ITMIG Classification of Mediastinal Compartments and Multidisciplinary Approach to Mediastinal Masses

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Abbreviations: FDG = fluorodeoxyglucose,
ITMIG = International Thymic Malignancy Interest Group,
JART = Japanese Association for Research on the Thymus,
SUV_{max} = maximal standardized uptake value

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See discussion on this article by Van Schil and Heyman (pp 436–438).

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Introduction

The mediastinum contains vital vascular and nonvascular structures and organs. Division of the mediastinum into specific compartments has traditionally been valuable in the identification, characterization, and management of various mediastinal abnormalities. Numerous classification systems have been developed and used to varying degrees by anatomists, surgeons, and radiologists. The most commonly used scheme in clinical practice is the Shields classification system, whereas the traditional Fraser and Paré, Felson, Heitzman, Zylak, and Whitten models are used in radiologic practice (1–7). One scheme has been devised to bridge the gap between the various models (8). Significant differences in the terminology and methods of mediastinal division or compartmentalization among these schemes have resulted in confusion among health care providers and the inability to reliably localize some lesions to a specific mediastinal compartment because of inherent limitations in each classification.

The existing schemes used in radiologic practice represent arbitrary nonanatomic divisions of the chest based primarily on the lateral chest radiograph. The lack of a classification scheme based on cross-sectional imaging is problematic, as multidetector computed...
TEACHING POINTS

- The lack of a classification scheme based on cross-sectional imaging is problematic, as multidetector computed tomography (CT) and magnetic resonance (MR) imaging are predominantly used for diagnosis, evaluation, and management of mediastinal abnormalities and a growing number of mediastinal lesions are detected with multidetector CT studies performed for lung cancer screening, cardiac screening, and other purposes. Therefore, a standardized classification scheme based on multidetector CT is necessary to appropriately describe mediastinal abnormalities and formulate relevant differential diagnoses.

- In some cases, the multidetector CT appearance of thymic hyperplasia is not straightforward and a more nodular or bulky configuration may be present, which can mimic a thymic epithelial tumor, lymphoma, or other soft-tissue neoplasm. In this setting, two options are available: (a) follow-up multidetector CT can be performed in ~3 months to allow a decrease in thymic size or (b) chemical shift MR imaging with in-phase and out-of-phase gradient-echo sequences. Thymic hyperplasia and the normal thymus characteristically demonstrate loss of signal on out-of-phase images due to the suppression of fat interspersed between nonneoplastic hyperplastic thymus, whereas thymic epithelial neoplasms, lymphoma, and other soft-tissue malignancies do not demonstrate suppression on out-of-phase images. Use of either of these options ensures that unnecessary biopsies or surgeries can be avoided.

- Internal heterogeneity resulting in soft-tissue attenuation at multidetector CT may be due to hemorrhagic or proteinaceous components or infection of the bronchogenic cyst; in this setting, MR imaging can be performed to confirm the cystic nature of the lesion, which demonstrates high signal intensity on T2-weighted images regardless of the other contents. The presence of hemorrhagic, proteinaceous, or mucoid content results in variable patterns of signal intensity on T1-weighted images.

- When a previously stable neurofibroma suddenly increases in size, develops regions of heterogeneity, and/or invades adjacent tissues, malignant transformation to a malignant peripheral nerve sheath tumor should be strongly considered. In patients with neurofibromatosis type 1, there is a 10% lifetime risk of developing a malignant peripheral nerve sheath neoplasm, and these lesions account for most cancer-related deaths in these patients. FDG PET/CT has demonstrated utility in distinguishing malignant peripheral nerve sheath tumors from benign neurofibromas, with sensitivity of 95% and specificity of 72%.

- Tuberculosis associated with involvement of the posterior elements, the presence of a large prevertebral and paravertebral soft-tissue component out of proportion to the degree of osseous destruction, and disk space narrowing enable differentiation of tuberculosis from pyogenic infection. Additionally, the presence of calcification without new bone formation or sclerosis strongly suggests the diagnosis of Pott disease of the spine.

tomography (CT) and magnetic resonance (MR) imaging are predominantly used for diagnosis, evaluation, and management of mediastinal abnormalities and a growing number of mediastinal lesions are detected with multidetector CT studies performed for lung cancer screening, cardiac screening, and other purposes (9,10). Therefore, a standardized classification scheme based on multidetector CT is necessary to appropriately describe mediastinal abnormalities and formulate relevant differential diagnoses.

In 2014, the Japanese Association for Research on the Thymus (JART) developed a four-compartment multidetector CT–based classification scheme for division of the mediastinal compartments, which was derived from a retrospective analysis of 445 nonconsecutive pathologically proved mediastinal masses (11). On the basis of discussions with experts in the field of mediastinal diseases, the International Thymic Malignancy Interest Group (ITMIG) has modified the JART model and introduced a new definition of mediastinal compartments to be used with cross-sectional imaging and adopted as a new standard (12).

In this article, we describe the new ITMIG mediastinal compartment classification system based on cross-sectional imaging that can be used to accurately localize and characterize mediastinal lesions and assist in the formulation of focused differential diagnoses and management strategies. Specific approaches to evaluation of abnormalities in the prevascular, visceral, and paravertebral compartments are presented here and primarily based on multidetector CT. It is important to note that these approaches are not intended to include every possible entity that may be encountered in the mediastinum, but instead to provide a practical and realistic algorithm for the radiologist. Although management strategies such as biopsy and surgery may be included when necessary, detailed treatment strategies for individual lesions are beyond the scope of this article.

Rationale and Methodology

ITMIG has an established method of developing international standards for mediastinal diseases, which was used in this instance to develop a practical division of the mediastinum based on cross-sectional imaging. A thorough analysis of the existing literature regarding the various compartment schemes was performed, with specific attention given to the model developed by JART. In an effort to develop a standard representing a consensus among clinicians and researchers interested in mediastinal diseases, a working group within ITMIG identified and surveyed a multidisciplinary group of experts in thoracic surgery, medical oncology, diagnostic radiology, and pathology regarding their preferences for specific details regarding a multidetector CT–based compartment model. Information requested included the following: (a) preference for a three-compartment or a four-compartment model and (b) specific reasons for this preference. After drafting of a proposed multidetector CT–based compartment model by an ITMIG work group, it was further refined by an extended work group and ultimately dissemi-
nated to the active ITMIG members (~225) for review. The final document, which we present in this article, was approved and adopted as a new standard by the ITMIG members.

Mediastinal classification models have traditionally divided the mediastinum into three or four compartments depending on whether a superior mediastinal compartment is included in the description. Four-division models include superior, anterior, middle, and posterior compartments, whereas three-division models include anterior, middle, and posterior compartments. In describing a cross-sectional imaging approach, both types of models have specific advantages and disadvantages. The principal advantages of a four-compartment cross-sectional imaging model include similarity to anatomic and radiologic four-compartment models, the efficacy of such a system as demonstrated by the JART proposal, and the fact that most cases of thyroid goiter are typically located in the superior mediastinum and can be distinguished from other mediastinal masses on this basis.

