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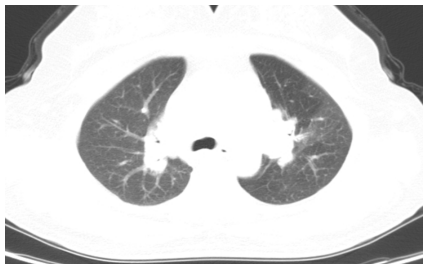
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The Imaging Analysis of Pulmonary Sarcodiosis

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Abstract: **Objective: To analysis radiographic features of thoracic sarcoidosis for further understanding of the disease. Methods: 42 cases of pulmonar sarcodiosis were proved by histopathology from April 2009 to July 2014, including 13male and 29 female, and their age were from 33 year-old to 75 year-old, with an average of 50 years. All the cases underwent CT scan. Among them, 25 cases received enhanced CT scan. The imaging findings were summarized by two chest imaging physician. Results: The main CT finding of pulmonar sarcodiosis was lymphadenopathy which were seen in 38 cases (90.5%), including mediastinal and bilateral hilar lymphadenopathy (n=27, 64.3%), mediastinal and the hilar lymphadenopathy (n=5, 11.9%), mediastinal lymphadenopathy (n=6, 14.3%) and the lesion of pulmonary parenchymal without mediastinal lymphadenopathy (n=4, 9.5%). The parenchymal abnormalities in sarcoidosis were seen in 34 cases (80.9%), of which 29 cases were noudles (69.0%) and 15 cases distributed around the bronchovascular bundles (35.7%), masses (n=4, 9.5%), consolidations (n=2, 4.8%), ground-grass (n=1, 2.4%), thickening of bronchovascular bundle (n=12, 28.6%), fibrosis (n=1, 2.4%) and pelural involvement (n=10, 23.8%). Conclusion: CT manifertations of pulmonar sarcodiosis are varied, but have some specific radiographic features. A correct diagnosis can be made combined with hilar and mediastinal adenopathy.**



Keywords: Sarcodiosis, Pulmonar, Tomography, X-ray computed

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1. Introduction

Sarcoidosis is a granulomatous disease affecting multiple body organs such as the lungs, lymph nodes, skin, eyes, tonsils, parotid gland, liver, spleen, kidney, gastrointestinal tract and bone joints. Among them, 90% affect the chest. The pathological feature is non-caseous necrotizing epithelioid granulomas [1]. Clinical diagnosis is often based on clinical symptoms, signs, laboratory tests and chest imaging manifestation. Patients mostly reports clinical symptoms of cough, sputum, fever and chest tightness. As 40% of the patients manifest no symptoms [2] and cannot obtain support from physical signs or laboratory tests, the disease is often detected by accident in a medical examination. Therefore, imaging is very important for the diagnosis of sarcoidosis. This paper retropectively analyzed the radiographic features of thoracic sarcoidosis in 42 cases in which had been diagnsed in the author's hospital from January 2009 to July 2014 intend to further improve the understanding of this disease.

2. Materials and Methods

2.1 General Materials

42 cases of pulmonar sarcodiosis were collected in the author's hospital from April 2009 to July 2014, including 14 male and 31 female, and their age were from 33 year-old to 75 year-old, with an average of 50 years. 12 cases manifested no obvious symptoms and the disease was found accidentally during physical examination. 28 patients manifested chest tightness, shortness of breath, cough, sputum, fever and other respiratory symptoms. 2 cases showed subcutaneous nodules. All cases were confirmed by histopathology.

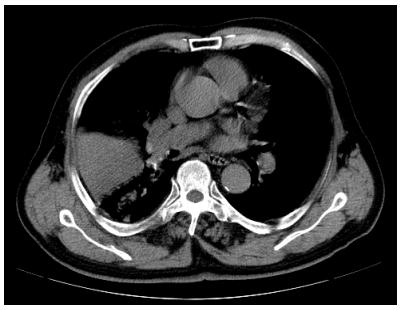


Figure 1. 75-year-old man with consolidation in right mid lung lobe.

