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CT EVALUATION OF MEDIASTINAL MASSES*

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Abstract—CT is an important modality for imaging mediastinal masses, and certain CT attenuation features (fat, calcium, or water attenuation, contrast enhancement) are well known to suggest specific diagnoses. In a series of 132 consecutive patients with tissue-proven mediastinal masses, these specific CT features were present in only 16. We evaluated the ability of CT to differentiate soft tissue mediastinal masses based on morphology and distribution of disease. Metastatic disease and lymphoma accounted for 69% of masses in this series, and CT could not generally differentiate them. However, CT was helpful in differential diagnosis in certain settings. CT demonstration of multiple mediastinal masses when conventional radiographs showed a single mass generally excluded diagnoses such as thymoma and teratoma. CT demonstration of a single middle mediastinal mass, frequently missed by conventional radiography, made metastatic disease a much more likely diagnosis than lymphoma. Finally, CT demonstration of certain ancillary findings strongly favored a diagnosis of lymphoma (axillary adenopathy) or metastatic disease (solitary pulmonary mass, focal liver lesions, bone lesions).

Mediastinum, CT Mediastinum, neoplasms Thorax, CT

INTRODUCTION

The CT features of various mediastinal masses have been the subject of numerous reports, and CT is firmly established as an important modality for imaging such masses. CT provides excellent delineation of mediastinal masses, and CT demonstration of fat, calcium, or water attenuation in a mediastinal mass often suggests a specific diagnosis. However, the ability of CT to differentiate soft tissue mediastinal masses on the basis of morphologic appearance and distribution of disease has not been fully explored.

We reviewed these characteristics as well as associated abnormalities in the chest or upper abdomen in 132 patients with mediastinal masses examined by CT to determine how often CT features led to specific diagnoses. We also assessed the relative accuracy of conventional chest radiography in detecting mediastinal masses in this group of patients.

MATERIALS AND METHODS

Retrospective review of our patient records from 1 July, 1981 through 30 September, 1984 disclosed 132 patients with CT-demonstrated mediastinal masses and histologic proof of radiologic findings. For the purpose of this study, a mediastinal mass was defined as an abnormal soft tissue structure that exceeded 1 cm in short axis dimension, thus avoiding confusion with normal mediastinal lymph nodes [1]. Scans of these patients were reviewed by one of us (B.H.G.), and the following parameters were recorded: presence of one or more masses, dominant mass location with respect to mediastinal landmarks such as the heart and trachea, size, attenuation characteristics (presence of contrast enhancement, calcification, fat [< -40 H.U.], or water [0–20 H.U.]), and presence of associated abnormalities in the chest and upper abdomen. Single masses were categorized as anterior, middle, or posterior in location by comparing the center of the lesion with the conventional radiographic mediastinal landmarks used by Felson [2]. Multiple masses were classified as solely anterior mediastinal, predominantly anterior mediastinal, involving the anterior and middle mediastinum, or involving all mediastinal compartments.

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Table 1. Diagnoses of study population—132 patients*

Metastatic neoplasm—56	Thymoma—2
Lymphoma and leukemia—36	Tuberculosis—1
Esophageal carcinoma—13	Histoplasmosis—1
Thyroid masses—8—2 malignant	Bronchogenic cyst—1
—6 benign	Cystic hygroma—1
Sarcoidosis—5	Thoracic spine fibrosarcoma—1
Pheochromocytoma—4	Reactive hyperplasia—1
Neural tumors—3	

*133 diagnoses—1 patient had 2 diagnoses.

CT scans were performed using GE 8800 or 9800 scanners with scan times of 2.0–5.6 s. Contiguous 1 cm thick sections were obtained, with dynamic scanning performed during and after a bolus of intravenous contrast beginning at the plane of the right upper lobe bronchus. Scans were photographed at lung (level = −600 H.U., window width = 1000 H.U.) and soft tissue (level = 30 H.U., window width = 500 H.U.) settings.