Significant disadvantages of a four-compartment cross-sectional imaging model include the relative complexity compared with a more streamlined three-compartment model, the perception that most clinicians and radiologists do not use the existing four-compartment schemes, and several nonanatomic features that limit applicability. For example, the division between the superior and inferior compartments is entirely artificial and nonanatomic; thus, neoplastic, infectious, and inflammatory disease processes can spread unimpeded within these two areas without fascial plane restrictions. Furthermore, neurogenic neoplasms in the posterior aspect of the chest do not respect this arbitrary separation of compartments. These factors limit the implementation and dissemination of any four-compartment cross-sectional imaging model.

The primary advantages of a three-compartment cross-sectional imaging model include similarity to the published anatomic, clinical, and radiologic three-compartment models previously developed and in current use, less complicated design relative to four-compartment models, and the fact that specific compartmental boundaries are established along true anatomic planes. The principal disadvantage of a three-compartment cross-sectional imaging model is that blending the superior and anterior compartments may not result in sufficient separation of lesions that occur in each of these locations. However, this is not a significant issue in clinical practice, as specific lesions that typically occupy the superior mediastinum, in particular thyroid goiter, can be readily identified at multidetector CT.

Among the surveyed multidisciplinary group of experts, 72% preferred a three-compartment model, 23% preferred a four-compartment model, and 5% did not have a specific preference. Reasons for selecting one model over another included the following: (a) optimal distinction of disease entities (67%), (b) similarity to what is currently used (63%), (c) anatomic nature (53%), and (d) ease of use (48%). On the basis of this feedback, a three-compartment model was selected as the foundation for the cross-sectional classification scheme developed by ITMIG.

**ITMIG Definition of Mediastinal Compartments**

The three-compartment cross-sectional imaging model of the mediastinal compartments developed by ITMIG includes prevascular (anterior), visceral (middle), and paravertebral (posterior) compartments (Table). Specific compartment boundaries and the anatomic structures they contain can be readily identified at multidetector CT (Fig 1).

**Prevascular Compartment**

In the ITMIG classification system, the following boundaries of the prevascular compartment are defined: (a) superiorly, the thoracic inlet; (b) inferiorly, the diaphragm; (c) anteriorly, the posterior border/cortex of the sternum; (d) laterally, the parietal mediastinal pleura; and (e) posteriorly, the anterior aspect of the pericardium as it wraps around the heart in a curvilinear fashion (Table). Briefly, the thoracic inlet has been defined as a thin plane of tissue outlined by specific osseous structures, including the superior border of the manubrium anteriorly and inferiorly, the body of the first thoracic vertebra posteriorly and superiorly, and the first pair of ribs and their costal cartilages.

On the basis of these landmarks, the major contents of the prevascular compartment include the thymus, fat, lymph nodes, and the left brachiocephalic vein. Therefore, the most common abnormalities encountered in the prevascular compartment include thymic lesions (cysts, hyperplasia, and malignancies such as thymoma, thymic carcinoma, and neuroendocrine neoplasms); germ cell neoplasms (which arise from germ cell rest remnants in the mediastinum); lymphoma; metastatic lymphadenopathy; and intrathoracic goiter.

**Visceral Compartment**

In the ITMIG classification system, the following boundaries of the visceral compartment are defined: (a) superiorly, the thoracic inlet; (b) inferiorly, the diaphragm; (c) anteriorly, the posterior boundaries of the prevascular compartment; and (d) posteriorly, a vertical line connecting a point
on the thoracic vertebral bodies 1 cm posterior to the anterior margin of the spine—this is referred to as the visceral-paravertebral compartment boundary line (Table). This vertical line was selected as the posterior boundary of the visceral compartment and the anterior boundary of the paravertebral compartment because most abnormalities in the latter are neurogenic neoplasms that arise from the dorsal root ganglia/neurons adjacent to the intervertebral foramina.

The major contents of the visceral compartment fall into two main categories: (a) vascular structures including the heart, superior vena cava, ascending thoracic aorta, aortic arch, descending thoracic aorta, intrapericardial pulmonary arteries, and thoracic duct; and (b) nonvascular structures including the trachea, carina, esophagus, and lymph nodes. In contrast to the JART model, the ITMIG model includes all structures within the pericardium (ie, heart and great vessels) in the visceral compartment. Note that the extrapericardial pulmonary arteries and veins are considered to be pulmonary structures and not mediastinal in location; thus, these are not included in the visceral compartment.

The most common abnormalities in the visceral compartment include lymphadenopathy (related to lymphoma or metastatic disease), duplication cysts, tracheal lesions, and esophageal neoplasms. Additionally, vascular lesions arising from the heart, pericardium, and great vessels may also be present.

### Paravertebral Compartment
In the ITMIG classification system, the following boundaries of the paravertebral compartment are defined: (a) superiorly, the thoracic inlet; (b) inferiorly, the diaphragm; (c) anteriorly, the posterior boundaries of the visceral compartment; and (d) posterolaterally, a vertical line along the posterior margin of the chest wall at the lateral aspect of the transverse processes (Table). The major contents of the paravertebral compartment include the thoracic spine and paravertebral soft tissues; therefore, most abnormalities in this region are neurogenic neoplasms that arise from the dorsal root ganglia/neurons adjacent to the intervertebral foramina. Other potential lesions in this compartment are of infectious (discitis/osteomyelitis) or traumatic (hematoma) origin, or miscellaneous lesions related to other underlying conditions (such as extramedullary hematopoiesis).

### Approach to Mediastinal Masses

#### General Considerations
Employing the existing nomenclature regarding the mediastinal compartments, slightly more than half of all mediastinal masses are located in the anterior compartment, whereas one-fourth each are identified in the middle and posterior mediastinal compartments (10,13–21). These compartments and the frequency of lesions located therein approximate the ITMIG compartment scheme. In
many instances, localization and characterization of a mediastinal abnormality using multidetector CT are sufficient to make the diagnosis. In other cases, correlation between imaging findings and clinical context, as well as additional imaging examinations such as MR imaging and fluorodeoxyglucose (FDG) positron emission tomography (PET)/CT and histologic sampling through image-guided or surgical biopsy, is necessary to make a definitive diagnosis and guide further management.

