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Case Report

Pulmonary mediastinal actinomycosis with "pound cake sign" on magnetic resonance imaging mimicking an infiltrative malignant tumor: A case report ☆

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ABSTRACT

Actinomycosis is a rare chronic suppurative granulomatous disease. Surgical biopsy is often performed in patients with chest actinomycosis because malignancy is suspected in most cases. A 62-year-old man presented to our hospital with fever and exertional dyspnea that had persisted for several months. Contrast-enhanced computed tomography showed an irregularly shaped mass with contrast enhancement in the anterior mediastinum and consolidation in the left upper lung lobe contiguous with this mass, as well as multiple nodules in both lungs. The pulmonary artery trunk was stenotic and surrounded by the mass, and the right heart system was enlarged. Thoracoscopic biopsy was performed but failed to yield a diagnosis. Contrast-enhanced computed tomography after one month revealed an increased mass and worsening right heart strain. ^{18}F-FDG (fluorodeoxyglucose) positron emission tomography/computed tomography and contrast-enhanced magnetic resonance imaging also suggested a malignant tumor, and an open chest biopsy was performed. No malignant cells were identified and actinomycetes were detected by histopathology and bacterial culture. The patient was treated with antibiotics, following which his contrast-enhanced computed tomography findings and general condition improved.

☆ Competing Interests: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Introduction

Actinomycosis is a chronic and rare infection caused by gram-positive anaerobic bacteria that can affect the cervicofacial area, chest, abdomen, and pelvis. It usually spreads contiguously to the adjacent tissues but can also spread hematogenously [1,2]. Diagnosing actinomycosis can be very difficult, and it is also frequently delayed owing to nonspecific clinical signs. In most cases, it is misdiagnosed as a malignant lesion despite being benign, and surgical biopsy or resection is often performed [3]. The definitive diagnosis is still based on histological or microbiological conformation [1].

Imaging can reveal some specific features of the actinomycosis, such as a highly infiltrative mass containing suppurative necrosis [1]. To our knowledge, little has been reported about thoracic actinomycosis involving the mediastinum in which contrast-enhanced magnetic resonance imaging was performed, and no studies in the literature that have mentioned the diagnostic findings of thoracic actinomycosis [4,5].

In this report, we have described a case of mediastinal abscess due to pulmonary actinomycosis, which was difficult to distinguish from malignancy and led to open chest surgery.

Case report

A 62-year-old man presented with a 4-month history of fever ranging from 37°C to 38°C and 2-week history of exertional dyspnea. He had also been presented with a low-grade fever a year earlier, and received symptomatic treatment and short-term oral antimicrobial therapy. He had a history of smoking 15 cigarettes per day for 20 years, and his medical history included chronic obstructive pulmonary disease. He worked as a hospital clerk. Physical examination revealed clear breath sounds and a systolic heart murmur. Oral hygiene was good, and there were no loose or carious teeth. Blood tests showed an inflammatory response, with a white blood cell count of 11,500/μL and C-reactive protein of 9.80 mg/dL. Tumor marker levels were not elevated except for a highly soluble interleukin-2 receptor level of 757 IU/mL. A left hilar mass and cardiac enlargement were observed in the chest radiograph, while the chest radiograph from one year prior showed aortopulmonary window opacification. Chest contrast-enhanced computed tomography (CT) revealed a 7 cm-sized irregularly shaped mass with a contrast enhancement in the anterior mediastinum. Contiguous with the mass, consolidation was observed in the medial upper lobe of the left lung and multiple nodules were present bilaterally in the lungs. The mass surrounded the pulmonary artery, and mild stenosis was observed in the main trunk of the pulmonary artery, along with mild enlargement of the right ventricle and right atrium (Fig. 1). An anterior mediastinal malignant tumor and multiple metastases to the lungs were suspected, and a thoracoscopic biopsy was performed; however, an accurate diagnosis could not be made.

