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Correlations between thin-section CT findings, histopathological and clinical findings of small pulmonary adenocarcinomas

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ABSTRACT

Study objectives: Previously, we reported that small pulmonary adenocarcinomas (tumor diameter 20 mm or less) could be classified according to attenuation on thin-section CT (TS-CT) images as either 'air-containing type' or 'solid-density type' (Lung Cancer 2002;36:49–57). Air-containing type was defined as having areas where TOM (tumor opacity on mediastinal window images) was half or less than half the size of those noted on lung window images. Solid-density type was defined as having areas where TOM was greater than half the size of those noted on lung window images. Our findings indicated that there was no microscopic evidence of metastasis with air-type nor any relapses nor deaths, after resection. By contrast, patients with solid-density types demonstrated a poor prognosis. At this time, the histopathological characteristics of areas of TOM have not been fully investigated. The purpose of this study is to define the correlations between TOM and histopathological findings of small lung adenocarcinomas.
Method: We retrospectively reviewed the records and CT scans of 134 patients, who had undergone surgical resection of peripheral adenocarcninomas. All tumor diameters were 20 mm or less in size. All 134 patients had undergone TS-CT prior to surgery. TS-CT Images were acquired by a model X-Vigor/Real or an Aquillion CT scanner (Toshiba Medical Systems). Thin-section images of tumors were obtained at 135 kVp at 250 mAs with 1–2 mm section thicknesses. All images were photographed using mediastinal (level, 40 HU; width, 400 HU) and lung (level, −600 HU; width, 1600 HU) window settings. We researched the histopathological components corresponding to the areas of TOM.
Results: Areas of TOM demonstrated five possible histopathological findings; (1) collapse (C), (2) collapse with bronchioloalveolarcell carcinoma (CwB), (3) adenocarcinoma cells (Cells), (4) fibroblasts (F), and (5) mucus (M). Areas of TOM in air-containing type adenocarcinomas (52 cases) demonstrated predominantly C and/or CwB (C/CwB type, 44 cases). Areas of TOM in solid-density type adenocarcinomas (82 cases), in comparison, demonstrated predominantly Cells and/or Cells/F (Cell/F type, 67 cases). We noted a statistically significant difference between the histopathological findings of the areas of TOM of air-containing type and solid-density type tumors. The 39 cases of Cell/F type adenocarcinomas revealed microscopic evidence of metastasis (pleural involvement, vascular invasion, lymphatic permeation, or lymphnode metastasis). Whereas, no C/CwB type adenocarcinomas cases revealed any microscopic metastasis. The prognosis of C/CwB type after resection is better than for Cell/F type.
Conclusion: We found that air-containing type adenocarcinomas demonstrated C/CwB type, and that solid-density type adenocarcinomas demonstrated Cell/F type. The histopathological findings of small pulmonary adenocarcinomas could be classified into three groups: C/CwB type, Cell/F type and M type. The prognosis of C/CwB type is better than for Cell/F type. Our results indicate that there are clear correlations between the areas of TOM and the histopathological components of small pulmonary adenocarcinomas. Therefore TS-CT findings are a useful aid in determining the best surgical methods.

1. Introduction

Correlations between thin-section CT findings (TS-CT) of small lung cancers and pathological findings have recently been researched. The results indicate that TS-CT findings reflect the char-

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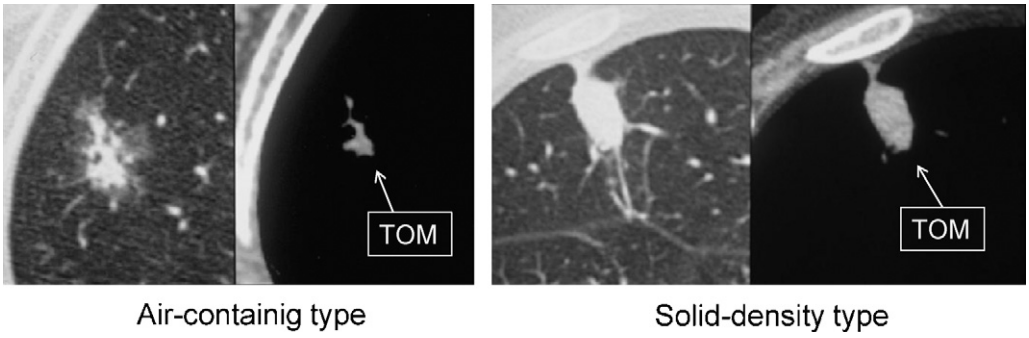

Fig. 1. TS-CT images of 'air-containing type' and 'solid-density type'. Air-containig type: the areas of tumor opacity on mediastinal window images (TOM) are half or less than half the size of those noted on lung window images. Solid-density type: the areas of tumor opacity on mediastinal window images (TOM) are greater than half the size of those noted on lung window images.