Concurrent conventional chest radiographs (within 2 weeks of the CT scan) were available for 90 patients. Many of the remaining 42 patients were referred for chest CT from other hospitals, and conventional radiographs for such patients were generally unavailable. Chest radiographs were reviewed by three of us (M.R., D.R.P., D.L.S.) without knowledge of the CT findings, and the following information was recorded: visibility of a mass, mass location (anterior, middle, or posterior mediastinal), number of masses, size, presence of abnormal radiographic density (calcification or fat), and associated chest abnormalities.

RESULTS

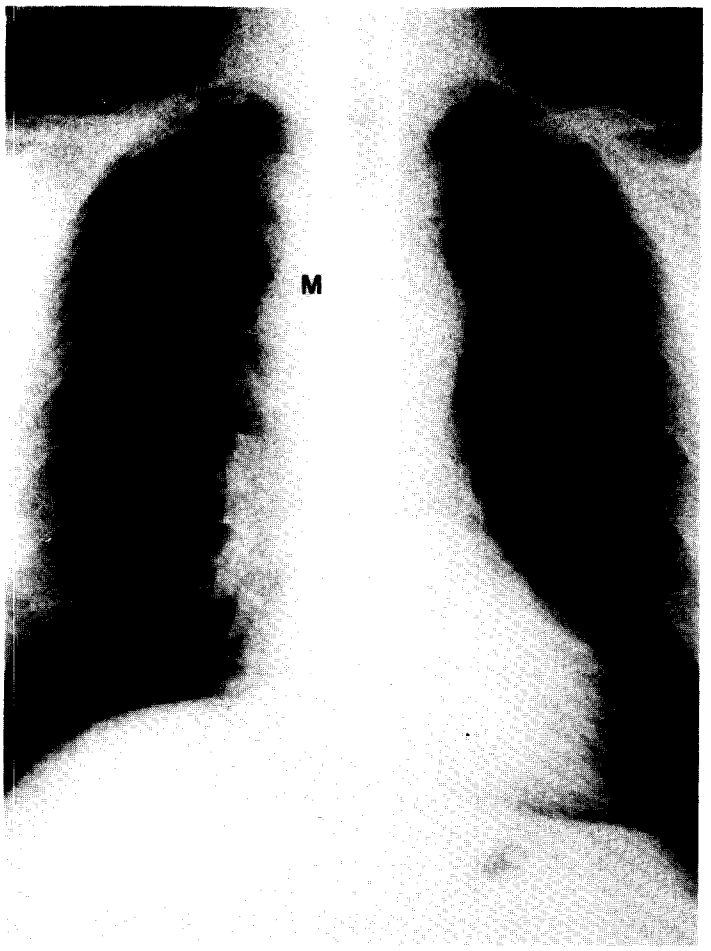
In our patient population, the most common cause of mediastinal mass was metastatic disease, accounting for 56 of 132 patients (42%). Carcinoma of the lung was the primary neoplasm in 34 of these 56 patients. Lymphoma was the second most common etiology of mediastinal mass, occurring in 36 patients. Nodular sclerosing Hodgkin disease was the most frequent diagnosis in lymphoma patients (21/36). Overall, 112 of 132 patients (85%) had malignant mediastinal masses. The most common benign mediastinal masses were mediastinal thyroid (6 patients) and sarcoidosis (5 patients). Etiologies are summarized in Table 1.

Mediastinal masses could be appreciated on conventional radiographs in 62 of 90 patients (69%) with available chest radiographs (Table 2). The rate of detection varied with the mediastinal compartment, ranging from 48% (10/21) for the middle mediastinum to 100% (4/4) for posterior mediastinal masses. The smallest mass visualized was 2 × 2 × 2 cm in size in the anterior mediastinum and represented adenopathy in a patient with sarcoidosis. The largest mass missed on conventional radiographs was 6 × 5 × 7 cm in the middle mediastinum and was metastatic oat cell carcinoma. Multiple masses were more frequently detected (28/35, 80%) than single masses (34/55, 62%), but their multiple nature was often not appreciated on chest radiographs (Fig. 1). Of 28 patients with multiple masses at CT and an abnormal chest radiograph, 12 (43%) were thought to have a single mass based on the chest radiograph.

