisted, text-based query of pathology reports for “aspiration”, “plant cell” or “exogenous lipoid pneumonia” or “foreign body” described in pathologic reports. During the 11-year periods, there were 20 patients identified with pathologic evidence of aspiration. Medical records were reviewed for type of lung biopsy, clinical presentation, risk factors for aspiration-related disease, radiologic studies, tracheoscopy findings, treatment and subsequent clinical outcome. Risk factors for aspiration surveyed included dysphagia, choking, cerebrovascular disease, head and neck operation, radiotherapy or chemotherapy for cervical tumors, gastroesophageal reflux disease (GERD), chronic respiratory diseases (including chronic obstructive pulmonary disease, asthma and obstructive sleep apnea hypopnea syndrome) and structural abnormalities involving the upper GI tract. Chest CT scans were independently reviewed by two radiologists. In the event of disagreement, the findings were discussed until a final diagnosis was determined.

Results

A total of 20 patients of aspiration diagnosed pathologically on lung biopsy or cytologic examination were identified. Clinical characteristics are summarized in Table 1. Median age was 64 years and 14(70%)were male patients. Nineteen (95%) Lung specimens included 6 surgical biopsy specimens (30%), 12 bronchoscopic biopsy specimens (60%) and 1 CT-guided lung aspiration biopsy. One patient was identified by cytologic examination of BAL fluid. Fourteen (70%) patients described recurrent cough and 13(65%) occurred expectoration at presentation. Cough included hemoptysis in 3 patients (15%). Seven patients presented with fevers and four patients (20%) had no symptom.

Table 1
Patient demographics and clinical features(N = 20).

Characteristic	Value
Gender	
male	14(70%)
Age(y)	
≥60	12(60%)
<60	8(40%)
Previous choking	9(45%)
Symptoms	16(80%)
fever	7(35%)
cough	14(70%)
expectoration	13(65%)
yellowish sputum	6(35%)
white sputum	4(20%)
bloody sputum	1(5%)
not mentioned	2(10%)
dyspnea	12(70%)
chest pain	5(25%)
asymptomatic	4(20%)
Duration of symptoms (months), median (range)	1(0.5–144)
Pulmonary auscultation	
crackles	6(30%)
normal	14(70%)
Types of lung biopsy	
bronchoscopic	12(60%)
surgical	6(30%)
CT-guided lung biopsy	1(5%)
Type of foreign body	
food	12(60%)

Characteristic	Value
lipid	6(30%)
unclear	2(10%)
Pulmonary function testing	13(65%)
restrictive dysfunction	1(5%)
obstructive dysfunction	7(35%)
diffusion dysfunction	3(15%)
normal	5(25%)

Five patients were suspected of pulmonary infectious diseases according to the radiographic and clinical evaluation and performed bronchoscopic biopsy. Thirteen patients (65%) underwent lung biopsy for evaluation of pulmonary infiltrates or mass that were eventually confirmed to be related to aspiration on pathologic examination. Among the remaining two patients, one patient was performed diagnostic surgical lung biopsy due to diffuse interstitial lung disease, another patient underwent sputum cleaning under bronchoscopy due to respiratory failure and was confirmed aspiration by biopsy accidentally.

Of the 6 patients who underwent surgical lobectomy, only 1 patient underwent bronchoscopy before operation and was found a cauliflower like organism suspected to be malignant at the opening of the anterior basal segment of the left lung. The other five lobectomy cases included four asymptomatic patients with solitary solid nodules or mass lesions suspicious for lung cancer and one patient performed open lung biopsy to clarify the diagnosis of interstitial lung disease.

The right lower lobe was the most common biopsy location, with 8 patients (40%) involved, followed by the right middle lobe, right upper lobe and lower lobe of the left lung, 4 patients respectively, and 1 patient underwent left main bronchus biopsy (Fig. 1).

