International Thymic Malignancy Interest Group Model of Mediastinal Compartments

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KEYWORDS

• Mediastinum • Compartments • CT • Chest • ITMIG

KEY POINTS

- The classification of mediastinal compartments developed by the International Thymic Malignancy Interest Group (ITMIG) has been designed for use with cross-sectional imaging examinations and is considered a standard.
- The ITMIG model divides the mediastinum into 3 unique compartments: the prevascular compartment, visceral compartment, and paravertebral compartment.
- Abnormalities originating from the prevascular compartment tend to be thymic abnormalities, germ cell neoplasms, lymphoma, metastatic disease involving lymph nodes, and goiter.
- Lesions arising in the visceral compartment include lymphadenopathy due to primary lymphoma or metastatic disease, foregut duplication cysts, tracheal lesions, esophageal neoplasms and vascular lesions originating from the heart, pericardium, and great vessels.
- Most abnormalities originating from the paravertebral compartment are neurogenic neoplasms, infections (discitis/osteomyelitis), or those related to trauma.

INTRODUCTION

Division of the mediastinum, a region of the thorax that contains many important vascular and nonvascular organs and other anatomic structures, into specific compartments on imaging examinations has been performed for many years by clinical radiologists. Experience has shown that this exercise is extremely valuable when identifying and characterizing masses and other mediastinal abnormalities, and for ultimately determining the next step in clinical management. Several classification schemes have been created not only by radiologists but anatomists and surgeons, although their use has not been uniform. The Shields scheme has been the model most frequently used in clinical practice, whereas the Fraser and Paré's, Felson, Heitzman, Zylak, and Whitten models have been used by radiologists in clinical practice.[1–7]

The limitations of existing classification schemes have been well-documented and include significant variations in the terminology and methods used for the identification of individual compartments, which has resulted in miscommunication between health care professionals and the inability to reliably localize some lesions to a specific compartment, and, on the imaging side, the use of arbitrary nonanatomic divisions of the thorax that are based principally on the lateral chest radiograph. In response to the need for a model of the mediastinal compartments designed for use with cross-sectional imaging techniques

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such as computed tomography (CT), MR imaging, and PET/CT, which are the imaging modalities primarily used in the identification and characterization of mediastinal masses, a new, modern classification scheme has been developed by the International Thymic Malignancy Interest Group (ITMIG), building on prior work by the Japanese Association for Research on the Thymus (JART).[8] In this article, the ITMIG model is illustrated with representative examples.

INTERNATIONAL THYMIC MALIGNANCY INTEREST GROUP MODEL DEFINITIONS

The rationale for and methodology used by ITMIG in the development of this classification scheme has been previously described.[9,10] The model developed by ITMIG includes 3 unique compartments: the prevascular compartment (corresponding to the anterior compartment on chest radiography), the visceral compartment (corresponding to the middle compartment on chest radiography), and the paravertebral compartment (corresponding to the posterior compartment on chest radiography) (**Table 1**). The specific boundaries of each department and the anatomic organs and structures that they normally contain can be easily identified on cross-sectional imaging examinations (**Fig. 1**). Understanding this model enables the radiologist to predict what lesions are most likely to originate from specific mediastinal compartments.

Prevascular Mediastinal Compartment

The prevascular mediastinal compartment has the following boundaries: (1) superiorly, the thoracic inlet, (2) inferiorly, the diaphragm, (3) anteriorly, the posterior border/cortex of the sternum, (4) laterally, the parietal mediastinal pleura, and (5) posteriorly, the anterior aspect of the pericardium. Using these anatomic landmarks, the most significant organs and structures contained in the prevascular compartment include the thymus, fat, lymph nodes, and the left brachiocephalic vein. The most common lesions to arise from the prevascular compartment are thymic abnormalities (cysts, hyperplasia, and thymic epithelial neoplasms including thymoma, thymic carcinoma, and neuroendocrine tumors), germ cell neoplasms, lymphoma, metastatic disease involving lymph nodes, and goiter (**Fig. 2**).

