

Imaging of Paediatric Mediastinal Masses

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Abstract

A review of mediastinal masses in children is important for several reasons. First, the mediastinum is the common location for thoracic masses in children. Second, the type and frequency of masses differ in children compared with adults. Third, anatomic variations can be misinterpreted as mediastinal masses. Lastly, there are special technical considerations for imaging mediastinal masses in children. This article is derived from a literature review and the author's personal experience with imaging mediastinal masses. Figures are used to illustrate the spectrum of lesions in the anterior, middle and posterior mediastinum in children. Familiarity with the types of masses, frequency of presentation and imaging features are extremely valuable in determining the appropriate subsequent care for the child.

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Introduction

A review of mediastinal masses in children, emphasising imaging features, is important for several reasons. Firstly, the mediastinum is the most common location for thoracic masses in children. Chest wall, vertebral, cardiac and paracardiac and lung parenchymal locations are relatively rare sites. Secondly, aetiologies for mediastinal masses are different in children than in adults.¹ Moreover, the age of the child is helpful in determining differential considerations when imaging features are not characteristic. Imaging choices and techniques can also differ from adults. For example, sonography of the anterior mediastinum, and in particular the thymus, is an option in children. It is also important for the radiologist to be familiar with the unique appearance of the mediastinum in children, particularly the variable appearance of the thymus gland. With familiarity of normal anatomy, as well as variations, unnecessary imaging evaluation can be prevented.

In addition to these unique considerations in children, there are other general considerations for imaging evaluation of pediatric mediastinal masses. The location of the mass and the age of the child help in determining imaging strategies. For example, sonography may be sufficient for anterior mediastinal mass in a neonate, whereas computed tomography (CT) evaluation is more useful in older children and adolescents. In general, middle mediastinal masses are

best assessed using CT, whereas magnetic resonance (MR) evaluation provides the most useful information for posterior mediastinal mass evaluation, given the neurogenic origin of the vast majority of these masses. The appropriate imaging modality can obviate further imaging evaluation by providing specific diagnostic information, reducing costs and use of other resources (such as those required for sedation or anaesthesia) and the need for administration of contrast media, or in the case of CT, ionising radiation. For example, sonographic evaluation of a suspected anterior mediastinal mass indicating normal thymic features would preclude CT, MR imaging or more invasive assessment. Imaging features can be highly specific or serve to narrow the differential considerations. The presence of fat, soft tissue and calcification in an anterior mediastinal mass seen by either a CT or MR imaging is almost always due to germ cell tumours (Fig. 1), and uncomplicated cystic masses usually represent congenital foregut masses such as bronchogenic cyst or oesophageal duplication cyst.

For these reasons, this article will review mediastinal masses in children and focus on imaging evaluation. The objectives of this information are to provide a brief discussion of the anatomic considerations of the mediastinum and discuss the various imaging options, consisting of radiography, sonography, CT, and MR imaging. The advantages and disadvantages of each

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modality are reviewed. Finally, differential considerations for mediastinal masses in children are reviewed, categorised based on their location in the anterior, middle and posterior mediastinal compartments.

Mediastinal Anatomy

The traditional classification of the mediastinum breaks this region into 3 compartments: anterior, middle and posterior based on the lateral chest radiograph.²⁻⁵ Para-cardiac masses are typically excluded from this classification scheme. The mediastinum extends from the thoracic inlet to the diaphragm and lies between the pleural surfaces of the right and left lungs, extending anteriorly to the posterior aspect of the anterior chest wall and posteriorly by the vertebral column and paravertebral gutters. The anterior mediastinum is defined superiorly by the thoracic inlet, anteriorly by the posterior portion of the sternum, laterally by the medial pleura surfaces of the right and left lungs, and posteriorly by the anterior wall of the trachea or the heart and great vessels. The anterior mediastinal compartment is typically distinct from the middle and posterior compartments. These compartments could be classified into a single compartment because of the anatomic continuity (Fig. 2). Basically, if the centre of the mass lies in the projection of the vertebral bodies, the mass is typically posterior mediastinal in location. Middle mediastinal masses

are centred anterior to the vertebra column. Clearly, masses, such as adenopathy or neurogenic tumours, can involve both posterior and middle mediastinum compartments.

The differential considerations for mediastinal masses, which will be discussed later, are based predominantly on the compartment (Tables I to III).^{3,5-7} However, it can also be helpful to think of structures in or adjacent to the compartment in compiling this list. For example, in the anterior mediastinum, masses may arise from the thymus gland, vasculature (including aorta and other vascular structures) and lymph nodes. In the posterior mediastinum, the predominant site of origin is going to be neurogenic tissue, but other tissues from which masses can arise include lymph nodes, vessels and vertebral body or disk space. In the middle mediastinum, tissues include the oesophagus, lymph nodes, vasculature or extension from structures or tissues from the posterior mediastinum. By combining the compartmental differentials with consideration of the tissues or organs in this region, a more complete and comprehensive list of possibilities can be compiled.

Imaging Options

The principal imaging options for evaluating mediastinum masses consist of radiography, sonography, CT and MR imaging. Sonography and CT, in addition, can serve useful purpose in percutaneous biopsies of mediastinal processes (Fig. 3).⁸ The role of nuclear medicine (for example, gallium scanning and positron emission tomography) is essentially a problem-solving tool or a follow-up evaluation of neoplasm, such as lymphoma. The overall goals for evaluating mediastinal masses in children are: to determine the presence of a mediastinal mass, to determine the extent, to determine the effect on adjacent structures such as

TABLE I: ANTERIOR MEDIASTINAL MASSES IN CHILDREN

Thymus

- Normal thymus*
- Hypertrophy*
- Lymphoma*
- Hyperplasia
- Thymolipoma/fibrolipoma
- Cyst
- Thymic carcinoma
- Thymoma
- Cystic dysplasia

Lymphoma*

Germ cell tumours

- Teratoma/teratocarcinoma*
- Seminoma
- Endodermal sinus tumour
- Choriocarcinoma
- Embryonal carcinoma
- Mixed types

Others

- Great vessel abnormality (such as aneurysm)
- Vascular malformations
- Metastases
- Thyroid ectopia
- Langerhans cell histiocytosis
- Extension of para-cardiac tumors/pericardial cysts

*More common.

