Mediastinal Masses
In
Children

Dr Hasan Nugud
Consultant
Paediatric Surgeon
The mediastinum is the most common location of chest masses in the pediatric population. Mediastinal masses may be nonvascular or vascular masses and represent congenital anomalies, infections, benign and malignant neoplasms, and pseudomasses. In both asymptomatic and symptomatic children with mediastinal masses, imaging plays a crucial role in making the diagnosis and developing a treatment plan. As in adults, mediastinal masses in pediatric patients are placed in one of three mediastinal compartments (anterior, middle, posterior) on the basis of the lateral chest radiograph. Further characterization can be made with ultrasound, CT, and MRI. Combining the characteristic imaging appearances with clinical information (age, physical examination findings, and laboratory analysis) often can provide a precise diagnosis.
Mediastinal Compartments
Medistinal Masses in Children

• Shield’s three-compartment model consists of an anterior compartment, visceral compartment and paravertebral sulcus (posterior mediastinum),

• The posterior mediastinum is the pleural-lined compartment lying posterior to the heart and pericardium, anterior to the vertebral column (but containing the sulci on each side), and between the parietal pleura of the two lungs.
Anterior compartment

Visceral compartment

Para-vertebral sulcus

Figure 2 - Map of the mediastinal lymph node stations with the maximum size of the short axis.
Medistinal Masses in Children

• The anatomic structures located within the posterior compartment are the thoracic portion of the descending aorta, azygos and hemiazigos veins, oesophagus, vagus and splanchnic nerves, thoracic duct, and lymphnodes,

• Incision of the pleura at the sulcus demonstrates the intercostal lymphatics, nerves and vessels,

• The length of the compartment stretches from the apex of the chest cavity to the costicodiaphragmatic recess.
Medistinal Masses in Children

- Masses localized to the anterior mediastinum may present with respiratory distress because the trachea is compressed and deviated,
- Masses of the middle mediastinum may present in the same fashion,
- Masses of the posterior mediastinum may present with respiratory distress, neuropathy or pain
**Anterior**
- Soft tissue
  - Lymphoma
  - Hyperplasia
- Fat
- Germ Cell Tumor
- Thymolipoma
- Water
- Lymphangioma

**Middle**
- Foregut duplication cysts
- Lymph nodes
  - Granulomatous
  - Metastatic
  - Lymphoma/Leukemia
- Low Attenuation
  - TB
  - Fungal
  - Calcified
  - TB
  - Fungal
  - Osteosarcoma

**Posterior**
- Virtually always neurogenic origin
- 1st decade
  - Usually malignant
  - Most commonly neuroblastoma
- 2nd decade
  - Usually benign
  - Ganglioneuroma
  - Neurofibroma
  - Rarely schwannoma
  - Extramedullary hematopoiesis
Boundaries

The anterior boundary of the anterior part is the back of the sternum. Its posterior boundary is the pericardium of the heart. The middle mediastinum is the pericardium and its cavity. The anterior boundary of the posterior mediastinum is the posterior pericardial wall. The posterior boundary is the anterior surfaces of the bodies of thoracic vertebrae T5-T12. In the dissection of cadavers, the posterior mediastinum is exposed by removing the pericardial sac and the heart. When this is done, we see the structures that lie immediately behind the pericardium. The relationships of the structures in the posterior mediastinum should also be studied on cross sections through the thorax and shown in the section on cross sections.
Superior Mediastinum

• Boundaries of the superior mediastinum are:
  • anterior - manubrium of the sternum
  • posterior - anterior surface of bodies of vertebrae T1 through T4
  • superior - plane of the thoracic inlet
  • inferior - plane of the sternal angle
  • lateral - mediastinal pleura

Contents of the Superior Mediastinum
If it helps to remember what is in the superior mediastinum, you can visualize the contents in planes from anterior to posterior: glandular plane, venous plane, arterial-nervous plane, visceral plane, lymphatic plane.
Medistinal Masses in Children

• Most lesions are discovered on plain chest radiographs. A lateral view helps to determine in which compartment of the mediastinum the mass is located (some cross-sectional imaging is necessary),

• Computed tomography is usually an adequate initial study and is easier to obtain,