Visceral Mediastinal Compartment

The visceral mediastinal compartment has the following boundaries: (1) superiorly, the thoracic inlet, (2) inferiorly, the diaphragm, (3) anteriorly, the posterior boundaries of the prevascular

Table 1
ITMIG classification of mediastinal compartments

Compartment	Boundaries	Contents
Prevascular	Superior: thoracic inlet Inferior: diaphragm Anterior: sternum Lateral: parietal mediastinal pleura Posterior: anterior aspect of the pericardium as it wraps around the heart in a curvilinear fashion	Thymus Fat Lymph nodes Left brachiocephalic vein
Visceral	Superior: thoracic inlet Inferior: diaphragm Anterior: posterior boundaries of the prevascular compartment Posterior: vertical line connecting a point on each thoracic vertebral body 1 cm posterior to its anterior margin	Nonvascular: trachea, carina, esophagus, lymph nodes Vascular: heart, ascending thoracic aorta, aortic arch, descending thoracic aorta, superior vena cava, intrapericardial pulmonary arteries, thoracic duct
Paravertebral	Superior: thoracic inlet Inferior: diaphragm Anterior: posterior boundaries of the visceral compartment Posterolateral: vertical line against the posterior margin of the chest wall at the lateral margin of the transverse process of the thoracic spine	Thoracic spine Paravertebral soft tissues

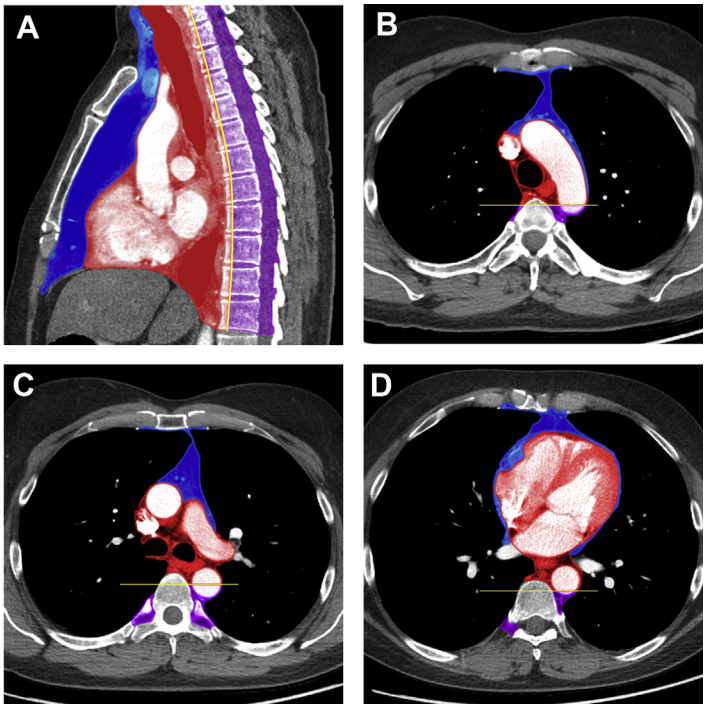

Fig. 1. ITMIG Definition of Mediastinal Compartments. Sagittal reformatted CT image (*A*) and axial CT images at the levels of the aortic arch (*B*), left pulmonary artery (*C*), and left atrium (*D*) demonstrate the model developed by ITMIG. The prevascular compartment (*blue*) wraps around the heart and pericardium, which are located in the visceral compartment (*red*). Purple = paravertebral compartment; yellow line = visceral-paravertebral compartment boundary line.

compartment, and (4) posteriorly, a vertical line connecting a point on the thoracic vertebral bodies 1 cm posterior to the anterior margin of the spine, referred to as the visceral–paravertebral compartment boundary line (see Table 1). Using these anatomic landmarks, the most significant organs and structures contained in the visceral compartment may be either vascular (the heart, superior vena cava, ascending thoracic aorta, aortic arch, descending thoracic aorta, intrapericardial pulmonary arteries, and thoracic duct) or nonvascular (the trachea, carina, esophagus, and lymph nodes). Of note, all structures within the pericardium are localized to the visceral compartment in the ITMIG classification system. The most common abnormalities in the visceral compartment include lymphadenopathy due to primary lymphoma or metastatic disease, foregut duplication cysts (bronchogenic and esophageal duplication cysts), tracheal lesions, esophageal neoplasms and vascular lesions originating from the heart, pericardium, and great vessels (Fig. 3).