TABLE II: MIDDLE MEDIASTINAL MASSES IN CHILDREN

Adenopathy

- Lymphoma*
- Metastases*
- Infection*
- Sarcoid
- Langerhans cell histiocytosis

Gastrointestinal/Foregut

- Oesophageal duplication cyst*
- Bronchogenic cyst*
- Neurenteric cyst
- Hernia
- Oesophagus (dilation)

Others

- Vascular malformations (such as lymphatic or venous)
- Para-cardiac tumours
- Aortic and other vascular aneurysms

* More common.

TABLE III: POSTERIOR MEDIASTINAL MASSES IN CHILDREN*

Neural (>85%)
Nerve cell (ganglion)
Neuroblastoma (including ganglioneuroblastoma)
Ganglioneuroma
Nerve sheath
Neurofibroma
Benign schwannoma (neurilemmoma)
Malignant schwannoma
Other (rare)
Para-ganglioma (alternate terms: chemodectoma, pheochromocytoma)
Non-neural (<15%)
Foregut
Bronchogenic cyst
Oesophageal duplication
Neurenteric cyst
Oesophageal dilation
Vascular
Aortic aneurysm
Azygos/hemiazygos enlargement
Haemangioma
Lymphatic
Lymphoma
Lymphangioma
Para-vertebral
Haematoma
Extramedullary haematopoiesis
Abscess
Metastases
Diaphragmatic
Bochdalek hernia
Para-oesophageal or hiatal hernia
Eventration
Others
Mesenchymal tumours (sarcoma, lipoma, fibroma)
Teratoma
Nodal infiltration (such as Castleman, sarcoid, histoplasmosis)
Leukaemia

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vasculature and airway; and to provide information in determining the list of the most likely options.

Radiography is usually the most common imaging modality since most mediastinal masses are first detected by chest radiography. The principal benefits of radiography are localising the mass and directing subsequent imaging evaluation. While radiography is relatively inexpensive and widely available, this modality is rarely sufficient at establishing a diagnosis and CT, MR imaging or sonography is most often necessary. Occasionally, fluoroscopy can be used to assess the dynamic affect of a mediastinal mass on the airway. This assessment can also be performed using cine technology during a CT scan performed for evaluation of the mass itself.

Sonography has many advantages compared with CT and MR imaging for the evaluation of mediastinal masses.^{9,10}

First, sonography is less expensive. Examinations can be performed portably (Fig. 4) and do not require sedation. There are no biological risks and no intravenous angiocatheter is required. In infants and young children, sternal and costal cartilages provide a sonographic window that is more limited in adults (Fig. 5). Another advantage of sonography is real-time evaluation. This is a particularly important evaluation of potential thymic abnormalities as the dynamic evaluation of the gland is helpful in determining whether the abnormality is simply a typical thymus or a true anterior mediastinal mass.¹¹ However, there are disadvantages with sonography. It is very operator-dependent and diagnosis is contingent on both technical expertise and familiarity with paediatric mediastinal anatomy and pathology. The role of sonography is relatively limited due to the need for an adequate acoustic window. There is very little role for transthoracic sonography for posterior or middle mediastinal masses since visualisation of these regions is limited. Conceivably, transoesophageal sonography would be a consideration for posterior or middle mediastinal masses, but this technique has not gained favour. Sonography can also detect the presence of posterior or some middle mediastinal masses; however, other imaging evaluation, either CT or MR imaging, is indicated. Therefore, if there is a high suspicion for a process in either of these two compartments, sonography should not be the first option.

CT is excellent for evaluating mediastinal masses and has a primary role in the evaluation of anterior and middle mediastinal masses.^{8,12} Posterior mediastinal evaluation is also an option for CT,¹³ but MR imaging is usually preferred. Newer, multi-detector chest CT techniques in children have recently been described elsewhere,¹⁴ but a summary for settings is found in Table IV. In short, contrast enhancement is important to delineate the mass, provide enhancement characteristics (for example, a hypervascular mass or lack of enhancement, such as with a soft tissue-attenuating cyst) (Fig. 6), define solid components and delineate adjacent structures. CT also provides excellent characterisation of tissue components of mass, such as cystic regions, soft tissue, fat and calcification. In addition, CT is excellent at assessing the effect on airways, such as encasement or narrowing. With multi-detector CT, the multi-planar and three-dimensional benefits have been well received by clinical colleagues.¹⁵ This has traditionally been one of the principal benefits of MR imaging.¹⁶ In addition, CT can demonstrate the osseous abnormalities, such as bone destruction or neural foraminal widening. While these vertebral abnormalities can be detected on CT, MR imaging is usually preferred for evaluating the effect on neural foramina, cord and bone marrow. The costs of CT include greater expense than radiography and sonography, lack of portability, the need for IV contrast media, occasional



Fig. 1. Teenage male with large anterior mediastinal mass due to malignant mixed cell-type germ cell tumour. Enhanced axial CT scan shows fluid attenuation areas, punctate calcification, and a malignant effusion along with pleural metastatic disease (arrows). Reprinted with permission from Frush.¹⁷

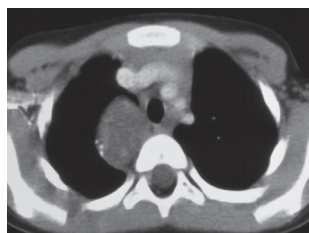


Fig. 2. Ganglioneuroblastoma in a 4-year-old female. Enhanced axial CT scan shows a soft tissue attenuation mass in the right upper mediastinum. Note peripheral calcifications. Reprinted with permission from the American College of Radiology.

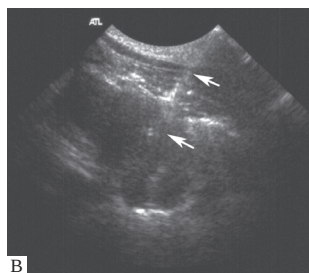
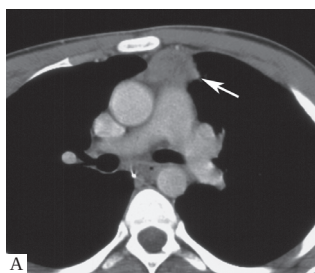


Fig. 3. 19-year-old male with chronic granulomatous disease and anterior mediastinal fungal abscess. (A) Enhanced axial chest CT scan at the level of the main pulmonary artery shows a mass (arrow) in the anterior mediastinum. (B) Transverse sonogram through the intercostal space, adjacent to the sternum, shows the aspiration needle track (arrows) in the mass. *Nocardia* was cultured from the aspirate.

