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Dynamic and contrast enhanced CT imaging of lung carcinoma, pulmonary tuberculoma, and inflammatory pseudotumor

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Abstract. – OBJECTIVE: Our main aim was to investigate the effect of dynamic and contrast enhanced CT imaging on differential diagnosis of lung carcinoma, pulmonary tuberculoma, inflammatory pseudotumor, and coexisting pulmonary tuberculosis and lung cancer.

PATIENTS AND METHODS: About, 144 patients with pulmonary sarcoidosis as the study subjects were chosen which included: 36 patients with lung carcinoma, 36 patients with pulmonary tuberculoma, 36 patients with inflammatory pseudotumor, 36 patients with coexisting pulmonary tuberculosis and lung cancer. CT imaging scan was carried out on all of these 144 patients.

RESULTS: CT scan value of lung carcinoma was different from other conditions such as pulmonary tuberculoma, inflammatory pseudotumor, and coexisting pulmonary tuberculosis and lung cancer ($p < 0.01$). Similarly, the peak of enhancement of lung carcinoma was different from others including inflammatory pseudotumor, and coexisting pulmonary tuberculosis and lung cancer ($p < 0.01$). Both, the intensive added values and S/A values of lung carcinoma, inflammatory pseudotumor, and coexisting pulmonary tuberculosis and lung cancer differed between them ($p < 0.01$).

CONCLUSIONS: Helical incremental dynamic CT is helpful in differential diagnoses of lung carcinoma, pulmonary tuberculoma, inflammatory pseudotumor, and coexisting pulmonary tuberculosis and lung cancer.

Key Words:
Lung carcinoma, Pulmonary tuberculoma, Inflammatory pseudotumor, CT, CT imaging.

Introduction

Pulmonary sarcoidosis is an intrapulmonary nodular disease with complex etiology, which can involve the various organs and this disease is easy to be misdiagnosed[1]. Once some patients detect nodules in their lungs, they will be highly stressful, worrying about getting lung carcinoma. In fact, pulmonary nodule exists in many other pulmonary diseases, such as pulmonary tuberculoma, lung carcinoma, inflammatory pseudotumour, etc[2]. Therefore, nodules in the lung may be the reflection of lung carcinoma and other benign diseases. It is supposed to use CT and other adjunctive methods to further analyze and diagnose the illnesses[3-5]. Spiral CT has been widely used for the diagnosis of pulmonary diseases. However, due to the changeable morphometry of lung sarcoidosis and the repeatability of imaging features, some patients are misdiagnosed[6]. Dynamic contrast scanning of spiral CT can implement dynamic scanning for pulmonary lesions, observe lesion shape and blood supply features in each period, thereby making the definitive diagnosis of pulmonary lesions[6]. At present, there are few comparative researches on dynamic contrast scanning of spiral CT for pulmonary tuberculoma, lung carcinoma, inflammatory pseudotumor and coexisting pulmonary tuberculosis and lung cancer. With the application of dynamic scanning of spiral CT, this manuscript aims to make a comparative analysis of the patients with pulmonary tuberculoma, lung carcinoma, inflammatory pseudotumor and coexisting pulmonary tuberculosis and lung cancer, in order to provide a useful reference for improving the accuracy of clinical diagnosis of pulmonary sarcoidosis.

Patients and Methods

Patients

A total of 144 patients with pulmonary sarcoidosis were selected from January to December in 2015 as research objects, including 82 males, and 62 females between 33-72 years of age with an average age of 60.5±5.4. Of these 144, 36 were lung carcinoma, 36 were pulmonary tuberculoma, 36 were inflammatory pseudotumor, and 36

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were coexisting pulmonary tuberculosis and lung cancer patients. Patients with over 3.0 cm lesions in the lung, calcification symptoms, coexisting pulmonary atelectasis and lymph nodes, mental illness, hematological diseases, allergies to iopamidol were excluded. The study obtained the Ethical Committee Approval from the First People's Hospital of Shangqiu. The study objectives were explained to the patients and signed informed consents were obtained, and they cooperated with this research.