Risk factors

One or more risk factors for aspiration were identifiable in 14 patients (70%); Ten patients (50%) had experienced dysphagia or choking before admission. Four patients had pharyngeal malignant tumors and 3 patients underwent surgical resection. Three patients had cerebrovascular disease recently. Two patients suffered from depression and received antidepressant treatment. Other risk factors including chronic respiratory diseases, GERD or esophageal cancer were less common(Figure2).

Bronchoscopy examination findings

Among the 15 patients who underwent bronchoscopy examination, seven patients showed a large number of purulent secretions. Two patients showed new organisms in the bronchial lumen, one patient was suspected malignant lung cancer, the other patient was suspected pulmonary tuberculosis that

proved to be aspiration pneumonia by lung biopsy. Foreign bodies were found to block the bronchus in 6 patients.

Seven patients underwent bronchoalveolar lavage. Four cases of BALF were gray turbidity. One patient was diagnosed exogenous lipoid pneumonia through lipid-laden macrophages on cytologic examination of BAL fluid. He had a definite history of paraffin oil aspiration. The proportion of neutrophils in BALF cytological classification of all patients increased significantly, 5 cases were mainly neutrophils (≥ 80%), 1 case was mainly lymphocytes (56%) and 1 case showed elevated proportion of eosinophils.

Of the 6 patients who underwent lower airway microbiology examination, 3 specimens were positive, including Morganella morganii, Candida albicans plus Ralstonia pwkettii, Candida albicans.

Radiographic presentation

Chest CT scans of 18 patients were reviewed and revealed a variety of abnormalities(Fig. 3), including mass in 9 patients(50%), ground glass opacity in 8 patients(44.4%), consolidation in 7 patients(38.9%), bronchiolitis in 5 patients(27.8%)(Table 2). Twelve patients (66.7%) showed at least 2 lung lobes involved. The distribution of abnormalities was predominantly lower lung in 14 patients (77.8%), followed by mid-lung in 11 patients (61.1%) and upper lung in another 9 patients (50%).

Table 2
Radiographic features of patients.

CT chest	N = 18(%)
Parenchymal pattern No. (%)	
bronchiolitis (centrilobular micronodules and tree-in-bud opacities)	5(27.8%)
consolidation	7(38.9%)
ground glass opacity	8(44.4%)
mass	9(50%)
cavity	3(16.7%)
other	2(11.1%)
Distribution of abnormalities, No. (%)	
upper lung	9(50%)
mid-lung	11(61.1%)
lower lung	14(77.8%)
≥ 2 lung lobes involved	12 (66.7%)
right lung	7(38.9%)
left lung	3(16.7%)
bilateral	8(44.4%)

Four asymptomatic patients underwent surgical lobectomy for nodules that was discovered incidentally. Among of them, two patients showed solitary solid pulmonary nodules in the right upper lung on chest CT with proven necrotizing granulomas by pathology. One patient showed irregular mass in the right middle lobe which was clinically suspected to be malignant. Another patient showed partial ground-glass nodule in the left lower lobe and the pathological examination both exhibited exogenous lipid pneumonia. As for recurrent aspiration, the chest radiographic lesions were diverse, which present the coexistence of acute and chronic lesions. A patient with multiple aspiration after radiotherapy to neck tumor showed a variety of lesions on chest CT, including mass, cavity, right middle lobe atelectasis, bronchiolitis and lymphadenopathy. He was suspected of lung cancer due to mass and cavity in the left lower lobe and underwent CT guided lung biopsy.

Pathological findings consistent with the imaging findings were shown in Fig. 4. We found that pathology of 6 patients showed acute inflammation, mainly presenting neutrophil infiltration, significantly increased proportion of neutrophils in alveolar lavage fluid and shorter duration of respiratory symptoms. The main manifestations of chest imaging were consolidation, ground glass and bronchiolitis. Unlike acute lung injury induced by aspiration, 14 patients were proved chronic inflammation by pathological examination,

including lymphocytes, macrophages and plasma cells infiltration, fibrous tissue proliferation and necrotizing granulomas. Those patients occurred respiratory symptoms at least 1 month before biopsy and present various abnormalities on chest imaging.