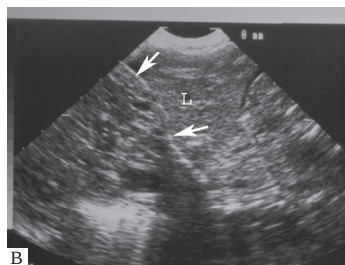
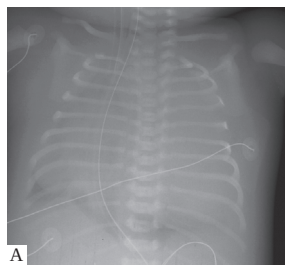


Fig. 4. Infant female with severe respiratory distress due to a large anterior mediastinal teratoma. (A) Anteroposterior chest radiograph shows near complete opacification of the thorax. Because of unstable medical condition, a portable chest sonogram was performed in the intensive care unit. (B) Sagittal sonogram at the junction of the abdomen and chest shows liver (L) with a large heterogeneous mass (arrows) containing small cystic areas in the anterior mediastinum.

need for sedation and ionising radiation.

MR imaging can be used for evaluation of any mediastinal mass; however, it is usually reserved for use as a primary cross-sectional modality for the evaluation of posterior mediastinal masses, or as a problem-solving tool for complex or confusing cases (Fig. 7). MR imaging provides excellent information on soft tissue contrast differences. This is particularly helpful in the evaluation of cystic regions, fat and vasculature. However, calcification may be more difficult to see than with CT. There is no ionising radiation

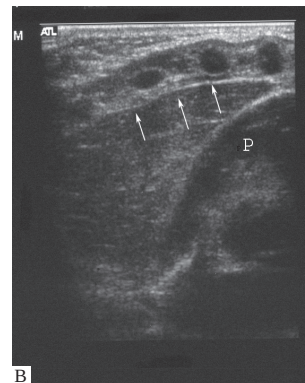


Fig. 5. Normal sonographic thymic appearance in an infant. (A) Transverse sonogram at the level of the brachiocephalic vein demonstrates the hypoechoic thymic architecture with linear septa and punctate echoes constituting the normal thymic appearance. (B) Sagittal sonogram shows the relationship of the thymus to the cartilaginous anterior chest wall (arrows). Pulmonary outflow tract (P) is subjacent. Reprinted with permission from Frush.¹⁷

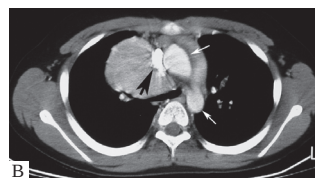
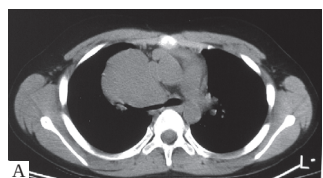


Fig. 6. Castleman's disease presenting as an anterior mediastinal mass in a child. (A) Axial CT scan at the level of the carina shows a soft tissue attenuation mass which slightly displaces the superior vena cava and aorta to the left. (B) Following administration of IV contrast material, this mass is seen to be densely enhancing. Note the improved depiction of the superior vena cava (arrow) and aorta (small arrows) relative to this mass. Reprinted with permission from Frush.¹⁷

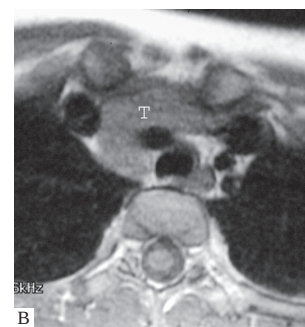
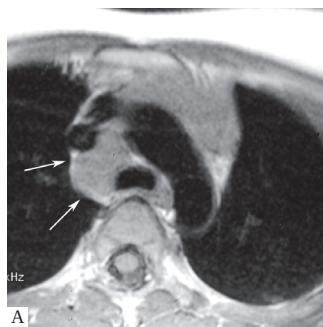


Fig. 7. Posterior extension of normal thymic tissue in a boy. This was originally seen by echocardiography as a possible mediastinal mass. (A) Axial T1-W MR image at the level of the arch shows intermediate signal intensity mass (arrows) behind the superior vena cava. (B) Axial image from the same examination obtained more superiorly, near the aortic branch vessels, shows that this tissue connects with normal thymus (T). Reprinted with permission from Frush.¹⁷

and intravenous contrast material is not routinely needed. Disadvantages of MR imaging compared with CT, include poorer lung parenchymal evaluation, more frequent need for sedation, less availability than CT and greater cost.

There is virtually no role for oesophagography in the evaluation of mediastinal masses, unless it is a problem-solving tool such as for potential communication of the

TABLE IV: GUIDELINES FOR CHEST MULTIDETECTOR COMPUTED TOMOGRAPHY PARAMETERS IN CHILDREN*

Weight (lb)	kVp**	mAs***		Slice thickness (mm)	Pitch			Thickness of detector (mm)			Increment (mm)
		SDCT	MDCT		4-	8-	16-	4-	8-	16-	
10-19	100-120	40	30	2.5-5	0.75	0.875	0.9375	2.5	1.25	1.25	5
20-39	100-120	50	30-40	5	0.75	0.875	0.9375	2.5	1.25	1.25	5
40-59	120	60	40	5	0.75	0.875	0.9375	2.5	1.25	1.25	5
60-79	120	70	50	5-7.5	0.75-1.5	1.35	1.375	2.5	1.25	1.25	5
80-99	120	80	60	5-7.5	1.5	1.35	1.375	3.75	2.5	1.25	5-7.5
100-150	120	100-120	70-90	5-7.5	1.5	1.35	1.375	3.75	2.5	1.25	5-7.5
>150	120	120-140	≥110	5-7.5	1.5	1.35	1.375	3.75	2.5	1.25	5-7.5

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* Parameters are based on General Electric single-detector CT (SDCT) and multidetector CT (MDCT) scanners

** Peak kilovoltage (kVp)

*** Tube current in milliampere seconds (mAs). Use 0.5 s gantry time when an option. Tube current (mA) is for 4-, and 8-slice MDCT. Sixteen-slice weight-based colour-coded mA are loaded on scanner. Sixteen-slice also has automatic exposure control where tube current ceiling is also based on a weight-based colour zone classification. Low dose, standard dose and high detail options (based on image noise) are also available for 16-slice scanner.

oesophagus with a congenital abnormality or other luminal origin of a mass (Fig. 8), or perhaps in a postoperative setting of contained oesophageal leak with an abscess. Occasionally, a vascular ring may be present without an obvious radiographic abnormality, such as a left-sided aortic arch and aberrant left subclavian artery. In this case, a screening oesophagram might be appropriate. However, in the context of a vascular anomaly presenting as a possible mediastinal mass (especially symptomatic), then more definitive preoperative imaging by CT or MR supplants the oesophagram. These indications are going to be relatively rare.