**Role of Imaging**

**Radiography.**—Although the ITMIG classification of mediastinal compartments is applicable only to multidetector CT and other cross-sectional imaging modalities, it is important to consider findings suggestive of a mediastinal abnormality at chest radiography, as it remains the most common imaging examination performed. Although small lesions may not be visible or produce subtle findings, large mediastinal abnormalities may manifest in a variety of ways, such as a soft-tissue mass, often accompanied by loss of the normal mediastinal contours or interfaces or thickening of specific lines or stripes. The lateral chest radiograph can be especially useful in detecting lesions that may not be visible on the posteroanterior radiograph, since mediastinal lesions may be visible only in the retrosternal space or overlying the upper thoracic spine.

The “silhouette sign,” which describes the loss of normal borders of intrathoracic structures,
can aid in detection of mediastinal abnormalities. For instance, a lesion in the right aspect of the anterior mediastinum may obscure cardiovascular structures such as the superior vena cava or right heart border, whereas a mass in the posterior mediastinum may result in loss of the normal paraspinal stripes. The “hilum overlay” sign may help differentiate a mediastinal mass from cardiomegaly or enlarged pulmonary vessels.

The “cervicothoracic sign” as described by Felson (4) is useful for localizing mediastinal abnormalities identified at radiography and for formulating a focused differential diagnosis. In such cases, obscuration of the lateral borders of an upper mediastinal mass as it extends above the clavicles into the neck implies that the lesion has both intrathoracic and cervical components. Although often misinterpreted as a manifestation of the cervicothoracic sign, an upper paravertebral (or posterior mediastinal) mass with borders visible above the clavicles is located entirely within the chest but does not exhibit the cervicothoracic sign.

**Multidetector CT.**—Once an abnormality is identified at chest radiography, cross-sectional imaging is employed to characterize the lesion, formulate a focused differential diagnosis, assess for other abnormalities, and guide further management. Multidetector CT with intravenous contrast material is the imaging modality of choice for evaluation and characterization of most mediastinal lesions. One study that analyzed 127 anterior mediastinal masses from various causes demonstrated that multidetector CT was equal or superior to MR imaging in diagnosis of anterior mediastinal masses except for thymic cysts (22). For this reason, ITMIG uses multidetector CT as the gold standard/reference modality for defining the mediastinal compartments.

Specific imaging characteristics that should be noted at multidetector CT include (a) location, size, and configuration of mediastinal lesions; (b) descriptive features such as attenuation, heterogeneity, and enhancement; (c) presence of intrasional fat, cystic components, soft tissue, and calcification; and (d) any connection with or invasion of adjacent structures. Some of these findings are more important than others; for instance, the presence of fat in a prevascular mediastinal lesion is highly suggestive of a small number of entities, whereas calcifications—whether punctate, coarse, or curvilinear—are nonspecific and cannot be used to discriminate benign from malignant prevascular mediastinal masses, as they may be associated with malignant neoplasms such as thymoma or treated lymphoma, as well as benign lesions such as mature teratoma (10,23).

**MR Imaging.**—MR imaging is not typically performed for evaluation of all mediastinal abnormalities; however, its effectiveness in specific scenarios has been demonstrated. For instance, MR imaging is the most useful imaging modality for distinguishing cystic from solid lesions (eg, thymic cysts from solid neoplasms), discerning cystic and/or necrotic components within solid masses, distinguishing cystic neoplasms from benign cysts, and identifying septa and/or soft tissue within cystic lesions (24,25).

For patients unable to undergo contrast-enhanced multidetector CT due to renal failure or allergy to intravenous contrast material, nonenhanced MR imaging with specific fluid-sensitive sequences may be performed to characterize the lesion and evaluate for involvement of vascular structures (26). Chemical shift MR imaging using in-phase and out-of-phase sequences is the best modality for differentiating thymic hyperplasia from thymoma and other thymic neoplasms in adult patients (27,28). Thymic hyperplasia can be identified when the microscopic fat interspersed between thymic tissue loses signal on out-of-phase images.

**FDG PET/CT.**—The role of fluorine 18 FDG PET/CT in the evaluation of many mediastinal abnormalities remains controversial. Several studies have been performed to investigate the ability of PET/CT to allow distinction between benign and malignant mediastinal lesions and between various types of malignant primary mediastinal neoplasms. In one of these, malignant neoplasms demonstrated significantly higher FDG uptake than benign lesions when a maximal standardized uptake value \( \text{SUV}_{\text{max}} \) equivalent value of 3.5 was used as a threshold (29). Others have used higher \( \text{SUV}_{\text{max}} \) thresholds such as 4.67 and suggested that PET/CT is complementary to other conventional imaging techniques and could potentially avoid unnecessary investigations, but noted that histologic sampling is required to confirm PET findings (30). There is significant overlap between the \( \text{SUV}_{\text{max}} \) of malignant neoplasms demonstrating increased FDG uptake, particularly high-risk thymic epithelial neoplasms (World Health Organization [WHO] types B2 and B3), lymphoma, paraganglioma, and nonseminomatous germ cell neoplasms (31).

Regarding thymic epithelial neoplasms, Sung et al (32) suggested that PET/CT could be used to distinguish low-risk thymomas (WHO types A, AB, and B1) from thymic carcinoma. Other groups have reported that PET/CT could be used to distinguish low-risk thymomas from high-risk thymomas (WHO types B2 and B3) and thymic carcinoma (33). However, other studies have been less definitive, with PET/CT not demonstrating a significant benefit in the staging of patients with
thymic epithelial neoplasms. It has been observed that thymic epithelial neoplasms tend to demonstrate variable, often only low-grade FDG uptake, making histologic differentiation between the various types of neoplasms unreliable.

A significant factor limiting the ability of PET/CT to accurately characterize mediastinal lesions is the potential for false-positive and false-negative examinations. Some benign processes such as thymic hyperplasia and inflammatory diseases such as fibrosing mediastinitis may demonstrate increased FDG uptake and mimic malignancy. Jerushalmi et al (34) demonstrated that FDG uptake in thymic hyperplasia is highly variable and in many instances can significantly overlap with that of mediastinal malignancies, with SUV_{max} as high as 7.3. In such cases, a combination of clinical history, focality of FDG uptake at PET/CT, and morphologic features at multidetector CT is necessary to determine whether the lesion is benign or malignant.

**Localization of Mediastinal Abnormalities**

Although localization of mediastinal lesions to a specific compartment is an important component of characterization, this may be difficult in some instances. For example, a large mediastinal lesion may appear to involve multiple compartments or extend from one compartment to another, making identification of the precise site of origin challenging. Two tools have been described by ITMIG and are recommended to help identify the compartment from which these lesions originate.

One of these tools is known as the “center method” and states that the center of a mediastinal lesion, defined as the center point of the lesion on the axial CT image that demonstrates the largest size of the abnormality, localizes the lesion to a specific mediastinal compartment (12). The JART study used this method and resulted in accurate localization of all 445 mediastinal masses in the study to specific compartments.

