Large mediastinal masses - etiology, imaging findings, differential diagnosis

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Learning objectives

• To review common and rare pathological entities that can present as large mediastinal masses.

• To describe radiological findings on a series of cases, from goitre, vascular lesions, neoplasms, lymphadenopathy to hernias.

• To review differential diagnosis of large mediastinal masses.

• To explain important factors in determining the etiology of large mediastinal masses.

Background

Mediastinal masses affect people of all ages. However, tumors and cysts are more common in younger patients, while aortic aneurysms are more common in older ones. Many mediastinal masses, especially benign ones, are asymptomatic and incidentally detected on routine chest x-rays. Others, especially malignant ones, may cause specific or nonspecific symptoms. Mediastinal masses in children are more often symptomatic than in adults due to a smaller chest cavity, and they typically produce respiratory symptoms as a result of airways compression.

By convention, the mediastinum is divided into three compartments: anterior, middle and posterior.

The anterior mediastinum lies in front of a line that extends along the anterior contour of the tracheal air column and the anterosuperior contour of the heart. It contains the thymus, fat, branches of the internal mammary artery and vein, lymphatics and some lymph nodes.

The middle mediastinum lies between the aforementioned line and the line extending along the anterior contour of the thoracic vertebral bodies. It contains the trachea, the heart with the great vessels and the esophagus. Also, most of the mediastinal lymph nodes are located in the middle compartment.

The posterior mediastinum lies behind the anterior contour of the thoracic vertebral bodies, and it contains the thoracic spine, the distal azygos vein and neural structures (1).
Although each type of mediastinal tumors or cysts shows a predilection for a specific mediastinal compartment (depending on the organ it is derived from), this should not be taken as a rule of thumb. Lesions may enlarge and expand, or even migrate into an adjacent compartment. Some tissues are present in more than one compartment, so lesions arising from them are not "compartment-specific", for instance, lymphatic tissue.

Masses that develop in the anterior mediastinum are (most common ones are in bold):

- thymic masses
- lymphomas
- germ cell tumors
- thyroid masses
- vascular lesions
- mesenchymal tumors
- mediastinal cysts
- Morgagni hernias
- lymphangiomas
- parathyroid tissue

Masses in the anterior mediastinum are more likely to be malignant, compared to the other two compartments. The four most common anterior mediastinal masses can be easily remembered as the 4 T’s: thymoma, teratoma, thyroid, (terrible) lymphoma.

Masses that develop in the middle mediastinum are:

- cysts (bronchogenic, pleuropericardial, esophageal, neurenteric, parathyroid cysts)
- lymphadenopathy (lymphoma, metastases, infections, sarcoidosis, pneumoconioses)
- vascular lesions (aortic aneurysm)
- primary tumors (trachea, esophagus)
- goiter (rarely)

The most common middle mediastinal masses can be easily remembered as the 4 A’s: adenopathy, (awful) primary neoplasms (trachea), aneurysms, abnormalities of development

Posterior mediastinum:

- neurogenic tumors (schwannomas, neurofibromas, neuroblastomas, ganglioneuromas)
- meningocoele
- vascular tumors
- mesenchymal tumors
• lymphatic lesions
• paravertebral abscess
• aortic aneurysm
• hiatal hernias
• goiter (rarely)

Some mediastinal masses, like lymphomas, cysts and metastases may develop in any of the three compartments. Therefore, they will be described separately.

Imaging findings OR Procedure details

CT is the modality of choice for imaging mediastinal masses. It allows precise visualization of anatomic details and differentiation between various tissues. It is faster, less expensive and has better spatial resolution than MRI, and allows performing of CT-guided biopsies. Also, it is better for visualizing lung pathology and calcifications within lesions, extent of the lesions and involvement of adjacent organs.

ANTERIOR MEDIASTINUM

Thymic masses

Thymoma

• Most common primary tumor of the anterior mediastinum in patients over 40
• Equal incidence in both sexes
• Mostly asymptomatic; if symptomatic, usually with myasthenia gravis; frequent paraneoplastic syndromes
• 30-35% are malignant, with local extension rather than metastasizing
• Round, oval or lobulated, well demarcated or encapsulated, usually asymmetric (2), sometimes with calcifications
• Mild, homogeneous contrast enhancement (2); more heterogeneous enhancement and lobulated contour - suspect malignancy