Anterior Mediastinal Masses

Differential considerations for anterior mediastinum masses are listed in Table I. The anterior mediastinum is the most common origin for mediastinal masses, accounting for up to 50% of all masses.^{1,6,7} The majority of anterior mediastinal masses are of thymic origin.¹⁷ Of these, lymphomas, teratomas and normal thymic enlargement are the most frequent and account for about 85% of all paediatric anterior mediastinal masses.^{6,7}

The thymus accounts for the majority of anterior mediastinal masses in children. These include congenital abnormalities, benign and malignant masses and manifestations of systemic disease, such as Langerhans cell histiocytosis. Thymic ectopia and aberrancy are usually considered synonymous conditions. Thymic ectopia is usually asymptomatic. While aberrant or ectopic thymic glands are often causes of neck masses, posterior mediastinal occurrence has been reported.¹⁸ The normal thymus can also be mistaken for a mediastinal mass (Fig. 7).

There is a wide variety of normal appearances of the thymus gland, particularly in infants.¹⁷ The typical thymus gland weighs 5 g to 50 g. There is some disagreement as to

when the gland is the largest.¹⁷ The thymus is certainly most visible in infancy and in young childhood. With any imaging modality, the thymus gland is homogeneous in appearance.^{11,17} With sonographic evaluation, thymic appearance is similar to that of the liver (Fig. 5). Dynamic evaluation during sonography demonstrates that this is a pliable organ that moves with respiration and cardiac pulsations. Importantly, on any imaging modality, the normal thymus does not displace adjacent structures, such as the trachea. Thymic enlargement can occur with rebound from systemic illness or other stress (such as chemotherapy), or with syndromes such as Beckwith-Wiedemann, T-cell dysfunction or myasthenia gravis. Giant thymic hyperplasia can also present as a large anterior mediastinal mass.¹⁹

Benign thymic tumours include thymoma, thymolipoma and rarely, hemangioma. Malignancies include lymphoma (a frequent cause of thymic neoplasms), germ cell tumours, malignant thymoma and thymic carcinoma. Thymomas are rare in children. Only 13% of thymomas occur between 10 and 29 years of age;²⁰ only about 2% occur in children in the first decade of life. The majority are seen in the 5th and 6th decades of life. There is no association with myasthenia gravis as in adults. However, pure red cell aplasia and hypogammaglobulinaemia are associations of thymoma in children. Heterogeneous signal intensity or attenuation is a non-specific finding seen with CT (Fig. 9) and MR imaging. Cysts are present in about 20% of cases. Other primary thymic tumours include carcinoid tumours. Carcinoid tumours of the thymus are very rare in children. Metastatic involvement of the thymus is also rare and includes neuroblastoma.

Lymphoma is the most common anterior mediastinal malignancy. Lymphoma involvement of the thymus can occur in Hodgkin's or non-Hodgkin's lymphoma. Hodgkin's disease is unusual under 10 years of age. Non-

Hodgkin's lymphoma occurs at any age. In general, CT is the preferred modality for evaluating lymphoma. The appearance can be that of a homogeneous infiltrating and encasing tumour or there may be areas of haemorrhage or necrosis giving low attenuation (Fig. 10). Calcification, especially an untreated lymphoma, is rare. It is especially important to look at involvement of adjacent structures, such as the superior vena cava, for signs of narrowing or complete obstruction, as well as displacement or narrowing of the airway.

The most common anterior mediastinal germ cell tumour is teratoma, which accounts for about 80% of all mediastinal germ cell tumours.²¹ Either MR imaging or CT is excellent for displaying the various contributions of fat, fluid, soft tissue and calcification (Figs. 4, 11 and 12). Differential diagnosis of fat-containing anterior mediastinal masses (Table V) includes germ cell tumours, mediastinal fat (Fig. 13), anterior hernia with bowel and attached fat and a thymolipoma.²² Thymolipomas are rare in children.²³

Differential considerations for cystic thymic processes are found in Table V. True thymic cysts represent <1% of all mediastinal masses in children. Usually, thymic cysts are not found below 20 years of age. Thymic cysts include true thymic cysts, cystic dysplasia seen with human immunodeficiency virus infection (Fig. 14)²⁴ and thymic masses, including germ cell tumours, thymomas and occasional lymphomas (usually treated). Imaging features are those of a cyst on CT or MR imaging (Fig. 15). Non-thymic anterior mediastinal masses include lymphatic malformations (Fig. 16).

Middle Mediastinal Masses

Table II lists considerations for paediatric middle mediastinal masses. The middle mediastinum is the least frequent compartment of origin of paediatric mediastinal masses, accounting for about 20% of these lesions.^{6,7} The vast majority of mediastinal masses are due to adenopathy.⁷ This may be infectious in nature (that is, tuberculosis or fungal disease such as histoplasmosis) (Fig. 17), metastatic disease (Figs. 18 and 19) or diffuse multicentric involvement by lymphoma. The second most common type of lesion is a foregut cyst. This group includes bronchogenic cysts, oesophageal duplication cysts and neurenteric cysts. Other lesions include abscesses, extension from adjacent vertebral elements, vascular abnormalities, such as venous or lymphatic malformations,²⁵ congenital aortic arch or branch vessel abnormalities, which extend into the middle mediastinum superiorly (Fig. 20) or postoperative vascular processes (Fig. 21).

