Review

Chest CT findings in systemic lupus erythematosus and its correlation with serum markers

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Abstract

Objective: The aim of this study was to assess the CT findings of chest lesions in patients with systemic lupus erythematosus (SLE), and to explore its correlation with the age and serum markers (anti-dsDNA antibodies, anti-Sm antibodies, CRP, ESR, C3, C4 and IgG), in an attempt to speculate the possible mechanism of chest lesions in SLE patients.

Materials and methods: Thirty nine patients who met the SLE classification criteria were enrolled into this study. All patients underwent serological tests and chest CT examination. The chest CT findings of each patients were analyzed, and its correlation with the age, serum markers were explored. All data were analyzed by using SPSS 19.0 software. Two-sample t-test was used to analyze the age difference between the two groups with or without chest lesions. Relationship between the serum markers and the chest lesions was analyzed by using the Fisher's exact probability method.

Results: All the 39 patients (34 females and 5 males), aged from 19 to 74 years old, the mean age was 44.13 ± 12.17 years old. Among the serum markers, the positive rate of C3 was the highest (79.49%), ESR positive in 22 patients (56.41%), 9 patients of CRP positive (23.08%). Of all the 39 patients, abnormal manifestations of chest CT were found in 29 patients (74.36%), the most common changes were pulmonary interstitial changes (66.67%), the second were mediastinal/pleural changes (61.54%), then were the pulmonary parenchymal changes (25.64%) and pulmonary vascular changes (12.82%). ESR positive rate difference was found between the two groups with or without pulmonary parenchymal lesions (P < 0.05), and CRP positive rate difference was found between the two groups with or without mediastinal/pleural lesions (P < 0.05).

Conclusion: Chest involvement occurred with high frequency in SLE patients, and the CT manifestations were complex and various, pulmonary interstitial lesions were the most common. Patients with ESR positive were more susceptible to have pulmonary parenchymal lesions, and mediastinal/pleural lesions were more common in patients with CRP positive.

Keywords: Systemic lupus erythematosus; Chest CT; Serum markers

1. Introduction

Systemic lupus erythematosus (SLE) is an autoimmune connective tissue disease, which can affect the skin, joints, kidneys, lungs, nervous system and other organs of the body. Up to now, the exact cause and pathogenesis of this disease remain unclear, which are generally accepted as the results of various factors. It is more common in young and middle-aged women, and its clinical manifestations are complex and diverse, mainly including: malar rash, discoid rash, photosensitivity, oral ulcers, arthritis, serositis, renal disorder, neurological disorder and so on. At present, the diagnosis of SLE is based on the SLE classification criteria revised by the American Rheumatism Association in 1997. Due to chest is rich in connective tissue, more than half of SLE patients have...
varying degrees of chest involvement during the course of the
disease [1], mainly involving pleura, pulmonary interstitium,
pulmonary parenchyma and respiratory muscles [2]. However,
chest CT findings in SLE are complex and variable, they are also
lack of relative specificity, so further research is needed.
As far as we know, about the research of chest CT findings in
SLE patients, there were a large number of literature reports
both at home and abroad. However, in the course of SLE, how
the relationship between the age of patients and the chest le-
sions, and how the correlation between the serum markers of
patients and the chest lesions, were less reported in the liter-
ature. Based on the above background, the aim of this study
was to assess chest CT findings in SLE patients, and to explore
the correlation between the chest CT findings and the age,
serum markers of the patients, through a retrospective analysis
of the chest CT findings and clinical data of 39 SLE patients,
in an attempt to speculate the possible mechanism of chest
lesions in SLE patients.

2. Materials and methods

2.1. Clinical data

This paper collected 39 SLE patients in the Department of
Rheumatism Immunity of the First Affiliated Hospital of
Nanchang University from March 2015 to October 2015, they
were all confirmed by clinic and met the SLE classification
criteria revised by the American Rheumatism Association in
1997. All the patients underwent serological tests and chest
CT examination. Of all the 39 patients (34 females and 5
males), aged from 19 to 74 years old, the mean age was
44.13 ± 12.17 years old. The clinical course was from several
days to several years. Some patients had a certain symptoms of
chest, mainly including: fever, chest tightness, chest pain,
shortness of breath, the area before the heart discomfort,
cough and dyspnea. Antibiotics had no effect on the chest
symptoms, but cortical hormone therapy had a good effect.
Meanwhile, excluding the chest lesions caused by bacteria,
fungi, tuberculosis, heart failure and so on. Serological tests
were performed in all patients, the serum markers included
anti-dsDNA antibodies, anti-Sm antibody, CRP, ESR, C3, C4,
and IgG.