Treatment and prognosis

Five patients occurred respiratory failure, including two patients suspected of pulmonary infection, one patient with clear aspiration of paraffin oil history, one patient with recurrent fever after nocturnal epilepsy and one patient with tracheotomy. Among them, 4 patients present type I respiratory failure and 1 patient showed type II respiratory failure. Four patients were supported by noninvasive ventilator. The patient who inhaled paraffin oil by mistake needed endotracheal intubation for auxiliary ventilation. Eventually, all patients survived and were discharged.

Discussion

Aspiration of foreign matter into the airways and lungs can cause a wide spectrum of pulmonary disorders, including vocal cord dysfunction, large airway obstruction with a foreign body, bronchiectasis, bronchoconstriction, diffuse aspiration bronchiolitis or parenchymal disorders[6]. However, the performances after aspiration are usually complex and comprehensive in clinical practice. We found that aspiration syndrome may both involve the airways and pulmonary parenchyma, resulting in a variety of abnormalities on chest CT. Repeated aspiration may produce irreversible damage to lung, even occurred destroyed lung lobe. Our study focused on patients with aspiration-related disease diagnosed by pulmonary pathological manifestations, trying to further describe the clinical characteristics with objective evidence.

Lung infiltrates of aspiration-related disease usually involve gravity-dependent lung segments (superior lower-lobe or posterior upper-lobe segments in a supine position during the event, or basal segments of the lower lobe in upright during the event)[7]. Ryu AJ et al. found that upper or mid-lung zone and diffuse lung filed involvement was not uncommon during aspiration-related lung disease confirmed by lung biopsy[5], that was consistent with our findings. Animal model study of acid aspiration also showed that unilateral instillation of hydrochloric acid could cause bilateral pulmonary damage[8]. The distribution of lung abnormalities in aspiration pneumonia is more extensive than the traditional gravity dependent area. Previous studies focused on the pathophysiological changes caused by acute aspiration. The impact of chronic inflammation caused by recurrent aspiration on the lung and other organs were indefinite. We found that acute inflammation induced by aspiration present consolidation, ground glass and bronchiolitis on chest CT while complex radiological abnormalities usually indicated the chronic or asymptomatic aspiration. The diversity of imaging and pathological changes we observed may be due to the duration of aspiration and the difference of immune response, increasing the difficulty of early diagnosis.

Aspiration is most likely to occur in subjects with a decreased level of consciousness, dysphagia, increased chance of gastric contents reaching to lung and impaired cough reflex[7]. Our study found that fairly proportion of patients had no common risk factors of aspiration. 2 patients among of them were asymptomatic and showed suspicious malignant single nodule on chest CT, but the abnormalities were finally confirmed to be related to aspiration after surgical lobectomy. We also found that the other two asymptomatic patients had a history of depression and took antidepressants orally for a long time. The use of antipsychotics reduced the consciousness and influence the swallowing function, thus increasing the risk of aspiration[10, 11]. Several observational studies have demonstrated that antipsychotics may increase the risk of pneumonia, particularly aspiration pneumonia in older patients in the community[12, 13].For patients with a history of mental illness presenting consolidation, ground glass or occupation in the lungs, the possibility of aspiration-related disease should be considered in the differential diagnosis.