^{18}F-FDG PET/CT (fluorodeoxyglucose positron emission tomography/computed tomography) showed high avidity, with a maximum standardized uptake value (SUVmax) of 19.0, from the anterior mediastinal mass to the left upper lobe consolidation, as well as high avidity in the multiple pulmonary nodules. High FDG accumulation was also observed in the right ventricular myocardium, suggesting right heart strain (Fig. 2). A contrast-enhanced CT after one month revealed an enlarged mass, progressive pulmonary artery stenosis, thrombus formation in the lumen, and worsening enlargement of the right ventricular system. Consolidation contiguous with the mass decreased, whereas a new consolidation appeared in the lingular segment. The bilateral lung nodules had partially decreased in size, but an increase in some lesions was also noticeable. In addition, left pleural effusion was observed (Fig. 3). Between the initial CT and contrast-enhanced CT the following month, no antibiotics were administered, except for a small intravenous dose of cefazolin (1 g) before and after thoracoscopic biopsy.

His general condition deteriorated, and blood tests showed a marked increase in the N-terminal pro-brain natriuretic peptide level to 5,714 pg/mL, indicating right heart failure.

Magnetic resonance imaging (MRI) showed an anterior mediastinal mass with mildly high signal intensity on T2-weighted image (T2WI) and equal signal intensity on T1-weighted image (T1WI) compared to the skeletal muscle, with heterogeneous high signal intensity on diffusion-weighted image (DWI) and decreased apparent diffusion coefficient (ADC). Fat-suppressed contrast-enhanced T1WI demonstrated heterogeneous enhancing effects, and pulmonary

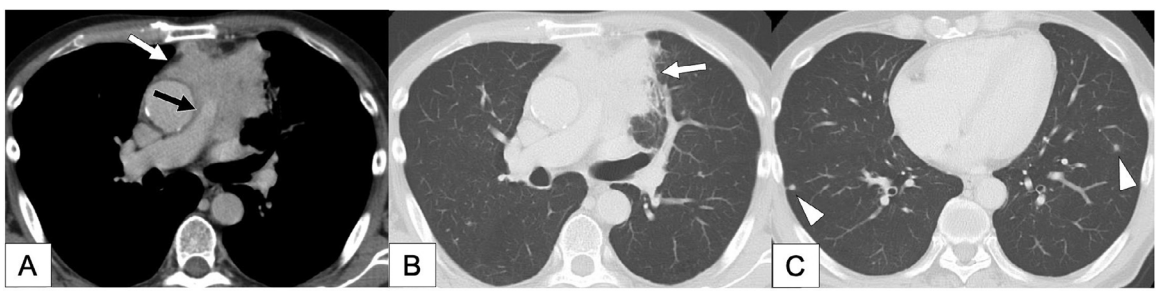

Fig. 1 – Axial portal phase chest computed tomography (CT) image. (A) In the mediastinal window, an irregular shaped mass with contrast enhancement is visible in the anterior mediastinum (white arrow). The pulmonary artery trunk shows mild stenosis due to the mass (black arrow). (B) In the lung window, the consolidation adjacent to the mass in the left upper lobe (arrow) and mild emphysema can be seen. (C) Multiple nodules in the bilateral lungs (arrowhead).

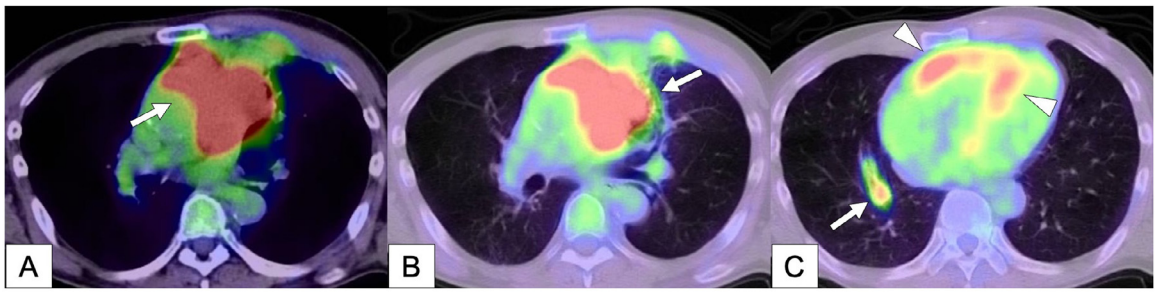

Fig. 2 – Axial fused 18-fluorodeoxyglucose positron emission tomography/computed tomography (^{18}F-FDG PET/CT). (A, B) There is high avidity, with a maximum standardized uptake value (SUVmax) of 19.0, in the anterior mediastinal mass and consolidation in the left upper lobe (arrow). (C) Pulmonary nodules are also hyperintense (arrow). Increased FDG accumulation is seen in the right ventricular myocardium, suggesting right heart strain (arrowhead).