CT Analysis

The selected patients were detected with 16-slice spiral CT (GE, Milwaukee, WI, USA). First, the patients' lungs were detected with plain scanning in a supine position under the guidance of medical personnel, and breath-hold scanning undertaken for the scope from pulmonary apex to diaphragm after inspiration. Then, the right amount of iopamidol contrast agents were injected into patients' peripheral vein with a high-pressure injector (4 ml/sec), followed by the dynamic contrast scanning of spiral CT at the two points of 6-48 seconds and 60-180 seconds after the bolus of contrast agents. The data of patients' CT appearances were processed with the ADW4.2 workstation. Through volume rendering and other ancillary methods, four senior radiologists worked together to read slices and analyze patients' lesions and observe their pathological changes.

Analyses of CT, Enhancement Peak, Intensive Added, and S/A Values

The parenchyma of patients' tumor was selected to measure their precontrast CT attenuation values and enhancement peak for 10 parallel measurements. Then, the average values of lesion/aortic intensive added and S/A ratio were calculated. The sensitivity and specificity of dynamic contrast scanning of spiral CT were also calculated according to the clinical pathology results.

Statistical Analysis

The data were analyzed with SPSS 20.0 statistical software (SPSS Inc., Chicago, IL, USA). The measurement data as ($x \pm s$), and variance analysis method, LSD method were used to conduct a pairwise comparison, with $p < 0.05$ taken as significant.

Results

Comparison Between Plain Scanning CT Value and Enhancement Peak

The plain CT scan value of lung carcinoma was significantly different from pulmonary tuberculoma, inflammatory pseudotumor, and coexisting pulmonary tuberculosis and lung cancer ($p < 0.01$). But, plain CT values did not significantly differ among pulmonary tuberculoma, lung cancer, and inflammatory pseudotumor ($p > 0.01$). A significant difference was noted in the peak of enhancement of lung carcinoma in comparison with inflammatory pseudotumor, and coexisting pulmonary tuberculosis and lung cancer ($p < 0.01$). But, the peaks of enhancement of pulmonary tuberculoma and coexisting pulmonary tuberculosis and lung cancer were similar ($p > 0.01$), whereas, the peaks of enhancement among pulmonary tuberculoma, lung cancer, and inflammatory pseudotumor were significantly different ($p < 0.01$, Table I).

Comparison of Intensive Added Value and S/A Value

The intensive added values of lung carcinoma, pulmonary tuberculoma, inflammatory pseudotumor, and coexisting pulmonary tuberculosis and lung cancer were significantly different ($p < 0.01$), wherein inflammatory pseudotumor was at the highest level and pulmonary tuberculoma was at the lowest level. There were also significant differences among the values of S/A on lung carcinoma, pulmonary tuberculoma, inflammatory

Table I. Comparison of plain CT values and enhancement peak values between different disease conditions.

Disease conditions	Patients (n)	Plain CT values	F-value	*p*-value	Enhancement peak values	F-value	*p*-value
Lung carcinoma	36	30.46 ± 9.74	5.335	0.01	79.63 ± 16.38	28.100	0.01
Pulmonary tuberculoma	36	29.82 ± 12.42			57.31 ± 21.44		
Inflammatory pesudotumor	36	27.85 ±11.38			94.51 ± 26.37		
Coexisting pulmonary tuberculosis and lung cancer	36	37.53 ± 10.16			57.94 ± 15.72		

Table II. Comparison of intensive added values and S/A values between different disease conditions.

Disease conditions	Patients (n)	Intensive added value (Hu)	F-value	*p*-value	S/A value	F-value	*p*-value
Lung carcinoma	36	49.42 ± 11.52	60.455	< 0.01	0.18 ± 0.06	35.771	< 0.01
Pulmonary tuberculoma	36	26.55 ± 14.38			0.12 ± 0.06		
Inflammatory pesudotumor	36	71.12 ± 17.62			0.27 ± 0.07		
Coexisting pulmonary tuberculosis and lung cancer	36	62.16 ± 15.54			0.21 ± 0.06		

pseudotumor, and coexisting pulmonary tuberculosis and lung cancer ($p < 0.01$), with inflammatory pseudotumor at the highest level and pulmonary tuberculoma at the lowest level (Table II).