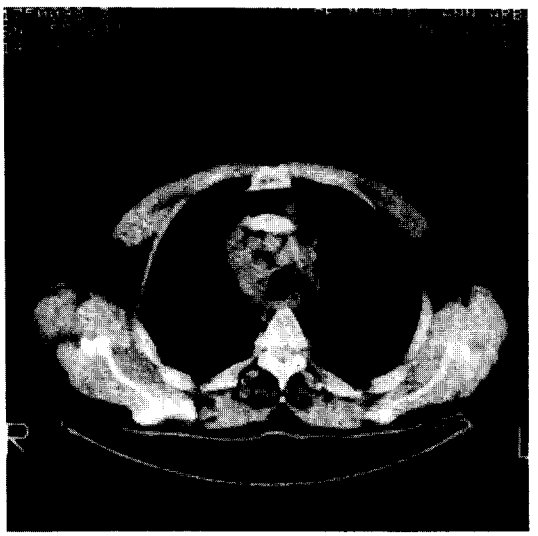
Specific CT attenuation characteristics included calcification in 8 masses (4 thyroid, 2 neuroblastoma, 1 metastatic lung adenocarcinoma, and 1 metastatic lung oat cell carcinoma), ossification in 1 (metastatic osteosarcoma), marked enhancement in 10 (5 thyroid, 4 pheochromocytoma, and 1 metastatic lung adenocarcinoma), and near water attenuation in 2 (1 bronchogenic cyst and 1 cystic hygroma). Nine masses contained zones of low attenuation that were higher in attenuation than water

Table 2. Mass detection on conventional radiographs

Mass description	Percentage visualized
Single anterior ($N = 30$)	67
Single middle ($N = 21$)	48
Single posterior ($N = 4$)	100
Multiple, solely anterior ($N = 8$)	63
Multiple, predominantly anterior ($N = 12$)	83
Multiple, anterior + middle ($N = 14$)	86
Multiple, all compartments ($N = 1$)	100

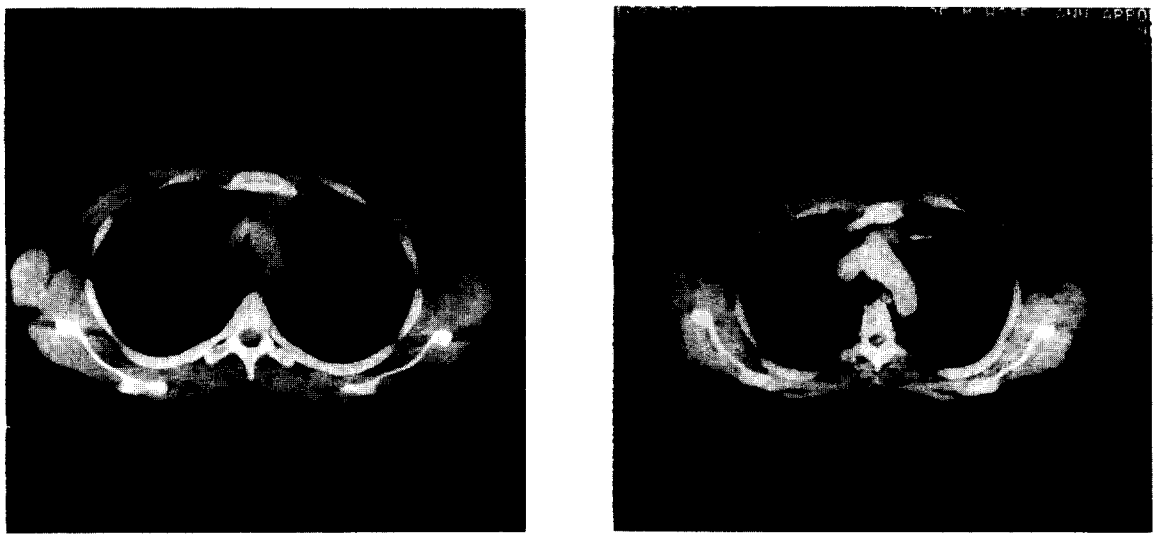


(A)



(B)

Fig. 1. Metastatic oat cell carcinoma of lung. (A) Posteroanterior chest radiograph shows a single right paratracheal mass (M). (B) CT reveals that there are actually multiple masses.



