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DIFFERENTIATION OF LUNG MASSES WITH RADIODENSITY DETERMINED CONTRAST ENHANCED COMPUTED TOMOGRAPHY

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ABSTRACT Lung cancer remains the leading cause of cancer-related death in both males and females. The disease has a poor prognosis with an overall 5-year mortality rate of approximately 84% (1). Twenty patients with lung cancer, 25 with pulmonary tuberculosis (TB) and 5 with inflammatory lung pseudotumors diagnosed by CT and confirmed by pathology in our hospital were selected. There were no significant differences in the radiodensities of the masses detected by plain CT among patients with lung cancer, TB and inflammatory lung pseudotumors ($P > 0.05$). However, there were significant differences ($P < 0.01$) between all the groups in terms of radiodensities of masses detected by contrast enhanced CT. The radiodensities of lung masses detected by contrast enhanced CT could potentially be used to differentiate between lung cancer, pulmonary TB and inflammatory lung pseudotumors.

KEYWORDS : Contrast enhanced computed tomography; Lung cancer; pulmonary TB.

Lung masses are one of the most common findings on chest radiographs. In patients with suspected lung cancer, the first imaging examination is that of a chest radiograph followed by a contrast-enhanced CT of the thorax. CECT of thorax has a higher specificity and sensitivity than chest radiography because of its ability to characterize superimposed structures on two-dimensional radiographs (2). It also allows for the assessment of surrounding structures. CT is the imaging modality of choice to reevaluate pulmonary nodules seen on chest radiographs and to follow nodules on subsequent studies for change in size (2). The availability of computed tomography (CT) allows radiologists to better characterize many lung masses. However, in some difficult cases (with similar interfaces, morphology and inner densities), transbronchial lung biopsy, CT-guided percutaneous biopsy or surgery are required to make a diagnosis. Further, non-invasive methods for differentiating lung masses are therefore required.

MATERIALS AND METHODS

This study investigated the differences in radiodensities detected by plain and enhanced CT, as a means of differentiating between lung masses of different etiologies. The study was continued for about 1 year from November 2016 to October 2017. Some relevant studies on solitary pulmonary nodules and CT were considered (3, 4).

Twenty patients with lung cancer, 25 with pulmonary tuberculosis (TB) and 5 with inflammatory lung pseudotumors, all diagnosed and pathologically confirmed by transbronchial lung biopsy, CT-guided percutaneous biopsy or surgery in our hospital were selected. Complete clinical data and CT information were available for all patients. The lung cancer group included 12 males and 8 females (age range, 32-75 years), the lung TB group included 14 males and 11 females (age range, 25-60 years) and the lung pseudotumor group included 2 males and 3 females (age range, 18-52 years). All patients were selected according to the following criteria: (a) Each patient had a round or oval-shaped mass in the lungs with a diameter larger than 1 cm and less than 3 cm, with no evidence of metastasis or atelectasis in the lungs. Patients with TB lesions resembling pneumonia or with satellite lesions around the lung masses were excluded from the study. (b) Absence of contraindications to the administration of contrast material. (c) Complete clinical and pathological information available.

CT scan instrument was General Electric (GE) 16 slice CT. Paranasal sinus CT scans are generally performed by 5 mm for axial sections, thin reconstruction of 1.25 mm for both axial and coronal sections. All patients received plain and enhanced examination with a scanning thickness of 5 mm. Contrast medium (contrapaque) was injected at 1.5-2.0 mL/kg at a velocity of 3.0 mL/s. Scanning began about 45-55 s after injection of the contrast medium. The scanning parameters were consistent throughout the study. The sizes of the masses were measured on the CT scanning images. The mean radiodensity calculated after excluding necrotic areas, image artifacts, calcification or cavities. The radiodensities of masses detected by plain and enhanced CT in each patient were recorded. The mean ± SD from each plain scan, the mean ± SD from each enhanced scan and the mean ± SD enhancement (value detected by enhanced CT minus the value detected by plain CT) were calculated for the patients in each group. The data were analyzed using F tests and the radiodensities of masses detected by plain and the enhanced CT were compared among the groups. $P < 0.05$ were considered to indicate a significant difference.

RESULTS

Comparing contrast enhanced CT with plain CT scans, 11 of the 20 lung cancer cases showed moderate and inhomogeneous enhancement (Figure 1), while the other lung cancer cases showed slight enhancement. Sixteen of the 25 pulmonary TB cases showed slight enhancement (figure 2) and 9 cases showed moderate, homogeneous or inhomogeneous enhancement. Two of the 5 cases of inflammatory lung pseudotumors showed obvious and homogeneous enhancement, 2 showed moderate and homogeneous or inhomogeneous enhancement and one showed slight enhancement. There was no significant difference in the radiodensities of masses detected by plain scans between any of the groups ($P > 0.05$). However, the radiodensities of masses detected by enhanced CT differed significantly among all three groups ($P < 0.01$). These data are shown in Tables 1 and 2.