Although the foreign bodies could not be seen directly during bronchoscopy, some nonspecific signs such as a large number of purulent secretions and the dominant proportion of neutrophils in alveolar lavage fluid may indicate the possibilities of aspiration pneumonia or pulmonary infectious diseases. Megahed et al.[14] randomized 76 mechanically ventilated subjects with aspiration pneumonitis to undergo early FB (within 24 hours after aspiration) or standard care. They demonstrated reduction in progression to pneumonia in the intervention arm than the standard care arm. However, they did not demonstrate any difference in mortality, ICU length of stay, or days spent on mechanical ventilation. The current opinion is that the value of FB for aspiration pneumonia is limited and unclear[7, 15]. FB may be suitable for patients with respiratory failure caused by foreign body obstruction or chemical pneumonitis. Previous study reported that if the inhaled foreign body was not removed timely, the continuous stimulation of inflammation may cause bronchial mucosal granulation tissue hyperplasia, bronchial stenosis and necrosis[16]. Our study also showed that untimely removal of foreign bodies and continuous inflammatory stimulation may form pulmonary nodules or masses, which were difficult to distinguish from malignant tumor. Further prospective study is needed to prove the value of endoscopic intervention in the diagnosis and prognosis of aspiration-related disease.

Our study has the following limitations. This was a single center retrospective study, including potential inclusion of the data and record bias (eg, presenting symptoms) in the medical records. Secondly, the number of cases was relatively small. Our study was aimed at hospitalized patients, excluding those who underwent lung biopsy in the clinic.

Conclusion

Our study confirmed the atypical clinical manifestations of aspiration-related disease. One patient could be characterized by the coexistence of multiple lesions and sites involvement. The possibility of aspiration-related disease should be considered in the differentiation of pulmonary lesions even without risk factors or respiratory symptoms.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the tenets of the amended Declaration of Helsinki. This study was approved by the Clinical Research Ethics Committee of the Peking University First Hospital, Beijing, China. Ethical review number is No. (2021) SCI (111). All methods were performed in accordance with the relevant guidelines and regulations. Informed consent was waived by the Clinical Research Ethics Committee of the Peking University First Hospital, as this is a retrospective study of deidentified data.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available due [them containing information that could compromise research participant privacy/consent] but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that no potential conflicts of interest exist in this work.

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Authors' contributions

(I) Conception and design: L Wang, M Shi, L Lin; (II) Administrative support: L Lin, X Liu; (III) Provision of study materials or patients: J Qiu, Y Xiong, S Ma; (IV) Collection and assembly of data: L Wang, M Shi; (V) Data analysis and interpretation: All authors; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

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Author information

Authors and Affiliations

Geriatric Department, Peking University First Hospital, Xicheng District, Xishiku Avenue No 8, Beijing, China. Zip code: 100034.

Lina Wang, Mingwei Shi, Lianjun Lin, Xinmin Liu.

Medical imaging department, Peking University First Hospital, Xicheng District, Xishiku Avenue No 8, Beijing, China. Zip code: 100034.

Shuai Ma, Jianxing Qiu.

Department of Pathology, Peking University First Hospital, Xicheng District, Xishiku Avenue No 8, Beijing, China. Zip code: 100034.

Yan Xiong.

Corresponding author

Correspondence to Lianjun Lin and Xinmin Liu.