Bronchogenic cysts are one of the spectrum of bronchopulmonary foregut malformations. Other lesions in this group which may occur in the middle mediastinum

TABLE V: SPECIFIC THYMIC IMAGING FEATURES

Thymic cysts and cystic conditions

- True thymic cysts (unilocular, multilocular)
- Germ cell tumours
- Langerhans' cell histiocytosis
- Lymphatic malformation (such as cystic hygroma)
- Lymphoma
- Treated lymphoma
- Thymic dysplasia of human immunodeficiency virus (HIV) infection
- Thymoma
- Thymic carcinoma

Thymic calcification

- Germ cell tumour
- Langerhans' cell histiocytosis
- Lymphoma
- Thymic cysts

Fat-containing thymic masses

- Thymolipoma
- Germ cell tumour (usually mature teratoma)
- Vascular malformations

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consist of abnormalities of the foregut, including oesophageal duplications cysts (ventral foregut) or neurenteric cysts (dorsal foregut). Foregut cysts account for up to 15% of all mediastinal masses in children. Bronchogenic cysts account for 65% of foregut cysts.⁴ Bronchogenic cysts cause symptoms in about 5% to 80% of cases, usually respiratory symptoms or chest pain.^{26,27} Those cysts resulting in symptoms are usually discovered before 5 years of age. The most common mediastinal location for bronchogenic cysts is subcarinal, followed by the para-tracheal area. About 85% of bronchogenic cysts are mediastinal in nature.^{26,27} The remaining 15% are parenchymal in location and about 67% of these are hilar in location.

Radiographic features of foregut cysts are those of well-circumscribed mediastinal mass. With a bronchogenic cyst, if infection has developed with communication of the airway, an air fluid level can be seen. On CT examination, foregut cysts are smooth with a thin or imperceptible wall with homogeneous attenuation, usually that of water (Fig. 22). This fluid may be slightly higher in attenuation if the cyst contains blood or relatively dense proteinaceous fluid. The cystic characteristics on MR imaging also reflect the content of fluid.^{28,29} Whereas most cysts are high on T2-weighted sequences, signal intensity varies with T1-weighted imaging and depends on the fluid composition. Calcification is a rare feature of foregut cysts.

Posterior Mediastinal Masses

Table III lists considerations for paediatric posterior mediastinal masses. Masses in the posterior mediastinum

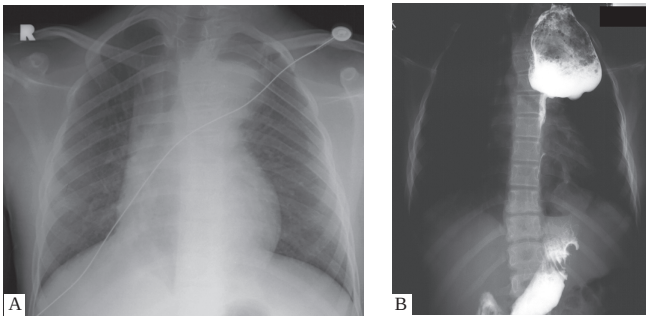


Fig. 8. Oesophageal dilation proximal to an oesophageal stricture in a 14-year-old female status post-repair of oesophageal atresia. (A) Convex opacity on frontal radiograph in the left upper mediastinum displaces the trachea to the right. (B) Frontal image from barium swallow demonstrates the dilated oesophagus proximal to a stricture.

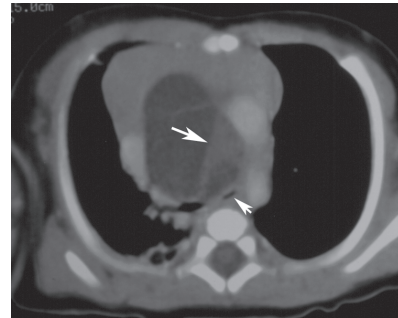


Fig. 11. Mature teratoma located predominantly in the anterior mediastinum in a 2-month-old male with respiratory distress. Enhanced axial CT scan at the level of the aortic arch shows a cystic mass with soft tissue in the left aspect (arrow). Note moderate narrowing of left bronchus (short arrow). Soft tissue anteriorly is normal thymus.

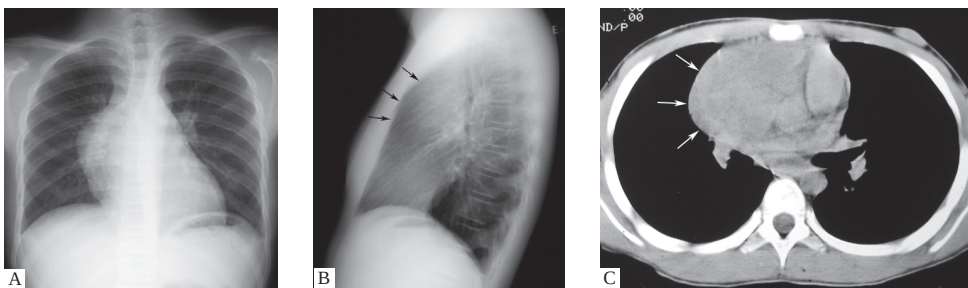


Fig. 9. Thymic carcinoma in a teenage male. (A) Frontal chest radiograph shows contour abnormality along the right medial thorax. (B) Increased soft tissue fills the anterior mediastinum (arrows) on the lateral radiograph. (C) Enhanced axial CT scan at the level of the main pulmonary artery shows a large soft tissue attenuation mass in the anterior mediastinum (arrows). Reprinted with permission from Frush.¹⁷

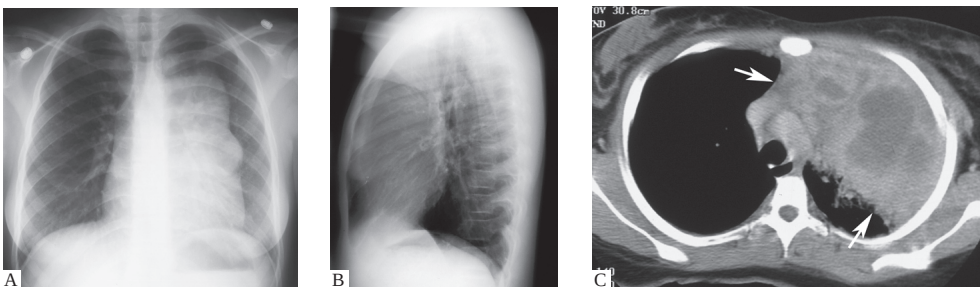


Fig. 10. Hodgkin's lymphoma in a teenage girl. (A) Frontal and (B) lateral chest radiographs show large anterior mediastinal mass. (C) Enhanced axial CT scan at the level of the aortic arch shows a mixed attenuation anterior mediastinal mass (arrows) which extends into the left thorax. Reprinted with permission from Frush.¹⁷

occur more often than in the middle mediastinum, and are up to as frequent as those in the anterior mediastinum.^{1,7,30} Approximately 85% of posterior mediastinal masses are neurogenic in origin.^{31,32} Neurogenic tumours include tumours arising from the nerve ganglion, nerve sheath or other nervous tissue.

