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Computed Tomographic Analysis of Pulmonary Nodules

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Abstract CT was carried out in 33 nodules showing non-calcified nodular shadow on the chest radiographs or conventional tomograms, and measurement of CT number and preparation of the distribution chart were performed. Five nodules and 3 nodules out of 14 benign lesions were diagnosed as a benignity by CT number and distribution chart of CT number, respectively. CT could supply information which are necessiated for the qualitative diagnosis of the pulmonary nodules.

Key Words : Computed tomography, Pulmonary nodule, Lung neoplasms, CT diagnosis.

Introduction

The attempt of the qualitative diagnosis of the pulmonary nodule from CT number measured in the nodule by using computed tomography (CT) as an aid of the diagnosis of the pulmonary nodule has been carried out by Siegelman et al. (1) since 1980. Subsequently, more reliable diagnosis of the pulmonary nodule by CT with combined use of the measurement of CT number and edge analysis has been created by Siegelman et al. (2). This time, we studied two points of (a) measurement of CT number of the pulmonary nodule and (b) analysis of the distribution of CT number in the nodule.

Materials and Mathods

Patient population

Thirty-three patients revealed non-calcified nodular shadow on the chest radiographs or conventional tomograms and perfomed CT in the Department of Radiology, Affiliated Hospital of Yamaguchi University from 1983 to 1987 were subjected.

The age ranged from 51 to 85 years old, and 19 males and 14 females were subjected. The size ranged from 0.8 to 3.5 cm.

Apparatus

CT scanner (Siemens ; Somatom DR3) was used. The analysis of the distribution of CT number was carried out by using Siemens therapy planning and imaging system MEVAPLAN.

Technique

CT was carried out under the conditions such as 125 kV, 350 MAS, 4sec. scan time and 4 or 8 mm sections. The measurement of CT number performed in the whole region, and in the marginal, intermediate and central regions dividing almost uniformly nodule at the section near the center of the nodule. CT number in these regions was demonstrated by mean level of CT number of the pixel including in each region without requiring by using computer printout.

In order to investigate the distribution of CT number in the nodule, distribution chart of CT number was prepared by binding with closed curve for CT number per 10-20 HU in the section near the center of the nodule, and this was called as iso-CT value map.

Results

In 33 patients 33 nodules were scanned. The primary lung cancers were noted in 12 nodules, and biopsied and resected. Seven nodules were lung metastases, and cases proven pathologically extrathoracic malignancy in all these and developed nodular shadow during observation of the progress. The benign lesions were noted in 14 nodules, and 2 cases with tuberculosis, 1 case with hamartoma and 1 case with bronchogenic cyst were resected. One case with silicosis and 1 case with sarcoidosis were biopsied. Four cases with tuberculosis were diagnosed by bacteriological examination. Other 4 nodules were diagnosed as a benignity by the serial radiographs according to the observation of its progress for more than 2 years.

The results of the measurement of CT number in the whole region are shown in Fig. 1. The mean ± S.D. was 39 ± 5.5 HU in the primary lung cancers, 36 ± 0.9 HU in the lung metastases and 69 ± 43.0 HU in the benign lesions. The mean ± S.D. of CT number in the marginal, intermediate and central regions was 38 ± 5.4 HU, 40 ± 6.3 HU and 40 ± 7.4 HU in the primary lung cancers, 35 ± 8.4 HU, 40 ± 8.6 HU and 39 ± 9.7 HU in the lung metastases, and 69 ± 39.0 HU, 72 ± 51.4 HU and 70 ± 47.8 HU in the benign lesions, respectively, and no significant difference was noted in CT number in the whole regions. When CT number in 19 malignant nodules was changed to the commonly used logarithm, it was similar with normal distribution, and mean + 4 S.D. was 76 HU. Using this criterion, five nodules with benigh lesions (35.7%) could be diagnosed as a benignity.

The iso-CT value map was classified into the following 5 types (Fig. 2).

Type I : The almost round and irregular -shaped high density areas are densely distributed. Type II : The high density areas with irregular margin and irregular saw -shape are diffusely distributed. Type III : The high density areas with smooth margin are diffusely distributed. Type IV : The distribution of high density areas is concentric. Type V : The distribution of high density areas is almost homogeneous. The results of the iso-CT value map are shown in Table 1. CT number in 3 cases with type IV was 43 -67 HU, and these cases were not diagnosed as a benignity by CT number. From the result of CT number in addition to that of the iso-CT value map, 8 nodules with benign lesions (57.1%) could be diagnosed as a benignity only by CT.