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Figures

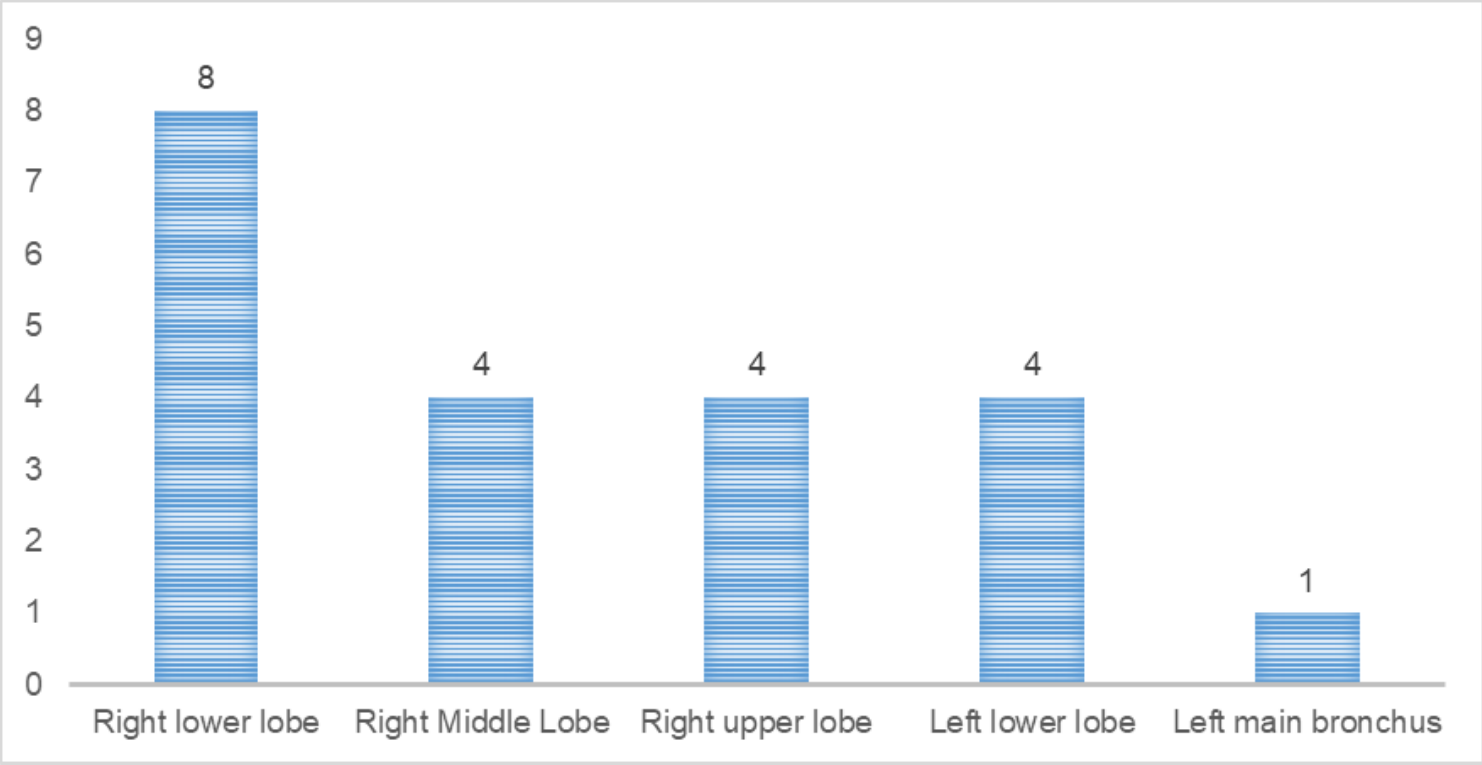

Figure 1

Location of lung biopsy.