Thymic carcinoma

• Heterogeneous group
• Large, solid, infiltrative masses with necrotic and/or cystic components, calcifications
• Often with pericardial and/or pleural effusion, invasion of mediastinal fat and great vessels
Thymic cysts

- Rare, usually congenital
- May follow neoplastic or inflammatory processes, or remain after radiation therapy for HL
- May show spontaneous hemorrhage
- At CT, they resemble other cystic lesions, but may be multilocular
- Higher attenuation values in case of hemorrhage or infection

Germ cell tumors

- Second most common tumors of the anterior mediastinum in patients younger than 40, after lymphomas
- Germ cell tumors nearly always develop in the anterior mediastinum, usually where the thymus used to be or in the thymus itself
- Usually asymptomatic or with symptoms of airways compression
- **Incidental anterior mediastinal masses in patients younger than 30, without other foci of disease and without symptoms typical for lymphoma usually are germ cell tumors** (3)
- Most common - mature teratomas; also seminomas (in men), choriocarcinomas, yolk sac tumors, malignant teratomas, mixed germ cell tumors...
- Germ cell tumors of the ovary or testicle rarely metastasize into the mediastinum
- Seminomas - usually large, homogeneous
- Other germ cell tumors - typically heterogenous with areas of cystic degeneration, hemorrhage or necrosis (3)
- Calcifications may be seen in both seminomatous and nonseminomatous tumors (3)
- Teratomas - mature, immature or malignant: the less mature they are, the more solid they are
- A typical mature teratoma is comprised of soft tissue, fat and fluid, with or without calcifications

Thyroid masses

Goiter

- 10% of all mediastinal masses
- About ¾ involve the anterior and ¼ the posterior parts of mediastinum
- Most patient are over 50 years of age; women are affected 3-4 times more often than men
- Mostly symptomatic - cervical mass, airways compression, dysphagia, facial flushing
• At CT - hyperdense, heterogeneous mass, contiguous with the cervical thyroid gland, often with calcifications and displacement of adjacent mediastinal structures (Fig. 1 on page 10, Fig. 2 on page 11)
• Attenuation prior to contrast administration often above 100 HU, with immediate, intense and prolonged postcontrast enhancement (2)

**Thyroid malignancy**

• Rare in the mediastinum
• Exception - anaplastic thyroid carcinoma frequently extends into the mediastinum
• CT findings are not specific and overlap with benign thyroid pathology, except lymphadenopathy and invasion of mediastinal fat (4)

**Other anterior mediastinal masses**

• Fat-containing masses - thymolipoma (often presents as a fatty mass with nodules of soft tissue), terato(carcino)ma, rarely lipoma, liposarcoma, angiolipoma
• Strong post-contrast enhancement - thymic carcinoid, hemangioma
• Paraganglioma - develops in the groove between the aorta and pulmonary artery (3)

**MIDDLE MEDIASTINUM**

**Aortic aneurysm**

• Various etiology: atherosclerosis, trauma, mycosis, syphilis, poststenotic...
• Saccular or fusiform
• Most commonly (in descending order): at the level of the ligamentum arteriosum (descending aorta), above the diaphragm, aortic arch, the ascending aorta
• Symptoms depend on size and location of aneurysm - aneurysms of the ascending and descending aorta, even very large ones, rarely cause symptoms; aortic arch aneurysms often present with hoarseness, cough, hemoptysis and cyanosis of face and upper extremities (5)
• CT findings - dilated aorta, with or without mural thrombi (Fig. 3 on page 12)
• Rupture - signs of instability: rapid change of size on serial examinations, periaortic hematoma, pleural effusion (especially with higher-attenuating fluid), crescent sign (high-attenuation crescent within the mural thrombus) (3)
• Dissection - typical finding: a wider, more opacified true lumen and a smaller, less opacified false lumen separated by an intimal flap

POSTERIOR MEDIASTINUM

Neurogenic tumors

• Most common posterior mediastinal masses
• Stem from peripheral nerves (schwannoma, neurofibroma), sympathetic ganglia (ganglioneuroma, ganglioneuroblastoma, neuroblastoma) or paraganglia (paraganglioma)
• Benign tumors, like schwannomas and neurofibromas, are more common in adults, while malignant ones, like neuroblastomas and ganglioneuroblastomas, are more common in children
• Mostly asymptomatic; ganglioneuromas may cause back pain and other neurologic symptoms due to compression or intraspinal extension; neuroblastomas often present with symptoms that depend on the tumor’s localization
• Mostly in the paravertebral areas, with occasional invasion of the spine
• Peripheral nerve tumors usually stem from the nerve root at the exit of the spinal canal; sometimes they extend through the neural foramina into the spinal canal, which gives them a "dumbbell" or "hourglass" appearance
• Benign neurogenic tumors usually are oval or round, with well-defined borders, low attenuation values (sometimes like cysts) and occasionally calcifications and/or areas of cystic degeneration (Fig. 4 on page 13)
• Irregular or ill-defined borders, greater size, areas of hemorrhage or necrosis, and invasion of adjacent structures are suspect for malignancy
• Contrast enhancement and homogeneity are not reliable criteria for benign/malignant nature of the lesion