2.2. Chest CT examination

All the patients were examined by using the Toshiba
Aquilion 64 slice CT. Patients were asked to take a deep
breath and routine chest scan was performed at the end of the
depth inspiration, scan ranged from the thoracic inlet to the
diaphragm, the exposure conditions: tube voltage = 120 kV,
tube current = 100 mA, slice thickness = 5 mm, layer
spacing = 5 mm, matrix = 512 × 512, then the thin-section
scan of 1 mm and post-processing reconstruction were
performed. CT images of all the patients were observed
and diagnosed by two experienced radiologists respective-
vely, combined with the lung window (window width: 1600–2000HU, window level: −600 – −800HU) and
mediastinal window (window width: 250–350HU, window
level: 30–50HU).

2.3. Statistical analysis

All data were analyzed by using the statistical software
(IBM SPSS 19.0). The age of the patients accorded with
normal distribution, so two-sample t-test was used to analyze
the age difference between the two groups with or without
chest lesions. The relationship between the serum markers
(anti-dsDNA antibodies, anti-Sm antibody, CRP, ESR, C3, C4,
IgG) and the chest lesions was analyzed by using the Fisher's
exact probability method, because the number of patients was
less than forty. A p-value less than 0.05 was considered sta-
tistically significant.

3. Results

3.1. Chest CT findings

Of all the 39 patients, abnormal manifestations of chest CT
were found in 29 patients (74.36%), the most common
changes were pulmonary interstitial changes (66.67%), the
second were mediastinal/pleural changes (61.54%), then were
the pulmonary parenchymal changes (25.64%) and pulmonary
vascular changes (12.82%). The proportion of the chest
changes was shown in Table 1, and the abnormal manifes-
tations of chest CT were shown in Figs. 1–4.

3.2. Serum markers

Among the serum markers, the positive rate of C3 was the
highest (79.49%), ESR positive in 22 patients (56.41%), 9
patients of CRP positive (23.08%), as shown in Table 2.

Table 1

<table>
<thead>
<tr>
<th>Chest CT findings</th>
<th>Cases</th>
<th>Proportion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary parenchymal changes</td>
<td>10</td>
<td>25.64</td>
</tr>
<tr>
<td>Consolidation</td>
<td>4</td>
<td>10.26</td>
</tr>
<tr>
<td>Patchy infiltration</td>
<td>9</td>
<td>23.08</td>
</tr>
<tr>
<td>Pulmonary interstitial changes</td>
<td>26</td>
<td>66.67</td>
</tr>
<tr>
<td>Ground-glass opacity</td>
<td>12</td>
<td>30.77</td>
</tr>
<tr>
<td>Honeycomb opacity</td>
<td>2</td>
<td>5.13</td>
</tr>
<tr>
<td>Funicular opacity</td>
<td>20</td>
<td>51.28</td>
</tr>
<tr>
<td>Subpleural line</td>
<td>9</td>
<td>23.08</td>
</tr>
<tr>
<td>Interlobular septal thickening</td>
<td>7</td>
<td>17.95</td>
</tr>
<tr>
<td>Emphysema</td>
<td>1</td>
<td>2.56</td>
</tr>
<tr>
<td>Bronchiectasis</td>
<td>4</td>
<td>10.26</td>
</tr>
<tr>
<td>Pulmonary vascular changes</td>
<td>5</td>
<td>12.82</td>
</tr>
<tr>
<td>Pulmonary artery trunk broadening</td>
<td>4</td>
<td>10.26</td>
</tr>
<tr>
<td>Mosaic sign</td>
<td>3</td>
<td>7.69</td>
</tr>
<tr>
<td>Mediastinal/pleural changes</td>
<td>24</td>
<td>61.54</td>
</tr>
<tr>
<td>Pleural thickening</td>
<td>8</td>
<td>20.51</td>
</tr>
<tr>
<td>Pleural effusion</td>
<td>11</td>
<td>28.21</td>
</tr>
<tr>
<td>Pericardial effusion</td>
<td>12</td>
<td>30.77</td>
</tr>
<tr>
<td>Podoid enlarging</td>
<td>10</td>
<td>25.64</td>
</tr>
<tr>
<td>Mediastinal lymphadenectomy</td>
<td>4</td>
<td>10.26</td>
</tr>
</tbody>
</table>