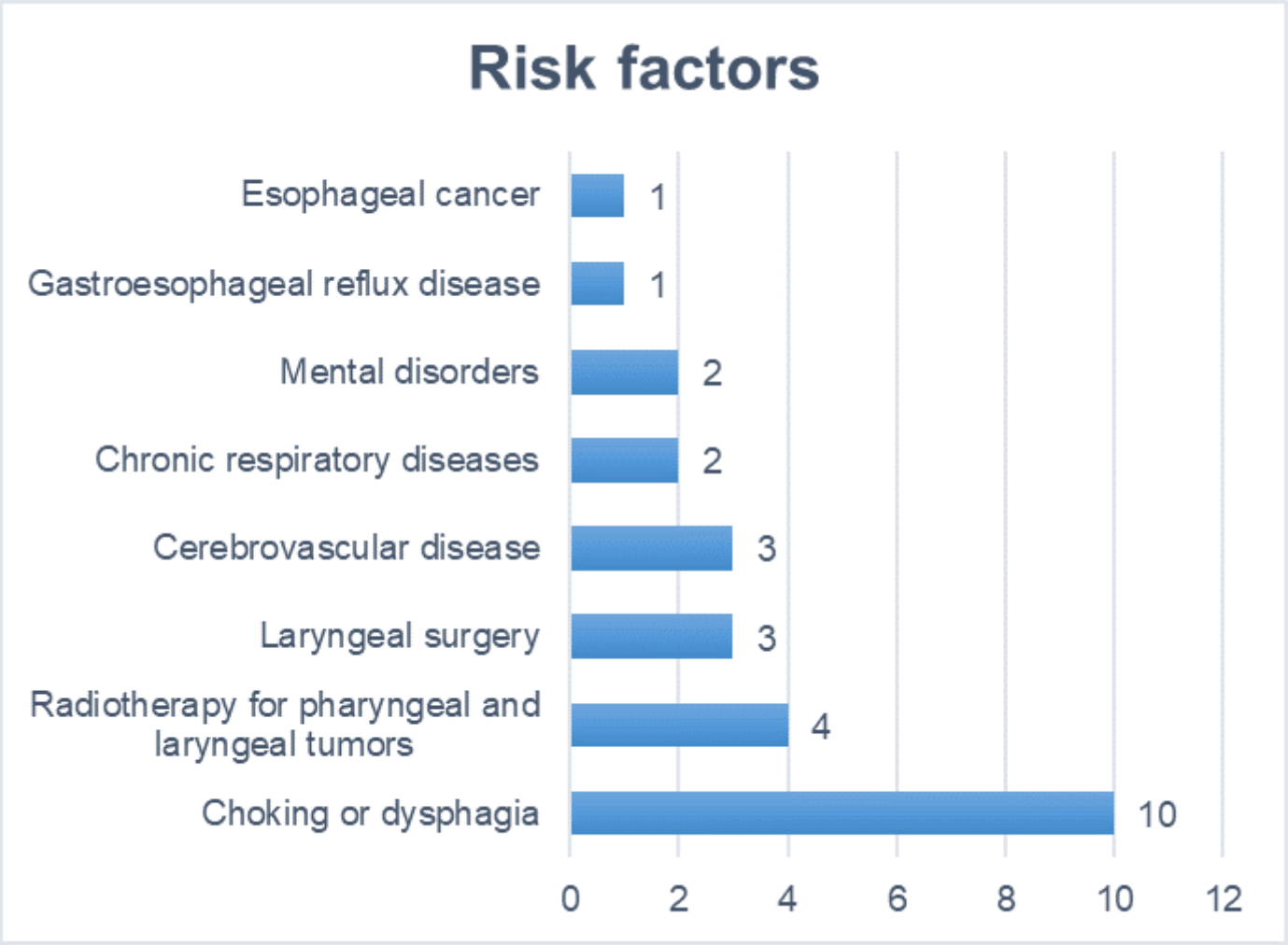

Figure 2

Number of patients with risk factors of aspiration.