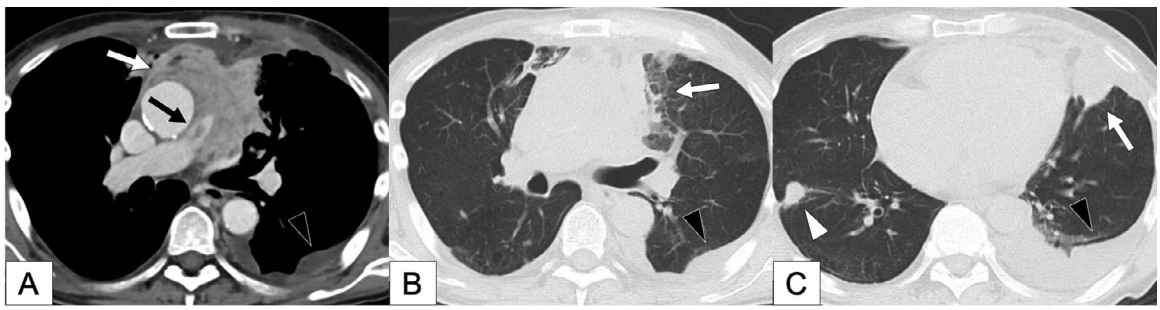

Fig. 3 – Axial portal phase chest computed tomography (CT) in the following month (each at the same level as Fig. 1). (A) In the mediastinal window, the mass is enlarged (white arrow), with progressive stenosis of the pulmonary artery trunk, along with a luminal thrombus (black arrow). (B) The consolidation contiguous to the mass is partially decreased (arrow). (C) A new consolidation has appeared in the lingular segment (arrow). Bilateral lung nodules are decreased, but an increase in some lesions is also noticeable (arrow). Left pleural effusion is seen (A-C, black arrowhead).

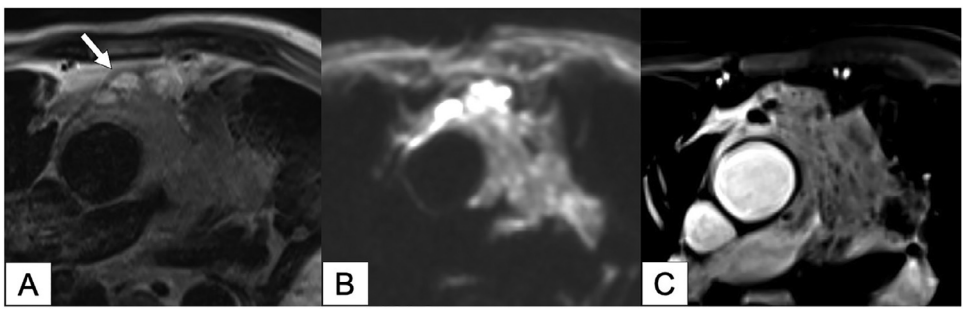

Fig. 4 – Axial chest magnetic resonance imaging (MRI). (A) T2-weighted image (T2WI) shows that the anterior mediastinal mass is mildly hyperintense compared to the skeletal muscle. A small amount of fluid on the ventral side of the mass is seen (arrow). (B) Diffusion-weighted image (DWI) shows heterogeneous hyperintensity. (C) In fat-suppressed contrast-enhanced T1-weighted image (T1WI), the mass is accompanied by heterogeneous enhancing effects and seems to be invading the surrounding structures, including the pulmonary artery trunk. There are multiple tiny areas of poor enhancement in the mass.

artery invasion was suspected. Multiple tiny areas with poor enhancement were observed inside the mass (Fig. 4).

