Detection and Diagnosis of Small Peripheral Lung Cancers Less than 15mm in Diameter

Yucheng Han
Yue Yuan
Jianguo Chu

Department of Radiology, Dalian Medical University Affiliated Central Hospital, Dalian 116033, China.

OBJECTIVE To assess the value of chest X-ray film, conventional CT (CCT), Spiral CT (SCT) and high resolution CT (HRCT) for detection and diagnosis of small peripheral lung cancers less than 15 mm in diameter.

METHODS Chest X-ray film, CCT, SCT and HRCT were taken in 59 cases of peripheral lung cancers less than 15 mm in diameter confirmed by pathological examination following an operation. The value of these procedures for diagnosis was analyzed retrospectively.

RESULTS In 47% of chest X-ray films and 17% of CCT, small lung cancers were not detected. However no tumor escaped detection by SCT. HRCT was superior for showing density and detailed image signs compared to chest films and CCT. The HRCT features of small peripheral lung cancers were quite different from those of larger peripheral lung cancers.

CONCLUSION The SCT is the best method for detection, and HRCT for diagnosis of small peripheral lung cancers less than 15 mm in diameter. CT guided percutaneous transthoracic needle biopsy should be advocated.

KEYWORDS: lung neoplasms/radiography, lung neoplasms/diagnosis, tomography, X-ray computed.

Presently the most available way for improving the prognosis of non-small-cell peripheral lung cancer is early diagnosis and operative resection. So for many years, chest X-ray films and cell examination of sputum have been regarded as the principal techniques for lung cancer screening and diagnosis. And in recent years, due to application of CT, especially high resolution CT (HRCT) and spiral CT (SCT), chances for detection and accurate diagnosis of small peripheral lung cancers (SPLC) have remarkably increased. In the present study, we retrospectively analyzed 59 cases, with intact radiological and pathological data, of SPLC less than 15 mm in diameter. All the tumors were confirmed by operation and pathology. We focused our attention on their clinical manifestations, as well as detection and diagnostic ability of various imaging techniques, such as conventional CT (CCT), SCT and HRCT etc, for SPLC less than 15 mm in diameter.

MATERIALS AND METHODS

Clinical data

A total of 59 cases of SPLC less than 15 mm, including 33 males and 26 females, were classified as Group I, 17 cases and Group II, 42 cases. Cases in Group I , verified by operation and pathology, were

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collected from three hospitals in Dalian during October, 1989 to October, 1998, while cases in Group III were obtained from the East Area, National Cancer Center, Japan over the period November, 1998 to February, 1999. Age of the patients ranged from 38 to 82 years (mean 59.6 years). Results of histological classifications were as follows: 43 cases of adenocarcinoma, 11 cases of bronchioalveolar carcinoma, 4 of squamous carcinoma and 1 carcinoid case. The maximal diameter of the postoperative fixed preparation was utilized as the criteria of evaluating the size of the tumor. Among all the 59 cases, there were 21 cases smaller than 10 mm, 38 cases in the range of 11~15 mm and the minimal diameter was 5mm. Of the total cases 37 (62.7%) were without any subjective symptoms, but were discovered by physical examination. 17 cases (28.8%) were detected by chest X-ray or CT examination due to pneumonia, bronchitis or preoperative examination and 5 cases (8.5%) were discovered because of symptoms of cough, hemoptysis and thoracalgia etc. Clinical classification: 52 cases were staged as I, 3 as II, 3 as III and 1 as IV. Results of the postoperative pathological classification: 53 cases (89.8%) were staged as I, 3 as II, 2 as III and 1 as IV ($\geq$10.2%).

Methods

All the patients were examined by chest X-ray films, CCT or SCT and HRCT. There were 15 chest films taken by the conventional posterior-anterior view, 13 cases by not only the conventional view but also by the CR chest film, 5 cases by fluororoentgenography, 14 cases by fluororoentgenography plus conventional chest film. Group I scans were obtained on GE9800Quick, TCT600XT. CCT images were obtained with use of the following technical factors: 120 KV, 100~120 mA, 2s scan time, 512×512 matrix, 40 cm field of view (FOV), 10 mm scan thickness and pitch, standard reconstruction algorithm. HRCT scan was: 120 KV, 100~200 mA, 2 s, 512×512, FOV: 15~20 cm, 1.5~2 mm thickness, 2~3 mm pitch, high resolution bone reconstruction algorithm (16 cases) and standard reconstruction algorithm (1 cases). All scans were photographed at window and level settings appropriate for lung (level =-700 HU, width=1,000 HU) and mediastinum (level=35 HU, width=500 HU). Group scans were obtained on TCT900S, Super Helix, X-Vigor. SCT technical scan parameters were 120 KV, 150~200 mA, 1 s scan time, 512×512 matrix, 40 cm FOV, 10 mm scan thickness and pitch and standard reconstruction algorithm. HRCT was: 130~140 KV, 150~200 mA, 512×512, FOV: 20 cm, 20 cm scan thickness and pitch, high resolution bone reconstruction algorithm. Lung windows (2,000 HU/-700~-500 HU), mediastinum windows (400~450 HU/30HU).