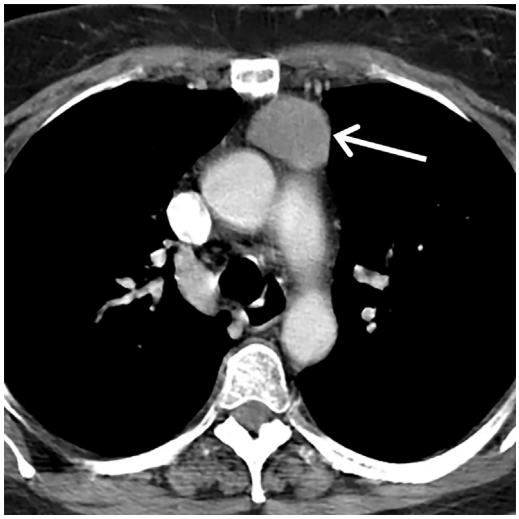

Fig. 2. Thymoma in the prevascular compartment. Contrast-enhanced axial CT of the chest of a 64-year-old woman with myasthenia gravis demonstrates a focal soft tissue mass (*arrow*) in the prevascular compartment consistent with a biopsy-proven thymoma.

Paravertebral Mediastinal Compartment

The paravertebral mediastinal compartment has the following boundaries: (1) superiorly, the thoracic inlet, (2) inferiorly, the diaphragm, (3) anteriorly, the posterior boundaries of the visceral compartment, and (4) posterolaterally, a vertical line along the posterior margin of the chest wall at the lateral aspect of the transverse processes (see Table 1). Using these anatomic landmarks, the most significant organs and structures

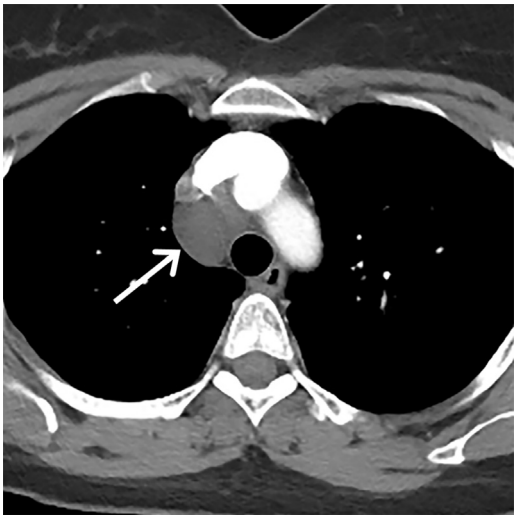

Fig. 3. Bronchogenic cyst in the visceral compartment. Contrast-enhanced axial CT of the chest of a 50-year-old woman demonstrates a well-circumscribed, fluid attenuation lesion (*arrow*), representing a bronchogenic cyst, located in the right paratracheal region, confirming its location in the visceral compartment.

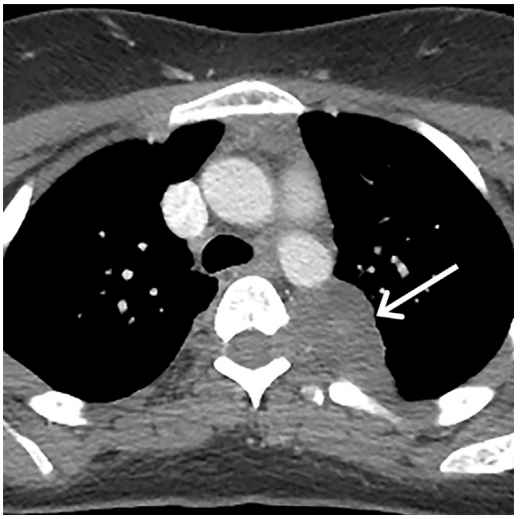

Fig. 4. Schwannoma in the paravertebral compartment. Contrast-enhanced axial CT of the chest of a 27-year-old woman shows a heterogeneous mass (*arrow*) in the left paraspinal region, localizing this neurofibroma to the paravertebral compartment.

contained in the paravertebral compartment include the thoracic spine and paravertebral soft tissues. The most common lesions originating from the paravertebral compartment are neurogenic neoplasms, infections (discitis/osteomyelitis), or those related to trauma (hematoma), although a wide variety of miscellaneous lesions related to other underlying conditions (such as extramedullary hematopoiesis) are possible (**Fig. 4**).