(A) (B)

Fig. 2. Different causes of single anterior mediastinal masses with similar morphologic appearances. (A) Nodular sclerosing Hodgkin disease (M). (B) Metastatic small cell carcinoma, primary unknown (arrow).

(20–40 H.U.), including 4 nodular sclerosing Hodgkin disease, 2 metastatic lung adenocarcinoma, 1 thymoma, 1 esophageal carcinoma, and 1 metastatic squamous cell carcinoma of the oral cavity. These differences in attenuation, evident on CT images, were not visible on conventional chest radiographs in any of our patients. None of the patients in our series had masses that contained fat.

Masses were single in 76 patients and multiple in 56. Number, size, and mediastinal compartmental distribution of masses were not generally useful in specific characterization of mass etiology. Metastatic disease and lymphoma, which together accounted for 69% of the masses in this series, overlapped considerably in morphologic appearance (Figs 2 and 3) (Table 3). The only major difference between them was that lymphoma seldom presented as a single middle mediastinal mass.

Associated abnormalities in the neck, chest and abdomen in patients with metastatic disease and lymphoma are tabulated in Table 4. Again, there was considerable variability in underlying etiology for many of these abnormalities. Several associated abnormalities were almost always indicative of

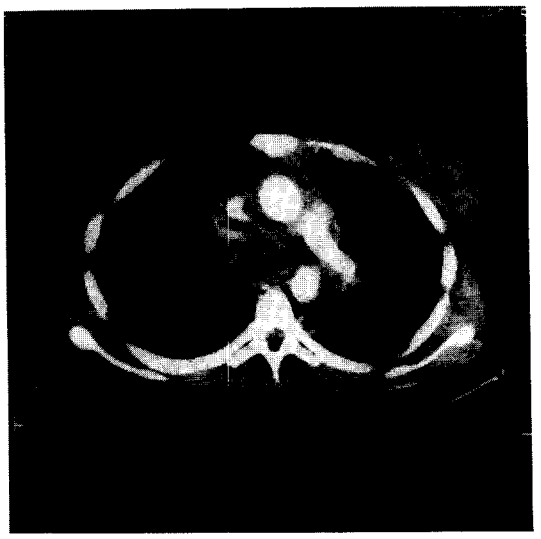
Table 3. CT morphologic appearance of metastic disease and lymphoma

Morphology	Metastatic lung carcinoma	Other metastases	Hodgkin disease	Other lymphoma
Single anterior	9	7	8	7
Single middle	7	5	1	0
Single posterior	1	1	0	0
Multiple, solely anterior	1	1	7	0
Multiple, predominantly anterior	9	3	3	2
Multiple, anterior and middle	7	4	4	4
Multiple, all compartments	0	1	0	0

Table 4. Ancillary CT findings

	Lymphoma	Hodgkin	Lung metastases	Other metastases
Neck masses	2/13*	6/23*	3/34	1/22
Axillary nodes	3/13*	3/23*	0/34	1/22
Single lung mass	0/13	1/23	8/34*	4/22*
Multiple lung nodules	0/13	3/23*	7/34*	11/22*
Bilateral hilar adenopathy	2/13*	8/23*	2/34	3/22*
Unilateral hilar adenopathy	2/13*	2/23	19/34*	3/22*
Pericardial effusion	2/13*	2/23	4/34*	0/22
Pleural effusion/mass	5/13*	4/23*	10/34*	2/22
Internal mammary nodes	0/13	3/23*	0/34	1/22
Abdominal nodes	3/13*	2/23	1/34	3/22*
Liver metastases	0/13	1/23	6/34*	4/22*
Bone metastases	0/13	0/23	3/34	4/22*

*Indicates a finding occurring in $\geq$ 10% of patients in a given category.