A ganglioneuroma is a benign ganglion cell tumour. It is at the differentiated and benign end of the spectrum of tumours that also consist of neuroblastoma and ganglioneuroblastoma. Age is an important consideration

in helping to form differential considerations of posterior mediastinal masses. While neuroblastoma occurs most frequently in young children (typically under 4 years of age), ganglioneuromas are more frequent in older children and adolescents.³² While the mean age of diagnosis of ganglioneuromas is still in childhood, it is substantially later (after 7 years of age) than that in neuroblastoma.³³ Ganglioneuromas are also often detected in adulthood and can be a serendipitous finding in autopsy.

Symptoms are common in ganglion tumours, occurring

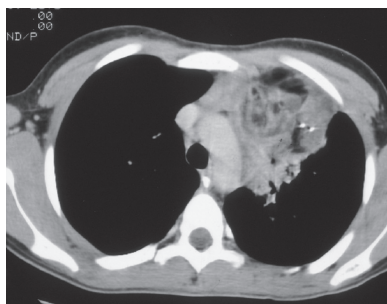


Fig. 12. Anterior mediastinal mature teratoma. Enhanced CT scan at the level of the aortic arch shows a mixed attenuation mass containing fat, soft tissue and calcification. Reprinted with permission from Frush.¹⁷

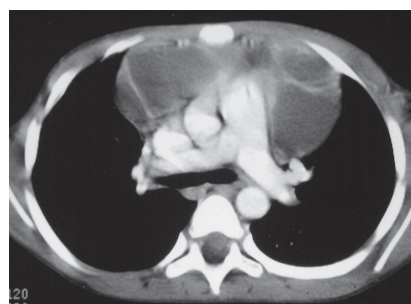


Fig. 14. Cystic dysplasia of the thymus in a child with human immunodeficiency virus infection. Enhanced axial CT scan at the level of the anterior mediastinum shows a multi-septated cystic thymus. Reprinted with permission from Frush.¹⁷

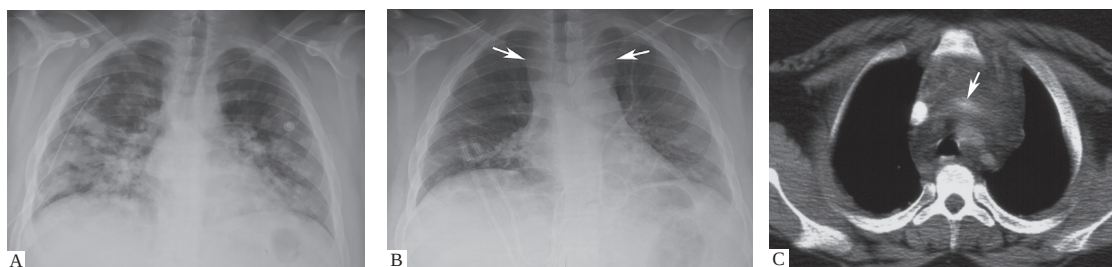


Fig. 13. Anterior mediastinal widening in a teenage boy being treated for leukaemia. (A) Anteroposterior chest radiograph obtained at diagnosis shows multiple parenchymal opacities which represent lymphomatous infiltrates. Note the normal width of the upper mediastinum. (B) Subsequent chest radiograph obtained a few months later demonstrates widening of the mediastinum (arrows). (C) Enhanced axial CT scan at the level of the left brachiocephalic vein shows marked attenuation of this vessel (arrow) with increased stranding in the mediastinal fat. This widening was due to a combination of acute brachiocephalic thrombophlebitis and mediastinal lipomatosis from steroid administration.

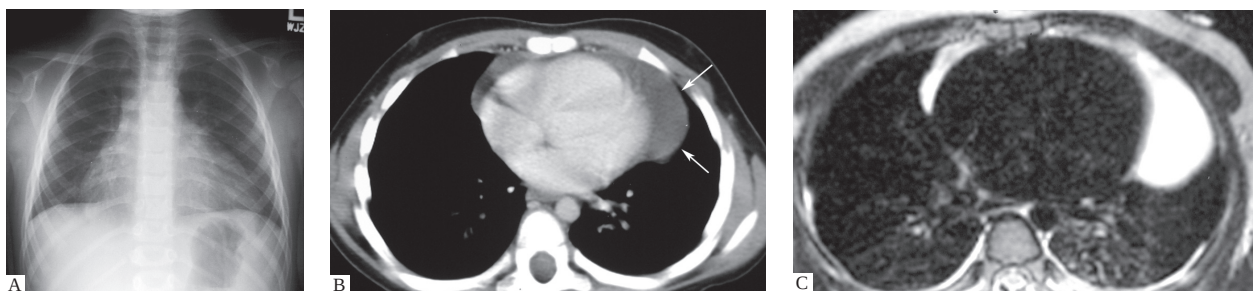


Fig. 15. Thymic cyst. (A) Frontal radiograph demonstrates apparent cardiomegaly. (B) Enhanced axial CT scan at the level of the interventricular septum shows fluid attenuation predominantly at the left side of the heart (arrows). (C) Axial T2-W MR image at approximately the same level shows the high signal intensity of this cyst. Reprinted with permission from Frush.¹⁷

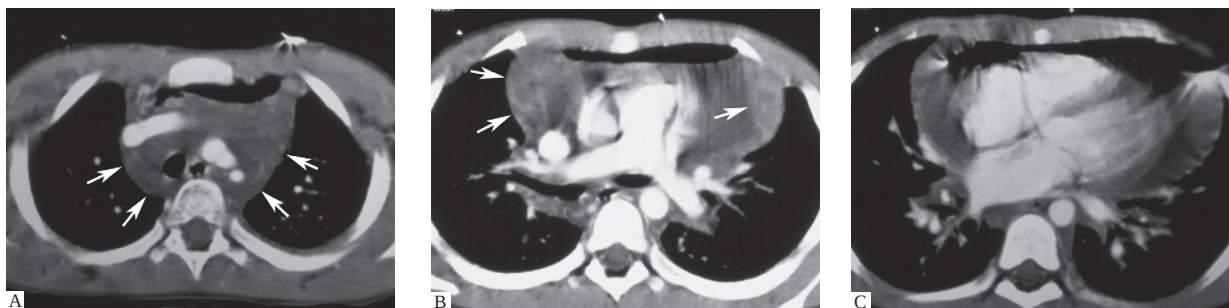


Fig. 16. Lymphatic malformation presenting as a diffuse mediastinal mass, including anterior mediastinal involvement in a 4-year-old male. (A) Enhanced axial CT scan at the level of the brachiocephalic vein shows fluid attenuation predominantly in the anterior and middle mediastinum (arrows). Gas anteriorly was due to tube placement to drain the fluid. (B) This mass has some increased soft tissue (arrows) attenuation and, at the more inferior extent, (C) at the level of the bifurcation of the pulmonary arteries. Fluid is seen in the posterior mediastinum, hilar regions and surrounding the heart.