LOCALIZATION CONSIDERATIONS

Although most normal organs and anatomic structures, variants, and associated abnormalities can typically be localized to an individual compartment using the ITMIG model, accomplishing this goal may be difficult depending on several factors. One of the most common scenarios is a large mediastinal mass that involves multiple compartments. ITMIG has described 2 tools—the center method and the structure displacement tool—that can assist the radiologist in identifying the compartment of origin. The center method, which was also used in the JART study, stipulates that the center point of a lesion, as visualized on the axial image showing its greatest size, can determine the compartment of origin[8] (**Fig. 5**). The structure displacement tool can be used when large mediastinal abnormalities displace organs and anatomic structures in other mediastinal compartments adjacent to the site of origin.[9] For example, a large paravertebral compartment mass may anteriorly displace organs of the visceral mediastinal compartment, such as the heart.

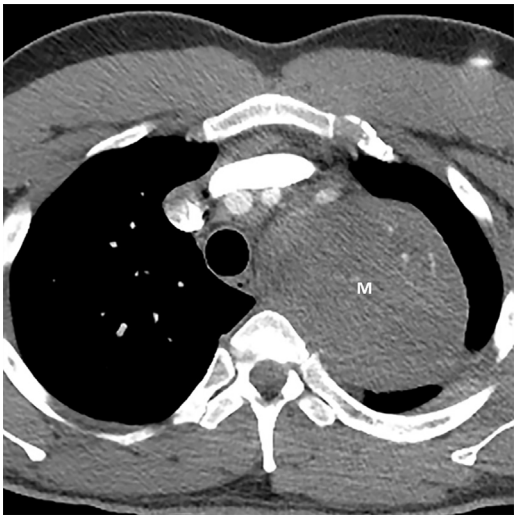

Fig. 5. Malignant peripheral nerve sheath neoplasm involving multiple compartments. Contrast-enhanced axial CT of the chest of a 30-year-old man with neurofibromatosis type 1 demonstrates a large mass (*M*) in the left mediastinum. Using the center method, the mass is centered in the left paravertebral compartment but extends to also involve the visceral mediastinal compartment. CT-guided biopsy revealed malignant peripheral nerve sheath tumor.

SUMMARY

The ITMIG definition of mediastinal compartments is a modern classification scheme developed using cross-sectional imaging techniques that has been accepted as a standard. As imaging modalities such as CT, MR imaging, and PET/CT are the primary methods of evaluating mediastinal abnormalities, using this model will improve lesion characterization, assist health care professionals in generating a focused differential diagnosis for detected masses, and facilitate appropriate biopsy and treatment plans.

DISCLOSURE

Nothing to disclose for all authors.

REFERENCES

1. Shields TW. Primary tumors and cysts of the mediastinum. In: Shields TW, editor. General thoracic surgery. Philadelphia: Lea & Febiger; 1983. p. 927–54.
2. The mediastinum. In: Fraser RS, Müller NL, Colman N, et al, editors. Fraser and Paré's diagnosis of diseases of the chest. 4th edition. Philadelphia: Saunders; 1999. p. 196–234.
3. The normal chest. In: Fraser RG, Paré PA, editors. Diagnosis of diseases of the chest. 2nd edition. Philadelphia: Saunders; 1977. p. 1–183.
4. Felson B. Chest roentgenology. Philadelphia: Saunders; 1973.
5. Heitzman ER. The mediastinum. 2nd edition. New York: Springer-Verlag; 1988.
6. Zylak CJ, Pallie W, Jackson R. Correlative anatomy and computed tomography: a module on the mediastinum. Radiographics 1982;2(4): 555–92.
7. Whitten CR, Khan S, Munneke GJ, et al. A diagnostic approach to mediastinal abnormalities. Radiographics 2007;27(3):657–71.
8. Fujimoto K, Hara M, Tomiyama N, et al. Proposal for a new mediastinal compartment classification of transverse plane images according to the Japanese Association for Research on the Thymus (JART) general rules for the study of mediastinal tumors. Oncol Rep 2014;31(2): 565–72.
9. Carter BW, Tomiyama N, Bhora FY, et al. A modern definition of mediastinal compartments. J Thorac Oncol 2014;9(9 suppl 2):S97–101.
10. Carter BW, Benveniste MF, Madan R, et al. ITMIG classification of mediastinal compartments and multidisciplinary approach to mediastinal masses. Radiographics 2017;37(2):413–36.