Typical CT Appearances

The typical CT appearances of left lower lung mucinous adenocarcinoma (Figure 1), tuberculoma of the apicoposterior segment of the upper lobe of the left lung (Figure 2), inflammatory pseudotumor of the lingular segment in upper lobe of right lung (Figure 3), and coexisting pulmonary tuberculosis and lung cancer in upper lobe of right lung (Figure 4) are presented. As can be seen from Figure 1, the dynamic contrast-enhanced CT scanning of left lower lung mucinous adenocarcinoma is shown in the enhancement of lung cancer, of which mostly for moderately and highly enhanced, a few cases have little or no contrast enhancement. Concerning the tuberculoma of the apicoposterior segment of the upper lobe of the left lung, a significant change of nodules is not found (Figure 2). In the case of inflammatory pseudotumor of the lingular segment of the upper lobe of the right lung, the nodules demonstrate marked homogenous enhancement. In Figure 4, where there is coexisting pulmonary tuberculosis and lung cancer in patients, the upper lobe of the right lung shows an obsolete pulmonary tuberculosis while the inferior lobe of the left lung shows a mass, which was confirmed as a squamous cell carcinoma by pathology.

Discussion

Pulmonary tuberculoma, lung carcinoma, inflammatory pseudotumor, and coexisting pulmonary tuberculosis and lung cancer belong to quite common lung lesions, however, it is difficult to adopt imaging methods to diagnose and identify clinically, which bring a great deal of trouble to doctors' accurate diagnosis and patients' effective and scientific cure[1-3]. Conventional CT diagnoses lung lesions mainly based on morphology[4,5]. However, its diagnosis rate is not high, which easily makes missed diagnosis and misdiagnosis. The advent and application of multi-slice CT can implement dynamic contrast-enhanced scan for lung lesions, which is more intuitive and accurate than conventional CT with high imaging precision, showing le-

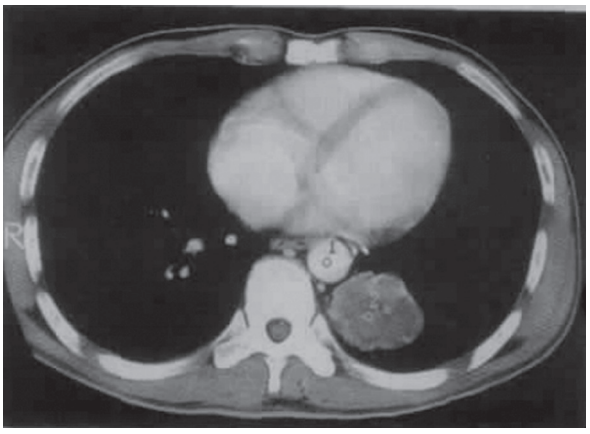

Figure 1. Dynamic contrast enhanced CT scan of left lower mucinous adenocarcinoma.

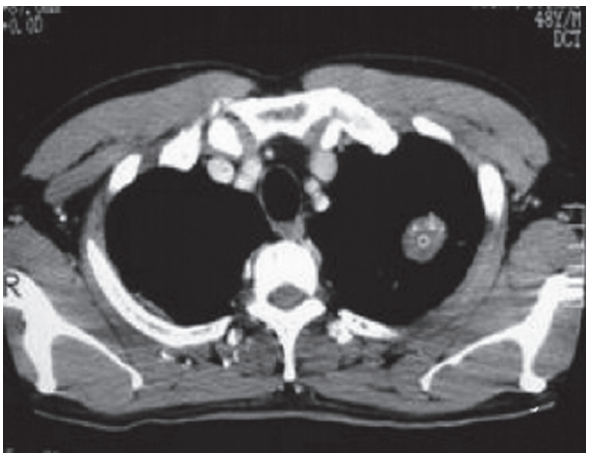

Figure 2. Tuberculoma of apicoposterior segment in upper lobe of left lung.

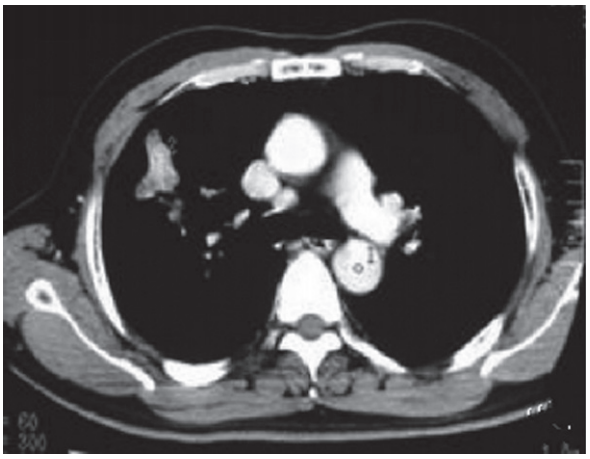

Figure 3. Effect of isoflurane and sevoflurane on the memory rentInflammatory pseudotumor of the lingular segment in upper lobe of righ lung.