RESULTS

Results for the detection of SPLC less than 15 mm in diameter obtained by plain X-ray film, CT and SCT are shown in Table 1. By chest film, the total detection rate was 52.5% and rate of missed diagnosis was 47.5%, For cancers less than 10 mm in diameter the missed diagnostic rate was 81.0%. For an examination by CCT, the rate of missed diagnosis for SPLC less than 15 mm and 10 mm were as low as 17.6% and 40%, respectively. By using SCT, no cases were missed. (Fig. 1-3).

Table 1. Detection by chest film, CCT and SCT for SPLC less than 15mm

Diameter		Chest film		CCT		SCT	
(mm)	Cases	Cases	%	Cases	%	Cases	%
≤10	21	4/21	19.0	3/5	60.0	16/16	100
11~15	38	27/38	71.1	11/12	91.7	26/26	100
Total	59	31/59	52.5	14/17	82.4	42/42	100

Fig. 1. Case 1. 65 years old female. CR chest film is nomal.

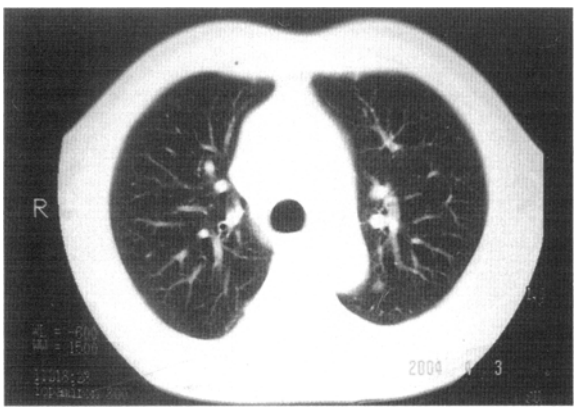

Fig. 2. Case as above. SCT shows there is a nodule shadow in the apical-posterior segment of the upper lobe of the left lung, which is about 5 mm in diameter and has an obscure outline.

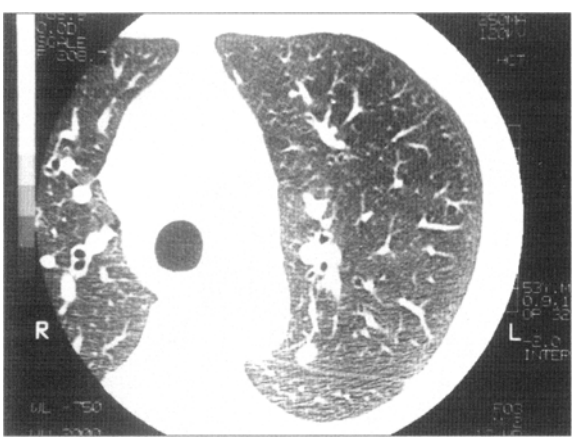

Fig. 3. Case as above. HRCT shows a 4 mm×6 mm nodule shadow with clear outline in the apical-posterior segment of the left upper lobe. The nodule adjoins intralobe fissure and has a vascular pack sign. And it was well-differentiated adenocacinoma verified by pathology.

Table 2 shows signs of chest film, CCT and HRCT for SPLC less than 15mm in diameter. With regard to the tumor density, compared with HRCT, CCT displayed a higher proportion of pneumatic type and lower of the dense type. All signs displayed by the chest film were not as high as 10%. Except for the similarity of CCT and HRCT in pleural indentation, cavitation and calcification appearances, display rates of lobulation, air bronchogram and bronchovascular pack signs and accuracy by CCT were inferior to HRCT.

