Computed Radiography of Pulmonary Nodules: Evaluation of Inflated-fixed Lung

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Abstract Authors photographed 16 inflated-fixed pulmonary nodules by using computed radiography (CR). The pixel value of both pulmonary nodule and normal lung was required by data incorporated in CR, and its ratio was analyzed. The primary lung cancer was noted in all 16 nodules, while significant correlation was noted between adenocarcinoma and other tissues by histological classification. Our results suggest strongly that there is potential for CR in the evaluation of pulmonary nodules.

Introduction

The pulmonary cancer in the pulmonary nodule is more often by thoracic roentgenography in the daily medical examination. The discrimination of the benignity or malignancy in this case is problematical.

Siegelman et al.[1] reported in 1980 that 22 cases of 33 cases with beningnity were diagnosed by measurement of a representative CT number of the pulmonary nodule by using computed tomography (CT). Zerhouni et al.[2] carried out CT densitmetric measurement of the pulmonary nodule by utilizing a special reference phantom. These reports suggest that densitmetric study is useful for the diagnosis of pulmonary nodule.

This time, we studied usefulness of the density measurements of the pulmonary nodule by using computed radiography (CR).

Materials and Methods

Patient population : Total 14 cases of 11 males and 3 females who revealed nodular shadow by plain roentgenography in the thoracic region, and performed surgery in the Department of Radiology, Affiliated Hospital of Yamaguchi Univeristy from 1987 up to 1989 subjected. The age ranged from 54 to 71 years old. The size ranged from 2.4 to 4.1cm.

Apparatus : The photographing apparatus for breast, MR-30 (Shimazu) was used, and data were recorded on the magnetic tape by using DAM-100 (National Instrument). The procedure of data was carried out using personal computer PC 9801 VX 2 (NEC).

Technique : The inflated-fixed lungs of 16 nodules in 14 cases were photographed by using CR. The X-rays were exposed under the conditioins (82mR) such as 30 kVp, 100 mA, 0.05 sec., and FFD 60cm using X-ray tube for photographing of the breast. High resolution(HR) was used as an

imaging plate. As conditions being incorporated data by CR, L-level (indicated level within dynamic range) was 3.3, and E-level (indicated level of the sensitivity) was 200. The data which were incorporated by CR were recorded on the magnetic tape (MT) by using accessory deck of CR system. The data were procedured after data on this MT were incorporated into personal computer via other MT decks.

First of all, region of interest (ROI) with short form which was internally touched to the nodule was established, and then average pixel value in the internal ROI was required. This value was defined as a pixel one of the nodule. Next, ROI with short form in the regions being considered to be nomal was established at the adjacent regions to the nodule, and average pixel value was similarly required. This value was defined as a pixel one in the normal region.

CR has a high linearity between X-ray dose and pixel value, while pixel value can be exchanged to the relative X-ray dose by using digital-characteristic curve (Fig.1). The data exchanged pixel value to the relative X-ray dose were also used in this study. The pixel value which was exchanged by digital-characteristic curve was required in the nodule and normal region,

and then in order to investigate its relative degree of X-ray absorption, nodule-normal ratio which pixel value of the nodule was divided by pixel value in the normal region, was studied.

Results

The malignancy was noted in all 16 nodules, and primary lung cancer was histopathologically proven in all cases. The adenocarcinoma in 4 cases were bronchio-alveolar carcinoma types.

The distribution of the nodule-normal ratio in 16 nodules is shown in Fig.2. The mean $\pm$ SD of the nodle-normal ratio in the squamous cell carcinoma was 0.951 ± 0.008. The mean $\pm$ SD of the nodule-normal ratio in the adenocarcinoma was 0.964 ± 0.008. The mean $\pm$ SD of the nodule-normal ratio in the large cell carcinoma was 0.951 ± 0.013. When value in the squamous cell carcinoma, adenocarcinoma and large carcinoma was retrospectively studied, significant correlation was noted between adenocarcinoma and squamous cell carcinoma, and between adenocarcinoma and large cell carcinoma
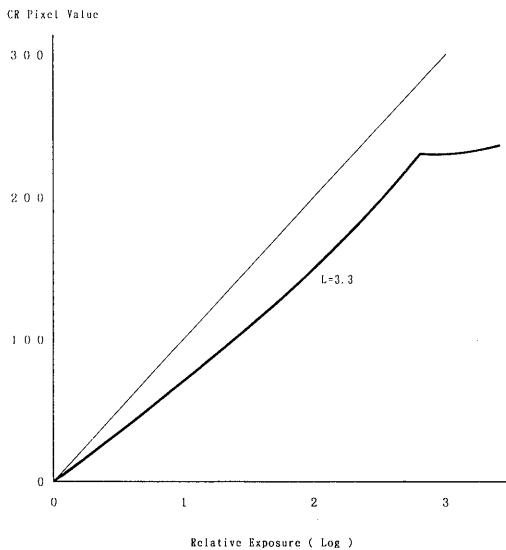