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3.3. Relationship between the age of patients and the chest lesions

All the 39 patients (34 females and 5 males), aged from 19 to 74 years old, the mean age was 44.13 ± 12.17 years old. Table 3 was a test of the age difference between the two groups with or without chest lesions (pulmonary parenchymal/interstitial/vascular and mediastinal/pleural changes). From the table, we knew that there was no statistical significance of the age difference between the two groups with or without chest lesions (P > 0.05).

3.4. Correlation between the serum markers of patients and the chest lesions

Tables 4–7 were tests of the positive rate difference of serum markers (anti-dsDNA antibodies, anti-Sm antibodies, CRP, ESR, C3, C4, IgG) between the two groups with or without chest lesions (pulmonary parenchymal/interstitial/vascular and mediastinal/pleural changes). From the tables, we found that there was positive rate difference of ESR between the two groups with or without pulmonary parenchymal changes (P = 0.002), and there was positive rate...
difference of CRP between the two groups with or without mediastinal/pleural changes (P = 0.007), but there was no statistical significance of the positive rate difference of serum markers between the two groups with or without other chest changes.

### 4. Discussion

SLE is an autoimmune connective tissue disease that various factors are involved in. It often affects multiple organs
and systems of the body, and a variety of autoantibodies positive can be found from the laboratory examination. The pathological basis of it are vasculitis and perivascular inflammation caused by immune complex deposition. Because lung is rich in collagen and blood vessels, lung damage can be usually found in SLE patients [3], mainly in: pulmonary interstitium, mediastinum/pleura, pulmonary parenchyma, and pulmonary vessel. In Clinic, the diagnosis of SLE mainly depends on clinical symptoms and combines detection of multiple autoantibodies, but it was rarely associated with chest changes. However, chest lesions can appear in any stage of the disease, and it closely related to the living quality of patients. In this paper, we studied the correlation between the chest CT findings and the serum markers of SLE patients, then speculated the possible mechanism of chest lesions in SLE patients, in the hope to guide the clinical diagnosis and treatment.

4.1. Chest CT

Compared with other connective tissue diseases, chest involvement in SLE are more common, but its incidence of each report is quite different, ranging from 7% to 100% [4,5]. In the past, the diagnosis of chest involvement in SLE mainly relied on chest X-ray, but it is difficult to find abnormalities while patients with slight chest lesions, especially in the early stage of some lesions. However, high-resolution computed tomography (HRCT) can find smaller lesions of lung and pleura with high sensitivity, it shows the incomparable superiority especially in the diagnosis of the early and mild disease that common X-ray cannot find [6]. Now it has been widely used in diagnosing chest lesions instead of the chest X-ray. The chest lesions of SLE patients mainly involve the pulmonary interstitium, the pleura, the pulmonary parenchyma and the respiratory muscle. Lung volume shrinking is relatively rare, but it is the characteristic expression caused by the damage of diaphragmatic muscle function [7]. In this study, we found that chest lesions in SLE patients were common, the most common lesions were pulmonary interstitial lesions, then they were the mediastinal/pleural lesions. However, Diane L [8] discovered that the most common changes were pleurisy or pleural effusion, followed by pulmonary interstitial and pulmonary parenchymal lesions.