Table 2. Signs of chest film, CCT and HRCT of 59 cases of SPLC less than 15 mm

	Chest film		CCT		HRCT	
Appearance	Cases	%	Cases	%	Cases	%
Density						
dense type	-	-	0	0	15	25.4
medial type	-	-	21	35.6	23	39.0
pneumatic type	-	-	38	64.4	21	35.6
Cavity	2	3.4	2	3.4	2	3.4
Air bonrchogranl	1	1.7	5	8.5	27	49.2
Calcification	0	0	1	1.7	1	1.7
Lobulation	5	8.5	18	30.5	12	20.3
Pleural indentation	3	5.1	7	11.9	15	25.4
Bronchovascular	3	5.1	18	30.5	20	33.9
Bronchovascular pack sign						
0	49	83.1	35	59.3	22	37.3
I	5	8.5	17	28.8	10	16.9
II	5	8.5	7	11.9	23	39.0
III	0	0	0	0	4	6.8

DISCUSSION

Lung cancer is a common malignant tumor with a high incidence rate and low cure rate. Viewpoints that early detection and diagnosis are of great importance have been comprehensively accepted. However, the latest reports revealed that even in Japan, where the detection and diagnosis of lung cancer is the most advanced, the 5-year survival rate is less than 20%[1], which suggests that earlier diagnosis is still a significant goal for us in the future. In our study, among 59 cases, 62.7% (37 cases) were verified by physical examinations, 28.8% (17 cases) were discovered by performing plain X-ray film and thoratic CT examinations due to focusing on lung or other diseases, and 8.5% (5 cases) were diagnosed because the patients were seeking medical advice because of subjective symptoms such as cough hemoptysis and chest pain etc. Relevant results related to our study were reported by Cai Zulong *et al.*[2] in China. In 65 cases they detected SPLC of a size less than 2 cm in diameter, 63% patients (41) felt well or had other disease when they were diagnosed, and 37% (24) had certain pulmonary symptoms. Foreign scholars [3,4] demonstrated that 8.1~11.4% of patients with SPLC less than 15 mm have symptoms, a number which was approximate to ours. These data suggested that patients with SPLC less than 15 mm in diameter often have no symptoms, namely, 9 cases in 10 were "normal". Therefore, radiological screening and

detection for high risk people without symptoms are of great importance in detecting SPLC less than 15 mm in diameter. In our study, 53 (89.8%) of all 59 cases were classified as stage I by the pathology. And similar to our patients, 86% ~90.6% cases with the same size tumor were staged as I as reported by other researches. Furthermore, we found that 21 cases in our research were staged as pathological I, which indicated to us that, on one hand, early detection of SPLC is of remarkable value for early therapy and prognosis, on the other hand, size of early SPLC, in our opinion, should be defined as less than 15 mm.

As shown in Table 1, differences exist among chest X-ray films, CT and SCT in detection ability for SPLC less than 15 mm. The false negative diagnostic rate for chest X-ray films was 47.5%, while for tumors less than 10 mm, it was up to 81.0%. For CCT, the index was 17.6%, and no cases escaped in using SCT. Egucikenzi *et al.*[3], suggested that tumor size of 10~15 mm should be regarded as the distinction line for a chest X-ray film. In 5 cases of SPLC less than 6 mm reported by Yamadakouzou et al. [6], results of plain films were all negative. According to some other referrences[4-7], the rate of missed diagnosis of SPLC in chest X-ray films ranged from 52% to 58%. Charles et al. [8] revealed that in chest X-ray the average diameter of missed diagnosis of lung cancer was 16 mm and the maximal diameter was up to 34 mm. In addition, Kakinumaryuutarou *et al.*[9] reached the conclusion that for chest X-ray, the detectable rate for lung cancer was 163/100,000, while CT was 393/100,000. With regard to the reason for missed diagnosis, besides weak displays caused by poor conditions for taking films, overlapping and screening by rib and cardiovessles and low density of the tumor, missed diagnosis should be considered as another significant source. Therefore, we do not think that chest X-ray films are an ideal means for detecting SPLC, especially when the quality of the chest X-ray films can not be assured. Furthermore, though the detectable rate of CCT for SPLC less than 15 mm has increased remarkably, yet the missed diagnosis cases can hardly be avoided because of factors such as thickness, volume effect and respiratory motion etc. In addition, because the scanning slices are always not consistent with the plane of the tumor, qualitative diagnosis for lung cancer is influenced by the limited diagnostic data. After analyzing 14 missed diagnostic cases by CT of lung cancer, Charles *et al.*[8] indicated that 12 mm was the average diameter of lung cancer which was missed by diagnosis, and that the maximal diameter was 20 mm. As far as we are concerned, we advocate performing CT, SCT and HRCT in particular, for detection and diagnosis of SPLC. In addition, on the goal of lowing the radiation dose, we advise that SCT be advocated for detection and diagnosis of lung cancer staged as I or II.