Spinal masses

• Most common - metastases in the spine (breast, lung, prostate kidney), but they rarely grow large
• Among primary bone malignancies, lymphoma is the most common
• Primary bone neoplasms (osteoid osteoma, osteochondroma, osteoblastoma...) rarely grow large
• Most typical sign for bone tumors - bone destruction

Hiatal hernia

• Very common; sliding hernia more common than fixed
• Lower posterior mediastinum
• Characteristic findings - air-fluid levels or gastric folds (Fig. 5 on page 14)
• May simulate a retrocrural or periesophageal mass - therefore the patient should drink contrast material or swallow air (1)

MORE THAN ONE COMPARTMENT

Lymphoma

• About one third are Hodgkin's lymphomas (HL) and two thirds are non-Hodgkin's lymphomas (NHL)
• Most common of all masses in the anterior and middle mediastinum, but uncommon in the posterior compartment (5)
• Most common malignancy of the anterior mediastinum in children
• HL - bimodal age distribution: patients between 20 and 30 and over 50 years of age; equally in both sexes
• HL tends to localize anteriorly, while NHL most frequently develops in the middle mediastinum (Fig. 6 on page 15, Fig. 9 on page 18)
• If lymphoma does develop in the posterior mediastinum, it usually forms a mantle of soft tissue that "drapes" over the vertebral bodies (3)
• HL - mostly multiple smaller nodal masses, rarely one large confluent mass
• HL more commonly infiltrates the thymus (6)
• Internal mammary and superior mediastinal nodes - more common in HL (2)
• Multiple thoracic lymph node groups - more common in HL
• Involvement of paracardiac and posterior mediastinal lymph nodes - usually NHL
• Cardiophrenic angle - mostly NHL (6)
• Extramediastinal involvement - more common in NHL (Fig. 10 on page 19)
• HL more often spreads directly and tends to invade the anterior chest wall and lungs, but rarely compresses or infiltrates the trachea, great vessels and other mediastinal structures, which is characteristic of NHL (Fig. 7 on page 16, Fig. 8 on page 17, Fig. 12 on page 21, Fig. 13 on page 22, Fig. 14 on page 23)
• NHL rarely spreads directly into the lung, it more often metastasizes (Fig. 11 on page 20)
• HL nearly always involves contiguous nodal groups (3), while NHL may "skip" groups
• If, besides a mediastinal mass, there are also enlarged lymph nodes in the neck, axilla or abdomen, as well as masses in the spleen or other organs - always think of lymphoma (3)
• Symptoms (chest or shoulder pain, respiratory, cardiac, SVC syndrome) due to compression of adjacent structures
• At CT, nodes are enlarged, homogeneous, with little or no postcontrast enhancement
• Lobulation - more common in HL
• Centrally hypodense, cystic or necrotic nodes - more common in HL (6, 7)
• Calcifications are rare, except after radiotherapy

Cysts

• Congenital or acquired
• Congenital: foregut cysts (bronchogenic, esophageal duplication, neurenteric), pericardial, thymic
• Usually asymptomatic; possible symptoms due to compression (cough, dyspnea, dysphagia, vomiting)
• Rounded, well-demarcated, homogeneous cystic mass with a thin or imperceptible wall and attenuation values similar to water (1) (Fig. 15 on page 24)
• Important sign - no enhancement of contents after intravenous administration of contrast material (1)
• No infiltration of surrounding structures
• Inflammation and hemorrhage induce formation of non-specific granulation tissue in place of epithelium - non-specific cysts
• If the cyst is in the anterior mediastinum within a solid mass or if there are multiple cysts - think of germ cell tumors!