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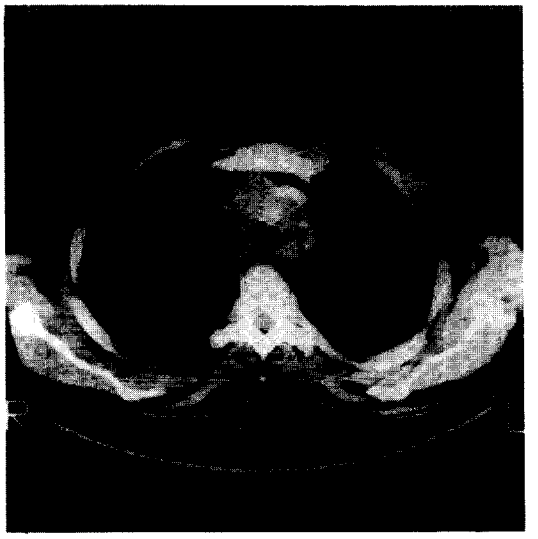

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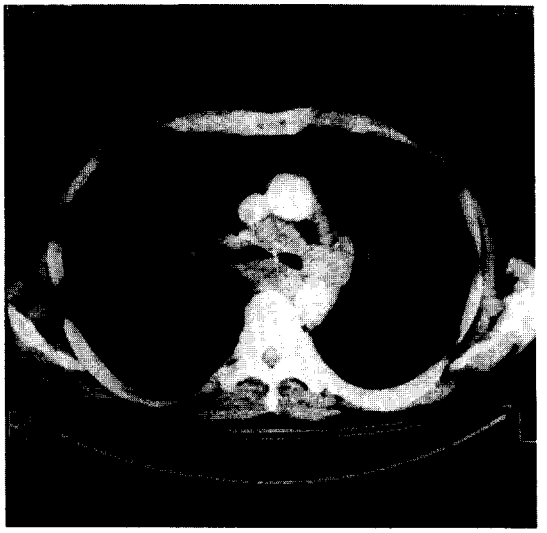

(C)

Fig. 3. Different causes of multiple mediastinal masses with similar morphologic appearances. (A) Diffuse histiocytic lymphoma. (B, C) Metastatic oat cell carcinoma of lung.

either metastatic disease or lymphoma. These discriminating findings included axillary adenopathy (usually indicative of lymphoma) and solitary pulmonary mass, focal liver lesions, and bone lesions (generally indicative of metastatic disease). It was impossible to separate Hodgkin disease from non-Hodgkin lymphoma or metastatic lung cancer from other metastatic disease based on these same associated features.

DISCUSSION

Other authors have reported their surgical and pathologic experience with mediastinal masses. Benjamin *et al.* [3] examined 215 patients with mediastinal masses over a 20-year period. Sixty percent of these masses were benign and 40% were malignant. Wychulis *et al.* [4] reviewed 40 years of Mayo Clinic surgical results. Of 1064 cases, neurogenic tumors (19.9%), thymomas (19.4%), and benign cysts (18.4%) accounted for approximately 60% of all cases.

In our CT series metastatic disease was most frequent, accounting for 42% of masses. This is due to the difference between surgical and medical patient populations. The majority of patients with metastatic disease involving the mediastinum are not surgical candidates and are therefore treated

medically. This also reflects the preponderance of oncologic patients imaged by body CT. The extrathoracic primary neoplasms that most commonly metastasized to the mediastinum in our series (adenocarcinoma of unknown primary, head and neck, breast, and renal carcinoma) are generally in accord with those described in a previous series based on conventional radiographs [5].

The lymphoma population in our series was similar to that of the Mayo Clinic. Sixty-four percent (23 of 36) of our patients had Hodgkin disease as opposed to 59% at the Mayo Clinic [4]. There was considerable variability of CT appearance for any given cell type of lymphoma, and there was also overlap of cell types for any given CT appearance. The only exception was lymphoblastic lymphoma; all four patients with that diagnosis in our series presented with a single anterior mediastinal mass.

Chest radiography is the usual screening tool for detecting mediastinal masses, and a limited differential diagnosis can often be generated based on an abnormal chest radiograph. However, only 69% (62 of 90) of the masses in our series were detected using conventional radiographs. The theoretical limitations of contrast resolution for chest radiography are well known, and the resultant practical implications have been previously documented. In one series of 16 patients with myasthenia gravis associated with thymoma, CT demonstrated the thymoma in 14 of 16 while conventional radiographs detected the lesion in only 9 of these patients [6]. The large number of structures of similar radiographic density in the middle mediastinum and the paucity of adjacent lung interfaces may explain why chest radiographs were poorest in detecting middle mediastinal masses (52% missed) and why a $6 \times 5 \times 7$ cm metastasis from oat cell carcinoma of the lung was missed. Conversely the intimate contact with adjacent lung and the small number of posterior mediastinal masses in our series likely account for our 100% detection rate in this mediastinal compartment.