2.2 Examination Method

Philips 16-slice CT scanner and Toshiba 640 CT were applied. All 42 cases underwent chest CT scan.

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Scan parameters: 120 kV, 100-160mAs, Acquistion matrix 512×512, reconstruction slice thickness 2 mm. The reconstructed images included the lung window and mediastinal window. 25 cases underwent enhanced scanning, using non-ionic contrast agent Ultravist (300 mgI/ml) 100 ml. The agent was injected with a high-pressure syringe through intravenous injection, flow rate of 3.0 ml.

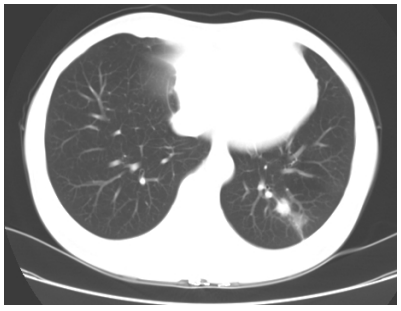


Figure 2. 48-year-old woman with ground-glass opacity in left lower lung lobe.

3. Results

3.1 Intrathoracic lymph nodes underwent changes

Mediastinal lymphadenopathy in 38 cases (90.5%). Mediastinal lymphadenopathy and bilateral hilar lymphadenopathy in 27 cases (64.3%). Mediastinal lymphadenopathy and the hilar lymphadenopathy in 5 cases (11.9%). Mediastinal lymphadenopathy without hilar lymphadenopathy in 6 cases (14.3%). No lymphadenopathy and only intrapulmonary changes in 4 cases (9.5%). Mediastinal lymphadenopathy mainly occurs to those close to the lower right trachea and the main pulmonary window and lymph nodes in the subcarinal area. Lymph nodes close to the lower right trachea enlarged in 35 cases (83.3%). Lymph nodes in the primary pulmonary window enlarged in 25 cases (59.5 %). Lymph nodes in the subcarinal area enlarged in 28 cases (66.7%). For 25 cases undergoing enhanced CT scan, lymph nodes all manifested moderate or significant enhancement.

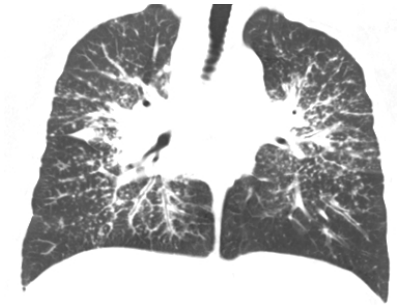


Figure 3. 51-year-old woman with bronchovascular bundles thickening in both lower lungs.

3.2 Lung disease classification based on lesion morphology

Nodules The main CT finding of parenchymal abnormalities in sarcoidosis were noudles (n=29, 69.0%) which incldue small nodules (diameter ≤ 1cm) in 21 cases and larger nodules (1cm < diameter < 3cm). Among these nodules, 15 cases distributed along the beam of bronchial vessels in, 6 cases diffused distribution in both lungs and 8 cases scattered distribution in both lungs. Nodules were located in upper lung lobe in 11 cases, in mid lung lobe in 10 cases; and in lower lung lobe in 8 cases.

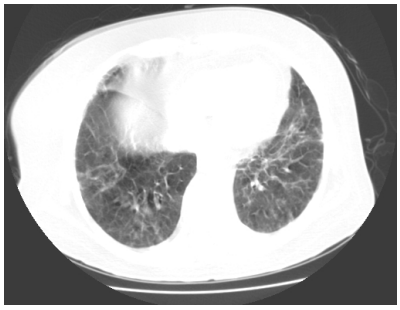


Figure 4. 52-year-old woman with fibrotic sarcodsis. CT scan reveals distortion pattern with bronchic deformation.

Masses Masses in the shape of dense shadows (diameter > 3cm) in 4 cases (9.5%). Among them, 2 cases were on the upper right lung and the other 2 cases were on the lower left lung.