acteristics of tumors. TS-CT findings can help us to differentiate malignant tumors from benign tumors [1,2]. Moreover, some studies have reported that we can predict the degree of the invasion and the post-operative prognosis of the small pulmonary adenocarcinomas. Some researchers have indicated that there is a relation between the percentages of ground-glass opacity (GGO) findings, and the prognosis and tumor aggressiveness [3–8]. Kodama and Aoki et al. indicated that the adenocarinomas with GGO greater than 50% show a better prognosis than for GGO with less than 50% [7,8]. These reports indicate that GGO findings correlate to clinical characteristics. GGO findings on TS-CT reflect the pathological areas of bronchioloalveolarcell carcinoma (BAC), which present growth patterns of tumor cells replacing alveolar lining cells [4,7]. BAC is non-invasive, therefore, we think that areas other than BAC, which present non-GGO findings on TS-CT may indicate the prognosis and aggressiveness [9]. Kondo and Shimizu et al. focused on solid areas of TS-CT findings [10,11], respectively. They reported that small pulmonary adenocarcinomas (tumor diameter 20 mm or less) could be classified according to attenuation on TS-CT images as either 'air-containing type' (= 'air-type') or 'solid-density type' (= 'solid-type'). Air-type was defined as having areas where tumor opacity on mediastinal window images (TOM) were half or less than half the size of those noted on lung window images. On the other hand, solid-types were defined as having areas where TOM was more than half the size of those noted on lung window images (Fig. 1). No microscopic evidence of metastasis with air-type has been revealed, nor have there been any relapses or deaths, after resection. In contrast, patients with solid-types demonstrated a poor prognosis. Therefore, the areas of TOM indicate the characteristics of tumors, but many questions remain, and we do not fully understand the histopathological characteristics of areas of TOM.

We investigated the pathological findings of TOM and the clinical characteristics of small pulmonary adenocarcinomas.

2. Method

We retrospectively reviewed the records and CT scans of 134 patients, who had undergone surgical resection of peripheral adenocarcinomas from November 1997 to January 2004. Bronchioloalveolarcell carcinoma (BAC) tumors, which were undetectable on the mediastinal thin-section CT window images were excluded. Tumors measuring 20 mm in diameter or less were included. All 134 patients had undergone TS-CT scans within one week prior to surgery. TS-CT images were acquired by a model X-Vigor/Real or an Aquillion CT scanner (Toshiba Medical Systems, Tokyo, Japan). TS-CT images targeted to the tumors were obtained serially at 135 kilovolt peak (kVp) and 250 mAs, with 1–2 mm section thicknesses, pitch 1, 1–2 mm section spacing, 512 × 512 pixel resolution, and 1 s scanning time, using high-spatial-reconstruction algorithm with a 20-cm field of view. All images were photographed using a mediastinal window level setting (MWLS; level, 40 Hounsfield units (HU); width, 400 HU) and a pulmonary window level setting (PWLS; level, −600 HU; width, 1600 HU). Contrast medium (60 ml) was infused intravenously during imaging, lesion sites were translocated in a helical scan mode with a CT table speed of 2 mm/s; TS-CT were obtained at one breath-holding.

All CT findings were reviewed by four thoracic oncologists, who were not informed beforehand, of the pathologic findings. We classified tumors into two types according to the TDR (tumor shadow disappearance rate). TDR was defined as follows:

$$\mathrm{TDR} = 1 - (\text{tumor area of the mediastinal windows (TOM)}/\text{tumor area of the lung windows}).$$

A TDR of 50% or greater was defined as 'air-containing type' (= air-type), and a TDR of less than 50% was defined as 'solid-density type' (= solid-type) (Fig. 1) [7,8].

Surgical specimens were fixed in an inflated state via transbronchial infusion of formalin and serially sectioned transversely. All sections were stained with hematoxylin and eosin, and Elastica-Van Gieson stain.

We researched microscopically the histopathological findings of the areas corresponding to the areas of TOM of the largest tumors (analogous to the plane of CT scans) under a magnifying glass. We analyzed the correlation between the areas of TOM and the pathological components, pleural involvement, vascular invasion, lymphatic permeation and survival outcomes.

3. Statistical analysis

Data is expressed as mean ± standard deviation (SD). Differences among groups were examined for chi square test and Fisher exact probability. A p-value of less than 0.05 denotes a statistically significant difference. Survival rates were analyzed statistically by the Wilcoxon test.

4. Result

4.1. Patient characteristics

Patient characteristics are summarized in Table 1. A total 134 patients (76 men and 58 women; age range, 29–84 years; mean age 64 years) were included in this study. Tumor diameters ranged from 7 mm to 20 mm, the average diameter was 15.6 mm. Classifications were determined according to TS-CT findings. 52 cases of air-containing type and 82 cases of solid-density type were identified. Pathological classification, in accordance with Noguchi's