An open chest biopsy was performed, and intraoperative rapid pathology did not identify any malignant cells. The mass showed multiple elongated discharges of a yellowish-white fluid that appeared to be pus. The mediastinal mass and the thickened and stiffened pericardium were resected as much as possible. Subsequently, pulmonary artery stenosis was relieved and the movement of the right ventricle improved. Histopathological examination revealed no malignant cells; however, sulfur granules, which are characteristic of actinomycetes, were observed. Grocott's staining revealed dark brown intertwined filamentous fungi forming a fungal mass (Fig. 5). In addition, *Actinomyces israelii and Actinomyces*

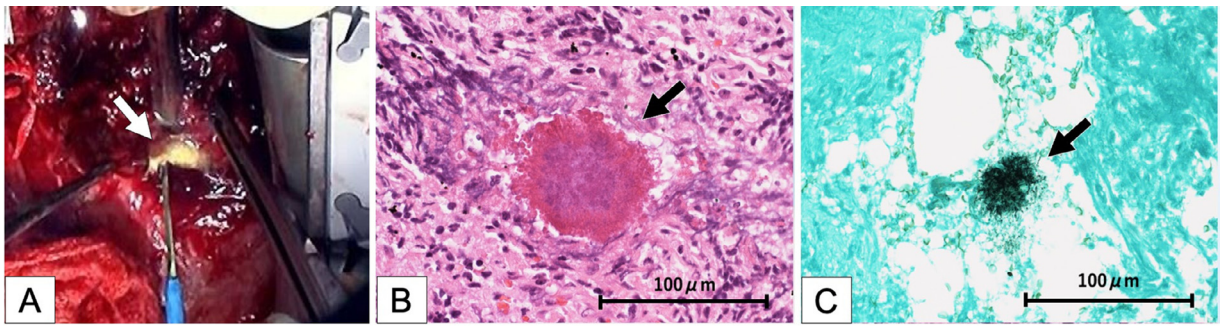

Fig. 5 – Intraoperative photograph and histopathology. (A) Pus-like yellowish-white fluid is observed to be draining from the mass (arrow). (B) Hematoxylin and eosin staining shows inflammatory findings and characteristic sulfur granules (arrow). (C) Grocott's stain shows dark brown filamentous fungi intertwining and forming a fungal mass.

meyeri were detected in bacterial cultures of the pus collected intraoperatively. The patient was diagnosed with an anterior mediastinal abscess associated with pulmonary actinomycosis.

He was treated with intravenous antibiotics (ampicillin/sulbactam 3 g QID) for 6 weeks, followed by oral antibiotics (amoxicillin/clavulanic acid 500 mg). The patient's clinical symptoms and inflammatory response gradually improved. Contrast-enhanced CT performed 2 months after surgery showed a decrease in the anterior mediastinal mass, consolidation, and pulmonary nodules; enlargement of the right heart had improved; and pleural effusion had disappeared. The patient recovered and was discharged from the hospital three months after surgery.

Discussion

Actinomyces belongs to the normal oral flora but also is a part of the gastrointestinal and genital flora of humans. Infections can affect every organ of the body, and cervicofacial actinomycosis is the most common type of infection [1,2]. Thoracic actinomycosis, which affects the lungs, mediastinum, pleura, and chest wall, accounts for approximately 10%-20% of all actinomycosis cases [1]. Inhalation of oropharyngeal secretions in patients with poor oral hygiene, seizure disorders, alcoholism, and a perforated esophagus is a risk factor [1]. In particular, mediastinal infections are considered rare, with the exception of infections in patients with medical devices such as esophageal stents [6].

It takes 1-12 months to diagnose thoracic actinomycosis, usually 3 months [1]. Diagnosis can be difficult due to prolonged nonspecific symptoms, such as cough, hemoptysis, chest pain, weight loss, and increased sputum production. In actinomycosis, cultures of clinical specimens are negative in >50% of the cases [1]. Therefore, histopathological examination of the infected tissue biopsies to identify sulfur granules is useful for diagnosis [1,2].

In this case, based on the findings of a plain chest radiograph taken one year prior, it was suspected that the patient had already been infected with actinomycetes, but more than a year had passed before the final diagnosis was made.

Thoracic actinomycosis usually results in the formation of masses (inflammatory pseudolesions) in the lungs and mediastinum, but can also present with extensive or localized pneumonia, pyothorax, and endobronchial masses [7]. In addition, mediastinal actinomycosis has been reported to cause pericardial effusions with or without pleural effusions, pericardial masses, and mediastinal masses, which can lead to various complications, including superior vena cava syndrome, Pancoast syndrome, and esophagotracheal fistulas [8].