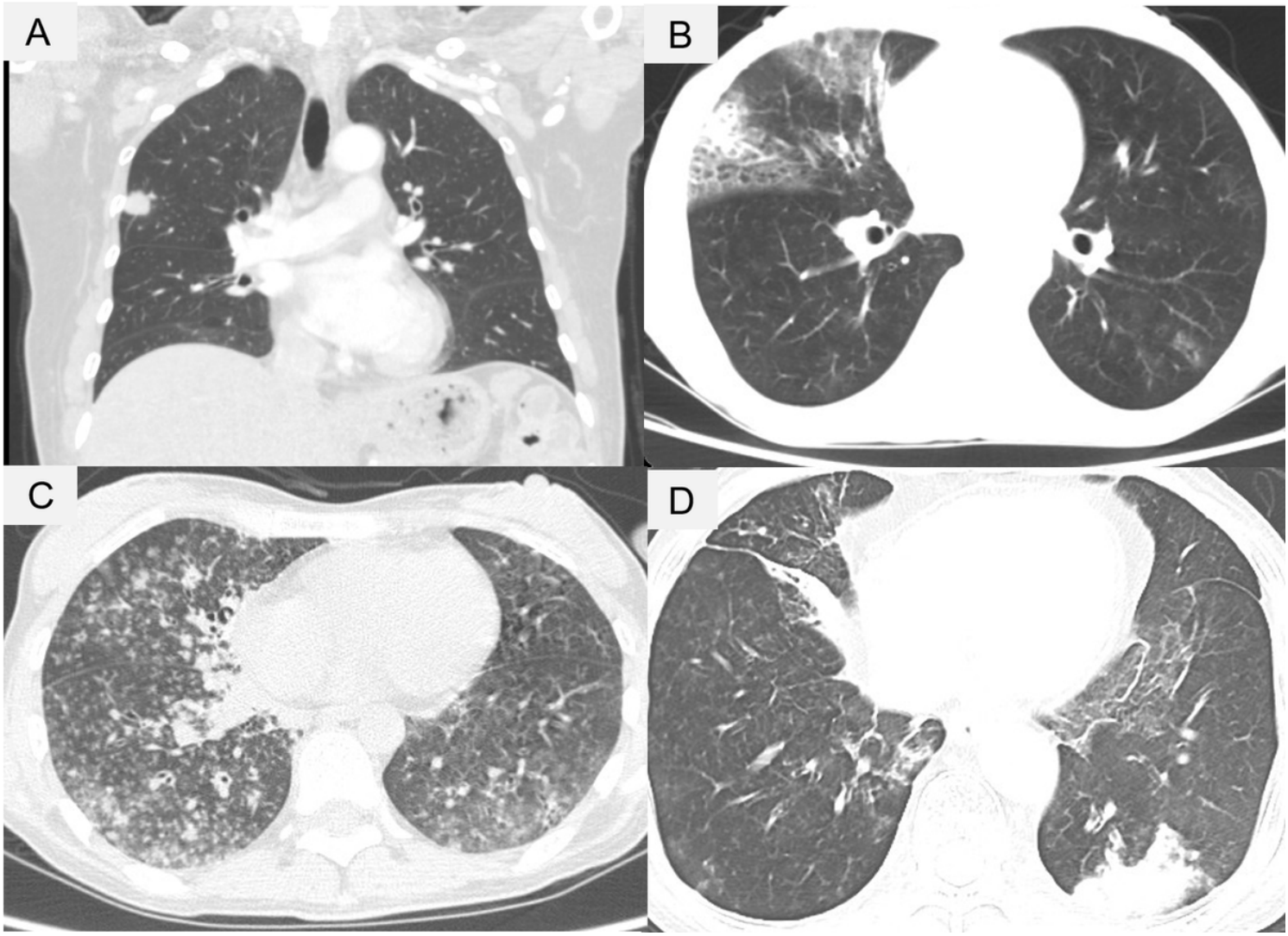

Figure 3

Chest CT images of mainly parenchymal patterns. *A*, Mass: focal consolidative opacity in the anterior segment of right upper lobe. *B,* Consolidation and ground-glass opacities: dense opacification involving the right middle lobe and patchy ground-glass opacities in the both lungs. *C,* Bronchiolitis: centrilobular nodules and tree-in-bud opacities diffusely in both lungs. *D,* Mixed lesions: Atelectasis in the right middle lobe, mass and patchy ground-glass opacities in the left lower lobe.