The second tool is known as the “structure displacement tool” and is useful in scenarios in which very large mediastinal lesions displace organs from other mediastinal compartments, typically those that abut the compartment from which the lesion originated (11). For instance, a very large prevascular mediastinal mass may posteriorly displace organs of the visceral mediastinal compartment such as the trachea, esophagus, or heart.

**Approach to the Prevascular Compartment**

**General Considerations**

The true incidence of prevascular mediastinal masses is difficult to ascertain for multiple reasons, the most significant of which is that different classification schemes have been used to define the mediastinal compartments in published studies (35). Additionally, there is variability in the inclusion of nonneoplastic lesions such as thymic hyperplasia and thymic and pericardial cysts and other neoplastic lesions such as lymphoma (35).

The most common neoplasms of the prevascular mediastinum include thymic epithelial neoplasms (thymoma, thymic carcinoma, and thymic neuroendocrine tumors) and lymphoma. Thymoma is the most common prevascular mediastinal mass and primary neoplasm of the prevascular mediastinum, with the highest incidence in middle-aged patients. Other neoplasms that may arise in the prevascular compartment include mature teratoma, nonteratomatous germ cell malignancies such as seminoma and nonseminomatous germ cell neoplasms, and metastatic disease. Nonneoplastic lesions of the prevascular mediastinum include substernal extension of thyroid goiter, thymic hyperplasia, cystic lesions such as thymic and pericardial cysts, and vascular-lymphatic abnormalities.

**Lesions Identifiable at Imaging**

**Thyroid Goiter.—** A heterogeneous prevascular mediastinal mass that demonstrates continuity with the cervical thyroid gland, is intrinsically hyperattenuating (with Hounsfield unit values of 70–85 due to the presence of iodine), and demonstrates intense and sustained enhancement after administration of intravenous contrast material can dependably be diagnosed as a mediastinal goiter. Cystic changes manifesting as internal foci of low attenuation and calcifications may be present. For cases in which a definitive connection with the cervical thyroid gland cannot be identified, these other findings at multidetector CT should strongly suggest the diagnosis (Fig 2). When additional findings such as loss of mediastinal tissue planes or associated cervical or mediastinal lymphadenopathy accompany a mediastinal goiter, then thyroid malignancy should be suspected and further evaluation performed (10,36).

**Fat-containing Lesions.**—The presence of visible regions of intralesional fat measuring between −40 and −120 HU at multidetector CT within a heterogeneous prevascular mediastinal mass is highly suggestive of a mature teratoma. These benign lesions characteristically demonstrate varying amounts of fat, fluid, calcification, and soft tissue; in rare cases, bone and tooth-like elements may be identified (23,37) (Fig 3a). Intralesional fat is identified in 50% of cases (37). Fat-fluid
levels are highly specific for mature teratoma but are much less common (38). These neoplasms typically affect young patients, accounting for 25% of prevascular masses in patients 10–19 years of age, 10%–15% in patients 20–49 years of age, and less than 5% in patients over 50 years of age in both men and women (10).

Other fat-containing lesions originating from the prevascular mediastinum are much less common and include a wide variety of benign and malignant neoplasms such as thymolipoma, lipoma, and liposarcoma. A predominantly fat-containing lesion present in a cardiophrenic angle may represent a thymolipoma, an uncommon lesion accounting for less than 5% of prevascular mediastinal masses in all age groups (Fig 3b). These benign encapsulated neoplasms are comprised of 50%–85% fat—although a fat composition of up to 95% has been reported—and scattered regions of solid tissue and fibrous septa (37,39). Thymolipomas tend to be very large at presentation with an average reported size of 20 cm, and a direct connection with the anatomic location of the thymus may be identified. Patients may be asymptomatic or have symptoms related to local mass effect; rare associations between thymolipoma and

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myasthenia gravis, Graves disease, and hematologic disorders have been reported (40).

Lipomas represent 2% of all primary mediastinal neoplasms and manifest at multidetector CT as encapsulated lesions composed predominantly of fat with a small amount of soft tissue and blood vessels in the prevascular compartment. Although mediastinal liposarcomas are also comprised predominantly of fat, these lesions may be distinguished from lipomas, thymolipomas, and other fat-containing lesions by the presence of aggressive features, including a greater proportion of soft-tissue components, local invasion, intrathoracic lymphadenopathy, and metastatic disease (41,42).

Fat-containing masses with attenuation values overlapping with those of other tissues at multidetector CT can be further evaluated with MR imaging. Fat demonstrates high signal intensity on T1- and T2-weighted images, low signal intensity on fat-saturated images, and loss of signal on out-of-phase images (37).

Cystic Lesions.—Cystic lesions of the mediastinum are those that have water or fluid attenuation at multidetector CT, with Hounsfield unit values between 0 and 20. A well-circumscribed homogeneous lesion in the prevascular mediastinum near the thymic bed that is round, oval, or saccular likely represents a thymic cyst. Most of these lesions are acquired and due to inflammation; iatrogenic processes such as surgery, radiation therapy, or chemotherapy; or malignant neoplasms. Some thymic cysts may demonstrate regions of higher attenuation than that of fluid due to hemorrhagic or proteinaceous components. In such a scenario, MR imaging should be performed, given its ability to allow distinction between cystic and solid lesions and identification of solid internal components.

Prevascular masses that are purely cystic with no soft-tissue components or internal septa can reliably be diagnosed as unilocular thymic cysts (43) (Fig 4). However, when cystic lesions contain internal soft-tissue components and/or internal septa, the differential diagnosis should include multilocular thymic cysts, cystic teratoma, lymphangioma, and cystic thymoma. In the clinical setting of symptoms related to myasthenia gravis or other paraneoplastic syndromes, especially in men and women older than 40 years, the diagnosis of cystic thymoma should be strongly considered (Fig 5).

In the setting of a large multilocular cystic lesion with internal septa and/or soft-tissue components that extends into the neck, axilla, or chest wall, the diagnosis of lymphangioma should be considered. Although mature teratomas may demonstrate internal fat at multidetector CT, a large percentage of these lesions manifest as predominantly or entirely unilocular or multilocal thin-walled cystic masses in the prevascular mediastinum. In contrast to simple cysts, cystic teratomas are typically associated with additional features such as internal septa and soft-tissue components and may enhance after administration of intravenous contrast material.
Two distinct histologic types of thymic hyperplasia have been described: true and thymic lymphoid (follicular) hyperplasia. In patients who have been treated with chemotherapy, radiation therapy, or corticosteroids or exposed to stresses such as burns or injuries, true thymic hyperplasia should be considered when there is diffuse symmetric enlargement of the thymus at multidetector CT (10). True thymic hyperplasia is also known as “rebound hyperplasia” and is characterized by an increase in thymic volume of greater than 50% over baseline after a causative stressor; approxi-
mately 10%–25% of patients undergoing chemotherapy may develop rebound hyperplasia (45).