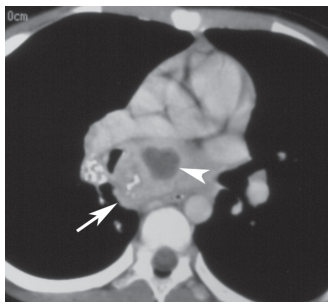


Fig. 17. Middle mediastinal adenopathy due to histoplasmosis infection in a 7-year-old female. Enhanced axial CT scan at the level of the right pulmonary artery shows calcified hilar and mediastinal (arrow) adenopathy, as well as a central area of necrosis (arrowhead).

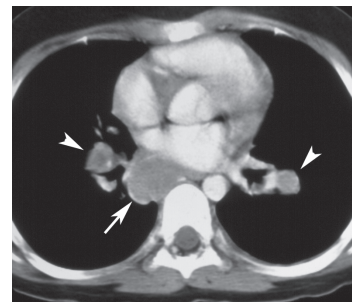


Fig. 18. Enhanced axial CT scan of an 8-year-old male shows middle mediastinal adenopathy (arrow) due to metastatic rhabdomyosarcoma. Note also bilateral hilar adenopathy (arrowheads).

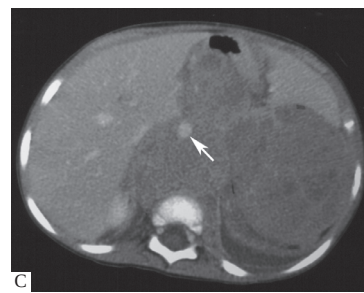
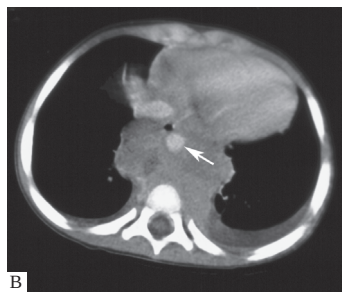
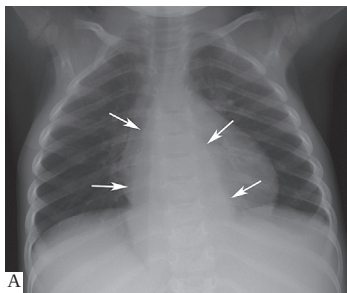


Fig. 19. A 2-year-old female with new diagnoses of neuroblastoma. (A) Frontal chest radiograph was initially obtained due to fever to assess pneumonia. Note para-spinal contour abnormalities bilaterally (arrows) at the lung bases. (B) Enhanced axial CT scan at the lung base shows a middle mediastinal mass, which was adenopathy, displacing and encasing the aorta (arrow). Left and smaller right pleura effusions were also noted. (C) The retroperitoneal origin of this mass is appreciated on a CT examination of the upper abdomen. Note encasement and displacement of the aorta (arrow) at this level as well.

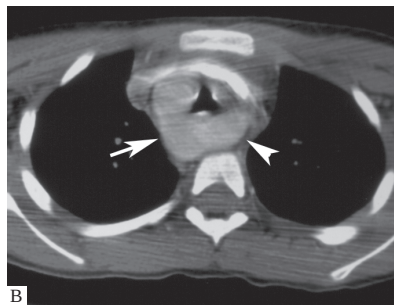
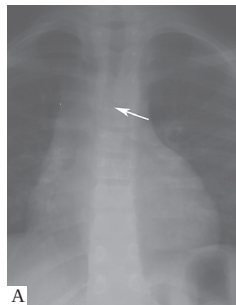


Fig. 20. Right-sided aortic arch with aberrant left subclavian artery presenting as a mediastinal abnormality in a 4-year-old male with wheezing. (A) Frontal radiograph of the upper thorax demonstrates soft tissue in the right of the trachea with narrowing of the distal trachea (arrow). (B) Enhanced axial CT scan at the level of the upper aorta shows the right-sided arch (arrow) and the beginning of the diverticulum (arrowhead) from which the aberrant left subclavian artery (not shown) originated.

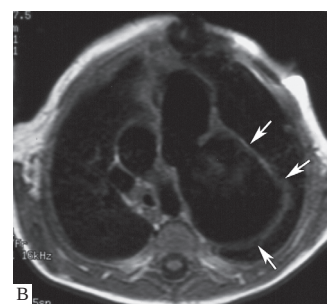
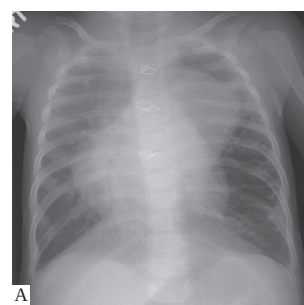


Fig. 21. A 6-month-old female with pseudoaneurysm of the pulmonary artery following repair of tetralogy of flow. (A) Anteroposterior chest radiograph demonstrates large opacity in the left upper mediastinum. (B) Axial T1-W MR image at the level of the main pulmonary artery shows a pseudoaneurysm (arrows), which projects over the middle mediastinum, communicating with the pulmonary artery.

in about 50% to 75% of patients.³² They include respiratory difficulties due to mass effect and neurologic symptoms; rarely, neuroblastoma will present with para-neoplastic syndromes of diarrhoea, opsoclonus or myoclonus.