The better contrast resolution and tomographic nature of CT result in a higher lesion detection rate, as our series demonstrated. In addition, CT can also better characterize an abnormality as single or multiple, a distinction frequently missed by plain radiographs in our series. This can have important diagnostic implications, since the presence of multiple mediastinal masses would virtually exclude etiologies such as thymoma, teratoma, or a thyroid abnormality. CT provides better definition of the specific anatomic location of a mass and is also better at detecting associated abnormalities of the chest and upper abdomen. These CT features would be expected to result in improved diagnostic capabilities. In this regard, CT was disappointing. The common etiologies of soft tissue mediastinal masses could not generally be distinguished on the basis of CT features. There was considerable overlap of CT characteristics for patients with lymphoma, metastatic disease, primary mediastinal neoplasms, and even benign mediastinal masses. Sarcoidosis in particular was indistinguishable from lymphoma or metastatic disease, generally presenting with multiple predominantly anterior mediastinal nodes. In contrast to published reports [7], we found significant prevascular nodal involvement in several patients with sarcoidosis.

Certain CT features of mediastinal masses have proven relatively specific. Calcification has been described in cases of neuroblastoma [8], teratoma [9], metastatic mucinous adenocarcinoma [10], metastatic ossifying osteogenic sarcoma [7], and in benign conditions such as toxic nodular goiter [7]. In our series there was also calcification in one patient with metastatic adenocarcinoma of the lung and one with metastatic oat cell carcinoma of the lung, perhaps representing metastases that engulfed granulomatous lymph nodes. CT enhancement in our series was seen in five patients with thyroid masses (3 benign, 2 malignant), four with pheochromocytomas, and one with adenocarcinoma of the lung. Thus the presence of significant enhancement virtually excludes the usual causes of mediastinal masses (metastatic disease and lymphoma). Water attenuation was noted in one bronchogenic cyst and one cystic hygroma [11, 12]. These more specific CT features were sufficiently rare in this series (allowing a specific diagnosis to be made in only 16 of 132 patients) to limit their overall diagnostic utility.

We undertook this study to see if mediastinal masses of soft tissue attenuation could be characterized on the basis of CT appearance. CT features such as size, number, and distribution of mediastinal masses proved disappointing at distinguishing the most common diseases, metastatic disease and lymphoma, although the latter rarely presented as a single middle mediastinal mass. Certain associated abnormalities were somewhat helpful in this regard, including axillary adenopathy (usually with lymphoma) and solitary pulmonary mass, focal liver lesions, and bone lesions (generally with metastatic disease). Contrast enhancement was useful at narrowing the differential diagnosis (almost eliminating metastases and lymphoma), as was the presence of multiple masses (virtually

excluding lesions such as thymoma, teratoma, and thyroid). The well known ability of CT to characterize certain masses based on attenuation characteristics (fat, calcium, or water) is not frequently helpful in day-to-day practice.

SUMMARY

CT is not generally able to distinguish among mediastinal masses of varying etiologies on morphologic grounds. Metastatic disease and lymphoma, the most common causes of mediastinal masses in our experience, demonstrated considerable overlap in CT appearance. Previously reported specific CT features (calcification, enhancement, water attenuation, fat attenuation) were encountered in only 16 of 132 patients in our series. Certain morphologic features were somewhat useful, including multiple masses (virtually excluding thymoma and teratoma), a single middle mediastinal mass (making lymphoma unlikely), and associated abnormalities such as axillary adenopathy, a solitary pulmonary mass, focal liver lesions, or bone lesions. Axillary adenopathy favors lymphoma as a diagnosis and a focal pulmonary mass, focal liver lesions, or bone lesions suggest metastatic disease. Although CT cannot differentiate soft tissue mediastinal masses, it is clearly superior to conventional chest radiography at detecting and characterizing these masses.

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