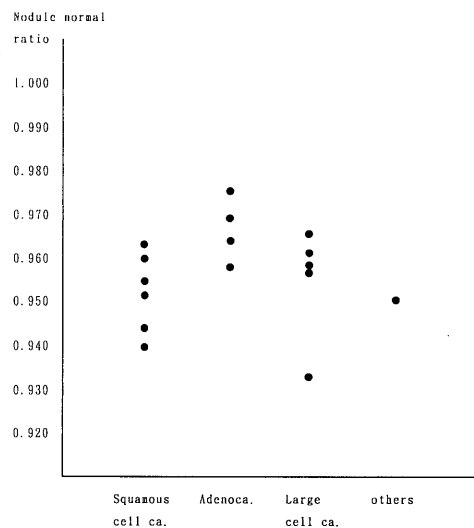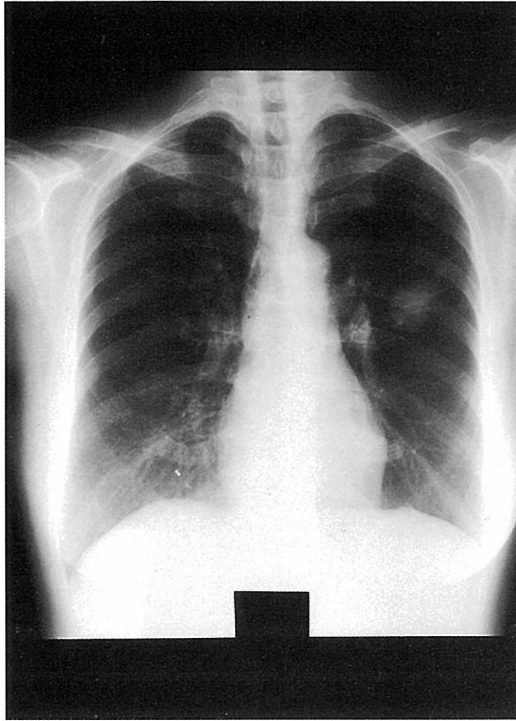Fig.1 Digital-characteristic curve of computed radiography(CR).

Fig.2 Distribution of nodule-nomal ratio for the 16 pulmonary nodules.

a

b

c

Fig.3 60-year-old woman with squamous cell carcinoma. (a) The chest radiogram shows a nodule in left middle lung field. (b) CR tomogram. (c) CR of the inflated -fixed lung.
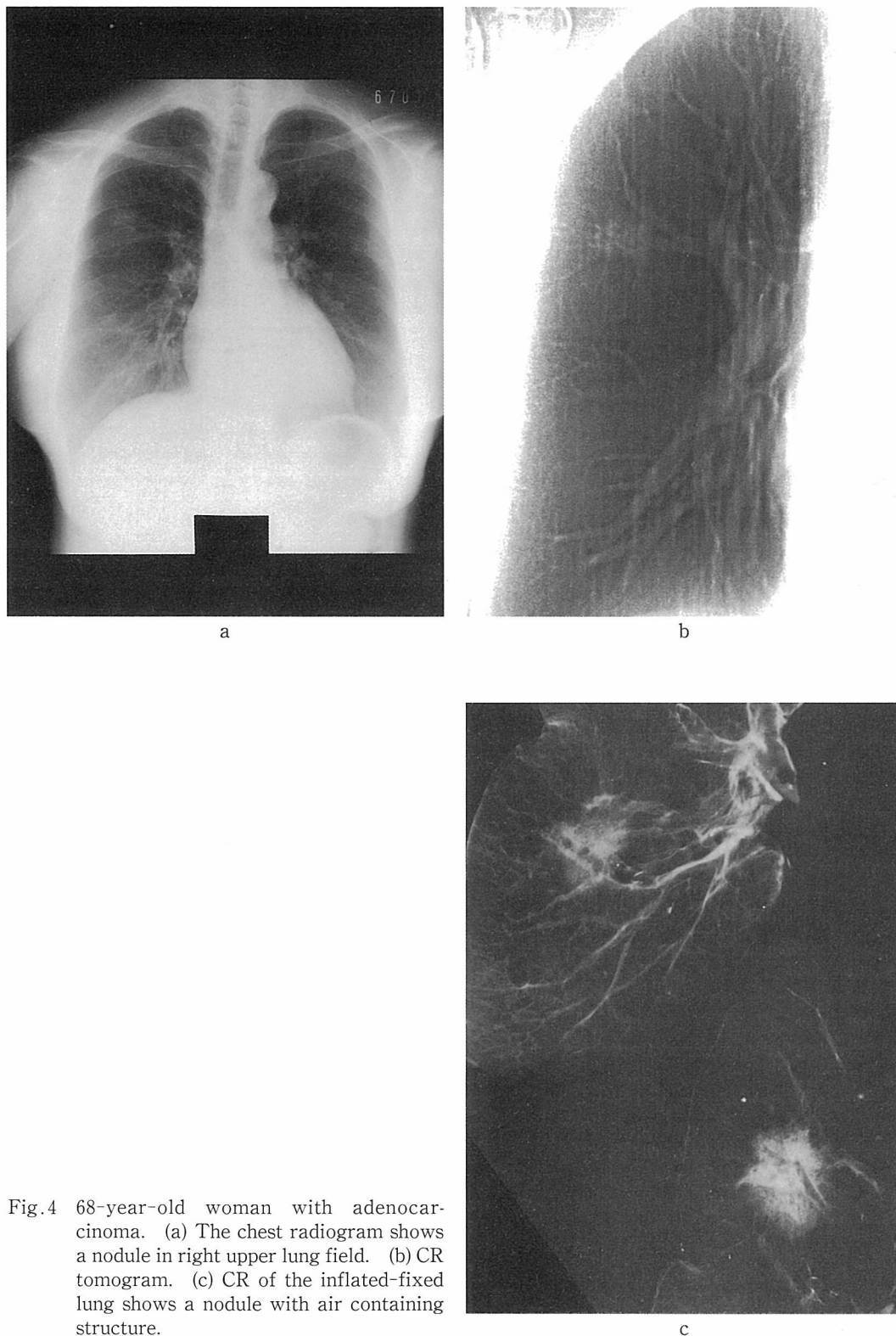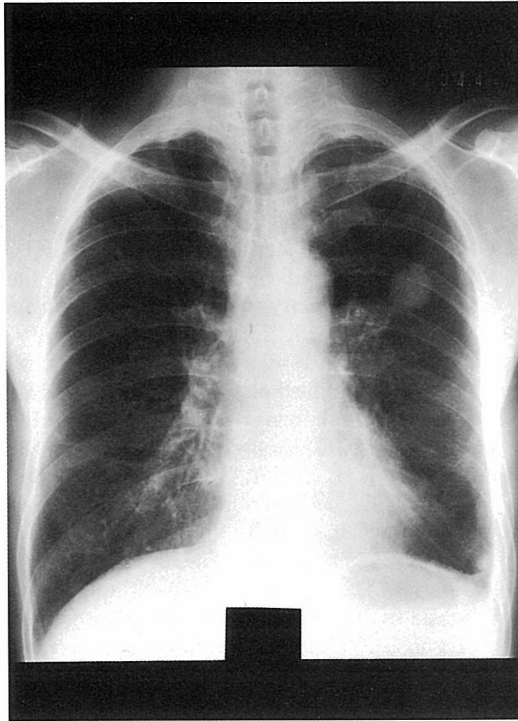
a