• MRI is superior at demonstrating neurogenic lesions at the posterior mediastinum.
Anterior mediastinum
- Aneurysm
- Angiomaticous tumor
- Goiter
- Lipoma
- Lymphoma
- Morgagni hernia
- Parathyroid tumor
- Pericardial cyst
- Teratoma
- Thymoma
- Thyroid tumor

Middle mediastinum
- Bronchogenic cyst
- Bronchogenic tumor
- Lymph node hyperplasia
- Lymphoma
- Pleuropericardial cyst
- Vascular masses

Posterior mediastinum
- Aneurysm
- Bronchogenic tumor
- Enteric cyst
- Esophageal diverticula
- Esophageal tumor
- Neurogenic tumor
# Imaging Strategy

- Localize to mediastinum
- Localize within the mediastinum
- Characterize on CT or MR

<table>
<thead>
<tr>
<th>Location</th>
<th>Lesions</th>
<th>Fluid</th>
<th>Fat</th>
<th>Vascular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>Thymic Lymphoma</td>
<td>Thymic C</td>
<td>Germ cell-b Thymolipoma Fat Pad</td>
<td>Thyroid Cardiac Coronary</td>
</tr>
<tr>
<td></td>
<td>Germ Cell</td>
<td>Thymoma Pericardial C Germ Cell</td>
<td>Lipoma Esophageal FV polyp</td>
<td>Arch anomaly</td>
</tr>
<tr>
<td></td>
<td>Goiter</td>
<td>Lymphoma</td>
<td>Extramedullary Hematopoiesis</td>
<td>Azygous Vein Vascular</td>
</tr>
<tr>
<td>Middle</td>
<td>Lymph nodes</td>
<td>Duplication C Necrotic nodes</td>
<td>Neuroenteric C Schwannoma Meningocele</td>
<td>Desc Aorta</td>
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<tr>
<td></td>
<td>Arch anomaly</td>
<td>Pericard recess Retroperitoneal</td>
<td>Meningocele</td>
<td></td>
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<tr>
<td>Posterior</td>
<td>Neurogenic Bone and marrow</td>
<td>Neuroenteric C Schwannoma</td>
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<tr>
<td>&gt;1 comp</td>
<td>Infection Hemorrhage Lung Cancer</td>
<td>Mediastinitis</td>
<td>Liposarcoma</td>
<td>Hemangioma</td>
</tr>
</tbody>
</table>
Medistinal Masses in Children

- Location of the mediastinal tumor dictates biopsy techniques,
- Lymphoma is the most common diagnosis of an anterior mediastinal mass and may be approached percutaneously, but cellular markers and immunohistochemistry may require a greater bulk of tissue biopsy in this case anterior 3rd intercostal space (Chamberlain procedure) may be necessary,
- Techniques include bone marrow sampling and superficial node biopsy,
Medistinal Masses in Children

- If the lesions are more superiorly located, an approach posterior to the sternum, using mediastinoscopy is another option,
- Because lesions of the posterior mediastinum usually are removed surgically,
- Formal open thoracotomy may be performed initially if after imaging the tumor appears to be removable, as in the case of neurogenic tumors.
The following characteristics indicate that a lesion originates within the mediastinum:

Unlike lung lesions, a mediastinal mass will not contain air bronchograms.
The margins with the lung will be obtuse.
Mediastinal lines (azygoesophageal recess, anterior and posterior junction lines) will be disrupted.
There can be associated spinal, costal or sternal abnormalities.

A lung mass abuts the mediastinal surface and creates acute angles with the lung, while a mediastinal mass will sit under the surface creating obtuse angles with the lung (Figure).
LEFT: A lung mass abuts the mediastinal surface and creates acute angles with the lung.