Thymic lymphoid (follicular) hyperplasia is a histologic diagnosis defined as the presence of an increased number of lymphoid follicles, which may or may not be associated with an increase in the size of the gland and is typically associated with immunologic diseases such as myasthenia gravis, hyperthyroidism, collagen vascular diseases, or human immunodeficiency virus (HIV) infection (10). At multidetector CT, follicular hyperplasia results in a normal appearance of the thymus, thymic enlargement, or a focal soft-tissue thymic mass. A rare manifestation of thymic hyperplasia at multidetector CT is a heterogeneously hypoattenuating prevascular mediastinal mass that results from deposition of fat between hyperplastic thymic tissue.

In some cases, the multidetector CT appearance of thymic hyperplasia is not straightforward and a more nodular or bulky configuration may be present, which can mimic a thymic epithelial tumor, lymphoma, or other soft-tissue neoplasm. In this setting, two options are available: (a) follow-up multidetector CT can be performed in ~3 months to allow a decrease in thymic size or (b) chemical shift MR imaging with in-phase and out-of-phase gradient-echo sequences. Thymic hyperplasia and the normal thymus characteristically demonstrate loss of signal on out-of-phase images due to the suppression of fat interspersed between nonneoplastic hyperplastic thymus, whereas thymic epithelial neoplasms, lymphoma, and other soft-tissue malignancies do not demonstrate suppression on out-of-phase images (27,28) (Fig 7). Use of either of these options ensures that unnecessary biopsies or surgeries can be avoided.

**Thymic Epithelial Neoplasms.**—A solid, homogeneous or slightly heterogeneous mass in the prevascular mediastinal compartment in men and women older than 40 years with immunologic diseases such as myasthenia gravis (most common) or other paraneoplastic syndromes such as pure red cell aplasia/Diamond-Blackfan syndrome, hypogammaglobulinemia, or aplastic anemia likely represents a thymoma (46) (Fig 8a). More than 80% of thymomas can be accurately diagnosed with multidetector CT or MR imaging in this setting, and tissue diagnosis is typically unnecessary (22). Pleural or pericardial dissemination may be present in advanced disease and is highly suggestive of thymoma; however, lymphadenopathy is typically absent.

A thymic epithelial neoplasm other than thymoma, such as thymic carcinoma or thymic carcinoid, should be considered when a large soft-tissue mass is present in the prevascular mediastinum with accompanying features such as increased heterogeneity, local invasion, lymphadenopathy, and/or distant metastasis (Fig 8b). Specifically regarding thymoma, studies have shown that lobulated or irregular contours, cystic or necrotic regions within the lesion, and multifocal calcifications are more suggestive of invasive thymoma than noninvasive thymoma (47,48).

**Lymphoma.**—A mildly enhancing lobular soft-tissue mass or group of enlarged lymph nodes in the prevascular mediastinum at multidetector CT, especially in the setting of lymphadenopathy in the neck, axilla, or elsewhere in the body, may represent lymphoma. Primary mediastinal lymphoma may be due to Hodgkin lymphoma or non-Hodgkin lymphoma, encompassing entities such as diffuse large B-cell lymphoma, gray zone lymphoma, and T-cell lymphoblastic lymphoma. Enlarged lymph nodes, often affecting several different lymph node groups or stations, without a focal mediastinal mass suggest secondary involvement by non-Hodgkin lymphoma arising from another location.
Figure 7. Thymic hyperplasia in a 34-year-old woman with hyperthyroidism. (a) Coned-down axial contrast-enhanced multidetector CT image below the level of the aortic arch shows a lobular soft-tissue mass (M) in the thymic bed of the prevascular mediastinum. (b, c) Axial in-phase (b) and out-of-phase (c) T1-weighted MR images show complete loss of signal in the mass (M) on the out-of-phase image, indicating the presence of microscopic fat interspersed between hyperplastic thymic tissue in thymic hyperplasia. In some cases, the multidetector CT appearance of thymic hyperplasia is not straightforward and a nodular or bulky configuration may be present, as in this case. Chemical shift MR imaging with in-phase and out-of-phase gradient-echo sequences can be used to differentiate thymic hyperplasia and normal thymus from thymic epithelial neoplasms, lymphoma, and other soft-tissue malignancies, as the latter do not show suppression on out-of-phase images. Use of this imaging technique ensures that unnecessary biopsies or surgeries can be avoided.

Although it may be difficult to distinguish lymphoma from other soft-tissue mediastinal masses, the infiltrative nature of some types of lymphoma enables differentiation from thymic epithelial neoplasms and germ cell tumors. In many cases, lymphomas encase or encircle vascular structures but do not result in invasion. When such findings are present in young patients who present with “B” symptoms such as fever, weight loss, and night sweats, which occur in ~50% of cases, the diagnosis of mediastinal lymphoma can be reliably made (Fig 9). Further evaluation is typically performed with core needle biopsy combined with aspiration for flow cytometry or surgical biopsy.

FDG PET/CT has become the modality of choice for staging and restaging of disease for many types of lymphoma, as it is more accurate than multidetector CT in detecting involvement of lymph nodes, with sensitivity of 94% and specificity of 100% compared with 88% and 86%, respectively, for multidetector CT (Fig 9). PET/CT is also effective in identifying intranodal and extranodal disease within the body, with sensitivity of 88% and specificity of 100% compared with 50% and 90%, respectively,
Figure 8. Thymic epithelial neoplasms. (a) Thymoma in a 64-year-old man. Coned-down axial contrast-enhanced multidetector CT image at the level of the left pulmonary artery shows a homogeneous soft-tissue mass (M) in the prevascular mediastinum. The clinical presentation was significant for progressive worsening of myasthenia gravis. This combination of clinical and imaging information enabled prospective diagnosis of a thymoma. Thymoma should be strongly suspected when a prevascular soft-tissue mass is identified in a patient older than 40 years and in the clinical setting of myasthenia gravis or another paraneoplastic syndrome such as pure red cell aplasia/Diamond-Blackfan syndrome or hypogammaglobulinemia. (b) Thymic carcinoma in a 52-year-old man. Coned-down axial contrast-enhanced multidetector CT image at the level of the aortic arch shows a heterogeneous soft-tissue mass (M) in the prevascular mediastinum, ipsilateral and contralateral mediastinal lymphadenopathy (*), and pleural metastatic disease in the right hemithorax (arrow). CT-guided biopsy revealed advanced thymic carcinoma. When a prevascular mediastinal mass is accompanied by features such as local invasion, lymphadenopathy, or distal metastasis, a diagnosis other than thymoma, such as thymic carcinoma or thymic carcinoid, should be considered.

Nonteratomatous Germ Cell Neoplasms.—Nonteratomatous germ cell neoplasms include a wide variety of lesions, the most common of which include seminoma and nonseminomatous germ cell tumors (NSGCTs). These lesions typically manifest as large soft-tissue masses in the prevascular mediastinum, and it can be difficult to distinguish these entities from lymphoma. However, the addition of demographic and clinical/serologic information usually enables diagnosis.