Consolidations Consolidations were found in 2 cases (4.7%), one in the mid lung lobe and the other in the mid-upper lung lobe (Figure 1).

Ground-glass opacity Ground-glass opacity was seen in one case (2.4%) in the lower lung lobe (Figure 2).

Bronchovascular bundles thickening Thickening of the bronchovascular bundles was seen in 12 cases (28.6%) with 4 cases in the upper lung, 5 cases in the mid lung and 3 cases in the lower lung (Figure 3).

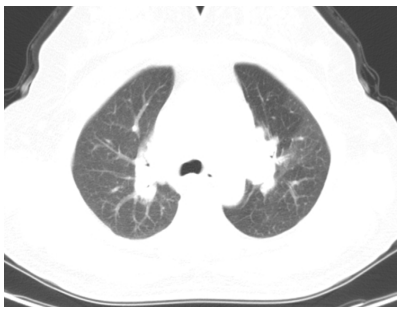


Figure 5. 52-year-old woman with patchy air trapping areas as the predominant manifestation of small airway involvement and lymph node

Fibrosis Fibrosis was seen in 1 case (2.4%) and manifests itself as grid shadow and bronchial deformation (Figure 4).

Air trapping Air trapping was seen in 2 cases

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(4.8%) (Figure 5).

involvement.

Bronchial stenosis Bronchial stenosis was seen in 2 cases (4.8%), with irregular and narrow bronchus (Figure 6).

Bronchial lesions Bronchial lesions were founded in 10 cases (23.8%), including pleural thickening in 8 cases and pleural effusion in 6 cases.

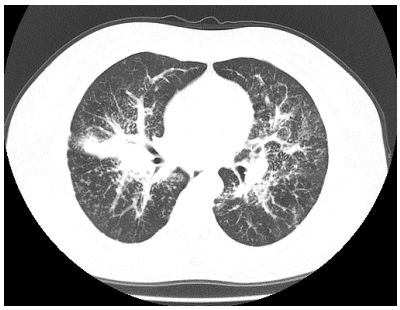


Figure 6. 45-year-old woman with bronchial stenosish in right upper lung lobe. CT scan reveals irregular and narrow bronchus.

4. Discussion

Sarcoidosis is a granulomatous disease of unknown etiology affecting multiple body systems. 90% affect the chest, most commonly the lungs and bilateral hilar lymph nodes. Common respiratory signs and symptoms of sarcoidosis include cough with a small amount of phlegm, fatigue, fever, night sweats, etc. 40% of the patients are asymptomatic. And the chest abnormalities are usually found in X-ray examination. The incidence of women is higher than men [3].

4.1 Radiographic manifestations of sarcoidosis

1) Changes in mediastinal lymph nodes:

Lymphadenopathy 75% -90% of sarcoidosis patients have manifest mediastinal and hilar lymphadenopathy. Typical manifestation is bilateral hilar and right paratracheal lymphadenopathy. Other common sites of lymphadenopathy include the aortopulmonary window and subcarinal region [4]. Mediastinal lymphadenopathy with or without one side hilar lymphadenopathy is the most common atypical manifestation (37%). 3 cases of mediastinal lymphadenopathy with one side hilar lymphadenopathy and 2 cases of mediastinal lymphadenopathy in this group appear mediastinal lymphadenopathy and bilateral hilar lymphadenopathy during the follow-up phase. It's probably because mediastinal and unilateral hilar enlargement is a stage of sarcoidosis which eventually manifest as mediastinal and bilateral hilar involvement. Therefore, radiological follow-up is essential in the diagnosis of the sarcoidosis.

Lymph node calcification CT detection ratio of lymph node calcification with sarcoidosis is 44% -53%. Calcification may occur to lymph nodes in any area and mostly involve the hilar and trachea. Calcification shows no specific features. But eggshell calcification is more common. 9% of sarcoidosis manifested eggshell calcification.