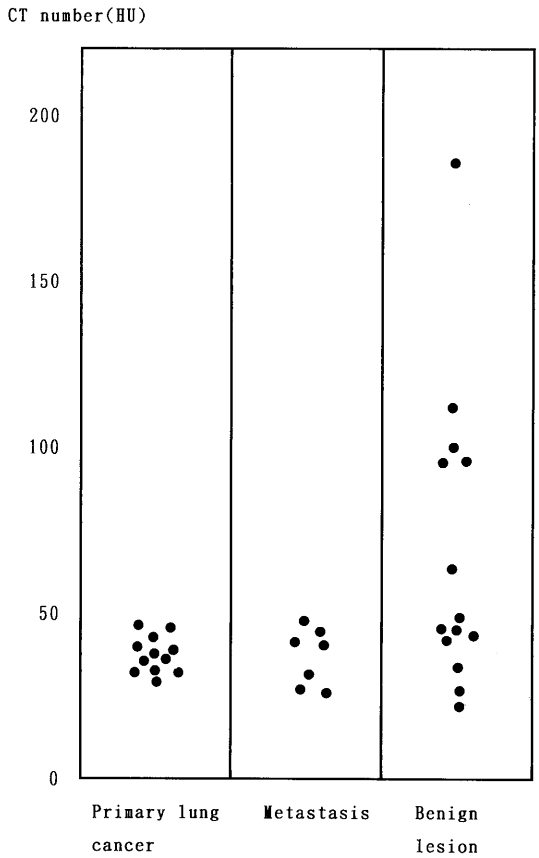

Fig. 1 Distribution of mean CT numbers in the whole region for 33 pulmonary nodules.

Discussion

Because CT is excellent in the decomposition capability of the density comparing with standard radiography (3), it supplies important information for the qualitative diagnosis of the pulmonary nodule in the presence or absence of calcification or cavitation of the nodule. Furthermore, it is reported that

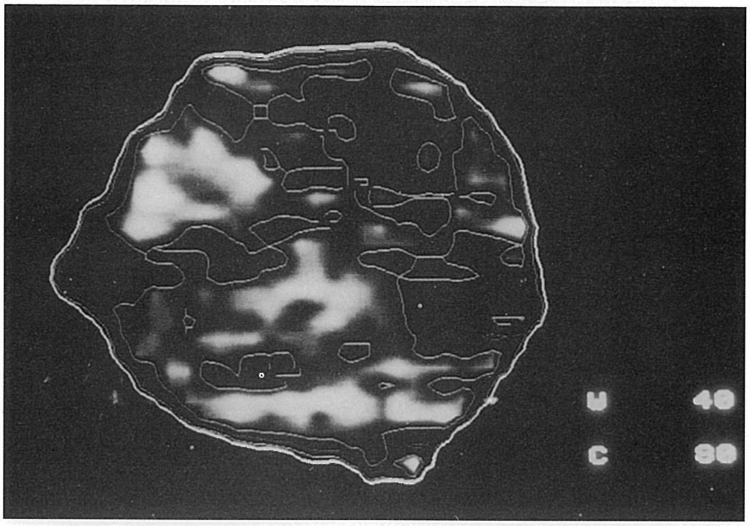

Fig. 2 (a) Type I

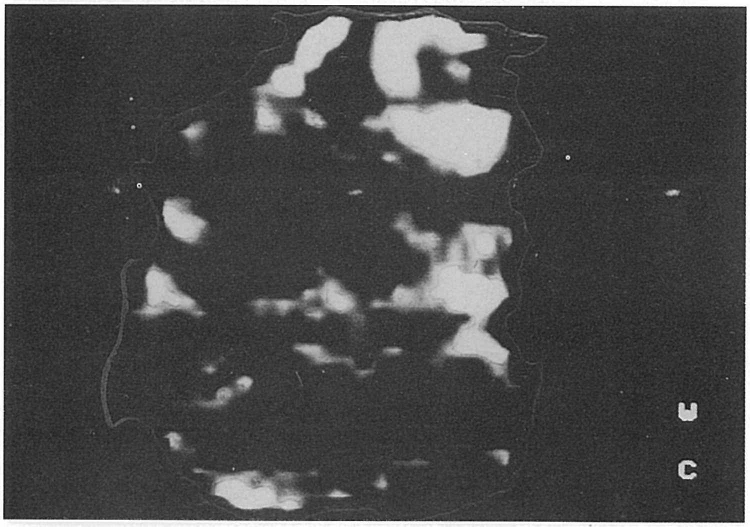

Fig. 2 (b) Type II

discrimination of the benignity or malignancy is available by measurement of CT number (4,5). In this study, 5 nodules out of 14 nodules with benign lesions were diagnosed by measurement of CT number, while CT number was 90-181 HU, and more than 164 HU was noted 1 case. Moreover, Siegelman et al. (1) repoted that the highest attenuation values distribute in the central region of the benign lesions and marginal region of the malignant lesions, while no significant difference was noted from results studied dividing into the marginal intermediate and central regions in this study.