The presence of a large, lobular, homogeneous soft-tissue mass in the prevascular mediastinum at multidetector CT in men 10–39 years of age should raise suspicion for seminoma (50) (Fig 10a). Approximately 10% of patients with seminoma demonstrate slightly elevated serum levels of β-human chorionic gonadotropin (β-HCG); however, α-fetoprotein (α-FP) level is usually normal. Although serum lactate dehydrogenase (LDH) levels are usually elevated, this may be seen with other malignancies such as lymphoma (51,52). Pleural effusions are rare but pulmonary metastases are relatively common, which also helps distinguish seminoma from many types of lymphoma. Further evaluation with core needle or surgical biopsy is usually performed.

When a heterogeneous prevascular mediastinal mass is present with lung metastases in men below the age of 40 years, NSGCTs should be included in the differential diagnosis (23,53) (Fig 10b). Approximately 90% of patients present with markedly elevated serum levels of α-FP or β-HCG, which is often highly suggestive of the disease (54,55).

Ectopic Parathyroid Adenoma.—In a patient with a clinical history of primary hyperparathyroidism, elevated serum calcium levels and/or elevated serum parathyroid hormone, with or without prior surgical parathyroidectomy, and a soft-tissue nodule in the prevascular mediastinum at multidetector CT, an ectopic parathyroid adenoma should be suspected. Although most parathyroid adenomas are juxtaglandular in location, they may occur in an ectopic location, with the mediastinum being the most common such site (56).

Many different imaging modalities can assist in diagnosis of these lesions, including high-resolution ultrasonography (US) with color Doppler, technetium 99m (99mTc) sestamibi single photon emission CT (SPECT), multidetector CT, and MR imaging. Recently, four-dimensional (4D) multidetector CT has been shown to be more...
sensitive than US and scintigraphy for preoperative identification and localization of parathyroid adenomas. The typical findings at 4D multidetector CT include intense contrast enhancement in the arterial phase, washout of contrast material in the delayed phase, and low attenuation at nonenhanced multidetector CT (57,58). An enlarged feeding artery or draining vein, referred to as the polar vessel, associated with the hypervascular parathyroid adenoma may also be seen (59).

**Approach to the Visceral Compartment**

**General Considerations**
As the visceral compartment contains both nonvascular and vascular structures, a wide variety of abnormalities may originate from this region. The most significant lesions include neoplasms of the airways, esophagus, and lymph nodes; enhancing masses; and nonneoplastic abnormalities such as bronchogenic and esophageal duplication cysts. A discussion of all visceral compartment abnormalities is beyond the scope of this article; the approach described here is based primarily on whether lesions can be identified at imaging alone or with a combination of radiologic and clinical information, and to a lesser extent by organ of origin and composition.

**Lesions Identifiable at Imaging**

**Cystic Lesions.**—A well-circumscribed, homogeneous, fluid attenuation lesion measuring 0–20 HU at multidetector CT in the visceral mediastinal compartment is compatible with a benign duplication cyst, the most common of which include bronchogenic and esophageal duplication cysts. Bronchogenic cysts result from abnormal budding of the primitive foregut, which also gives rise to the tracheobronchial tree, during embryologic development. Although bronchogenic cysts may arise from any mediastinal compartment, they typically occur...
in the visceral compartment near the carina or, less commonly, the right paratracheal region (44).

At multidetector CT, bronchogenic cysts manifest as a single, smooth, round or ovoid mass with internal low attenuation (Fig 11). The wall has variable perceptibility and may enhance or demonstrate intrinsic calcifications. Internal heterogeneity resulting in soft-tissue attenuation at multidetector CT may be due to hemorrhagic or proteinaceous components or infection of the bronchogenic cyst; in this setting, MR imaging can be performed to confirm the cystic nature of the lesion, which demonstrates high signal intensity on T2-weighted images regardless of the other contents. The presence of hemorrhagic, proteinaceous, or mucoid content results in variable patterns of signal intensity on T1-weighted images (Fig 11).

Esophageal duplication cysts are uncommon developmental anomalies that manifest as well-circumscribed, homogeneous, fluid attenuation lesions adjacent to the esophagus or associated with the esophageal wall at multidetector CT (44) (Fig 12). As with other cystic lesions, internal heterogeneity may be present, in this case typically due to hemorrhage or infection caused by the presence of ectopic gastric mucosa. The presence of ectopic gastric mucosa can render these lesions visible on 99mTc sodium pertechnetate scans and may be helpful in diagnosing these lesions in pediatric patients, in 50% of whom thoracic duplication cysts contain ectopic gastric mucosa (60). In contrast to bronchogenic cysts, esophageal duplication cysts may have thick walls.

Lesions Identifiable with a Combination of Imaging and Clinical Context

Enhancing Masses.—Several entities should be considered when a visceral compartment mass demonstrates enhancement after administration of intravenous contrast material. Paragangliomas or extra-adrenal pheochromocytomas are highly vascular neoplasms that arise from chromaffin tissue located in the para-aortic ganglia that may secrete catecholamines; however, the majority of these neoplasms are nonfunctional. Typical clinical symptoms include hoarseness, dysphagia, shortness of breath, and chest pain (61,62). Paragangliomas usually manifest as intensely and homogeneously enhancing mediastinal masses at multidetector CT, although regions of internal heterogeneity representing necrosis may be present (Fig 13a). Further diagnostic studies such as MR imaging, at which paragangliomas demonstrate intermediate signal intensity on T1-weighted images and high signal intensity on T2-weighted images, and iodine 123 (123I) metaiodobenzylguanidine (MIBG) scintigraphy can help support the diagnosis.

Castleman disease represents a form of nonclonal lymph node hyperplasia and is classified as hyaline vascular, plasma cell, or human herpesvirus 8 (HHV-8) types (63) and may be unicentric.
or multicentric. Unicentric hyaline vascular type is the most common and may manifest as a noninvasive mass, an infiltrative mass with associated lymphadenopathy, or matted lymphadenopathy with intense enhancement (64) (Fig 13b).

Finally, metastatic disease from vascular primary malignancies such as renal cell and thyroid neoplasms, melanoma, choriocarcinoma, and some sarcomas may result in intensely enhancing lymphadenopathy in the visceral compartment. The diagnosis of metastatic lymphadenopathy can be inferred when the clinical history is significant for one of these neoplasms. In the absence of such information, further evaluation with histologic sampling may be necessary; however, this should be done carefully, as biopsy of mediastinal vascular lesions may result in significant intrathoracic hemorrhage.