Table 1. Radiodensities of Masses measured by Plain CT

Radiodensity (HU)	Lung Cancer	Pulmonary TB	Inflammatory Lung Pseudotumor
Minimum	18	28	37
Maximum	52	58	48
Mean ± SD	37 ± 3	42 ± 11	41 ± 4

Table 2. Radiodensities of Masses measured by Enhanced CT

Radiodensity (HU)	Lung Cancer	Pulmonary TB b	Inflammatory Lung Pseudotumor
Minimum	47	39	78
Maximum	80	68	99
Mean ± SD	68 ± 9	51 ± 7	84 ± 7
Enhancement, Mean ± SD	29 ± 12	9 ± 5	44 ± 9

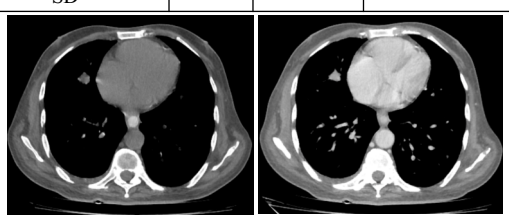

Figure 1: Computed Tomography of a 62-Year-Old Man Presenting With Chest Pain and Cough. Plain CT scan shows a round mass in the right lung. Enhanced CT scan shows moderate homogeneous enhancement in the mass which was verified to be lung cancer.

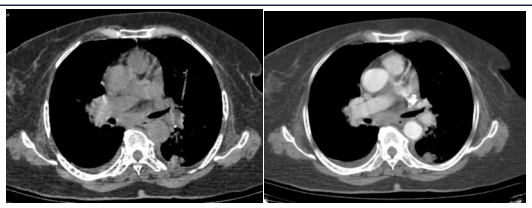

Figure 2 : Computed Tomography of a 42-Year-Old Man Presenting With fever and Cough. Plain CT scan shows a round mass in the left lung. Enhanced CT scan shows slight enhancement in the mass which was verified to be a case of pulmonary TB.

The most important technical limitation of our study was in general is respiratory motion, which can lead to image misregistration and errors in calculation of radiodensity values. This was evaluated in a study with 11 lung tumour patients by Ng et al (5) using 16-detector row CT. The authors found that the perfusion values were significantly influenced by respiratory motion and the duration of data acquisition. In our study, the patients were instructed to hold their breath or to breathe shallowly in an attempt to minimise respiratory motion.

DISCUSSION

Lung masses are common findings in chest imaging. They may be benign or malignant; pulmonary TB, lung hamartomas and inflammatory lung pseudotumors are benign, while squamous cell carcinomas, adenocarcinomas and small and large cell carcinomas are malignant. Benign masses often appear spherical with smooth margins, while malignant lung cancers often appear lobular. Some masses have specific manifestations on CT images, such as cavities or satellite lesions. TB may manifest with cavities surrounded by satellite lesions and fiber bundle shadows; lung hamartomas have fatty elements and popcorn calcifications; malignant masses may include eccentric cavities and have indistinct margins with sunken pleura accompanied by enlarged lymph nodes at the hilus and mediastinum. Patients with pulmonary TB may suffer from low fever, night sweating and hemoptysis, while patients with lung cancer also suffer from symptoms such as hemoptysis, irritable cough and chest pain. However, masses may be difficult to differentiate when the symptoms and the shapes or densities of the masses on CT images are similar with no distinctive cavities or satellite lesions. Nevertheless, the different pathologic structures and blood vessel contents may result in differences in detectability by enhanced CT. The results of the current study showed no significant differences in radiodensities of masses detected by plain CT between any of the groups. The variation in detected radiodensities was larger in the TB group than in the other groups, because of the large variations in necrotic tissue in TB. Previous studies have suggested that an enhancement of less than 20 Hounsfield units (HU) is likely to represent a benign mass, while 20-60 HU suggests malignancy and an enhancement higher than 60 HU may indicate an inflammatory tumor (3,4). In this study, the mean enhancement in cases with pulmonary TB (benign masses) was 9 HU (< 20 HU), in lung cancer cases (malignant masses) the mean enhancement was 29 HU (20-60 HU), and in cases of inflammatory lung pseudotumors (inflammatory tumors) this figure was 44 HU (< 60 HU). The lower than expected value for inflammatory lung pseudotumors may have been due to the presence of multiple cells and the pathologic phase.

Angiogenesis varies greatly between benign and malignant masses (6-9). Based on pathologic analysis, pulmonary TB includes tissues with structural necrosis and few blood vessels and internal enhancement is subsequently not obvious. Lung cancer shows pathologic proliferation and inappropriate angiogenesis with the establishment of vascular networks that support tumor growth. Tissues inside lung cancer masses grow inhomogeneously, some having rich blood supply and others poorer blood supply. Inflammatory pseudotumors are actually granulomas formed by inflammatory proliferation. They include many capillaries and a rich blood supply, hence explaining the high degree of enhancement on CT. However, during the progression from an active to a chronic pseudotumor, the fibrous content increases and the vascular content decreases.

CONCLUSION

Enhancement in pulmonary TB was mainly slight or moderate, as a result of internal necrosis and the inhomogeneous supply of blood vessels. Enhancement in lung cancer cases in this study was mainly moderate and inhomogeneous, related to cancer necrosis and the inhomogeneous blood supply. Enhancement in inflammatory lung pseudotumors was mainly obvious and inhomogeneous, because the inflammation results in a mass with a relatively homogeneous blood supply. The results of this study suggest that lung masses of similar shapes and densities may be differentiated on the basis of enhanced CT, allowing improved preoperative diagnostic accuracy, accordingly aiding the selection of appropriate surgical treatment.

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