2) Intrapulmonary changes

Pulmonary nodules Pulmonary nodules are the most common manifestation of chest sarcoidosis on CT. Pulmonary nodules are usually symmetrical and mainly located in the mid and upper lung. The diameter of the majority of nodules is 0.2 ~ 1.0cm with irregular and sharp edges. Nodules are mostly distributed in the perilymphatic sapce along the bronchovascular sheath, interlobular septum and subpleural membrane including interlobular fissure. This results in irregular thickening of normally smooth bronchovascular bundles, pleural membrane and interlobular fissure with beaded manifestation. Compared to lesions distributed around the bronchovascular bundles, manifestations located in lung peripheries are more common. They are usually found in lobular center, subpleural area and interlobular fissures [5]. Interlobular septal thickening is rarely found. It's because small nodules of sarcoidosis are rarely distributed around the interstitium [6]. There are large differences in the number of nodules which may significantly involve the entire lungs (usually the upper, central and rear parts of the lungs) or are sparsely scattered or in local distribution. When the number of nodules is large, they may be integrated into large nodules, patches and masses greater than 1cm in diameter. Pathologically, gathering and fusion usually occur to granulomas which may manifest cavities and rare single calcifications. 29 cases (69%) in this group had nodules. 21 cases had small nodules (diameter ≤ 1cm), 8 cases had large nodules (1cm < diameter < 3cm). In 15 cases, the nodules were distributed along bronchovascular bundles.

Ground-glass opacities Pathologically, ground-glass opacities are alveolitis caused by interstitial granulomatous or inflammatory cells widely distributed and remaining within the alveolar space and alveolar septa. CT scan shows increased lung density without shielding the interior vascular texture. Gas-containing bronchus images are also discernible, usually accompanied by other lung abnormalities [6]. Ground-glass opacities may be improved after treatment. Opacities disappear fairly quickly. But there are also some ground-glass opacities which do not improve at all and even manifest signs of fibrosis. CT scan also shows traction bronchiectasis and bronchiolectasis. According to the literature, about 40% of patients have been reported to manifest ground-glass opacities [2]. But only 1 case in this group shows ground-glass opacities (2.3%), lower than reported in the literature. It's probably because some patients improved after treatment or by self-healing.

Bronchovascular bundles thickening Thicken-ing of the bronchovascular bundles is another major

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sign of sarcoidosis. Adjacent nodules thicken bronchovascular bundles and make their shape irregular. They also make lobular central structure look coarse and obvious. Thickened bronchovascular bundles shown on CT images consist of irregularly enlarged blood vessels, thickened bronchial walls and small nodules distributed along the small blood vessels. Epithelioid granulomas located in or around the bronchovascular bundles irregularly thicken pulmonary vasculars and bronchial walls. Although there are many interstitial granulomatous, more granulomatous tend to be around pulmonary vasculars and in connective tissue sheaths surrounding the trachea. In bronchial vascular sheaths, epithelioid granulomas are mostly distributed along the lymphatic vessels [7]. 12 cases in this group had thickened bronchovascular bundles and visible nodule shadows around.

Fiber foci formation Pathologically, a small number of epithelioid granulomas may often be seen within the fibrous lesions. Approximately 20% -25% of cases manifested the formation of fibrosis. The formation of fibrous lesions may be shown in varied forms on CT. There are mainly three different manifestations: (1) bronchial distortion (mainly central, 47%). Principal bronchi or upper lobe bronchus shift backwards suggests lung volume reduction at the rear part of the upper lobe. This is more widely seen than cellular and traction bronchiectasis. Interlobular fissure distortions also suggest lung volume reduction. (2) 29% of the cases had cellular bronchiectasis (mainly peripheral). (3) 24% of the cases had linear opacities (mainly diffusive) [8]. This group had only one case of fibrosis with grid-like change, suggesting an early manifestation of fibrosis. In later stages, fibrosis manifests cellular lung changes accompanied by bronchial dilation, compensatory emphysema and bronchial distortion.