sions more clearly[6,7]. It has been reported that multi-slice CT can obtain time-density curve in the process of dynamic contrast-enhanced scan, and has higher clinical application value in the diagnosis of lung nodules[8,9]. The variable nature of lung nodules makes a difference of hemodynamics. Therefore, the time-density curve obtained by enhanced multi-slice CT can reflect the hemodynamic characteristics of lung nodules with different nature, laying the foundation for qualitative diagnosis[10,11].

Most of the morphological features of pulmonary tuberculoma are round and polygonal[12]. With the dynamic contrast-enhanced scan of 36 pulmonary tuberculoma cases, we find that most of them are not enhanced. It is probably because there is caseous necrosis inside the tuberculoma

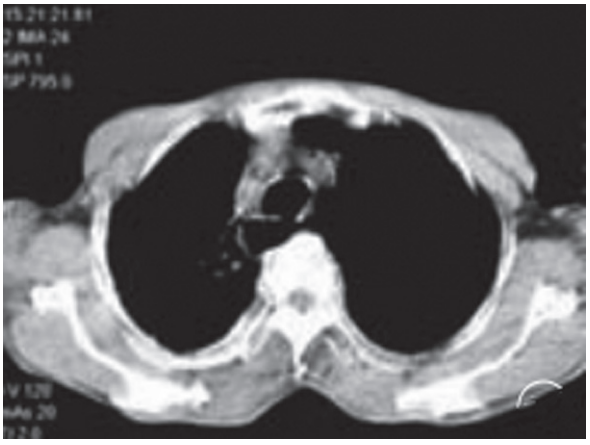

Figure 4. Pulmonary tuberculosis in upper lobe of right lung.

without the blood supply, resulting in non-enhancement of dynamic contrast-enhanced CT scan. The obtained time-density curve is flat, and there is no obvious change in CT value.

Our work showed that there is an enhancement in the contrast-enhanced CT scan of inflammatory pseudotumor. It is because the necrosis of inflammatory pseudotumor is relatively rare[13-15]. For lung cancer, the tumor grows rapidly, and there will be necrosis of focal tumor in the case of blood vessels. Also, there are anastomotic vascular pools and vascular lakes inside the tumor, and the direction of the blood vessel is in twist state. Therefore, most of the lung cancers are moderate and have high heterogeneous enhancement, but there is also mild enhancement and no enhancement because of early stage lung cancer.

In recent years, the incident rate of coexisting pulmonary tuberculosis and lung cancer is increasing in clinical practice. In the comprehensive literature, there are the following three theories related to lung cancer and pulmonary tuberculosis[16,17]: (1) pulmonary tuberculosis patients easily have coexisting lung cancer (2) lung cancer and pulmonary tuberculosis has no relation with each other (3) pulmonary tuberculosis exhibits an antagonistic relationship with lung cancer. Most researchers are more likely to choose the first theory. Some literature also show that pulmonary tuberculosis patients belong to high incidence area of lung cancer, largely because their immune function has decreased. At the same time, chronic inflammatory cytokines also will contribute to the pathogenesis[18,19]. However, since lung cancer patients always use immunosuppressive agents after diagnosis in clinic, the immune function becomes abnormal and declines gradually, which causes them to coexist with pulmonary tuberculosis easily[20]. It has been reported from literature that, the morbidity rate of lung cancer patients suffering from pulmonary tuberculosis is higher than the person without cancer. Our study shows that lung lesions can be identified and diagnosed through the characteristics of contrast-enhanced spiral CT scan in an effective manner.

Conclusions

If conventional CT scan cannot detect the pulmonary sarcoidosis patients with typical morphologic characteristics, then it can adopt multi-slice CT to implement dynamic contrast-enhanced

scan, and rapidly and accurately diagnose lung carcinoma, pulmonary tuberculoma, inflammatory pseudotumor, and coexisting pulmonary tuberculosis and lung cancer.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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