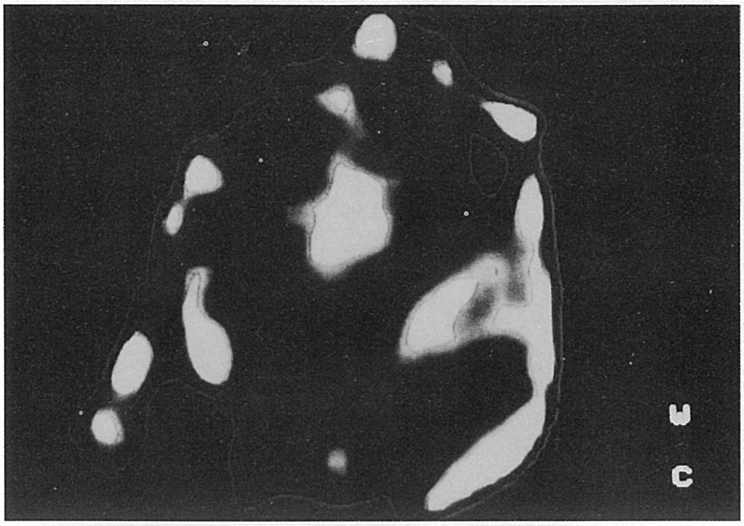

Fig. 2 (c) Type III

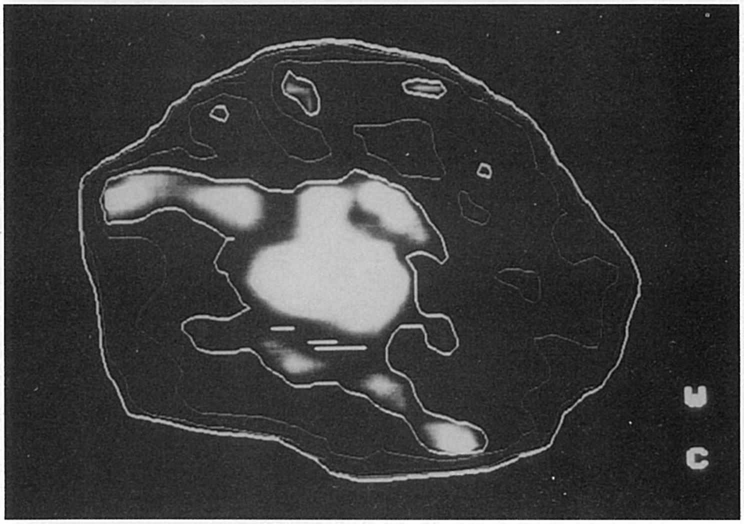

Fig. 2 (d) Type IV

The distribution chart of CT number was prepared for the discrimination of the benignity or malignancy by investigation of the distribution of CT number in the pulmonary nodule, while almost concentric distribution was noted in benign lesions.

From the above-mentioned results, measurement of CT number could provide significant information for the diagnosis of the pulmonary nodule.

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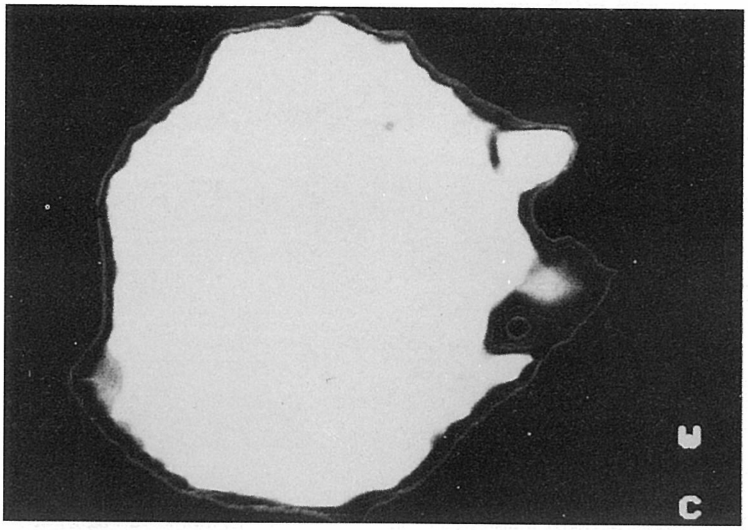

Fig. 2 (e) Type V

Fig. 2 Typical appearance of nodules by iso-CT value map.

Table 1 Distribution of Pulmonary Nodules by iso-CT Value Map

Category	iso-CT value map type					Total
	I	II	III	IV	V	
Primary lung cancer	3	4	5			12
Metastasis	4		1		2	7
Benign lesion	1		5	3	5	14
Total	8	4	11	3	7	33

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