Bronchial lesions Pathologically, bronchial wall thickening involves massive granulomas in the bronchial mucosa and the whole layer of the bronchial wall. Wall thickening also reflects interstitial granulomas distributed along the lymphatic vessels around the bronchovascular bundles. Main manifestations include regular or irregular and nodular mucosal thickening (65%) and smooth or irregular and nodular stenosis (23%) [5]. They also include localized bronchiectasis due to proximal trachea obstruction caused by lymph node compression or granulomas infringing bronchial endomembranes. Among them, bronchial mucosa or vascular bundle thickening due to wall thickening is the most common. In addition to lymphadenopathy and nodules, this is also one of the most common signs of chest sarcoidosis. Furthermore, sarcoidosis may also affect bronchioles. Granulomas around bronchioles can cause bronchial stenosis and dysfunction. On end-expiratory HRCT can be seen air trapping. The manifestation is local low-density areas in lung lobes. Air trapping is a common manifestation of sarcoidosis. It may occur at any stage of the disease and may also be the only manifestation of the lungs [2]. In this group, 12 cases (28.6%) had bronchovascular bundles thickening. 2 cases (4.8%) had air trapping. 2 cases (4.8%) had bronchial stenosis.

Pleural lesion It's rare compared to mediastinal and hilar lymph nodules and granulomatous nodules in the lungs. It's often accompanied by diffusive parenchymal changes. According to the literature, pleural effusion accounts for 3% of all cases [9]. 10 cases (23.8%) in this group were found with pleural lesions. Among them, 6 cases had pleural effusion. 8 cases had pleural nodules and thickening. Pleural lesions are often associated with multiple pulmonary nodules.

4.2 Differential diagnosis

The most common manifestations of pulmonary sarcoidosis is bilateral hilar lymphadenopathy and multiple mediastinal lymphadenopathy. Atypical manifestations of sarcoidosis primarily are mediastinal lymphadenopathy with or without unilateral hilar lymphadenopathymultiple. Mediastinal lymph nodes usually multiply in several sets on the middle mediastinum. It often occurs close to the middle aortic arch, behind the superior vena cava and under the bulge. Swollen lymph nodes generally do not converge.The density is uniform and the boundary is clear. They are in lobulated shape with calcification inside, especially the eggshell calcification. Lymph node enhancements are usually uniform. Moderate or significant enhancements are more commonly seen. The parenchymal abnormalities in sarcoidosis mainly are nodules distributed around bronchovascular bundles and a few are diffuse distribution. Nodules are of different sizes and may form ground-glass opacities and masses.

It is mainly differentiated from the following diseases:

1) Lymphoma: It's mainly mediastinal lymphadenopathy accompanied by hilar lymphadenopathy. Lymphoma is asymmetric enlargement and easily converges into groups. It's usually invasive growth and invasion of peripheral vascular. It's generally without calcification. Moderate enhancement can be seen after scanning.

2) Lymphatic tuberculosis: Mediastinal lymphadenopathy is unilateral. Early lesions seldom converge. At later stages, they converge into groups due to lymph node capsule ruptures in adjacent regions. The density is uniform. Ring-shape enhancement is usually seen. Nodular calcification usually manifests in diffusive calcification.

3) Metastatic tumor: Mediastinal lymphadenopathy is mostly asymmetric. Liquefactive necrosis and integration can be seen. Contrast scan shows heterogeneous enhancement.

4) Miliary tuberculosis: Nodules are evenly distributed in the whole lung instead of bronchovascular bundles. The diameter is about 1-3mm. It's an acute disease and generally is not difficult to identify.

5) Cancer lymphangitis: It obviously affects

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surrounding interstitial septum. Interlobular septal thickening is significant. Sarcoidosis granulomas are sparsely distributed in the surrounding interstitial septum. Interlobular septal thickening is not significant. In conclusion, CT manifestations of pulmonary sarcoidosis take various forms. Considering pulmonary signs and lymph node changes may support the diagnosis of sarcoidosis.

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