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Research paper

Quantitative computed tomography texture analyses for anterior mediastinal masses: Differentiation between solid masses and cysts

Koichiro Yasaka[a], Hiroyuki Akai[a], Osamu Abe[b], Kuni Ohtomo[b], Shigeru Kiryu[a,c,*]

[a] Department of Radiology, The Institute of Medical Science, The University of Tokyo, 4-6-1 Shirokanedai, Minato-ku, Tokyo, 108-8639, Japan
[b] Department of Radiology, Graduate School of Medicine, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-8655, Japan
[c] Department of Radiology, Graduate School of Medical Sciences, International University of Health and Welfare, 537-3 Iguchi, Nasushiobara, Tochigi, 329-2763, Japan

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ABSTRACT

Objectives: To investigate whether solid anterior mediastinal masses could be differentiated from cysts using quantitative computed tomography (CT) texture analyses in unenhanced CT (UECT) or contrast enhanced CT (CECT).

Materials and methods: This clinical retrospective study included 76 UECT images (40 men and 36 women, 28 cystic (mean diameter, 29.5 mm) and 48 solid (mean diameter, 48.2 mm)) and 84 CECT images (45 men and 39 women, 26 cystic (mean diameter, 31.4 mm) and 58 solid (mean diameter, 51.4 mm)) of anterior mediastinal masses, which were diagnosed histopathologically or using imaging criteria. Polygonal regions of interest were placed on these masses. CT histogram analyses for images of masses with or without filtration (Laplacian of Gaussian filters with various spatial scaling factors) were performed. DeLong's test was performed to compare areas under the curve (AUC) with receiver operating characteristic analyses.

Results: From logistic regression analyses with a stepwise procedure, a combination of the mean in unfiltered images (mean0; i.e., CT attenuation) and mean in filtered images featuring coarse texture for UECT (AUC = 0.869) and the combination of mean0 and entropy in filtered images featuring fine texture for CECT (AUC = 0.997) were found to predict better the internal characteristics of anterior mediastinal masses. In UECT and CECT, diagnostic performance using these combinations tended to be high compared to mean0 alone (AUC = 0.780 [p = 0.033] and AUC = 0.983 [p = 0.130], respectively).

Conclusion: Solid anterior mediastinal masses can be differentiated from cysts using quantitative CT texture analyses with moderate and high diagnostic performance in UECT and CECT, respectively.

1. Introduction

Anterior mediastinal masses can be found incidentally by computed tomography (CT). Several histological types of masses arise in the anterior mediastinal space. For differential diagnosis with CT, detection of fat attenuation within the mass is a key feature. For such masses, diagnoses can be narrowed down to teratomas, lipoma, liposarcoma, and the like [1,2]. For other anterior mediastinal masses, whether the masses are cystic or solid is an important imaging finding to consider [1,2]. This differentiation is also important because solid masses include malignant lesions such as thymic carcinoma and malignant lymphoma, while cysts are typically benign in nature.

The internal characteristics (solid or cystic) are determined if it is enhanced using contrast material. However, in most cases, both unenhanced CT (UECT) images and contrast enhanced CT (CECT) images are not always available at the examinations when anterior mediastinal masses are found. Therefore, to determine if they are cystic or solid, further examinations are required that would increase the time and cost.

The internal characteristics are also associated with tumor heterogeneity. Determining the heterogeneity is typically performed using a subjective and qualitative approach. However, in the era of radiomics, quantitative data on the heterogeneity of the anterior mediastinal masses based on internal characteristics are required.

Among the several methods of quantitative texture analyses [3], a technique that incorporates histogram analyses for images with or

Abbreviations: AUC, area under the receiver operating characteristics curve; CECT, contrast enhanced computed tomography; CT, computed tomography; HU, Hounsfield unit; ROC, receiver operating characteristics; ROI, region of interest; SD, standard deviation; SSF, spatial scaling factor; UECT, unenhanced computed tomography

* Corresponding author at: Department of Radiology, Graduate School of Medical Sciences, International University of Health and Welfare, 537-3 Iguchi, Nasushiobara, Tochigi 329-2763, Japan.
E-mail address: kiryu-tky@umin.ac.jp (S. Kiryu).

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without processing using Laplacian of Gaussian filters is gaining attention, recently. This method allows evaluations of fine to coarse heterogeneity of the tumors. Features derived from this method are known to provide clinically useful information for estimating histopathological subtypes of the tumor [4–6], for predicting the survival of patients with a tumor [7,8], and for exploring the effectiveness of tumor treatment [9–11]. We hypothesised that this method would allow one to determine the heterogeneity of anterior mediastinal masses and would be an effective tool for distinguishing between solid masses and cysts. If the internal characteristics of them are found to be estimated with single phase CT scan, it might be related to reducing radiation exposure to patients and saving medical resources. Therefore, this hypothesis should be investigated.

We investigated whether solid anterior mediastinal masses without apparent fat tissue could be differentiated from cysts using quantitative CT texture analyses in UECT or CECT.