In this case, the main lesion was a continuous mass in the left upper lung lobe and anterior mediastinum, with multiple small lesions in both lungs. There are two possible routes of infection. One is the spread of the infection to the mediastinum from pneumonia due to a respiratory tract infection. The second is hematogenous spread from other foci to the lungs and mediastinum. Although this patient did not have a history of poor oral hygiene or a high risk of aspiration, we believe that a respiratory tract infection was the more likely route because no findings other than those in the lungs and mediastinum were suggestive of infection. Therefore, the consolidation adjacent to the anterior mediastinal mass in this case was considered actinomycotic pneumonia.

On reviewing the CT scans, we found that some of the lung consolidation adjacent to the mass had decreased before surgery, and some of the nodules suspected to be metastatic lesions had also reduced. Furthermore, the consolidation had a regional distribution, which was atypical for mediastinal tumor invasion of the adjacent lungs. Careful interpretation of the CT images led to a diagnosis of an inflammatory mass rather than a malignant tumor.

The common PET/CT finding in actinomycosis is severe hypermetabolism, comparable to that in malignancy; therefore, hyperintensity does not exclude actinomycosis [9]. The SUVmax of 19.0 in the anterior mediastinal lesion in this case indicated hyperintensity and did not aid in differentiation from malignancy. However, it became clearer that no other lesions were present, except for those in the thoracic region.

Only a few cases of thoracic actinomycosis involving the mediastinum in which MRI was performed, have been reported. To our knowledge, contrast-enhanced MRI was performed in only two such cases, and there is no literature on the diagnosis of thoracic actinomycosis [4,5]. The multiple tiny areas with poor enhancement in the mediastinal mass

on fat-suppressed contrast-enhanced T1WI in the present case were thought to correspond to the numerous elongated abscesses and fistulae observed during surgery. We named this MRI finding the "pound cake sign" because it resembles the cut surface of a pound cake. The "pound cake sign" is considered a characteristic feature of pyogenic granulomas formed by actinomycosis and may help to differentiate them from malignant tumors.

Malignant tumors arising in the anterior mediastinum that can be differentiated prior to open chest biopsy include high-risk thymomas, thymic carcinomas, and leiomyosarcomas. Common imaging features of these malignant anterior mediastinal tumors include a heterogeneous enhancement, infiltrative tendency, high signal on DWI, and increased FDG uptake [10-13]. Furthermore, high-risk thymomas and thymic carcinomas also show marginal irregularities and severely reduced ADC, and lymph node and hematogenous metastases have also been reported in thymic carcinomas [14]. In fact, the mass in this case had several signs in common with the malignant tumors mentioned above, including a heterogeneous enhancement, infiltration of the pulmonary artery, high signal on DWI, decreased ADC, and high FDG uptake. Consequently, a malignant tumor was strongly suspected in this patient from the beginning and the images were not interpreted carefully, making preoperative diagnosis even more difficult.

The principal treatment of actinomycosis is 2-6 weeks of intravenous high-dose antimicrobial agents, followed by 6-12 months of oral benzylpenicillin or amoxicillin [1]. Surgical approaches are considered if abscesses, extensive necrotic tissue, or fistulas are present, antimicrobial agents are unsuccessful, or when the purpose is to exclude malignancy [1]. Our patient was successfully treated by removing the granulation tissue and abscess through open chest surgery, followed by the administration of antibiotics.

Conclusions

Pulmonary mediastinal actinomycosis is a rare infectious condition that often mimics malignancy. Diagnosis is often delayed owing to a lack of specific imaging findings. The present case showed multiple tiny areas with poor enhancement in the mediastinal mass on fat-suppressed contrast-enhanced T1WI, which we named the "pound cake sign." This finding is believed to be characteristic of actinomycosis, reflecting abscesses and fistulas in pyogenic granulomas, and it may be useful in differentiating actinomycosis from malignant tumors.

Patient consent

Informed consent was obtained from the patient for publication of the report and associated images.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.radcr.2024.05.001.

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