RIGHT: A mediastinal mass will sit under the surface of the mediastinum, creating obtuse angles with the lung.
Middle mediastinum

Contents
pericardium
heart
great vessels joining the heart
ascending aorta
pulmonary trunk
right and left pulmonary arteries
lower half of the superior vena cava
tracheal bifurcation and both main bronchi
phrenic nerves
cardiac plexus
tracheobronchial lymph nodes

Related Pathology
malignancy
lymphadenopathy
hiatus hernia
thoracic aortic aneurysm
thyroid mass
bronchogenic cysts
oesophageal duplication
cysts
Medistinal Masses in Children

- Tumors of the anterior mediastinum:

- Think of the four T’s;

- Terrible lymphoma,

- Terratoma,

- Thymoma,

- Thyroid goiter,

- Lymphatic malformations (cystic hygroma) must be included in lesions of both anterior and middle mediastinum.
Medistinal Masses in Children

• The important considerations of masses of the anterior mediastinum is to determine whether the lesion is malignant and to ensure that the determination is made safely.

• Usually these masses is managed in a multidisciplinary fashion (e.g lymphoma is not treated by resection. It is a systemic disease treated with systemic therapy and biopsy with careful pathologic evaluation which is vital).
Mediastinal Masses in Children

For practical purposes and to facilitate the diagnosis, anterior mediastinal masses in children can be classified on the basis of their density into the three categories: solid, fatty, and cystic lesions.

**Solid Lesions** *Prominent thymus (pseudomass).*

On chest radiographs, the normal thymus is not visible. Ultrasound, CT, or MRI can confirm the presence of a prominent but normal thymus. Almost half of mediastinal tumors cause no symptoms and are found on a chest x-ray done for another reason. Symptoms that do occur are due to pressure on (compression of) local structures and may include:

- Chest pain
- Chills
- **Coughing up blood** (hemoptysis)
- Fever
- Hoarseness
- Night sweats
- Shortness of breath
On the left you see two different patients. Describe the findings and continue.

On the x-ray on the left there is a lesion that has an acute border with the mediastinum. This must be a lung mass. The chest radiograph on the right shows a lesion with an obtuse angle to the mediastinum. This must be a mediastinal mass. Since there is a silhouette-sign with the right heart border - which is located anteriorly - we can deduce that the mass must be located within the anterior mediastinum. The lesion on the left was a pancoast tumor. The lesion on the right was a thymoma, located within the anterior mediastinum.
Obliterated retrosternal clear space

On the PA film there is a lobulated widening of the superior mediastinum.
On the lateral chest film the retrosternal clear space is obliterated.

This happened to be a patient with lymphoma.
Hilum Overlay Sign

a mediastinal mass and still we can see the hilar vessels through this mass, What confirms that the mass does not arise from the hilum. This is known as the hilum overlay sign.

Because of the geometry of the mediastinum most of these masses will be located in the anterior mediastinum.

On the chest film there is a mass that has obtuse angles with the mediastinum, so it is a mediastinal mass. The hilar vessels are seen through this mass, so it does not arise from the hilum and probably will arise from the anterior mediastinum.

The anterior location was confirmed on a CT.

Most commonly this will be a mass of thymic or lymphatic origin. This proved to be a lymphoma in a HIV-positive patient.
The CT shows a mass located in the anterior mediastinum. The mass is cystic but has solid enhancing septa. This finding is very specific for a germ cell tumor.

The CT shows a mass located in the anterior mediastinum. The mass is cystic but has solid enhancing components, so we are worried about lymphoma, germ cell tumor and cystic thymoma. This proved to be a cystic thymoma.

Now many think that germ cell tumors contain fat and if a lesion does not contain fat, it cannot be a germ cell tumor. You have to remember, that only about 60% of germ cell tumors contain fat, so you must realize that the absence of fat does not exclude a germ cell tumor from the differential diagnosis. The more solid components a germ cell tumor has, the more likely the tumor is to be malignant.
The majority of middle mediastinal masses will consist of foregut duplication cysts (eg oesophageal duplication or bronchogenic cysts) or lymphadenopathy. Aortic arch anomalies can also present as middle mediastinal masses.

Fluid containing lesions are usually duplication cysts or necrotic lymph nodes. A pancreatic fluid collection due to pancreatitis may also present as a mediastinal mass. A fibrovascular esophageal polyp is a mesenchymal lesion which almost always contains fat. Vascular lesions are arch anomalies, azygos continuation due to interrupted inferior vena cava or hyperenhancing lymph nodes.
Displaced azygoesophageal recess will be seen on the right. On the left you may have a pseudoparavertebral line. This is a new interface that looks like a paravertebral line.