Bronchogenic cysts

• Most frequent mediastinal cysts
• Usually in the middle or posterior mediastinum - in order of frequency: carinal area, paratracheal area, esophageal wall, retrocardiac area (1)
• Mostly solitary
• May have higher attenuation values, due to increased density of their contents (however, there is high signal intensity on T2-weighted MR images regardless of the nature of the cyst's contents) (8)
• May have fluid-fluid level
• May have smooth or lobulated borders

Esophageal cysts

• Mostly in the lower posterior mediastinum along the esophagus
• May have a thicker wall compared to other cysts

Pericardial cysts

• Mostly in the anterior cardiophrenic angle, more on the right side (9)
• Connected to the pericardium
• CT appearance similar to other cysts
Meningocele

- Mostly in adults, often with neurofibromatosis
- Well-defined, homogeneous, low-attenuated paravertebral masses; sometimes with enlargement of intervertebral foramina, vertebral or rib anomalies or scoliosis (9)

Lymphangiomas

- Rare, benign tumors, mostly in young children
- Mostly in the anterior compartment, but sometimes in the middle or posterior compartment
- May look like a foregut or thymic cyst, but they also may be multicystic and infiltrating the mediastinum

Metastases

- Mostly in the middle compartment, rarely in the anterior compartment
- May form large, confluent masses (Fig. 18 on page 27) that compress the adjacent mediastinal structures (Fig. 19 on page 28)
- Metastases in mediastinal lymph nodes - mostly from lung cancer; depending on the localization of the lung tumor, lymphatic drainage will be different, and therefore different lymph node groups will be involved (Fig. 16 on page 25, Fig. 17 on page 26, Fig. 20 on page 29)
- Extrathoracic malignancies rarely cause metastatic mediastinal lymphadenopathy (exceptions: nasopharyngeal carcinoma, melanoma, renal cell carcinoma, germ cell tumors, breast carcinoma, chronic lymphocytic leukemia) (3)
- Lymph nodes in the pericardial fat - pleural or hepatic tumor (3)
- Left subclavian lymph nodes (Virchow’s node) - abdominal malignancies
- Metastatic mediastinal lymphadenopathy may be confused with benign lymphadenopathy (sarcoidosis, granulomatous infections)

Images for this section:
**Fig. 1:** Large retrosternal goiter - heterogeneous anterior mediastinal mass with bright contrast enhancement.
Fig. 2: Retrosternal goiter prior to intravenous administration of contrast - large calcifications can be seen.
Fig. 3: Large aneurysm of the ascending aorta.
Fig. 4: Oval, homogeneous mass with well-defined borders that develops in the posterior mediastinum - peripheral nerve tumor.
Fig. 5: Large hiatal hernia
Fig. 6: Large NHL in the upper middle mediastinum
Fig. 7: Large NHL of the upper anterior and middle mediastinum with compression of adjacent structures and bilateral pleural effusions
Fig. 8: Same patient as in Fig. 7 - Large NHL of the upper anterior and middle mediastinum with metastases in the right hilar lymph nodes
Fig. 9: NHL of the upper middle and posterior mediastinum
Fig. 10: Large NHL of the middle mediastinum with pleural metastases on the right side
Fig. 11: Large NHL of the middle mediastinum with metastases in the right lung
Fig. 12: Large NHL of the middle mediastinum compresses the right pulmonary artery
Fig. 13: Large NHL of the middle and posterior mediastinum compresses the trachea
Fig. 14: Large NHL of the middle and posterior mediastinum compresses the trachea
Fig. 15: Large, hypodense, homogeneous mass in the middle and partly in the posterior mediastinum, with a thin, well-defined wall - mediastinal cyst, probably bronchogenic.
Fig. 16: Metastases of lung cancer in mediastinal lymph nodes
Fig. 17: Metastases of lung cancer in mediastinal lymph nodes
Fig. 18: Confluent metastases in mediastinal lymph nodes.
Fig. 19: Metastases in mediastinal lymph nodes with compression of the superior vena cava.
Fig. 20: Metastases of lung carcinoma in mediastinal, hilar and cervical lymph nodes (the same patients also had metastases in the right scapula, ribs and abdomen)
Conclusion

A proper radiological evaluation of a mediastinal mass (CT appearance, post-contrast enhancement, localization and relation to adjacent structures), combined with patient data and history, is crucial for establishing the correct radiological diagnosis. Although the final diagnosis should always be confirmed by histology, it is often possible to establish the exact diagnosis solely based on radiological findings. Also, precise localization of mediastinal masses and their relationship to adjacent structures allows successful performing of guided biopsies and drainage of fluid collections.

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References