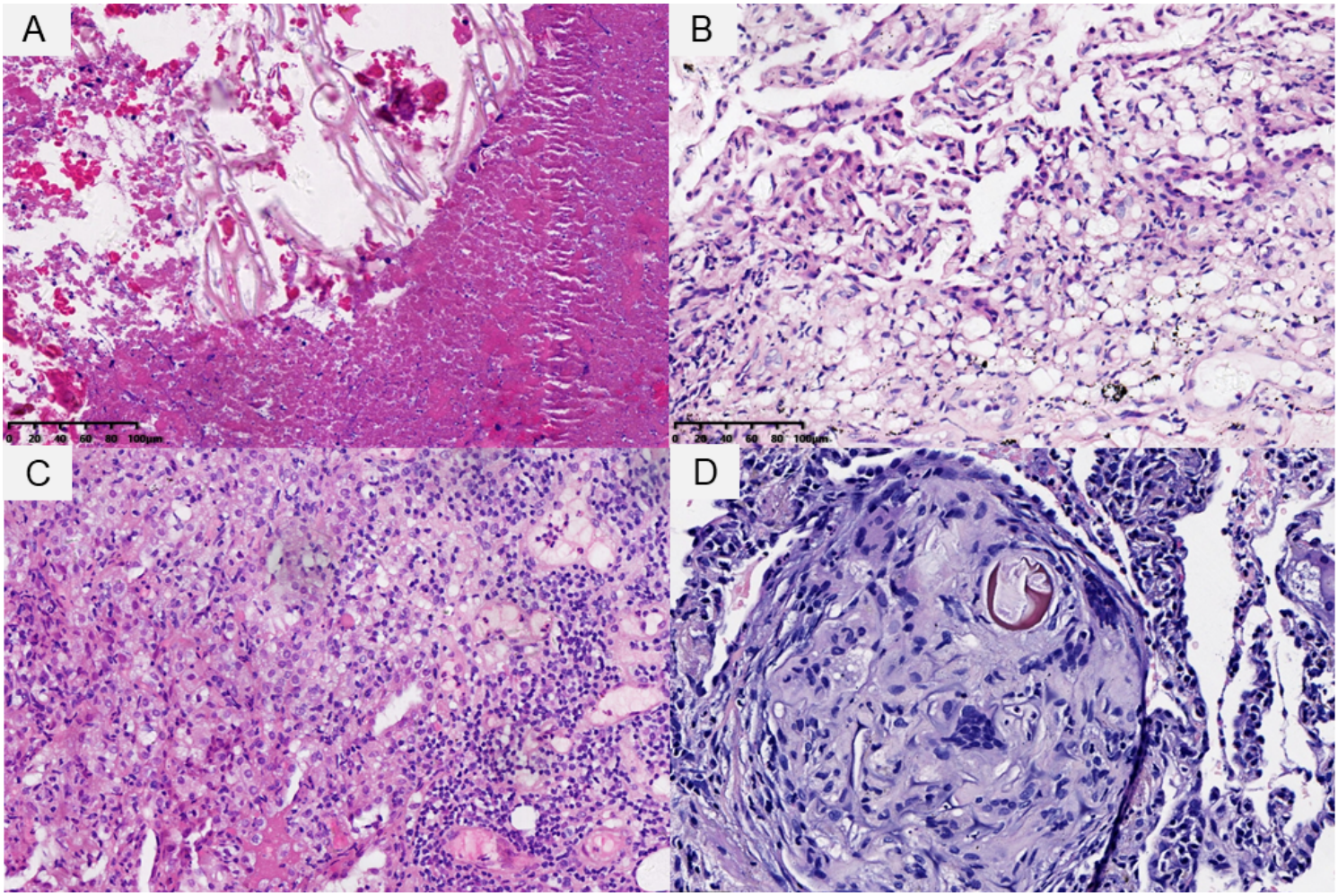

Figure 4

Pathological findings that correspond to chest CT finding respectively in figure 3. *A,* Necrotizing granulomatous inflammation, calcification with foreign body in the center of necrosis area hematoxylin and eosin staining [HE], ×200).*B,* Lipid droplets in the pulmonary interstitium and alveolar cavity, accompanied by interstitial fibrosis and chronic inflammatory cell infiltration (HE, ×200).*C,* Consolidation and inflammatory cell infiltration (HE, ×20). *D,* Granulomatous inflammation and secondary organizing pneumonia (HE, ×200).