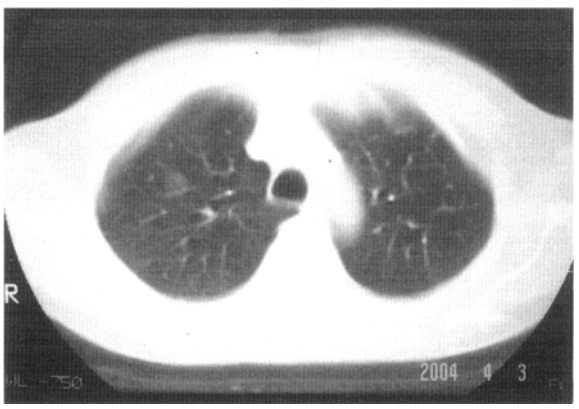

Fig. 4. Case 2, 71-year-old male. CCT scan shows a faint obscure nodule shadow in right upper lobe which can't be measured accurately.

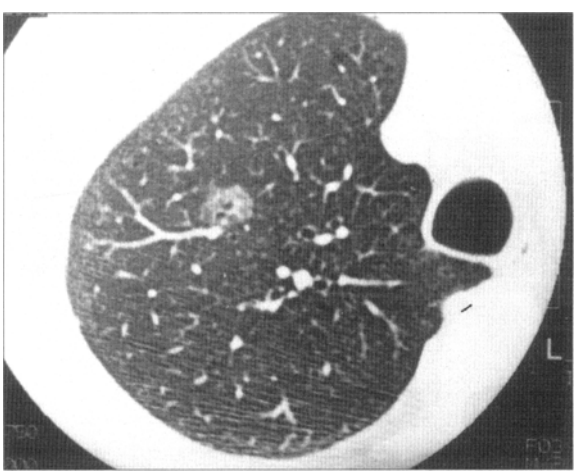

Fig. 5. Case as above. HRCT scan shows a 10 mm×13 mm ground-glass density shadow with a clear outline in right upper lobe in which, the vascular shadow and air bronchogram can be seen. The pathological result was well-differentiated adenocarcinoma.

Table 2 indicates to us that for SPLC less than 15 mm, chest X-ray films expressed the lowest display rate of all signs, and compared to CCT, HRCT had similar display rate in cavitation, calcification and pleural indentation, while for air bronchogram, lobulation and bronchovascular pack sign, HRCT had a higher display rate(Fig.4, 5).

Our results differed from previous reports in that the coarse spiculation had a high display rate in CCT in our study, since part of the bronchovascular pack sign was mistaken for coarse spiculation. Results of tumor density judged by the lung –mediastinum window reduction rate (so called lung–mediastinum window reduction rate can be defined as the reduced percentage of nodule – maximal area in CT scans at lung window being converted into the mediastinum) are as follows: CCT displayed the highest proportion of pneumatic type as high as 64.4% . In contrast, HRCT showed a majority of medial type and dense type (total 64.4%). The CCT thickness and pitch are larger and the volume of the lung cancer is smaller, consequently, the effect of partial volume results the difference and the reduction rate of lung–mediastinum is overestimated, so some median type even dense type are mistaken for pneumatic type. Hence, lung – mediastinum window reduction rate of CCT should not be used to estimate the density of small lung cancer. Our present results, as well as researches before, revealed that HRCT was superior to CCT in the display rate of all sorts of signs in SPLC, especially for those of less than 15 mm. The smaller a tumor is, the more obvious are the differences of display rate among chest film, CCT and HRCT. Our investigation also demonstrated that [5,10], in contrast with large tumors, display rates of various signs are different in SPLC which are less than 15 mm. Appearances of lobulation, coarse spiculation and pleural indentation etc, reduced more or less, while air bronchogram and bronchovascular pack signs increased. We consider the reason as follows: SPLC less than 15 mm can not form coarse spiculation, lobulation and pleural indentation clearly because of their small volume and short growth span. Accordingly, it is desirable that air bronchogram and bronchovascular pack signs be observed in small tumors with low density. For SPLC less than 15 mm, the diagnosis and differential diagnosis were rather difficult for their low display rate of various malignant symptoms such as coarse spiculation, lobulation and pleural indentation etc. In order to make a quick and accurate diagnosis for early SPLC, it is indispensable to perform CT guided percutaneous transthoracic needle biopsy. In our Group I, because of not using percutaneous transthoracic needle biopsy, 7 cases (29.2%) of benign nodules including inflammation, tuberculosis and hamartoma etc, were simultameously removed when we operated on 17 cases of SPLC. Whereas for Group II things differed. Due to application of the advanced technique, only 3 cases (6.7%) of tuberculosis and inflammatory nodules were resected at the time of operation on 42 cases of SPLC less than 15 mm.

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