2. Materials and methods

This clinical retrospective study was approved by our institutional review board. The requirement for written informed consent was waived.

2.1. Patients

A radiologist (K.Y., with 6 years of imaging experience) searched picture archiving and communication system for CT images of patients with solitary anterior mediastinal masses. From January 2010 to October 2016, 150 consecutive candidate patients (117 UECT images and 116 CECT images) were identified (a flowchart is shown in Fig. 1). The following were excluded (n = 41 in UECT and n = 32 in CECT); images of patients with anterior mediastinal masses that could not be diagnosed as cystic or solid using the pathological or imaging criteria (described in detail later), images of small masses less than 1 cm in diameter, images of masses containing fat or diagnosed as mature teratomas, image of masses with a past history of treatment, images containing considerable artifacts, images scanned at a low radiation dose, images reconstructed with a slice thickness other than 5 mm, or images reconstructed with a field of view other than 35–40 cm. Overall, 93 patients (76 UECT images [40 men and 36 women; mean age, 59.8 ± 16.4 years] and 84 CECT images [45 men and 39 women; mean age, 58.5 ± 16.3 years]) were included in the final analyses.

Table 1
Histopathological diagnoses for anterior mediastinal masses.

	Number of patients	
Diagnoses	UECT	CECT
Thymic cyst	3	2
Bronchogenic cyst	2	0
Pericardial cyst	0	1
Thymoma	30	34
Thymic carcinoma	2	2
Thymic carcinoid	1	3
Malignant lymphoma	4	3
Seminoma	2	3
Squamous cell carcinoma	2	3
Castleman disease	0	1
Solitary fibrous tumor	0	1
Small cell carcinoma	1	1
Poorly differentiated carcinoma	0	1

Note: CECT, contrast enhanced computed tomography; UECT, unenhanced computed tomography.

2.2. Reference standard

Diagnosis of the anterior mediastinal mass as cystic or solid was made pathologically (n = 47 in UECT and n = 55 in CECT) or using imaging criteria (n = 29 in UECT and n = 29 in CECT). Pathological diagnosis was made after surgery or biopsy and was performed by experienced pathologists in our hospital (Table 1). Images scanned prior to and closest to the surgery or biopsy were included in analyses. The median time interval from CT scan to surgery was 21.5 days (range, 1–99 days) in UECT and 21 days (range, 1–147 days) in CECT. The median time interval from CT scan to biopsy was 11 days (range, 0–99 days) in UECT and 10.5 days (range, 2–25 days) in CECT.

Following lesions were diagnosed using imaging criteria; pathological diagnosis cannot be made and both the UECT and CECT scanned at the same time were available. The criteria were based on the

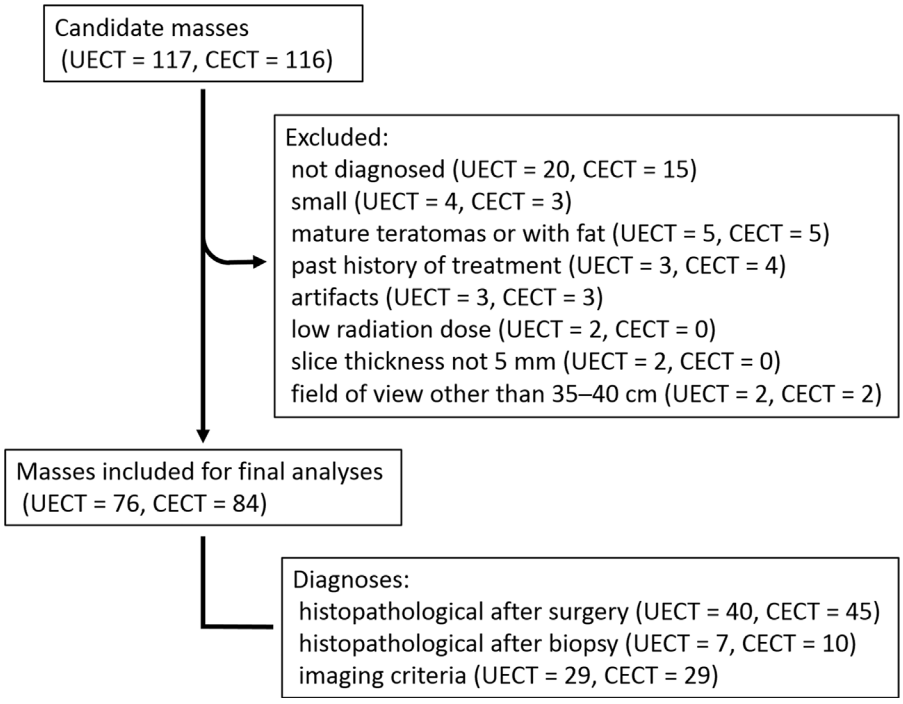

Fig. 1. Flowchart of the study population.