4.2. Pulmonary interstitial lesions

The basic pathological characteristics of pulmonary interstitial lesions are the extensive destruction of alveolar walls, the loss of functional capillaries and the formation of fibrous scar. The pathogenesis may be due to the immune complex

| Table 4 |
| Test of the positive rate difference of serum markers between the two groups with or without pulmonary parenchymal changes. |
| Pulmonary parenchymal changes | Anti-dsDNA antibodies | Anti-Sm antibodies | CRP | ESR | C3 | C4 | IgG |
| Positive | 5 | 4 | 6 | 4 | 6 | 10 | 0 | 9 | 1 | 6 | 4 | 7 | 3 |
| Negative | 8 | 21 | 9 | 20 | 5 | 24 | 12 | 17 | 22 | 7 | 20 | 9 | 19 | 10 |
| P value | 0.253 | 0.704 | 0.197 | 0.002 | 0.653 | 0.704 | 1.000 |

| Table 5 |
| Test of the positive rate difference of serum markers between the two groups with or without pulmonary interstitial changes. |
| Pulmonary interstitial changes | Anti-dsDNA antibodies | Anti-Sm antibodies | CRP | ESR | C3 | C4 | IgG |
| Positive | 10 | 10 | 16 | 7 | 19 | 17 | 9 | 19 | 7 | 18 | 8 | 19 | 7 |
| Negative | 3 | 10 | 3 | 10 | 2 | 11 | 5 | 8 | 12 | 1 | 8 | 5 | 7 | 6 |
| P value | 0.477 | 0.477 | 0.689 | 0.172 | 0.229 | 0.725 | 0.290 |

| Table 6 |
| Test of the positive rate difference of serum markers between the two groups with or without pulmonary vascular changes. |
| Pulmonary vascular changes | Anti-dsDNA antibodies | Anti-Sm antibodies | CRP | ESR | C3 | C4 | IgG |
| Positive | 2 | 3 | 3 | 2 | 1 | 4 | 2 | 3 | 4 | 1 | 5 | 0 | 4 | 1 |
| Negative | 11 | 23 | 10 | 24 | 8 | 26 | 20 | 14 | 27 | 7 | 21 | 13 | 22 | 12 |
| P value | 1.000 | 0.310 | 1.000 | 0.636 | 1.000 | 0.149 | 0.648 |

| Table 7 |
| Test of the positive rate difference of serum markers between the two groups with or without mediastinal pleural changes. |
| Mediastinal pleural changes | Anti-dsDNA antibodies | Anti-Sm antibodies | CRP | ESR | C3 | C4 | IgG |
| Positive | 10 | 8 | 14 | 8 | 16 | 9 | 15 | 16 | 8 | 19 | 5 | 17 | 7 | 16 | 8 |
| Negative | 3 | 12 | 5 | 10 | 0 | 15 | 6 | 9 | 12 | 3 | 9 | 6 | 10 | 5 |
| P value | 0.295 | 1.000 | 0.007 | 0.184 | 1.000 | 0.508 | 1.000 |
deposition in the pulmonary interstitium, it activates macrophages in the lungs to release chemokines and inflammatory mediators, then leads to inflammatory response, at the same time stimulates fibroblast proliferation. CT manifestations mainly include: ground-glass opacity, funicular opacity, honeycomb/reticular opacity, subpleural line, interlobular septal thickening, emphysema and bronchiectasis. The ground-glass opacity often suggests that the lesion is reversible in the early stage of the disease, while reticular and honeycomb opacities often indicate longer duration of the disease.

4.3. Mediastinal/pleural lesions

In the present study, the incidence of mediastinal/pleural changes was only inferior to pulmonary interstitial changes. As we all known, the pathological changes of pleural and pericardial effusion were mainly infiltration of lymphocytes, monocytes and plasma cells, sometimes accompanied by small vasculitis and varying degrees of fibrosis. CT manifestations mainly include: pericardia/pleural effusion, pleural thickening, mediastinal lymphadenecrosis. In this study, we found that medium or small amount of pleural effusion was common in SLE patients, a large amount of pleural effusion was rare. The pleural effusion could be on one side or both. When the pleural effusion was on both sides, it would be distributed evenly on both sides of the thorax.

4.4. Pulmonary parenchymal lesions

The pathological manifestations of pulmonary parenchymal lesions are not specific, mainly manifest destruction and necrosis of the alveolar structure, infiltration/hemorrhage/edema of inflammatory cells, and formation of the transparent film. The main CT findings are consolidation and patchy infiltration, mostly on both sides, also on one side, the bottom and periphery of the lung are more obvious. The image cannot be identified with other pulmonary infections.