On the AP chest radiograph of this patient there is widening of the azygoesophageal recess on the right. There is an apparent widening of the paravertebral line on the left. On the lateral film the mass is anterior to the spine and therefore is located in the middle mediastinal.
The posterior mediastinum contains the following structures: sympathetic ganglia, nerve roots, lymph nodes, parasympathetic chain, thoracic duct, descending thoracic aorta, small vessels and the vertebrae. Most masses in the posterior mediastinum are neurogenic in nature. These can arise from the sympathetic ganglia (e.g., neuroblastoma) or from the nerve roots (e.g., schwannoma or neurofibroma). Don't forget lymphadenopathy, the vertebrae and the descending thoracic aorta as potential causes for posterior mediastinal masses. Cystic lesions will be either neuroenteric cysts, schwannomas or meningoceles. Fat containing lesions will be extramedullary hematopoiesis. When the anemia is resolved the extramedullary marrow will stop producing blood and become fatty. On conventional radiographs look for: Cervicothoracic Sign Widening of the paravertebral stripes
Cervicothoracic sign
The anterior mediastinum stops at the level of the superior clavicle. Therefore, when a mass extends above the superior clavicle, it is located either in the neck or in the posterior mediastinum. When lung tissue comes between the mass and the neck, the mass is probably in the posterior mediastinum. This is known as the Cervicothoracic Sign. If we study the image on the frontal view on the left, we see a mass extending above the level of the clavicle and there is lung tissue in front of it, so this must be a mass in the posterior mediastinum.
Since there are no tissue planes separating the mediastinal compartments, there are lesions that do not respect our approach to the mediastinum. These lesions tend to occupy more than one compartment and include: mediastinitis, hematomas, vascular entities, bronchogenic cancer, metastases and lymphangiomas (fluid containing).

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<th>Vascular</th>
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<td>Mediastinitis</td>
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<tr>
<td>Lung Cancer</td>
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More than one compartment
**Take away messages**

Once you have localized a mediastinal mass, next try to characterize it by assessing whether it has any of the following characteristics:

- Does the mass contain fluid?
- Does it contain fat?
- Does it enhance following the administration of intravenous contrast?

<table>
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<tbody>
<tr>
<td>Thymic Cyst</td>
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<tr>
<td>Thymoma</td>
</tr>
<tr>
<td>Teratoma</td>
</tr>
<tr>
<td>Pericardial Cyst</td>
</tr>
<tr>
<td>Foregut Duplication</td>
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<tr>
<td>Meningocoele</td>
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<tr>
<td>Neuroenteric Cyst</td>
</tr>
<tr>
<td>Cystic Lymphadenopathy</td>
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<tr>
<td>Lymphangioma</td>
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If a mass contains fluid it could be a teratoma (on the left) or a thymic cyst (on the right). Note that this teratoma does not contain fat.

Teratomas are the most common benign germ cell tumors. The most common malignant germ cell tumor is the seminoma.
Take away message

Fat containing masses
The differential diagnosis of fat containing mediastinal masses is:
Thymolipoma
Teratoma (Germ cell tumors)
Esophageal lipoma
Fat deposition
Lipoma
Lipoblastoma
Liposarcoma
Extramedullary hematopoiesis

On the left we see an fat-containing anterior mediastinal mass.
This is the typical finding of a fat-containing teratoma

The axial CT and sagittal MR demonstrate a lipomatous lesion within the lumen of the esophagus.
This is typical for a esophageal lipoma and its fibrovascular stalk.
Enhancing masses
The differential diagnosis of enhancing mediastinal masses is:
Hyperenhancing lymph nodes
Thyroid tissue
Paragangliomas
Hemangiomas
Vascular Etiologies

Enhancing lymphomas can be seen in:
Melanoma
Renal cell carcinoma
Thyroid carcinoma
Castlemann's disease (as in this case)
First notice the large thymus in this young child. There is also an enhancing mass in the posterior mediastinum extending into the vertebral canal. This is typical for a hemangioma.

Somewhat irregular enhancing mass in the anterior mediastinum. This proved to be a thyroid mass.