Ganglioneuromas are typically large at diagnosis, spanning several intracostal spaces (Fig. 23). The morphology of these tumours is that they tend to be smooth, versus neuroblastomas which may be indistinct and more irregular in shape. The appearance on CT of a ganglio-

neuroma is homogeneous with attenuation similar to that of muscle. Intermediate T1-weighted signal intensity with high T2-weighted signal intensity is seen with MR imaging. Ganglioneuromas are reported to have calcification less often (20%) than neuroblastomas (40%).³³ CT is better at depicting calcification than MR imaging. Because it is not possible, from imaging features, to determine whether or not a nerve cell tumour is malignant, these are removed or biopsied.

Nerve sheath tumours (schwannomas and neurofibromas)

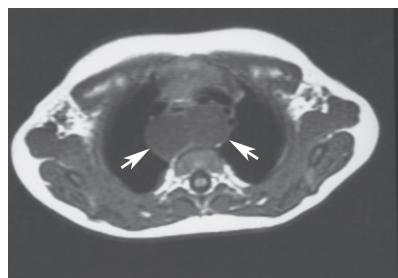


Fig. 22. Oesophageal duplication cyst in the middle mediastinum in an infant. Axial T1-W MR image at the level of the brachiocephalic vein shows a bilobed middle mediastinal mass (arrows) with fluid attenuation displacing vessels and trachea anteriorly. Courtesy of George S Bisset III, Durham NC, USA.

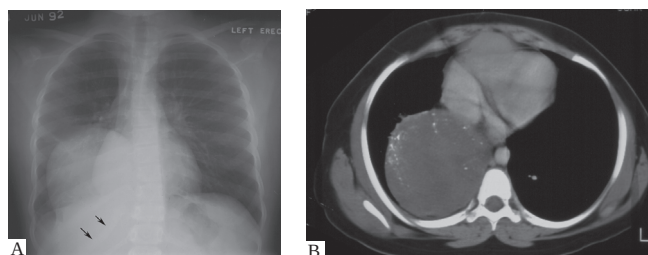


Fig. 23. Posterior mediastinal ganglioneuroma in a 3-year-old female. (A) Frontal chest radiograph shows a large, well-defined rounded mass at the medial right base. Note subtle displacement of a lower right rib (arrows). (B) Enhanced axial chest CT scan at the lung base shows that this mass is centred near the junction of the posterior and middle mediastinum. Note punctate calcifications in the periphery. Reprinted with permission from the American College of Radiology.

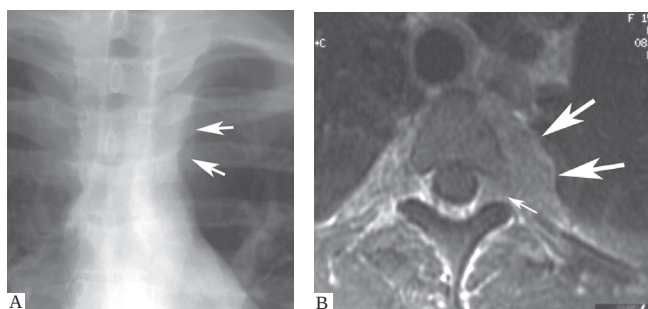


Fig. 24. Chloroma in a 15-year-old female with acute myelogenous leukaemia. (A) Frontal radiograph of the left upper chest demonstrates subtle mediastinal contour abnormality (arrows). (B) Axial T1W MR image shows that this mass (arrows) is posterior in location and has soft tissue signal intensity. Note invasion of neural foramen (small arrow).

usually occur after 10 years of age. Other aetiologies of posterior mediastinal masses are found in Table III (Figs. 24 to 27).

Conclusion

Familiarity with mediastinal masses in children is important since the type and frequency of lesions differ from adults. Moreover, the selection of the appropriate imaging modality, or sequence of modalities, and appropriate paediatric techniques are important to optimise both the use of resources and the diagnostic yield.

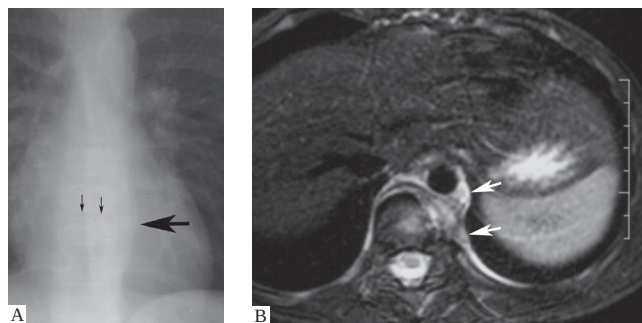


Fig. 25. Discitis in a 7-year-old male presenting as a posterior mediastinal process. (A) Frontal radiograph of the medial lower chest shows subtle expansion of the posterior para-spinal line (arrow). Note subtle narrowing of disc space (small arrows). (B) Axial T2-W MR image near the aortic hiatus shows expansion and increased signal intensity of the soft tissues to the left of the vertebral body (arrows).

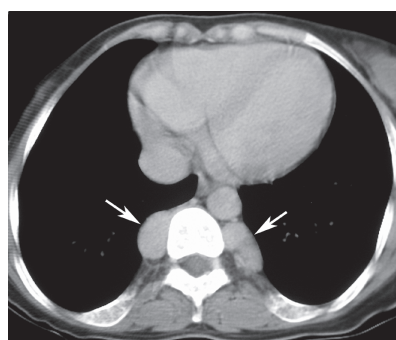


Fig. 26. Extramedullary haematopoiesis in a child with thalassaemia manifesting as posterior para-spinal soft tissue masses (arrows) demonstrated on enhanced axial CT scan of the lower thorax. Courtesy of Lynne Hurwitz, MD, Durham, NC, USA.

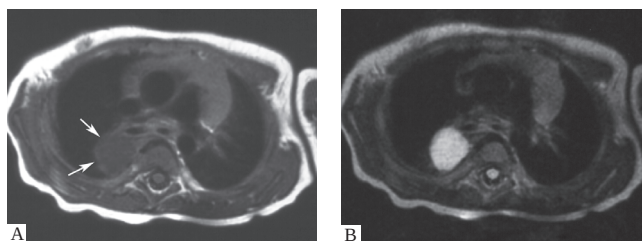


Fig. 27. Posterior mediastinal location of an oesophageal duplication cyst in a 6-month-old female. (A) Axial T1-W MR image at the level of the main pulmonary artery shows a well-defined mass (arrow) with signal intensity slightly lower than soft tissue. (B) Axial T2-W MR image at the same level shows high signal intensity of this cyst. Reprinted with permission from the American College of Radiology.

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