4.5. Pulmonary vascular lesions

Pulmonary vascular lesions are mainly manifested as pulmonary artery hypertension. Pulmonary artery hypertension is mainly caused by small vasculitis, small pulmonary artery embolism and plexal changes of small pulmonary artery. The main CT findings are mosaic sign and pulmonary artery main trunk broadening. SLE patients with pulmonary artery hypertension suggest that the prognosis is not good, the survival rate of 2 years is less than 50%, Cardiac Ultrasonic examination can be used as a noninvasive screening [9].

4.6. Relationship between the age of patients and the chest lesions

About the research of relationship between the age of patients and the chest lesions in SLE patients, there were few literature reports both at home and abroad. Of all the 39 patients in this study, 34 females and 5 males, ranged from 19 to 74 years old, the average age was 44.13 ± 12.17 years old. We found that there was no relationship between the age of patients and the chest lesions (pulmonary interstitial, mediastinal/pleural, pulmonary parenchymal and pulmonary vascular lesions) in this study.

4.7. Correlation between the autoantibodies and the chest lesions

As an autoimmune connective tissue disease, the serum of SLE patients contains a variety of autoantibodies. Anti-dsDNA antibody is the marked antibody of SLE, it almost exists in the serum of all SLE patients and its specificity is strong. High titer of anti-dsDNA antibody is an important basis for the diagnosis of SLE, and it is also the sign of disease activity; Anti-Sm antibody is the anamnestic antibody of SLE, the positive rate of it is lower, but the specificity of it is extremely high, almost up to 100%, so it is often known as the specific antibody of SLE, but it has nothing to do with the disease activity. In this study, we found that both the anti-dsDNA antibody with close relationship to the disease activity and the anti-Sm antibody of extremely high specificity had no correlation with the chest lesions (pulmonary interstitial, mediastinal/pleural, pulmonary parenchymal and pulmonary vascular lesions). It suggests that the chest lesions of SLE have a more complex pathogenesis and need further research.

4.8. Correlation between the inflammatory indicator and the chest lesions

CRP is one of the acute phase proteins, which can be used as the antimicrobial molecule and the marker of inflammation. Most scholars believe that SLE patients have low levels of CRP because of the presence of CRP antibody, but the level of CRP can increase when the patients have serosal effusion [10,11]. In this study, we found that CRP was associated with mediastinal/pleural lesions, patients of CRP positive were more likely to have mediastinal/pleural lesions, which were mainly manifested as pleural/pericardial effusion, this was consistent with other studies. At the same time, pleural/pericardial effusion is the active performance of SLE, whether we could speculate that the level of CRP was related to the disease activity of SLE? However, the foreign literature has reported that there was no correlation between the level of CRP and the disease activity of SLE, but the specific mechanisms still need further research [12], so this speculation has yet to be further studied.

ESR is also a common indicator of inflammation in clinic, its rise usually prompt that the body is in a state of inflammation. In this study, we found that ESR was associated with pulmonary parenchymal lesions, patients of ESR positive were prone to have pulmonary parenchymal lesions. But due to the specificity of ESR is poorer, it can also rise in SLE patients with anemia, infection, disease activity and organ damage, and the number of patients in this study was relatively small, the credibility of the conclusion needs to be improved.

In addition, we also discovered that there was no clear correlation between C3, C4, IgG and the chest lesions.
5. Conclusion

In summary, it was very common to find chest involvement in SLE patients. Currently, HRCT is the best imaging technology in diagnosing the chest lesions in SLE patients. Of all the patients in this study, chest lesions occurred with high frequency, and the CT manifestations were complex and various, pulmonary interstitial changes were the most common. We can draw preliminary conclusions that pulmonary parenchymal changes were more common in patients with ESR positive, and mediastinal/pleural changes more likely occurred in patients with CRP positive. Nevertheless, the number of patients in this study was relatively small, and all of them were inpatients for a period of time, so it could lead to the inaccurate results. In addition, this study did not group the patients into active and stable stage. These problems need for improving in future research.

References