b

c

Fig. 4 68-year-old woman with adenocarcinoma. (a) The chest radiogram shows a nodule in right upper lung field. (b) CR tomogram. (c) CR of the inflated-fixed lung shows a nodule with air containing structure.

a

b

c

Fig.5 66-year-old man with large cell carcinoma. (a) The chest radiogram shows a nodule in left middle lung field. (b) CR tomogram. (c) CR of the inflated-fixed lung.

(p < 0.05, t-test).

The cases are shown in Figs. 3, 4 and 5.

Discussion

The benignity or malignancy could not be discriminated by this study using CR because of all malignant pulmonary nodules, while fact that significant correlation was histologically noted suggests that CR may assist the analysis of pulmonary nodules.

Sherrier et al.[3] reported that benignity was diagnosed in 9 of 21 nodules by imaging analysis which was digitized the conventional chest radiograph. Giger et al.[4] reported that digital radiography had a high possibility contributing to the discovery and diagnosis of the lung cancer by performance of the quantitative analysis of the digital chest radiograph.

It is considered that high value of the nodule-normal ratio in the adenocarcinoma in this time is caused by bronchioalveolar carcinoma wiht air-containing structure, and internal structure of the nodule obtained by CR may be reflected. Although X-ray tube in the mammography was used in this time, diagnosis of the benign nodules is cnsidered to be available because detecting capability of the calcification is elevated by it.

References

1) Siegelman, S.S., Zerhouni, E.A., Leo, F.P., Khouri, N.F. and Stitik, F.P. : CT of the solitary pulmonary nodule. *Am. J. Roentgenol.*, **135** : 1-13, 1980.

2) Zerhouni, E.A., Boukadoum, M., Siddiky, M. A. et al. : Standard phantom for quantitative analysis of pulmonary nodules by computed radiography. *Radiology*, **149** : 767-773, 1983.

3) Sherrier, R.H., Chiles, C., Johnson, G.A. and Ravin, C.E. : Differentiation of benign from malignant nodules with digitized chest radiographs. *Radiology*, **162** : 645-649, 1987.

4) Giger, M.L., Doi, K. and MacMahon, H. : Image feature analysis and computer-aided diagnosis in digital radiography. 3. Automated detection of nodules in peripheral lung field. *Med. Phys.*, **15** (2) : 158-165, 1988.