**Esophageal Lesions.**—When an abnormality of the thoracic esophagus such as wall thickening or a focal mass is identified at multidetector CT, the possibility of esophageal malignancy must be considered. Any portion of the esophagus may be affected, although the distal esophagus is typically involved due to the rising incidence of adenocarcinoma due to gastroesophageal reflux disease. The differential diagnosis for esophageal wall thickening is broad and includes inflammatory, infectious, and neoplastic causes. The presence of a focal esophageal mass is more concerning for an esophageal neoplasm such as adenocarcinoma or squamous cell carcinoma; however, multidetector CT may not allow differentiation between malignant and benign esophageal lesions.

Although the diagnosis can often be strongly suggested by a combination of imaging and clinical history, further evaluation with upper endoscopy and biopsy is ultimately required for definitive diagnosis (Fig 14). Multidetector CT can be useful in differentiating some benign lesions such as fibrovascular polyp and lipoma from esophageal cancer. The former manifests as an intraluminal mass with smooth margins (as compared with

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**Figure 11.** Bronchogenic cyst in a 33-year-old woman. (a) Coned-down axial contrast-enhanced multidetector CT image at the level of the left atrium shows a well-circumscribed homogeneous subcarinal mass (arrow). The internal Hounsfield unit value was 45, suggesting a soft-tissue mass. (b, c) Coned-down axial T2-weighted (b) and nonenhanced T1-weighted (c) MR images show that the lesion (arrow) is entirely cystic with a dependent fluid-fluid level (arrowhead). Although many bronchogenic cysts manifest as homogeneous fluid attenuation lesions at multidetector CT, internal heterogeneity may be due to hemorrhagic or proteinaceous components or infection. In this scenario, MR imaging can be performed to confirm the cystic nature of the abnormality, which demonstrates high signal intensity on T2-weighted images regardless of the other contents. Hemorrhagic, proteinaceous, or mucoid content results in variable patterns of signal intensity on T1-weighted images.
the irregular margins and lobulated appearance of many esophageal cancers), and both of these benign lesions may demonstrate internal fat attenuation due to the presence of adipose tissue (65).

**Cardiac Masses.**—When a mass involving the heart or pericardium is identified at multidetector CT, a wide variety of malignant and benign lesions should be considered. One of the most important features is the location of the abnormality, as masses can be categorized as intracavitary, valvular, intramural, or epicardial/pericardial. Other significant features include composition (soft tissue, fat, calcium, and attenuation), behavior (well-defined or infiltrative), and enhancement characteristics after administration of intravenous contrast material.

In the setting of a known primary malignancy, the presence of a cardiac mass is compatible with metastatic disease until proven otherwise. In the absence of known malignancy, a cardiac mass represents either thrombus or a benign or malignant neoplasm. It is beyond the scope of this article to discuss the distinguishing characteristics of individual cardiac neoplasms;
however, it is important to emphasize that when these lesions are identified at multidetector CT, further evaluation with more advanced imaging such as electrocardiographically (ECG) gated cardiac CT, cardiac MR imaging, and/or echo-cardiography is necessary for full characterization (Fig 15).

**Approach to the Paravertebral Compartment**

**General Considerations**
As the paravertebral compartment includes the thoracic spine and paravertebral soft tissues, most lesions originating in this region are neoplasms of neurogenic origin. Other less common neoplastic conditions in this compartment include lymphoma, primary osseous tumors, and metastases. Nonneoplastic causes include thoracic spinal infections due to bacterial and mycobacterial agents, cystic lesions such as thoracic meningocele and neuroenteric cyst, and extramedullary hematopoiesis.

The approach outlined in this section is based primarily on the composition of the mediastinal abnormality, as there are a limited number of structures from which lesions can arise in the paravertebral compartment. While specific masses may be included in the differential diagnosis on the basis of imaging features, clinical information is necessary in most cases.

**Soft-Tissue Lesions**

**Neurogenic Neoplasms.**—When a smooth, round, or oval mass is present in the paravertebral region at multidetector CT, the most likely diagnosis is a neurogenic neoplasm, typically a benign peripheral nerve sheath tumor such as schwannoma or neurofibroma. Neurogenic neoplasms, 70%–80% of which are benign, are the most common cause of paravertebral compartment masses and account for 20% and 35% of all adult and pediatric mediastinal neoplasms, respectively (66). Peripheral nerve sheath neoplasms typically arise from spinal or proximal intercostal nerves, less commonly from the vagus, recurrent laryngeal, or phrenic nerves, and account for 70% of mediastinal neurogenic tumors (66). At multidetector CT, periph-
eral nerve sheath neoplasms may demonstrate a dumbbell morphology and communication with the spinal canal. Regions of heterogeneity may be due to cystic changes or hemorrhage and are more common in schwannomas than in neurofibromas (66) (Fig 16).

Neurogenic neoplasms may cause benign pressure erosion of adjacent ribs or vertebrae and enlargement of the neural foramina. These findings are suggestive of a benign lesion, compared with the osseous invasion and destruction typical of malignancies. MR imaging optimally demonstrates the extent of intraspinal/extradural extension, and several imaging signs for peripheral nerve sheath tumors have been described. The “fascicular sign” describes multiple hypointense, small, ring-like structures corresponding to fascicular bundles and is typically associated with schwannomas. The “target sign” is characterized by central low signal intensity and surrounding peripheral high signal intensity and is more commonly seen with neurofibromas than with schwannomas.

When a previously stable neurofibroma suddenly increases in size, develops regions of heterogeneity, and/or invades adjacent tissues, malignant transformation to a malignant peripheral nerve sheath tumor should be strongly considered (Fig 17). In patients with neurofibromatosis type 1, there is a 10% lifetime risk of developing a malignant peripheral nerve sheath neoplasm, and these lesions account for most cancer-related deaths in these patients. FDG PET/CT has demonstrated utility in distinguishing malignant peripheral nerve sheath tumors from benign neurofibromas, with sensitivity of 95% and specificity of 72% (67). Another study revealed sensitivity of 97% and specificity of 87% for detection of malignant peripheral nerve sheath tumors and suggested that lesions with $SUV_{\text{max}}$ less than 2.5 should be considered benign, those with $SUV_{\text{max}}$ greater than 3.5 should be considered malignant, and those with $SUV_{\text{max}}$ of 2.5–3.5 should be followed with surveillance imaging (68).

Other neurogenic neoplasms that may originate in the paravertebral compartment include sympathetic ganglion neoplasms such as ganglioneuromas, ganglioneuroblastomas, and neuroblastomas and neuroendocrine neoplasms such as paragangiomas and are much less common. The imaging features of other neurogenic neoplasms are often nonspecific, and histologic sampling is often necessary for diagnosis. The presence of intense homogeneous enhancement in a paravertebral mass should raise suspicion for a paraganglioma.

**Extradural Hematopoiesis.**—In the setting of paravertebral masses adjacent to thoracic vertebrae and/or ribs at multidetector CT in a patient with imaging and clinical evidence of a hematologic disorder resulting in bone marrow replacement (myelofibrosis or chronic myelogenous leukemia) or hemolytic anemia (thalassemia, sickle cell anemia, or hereditary spherocytosis), extradural hematopoiesis should be strongly considered (69). These masses may be large or small and unilateral or bilateral and typically enhance after administration of intravenous contrast material due to high vascularity. Heterogeneous attenuation and/or enhancement may be seen in the setting of iron deposition and fat infiltration in long-standing lesions (70) (Fig 18).

In the absence of specific osseous findings suggesting an underlying hematologic disorder, functional imaging with $^{99m}$Tc sulfur colloid bone marrow scanning and SPECT/CT bone marrow scanning may noninvasively confirm the presence of functioning hematopoietic tissue, thus avoiding biopsy. In patients with sickle cell disease, the ancillary finding of autosplenectomy
serves as a clue to the diagnosis of extramedullary hematopoiesis.

Cystic Lesions

Intrathoracic Meningocele.—When a smooth and unilocular mass with fluid attenuation at multidetector CT is present in the paravertebral mediastinum and is associated with vertebral anomalies such as hemivertebrae, butterfly vertebra, or spina bifida, the likely diagnosis is an intrathoracic meningocele. An intrathoracic meningocele represents anomalous herniation of the leptomeninges through an intervertebral foramen or vertebral body defect and is more common in adults than in children (56,71). Associated findings include enlargement of intervertebral foramina and vertebral and/or rib anomalies or scoliosis (Fig 19).

Although it may be difficult to distinguish intrathoracic meningoceles from other low-attenuation paravertebral masses such as neurenteric cysts or neurogenic neoplasms, the clinical setting of neurofibromatosis type 1 should clinch the diagnosis. However, in uncertain cases, multidetector CT, MR imaging, or myelography performed after intraspinal injection of contrast material will reveal filling of the meningocele (72).

Mediastinal Abscess.—Mediastinal abscess should be considered when a low-attenuation mass is identified at multidetector CT in a patient after surgery or esophageal perforation or in the setting of infection in the adjacent thorax. Internal foci of air may be present, and communication may be seen with coexisting subphrenic abscesses or empyema (73). In the majority of situations, the clinical context permits definitive diagnosis; however, in selected cases, percutaneous needle aspiration may be necessary to differentiate between abscess and postoperative seroma or hematoma.

Pancreatic Pseudocyst.—A cystic mass in the paravertebral mediastinum that develops over a short period of time in the clinical setting of pancreatitis may represent intrathoracic extension of a pancreatic pseudocyst (74). These uncommon lesions contain pancreatic secretions, blood, and necrotic material and spread through the esophageal or aortic hiatus (69). At multidetector CT, these lesions typically manifest as thin-walled masses that may be isodense or hyperattenuating depending on the presence of hemorrhage or infection. Separate intra-abdominal pseudocysts may or may not be present.

Spinal Infections
When ill-defined soft tissue, unorganized fluid, and/or a loculated collection are present in the paravertebral compartment in a patient with clinical symptoms such as back pain, fever, and
Figure 18. (a) Extramedullary hematopoiesis in a 51-year-old man with myelofibrosis. Coned-down coronal nonenhanced multidetector CT image through the thoracic spine shows numerous paravertebral soft-tissue nodules and masses (arrows), compatible with extramedullary hematopoiesis. (b) Extramedullary hematopoiesis in a 62-year-old woman with bone marrow replacement due to a chronic myeloid neoplasm. Coned-down axial contrast-enhanced multidetector CT image at the level of the aortic arch shows multiple heterogeneous paravertebral masses (M) composed of both fat and soft tissue, which is characteristic of extramedullary hematopoiesis. Note the expansion of the marrow spaces of the ribs and vertebral bodies (*), supporting the diagnosis. At multidetector CT, the lesions of extramedullary hematopoiesis may appear as soft-tissue lesions that enhance after administration of intravenous contrast material due to high vascularity or heterogeneous masses due to iron deposition and fat infiltration in long-standing disease.

Figure 19. Intrathoracic meningocele in a 49-year-old woman with neurofibromatosis type 1. (a) Coned-down axial contrast-enhanced multidetector CT image at the level of the aortic arch shows a large fluid attenuation mass (M) in the posterior right hemithorax that communicates with the spinal canal. Note the irregularity of the adjacent vertebral body and expansion of the spinal canal. (b) Coned-down axial contrast-enhanced multidetector CT image at the level of the kidneys shows multiple cutaneous neurofibromas (arrows). When a homogeneous low-attenuation paravertebral mass is present in a patient with neurofibromatosis type 1 and associated with vertebral anomalies such as hemivertebrae, butterfly vertebra, or spina bifida, a definitive diagnosis of intrathoracic meningocele can be made.

malaise, spinal infection should be included in the differential diagnosis. These infections are typically due to bacterial organisms, and significant risk factors include diabetes, autoimmune diseases, malignancy, immunosuppression, and intravenous drug use (75). Early multidetector CT findings include paravertebral fat infiltration and intervertebral disk hypointensity, whereas osseous erosion, disk space narrowing, and sequestrum formation may be present in later stages (75) (Fig 20).
In the setting of immunodeficiency, particularly human immunodeficiency virus (HIV) infection, tuberculous involvement of the spine should be considered. It has been demonstrated that up to 60% of HIV-positive patients with tuberculosis have skeletal involvement, and the spine is the most commonly affected site, involved in approximately 50% of cases. Tuberculosis associated with involvement of the posterior elements, the presence of a large prevertebral and paravertebral soft-tissue component out of proportion to the degree of osseous destruction, and disk space narrowing enable differentiation of tuberculous from pyogenic infection. Additionally, the presence of calcification without new bone formation or sclerosis strongly suggests the diagnosis of Pott disease of the spine (76,77).

Conclusion
The new mediastinal division scheme developed by ITMIG is designed to enable precise identification of mediastinal abnormalities at cross-sectional imaging by radiologists and consistent communication between health care providers. It is anticipated that this system will improve lesion localization, help generate a focused differential diagnosis, and assist in tailoring biopsy and treatment plans. Although mediastinal masses are uncommon, this article presents approaches that radiologists may find helpful when faced with a mediastinal abnormality at multidetector CT.

Some mediastinal masses manifest with specific features at multidetector CT that enable identification with imaging alone, whereas others may demonstrate suggestive but inconclusive imaging characteristics. In many cases, a combination of clinical and imaging information permits a presumptive diagnosis. Therefore, the approaches presented here recommend initial inclusion or exclusion of lesions on the basis of multidetector CT features and correlation of less conclusive imaging features with specific clinical information. In many cases, this will strongly suggest a particular diagnosis and a further evaluative or treatment strategy.

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