
PICTORIAL ESSAY

Computed Tomography of Anterior Mediastinal Masses

S Lau,¹ WH Yeung,² WH Kwan,² CS Cheng,² HS Lam¹

¹Department of Radiology, Kwong Wah Hospital, and ²Department of Diagnostic Radiology, Ruttonjee and Tang Siu Kin Hospitals, Hong Kong

ABSTRACT

Anterior mediastinal masses have diverse origins and aetiologies. Correct diagnosis requires a logical and practical strategy, recruiting as much clinical and radiological information as possible. Computed tomography is a common imaging modality for evaluating mediastinal lesions and can often offer a limited differential diagnosis or even suggest a specific diagnosis in some situations. Computed tomography also helps in the planning of further invasive diagnostic procedure, as well as therapeutic decisions. Familiarity with the prevalence and pathological characteristics of various mediastinal masses, as well as the typical computed tomography findings is the key for correct diagnosis and proper management.

Key Words: Computed tomography, Germ cell tumour, Goiter, Lymphoma, Mediastinal disease, Thymic cancer

INTRODUCTION

The mediastinum is conventionally divided into anterior, middle, and posterior compartments to aid lesion localisation and differential diagnosis. Nevertheless, it should be borne in mind that this artificial division is descriptive rather than anatomical. The radiographic anterior mediastinum is bounded superiorly by the thoracic inlet, anteriorly by the sternum, posteriorly by the pericardium, and inferiorly by the diaphragm. This area normally contains adipose tissue, lymph nodes, internal mammary vessels, and the thymus and thyroid glands. Abnormal mediastinal contour or widening on plain chest X-ray is one of the most common reason for requiring a thoracic computed tomography (CT) scan. CT can often offer a limited differential diagnosis or a specific diagnosis in some instances. This pictorial essay aims to demonstrate typical CT features of the most commonly encountered anterior mediastinal masses.

ANTERIOR MEDIASTINAL MASSES

Thymoma

Thymoma is the commonest primary tumour of the anterior mediastinum.¹ It occurs most frequently in

adults older than 40 years and is rare in children and adolescents. Approximately half of patients with thymoma have parathymic syndromes including myasthenia gravis, red cell aplasia and hypogammaglobulinaemia.² All patients with anterior mediastinal masses should be evaluated preoperatively for myasthenia gravis that could result in respiratory failure in the postoperative period if untreated.³

Thymoma appears as a well-defined, rounded or lobulated anterior-superior mediastinal mass anterior to the aortic root. The mass contains either homogeneous or heterogeneous contents depending on the presence of haemorrhage, necrosis, or cyst formation. Calcific foci are seen on CT in a minority of patients (Figure 1).

Approximately 15% to 37% of thymomas are invasive but are histologically indistinguishable from benign thymomas.⁴ The term 'invasive thymoma' is preferred to 'malignant thymoma' because there are no distinguishing histological features.⁵ An irregular interface with adjacent lung, infiltrative appearance, and vascular involvement are suggestive of invasion (Figure 2). Invasive lesions can also seed the pleural space to encase the lung and thus mimic the appearance of a diffuse malignant mesothelioma. Thoracic CT for the evaluation of thymoma should extend through the upper abdomen to exclude transdiaphragmatic extension, which occurs in up to 30% of patients.⁶ Due to

Correspondence: Dr S Lau, Department of Radiology, Kwong Wah Hospital, 25 Waterloo Road, Kowloon, Hong Kong. Tel: (852) 2781 5189; Fax (852) 2781 5454; E-mail: sbunlau@hkcr.org

Submitted: 10 September 2002; Accepted: 13 May 2003.

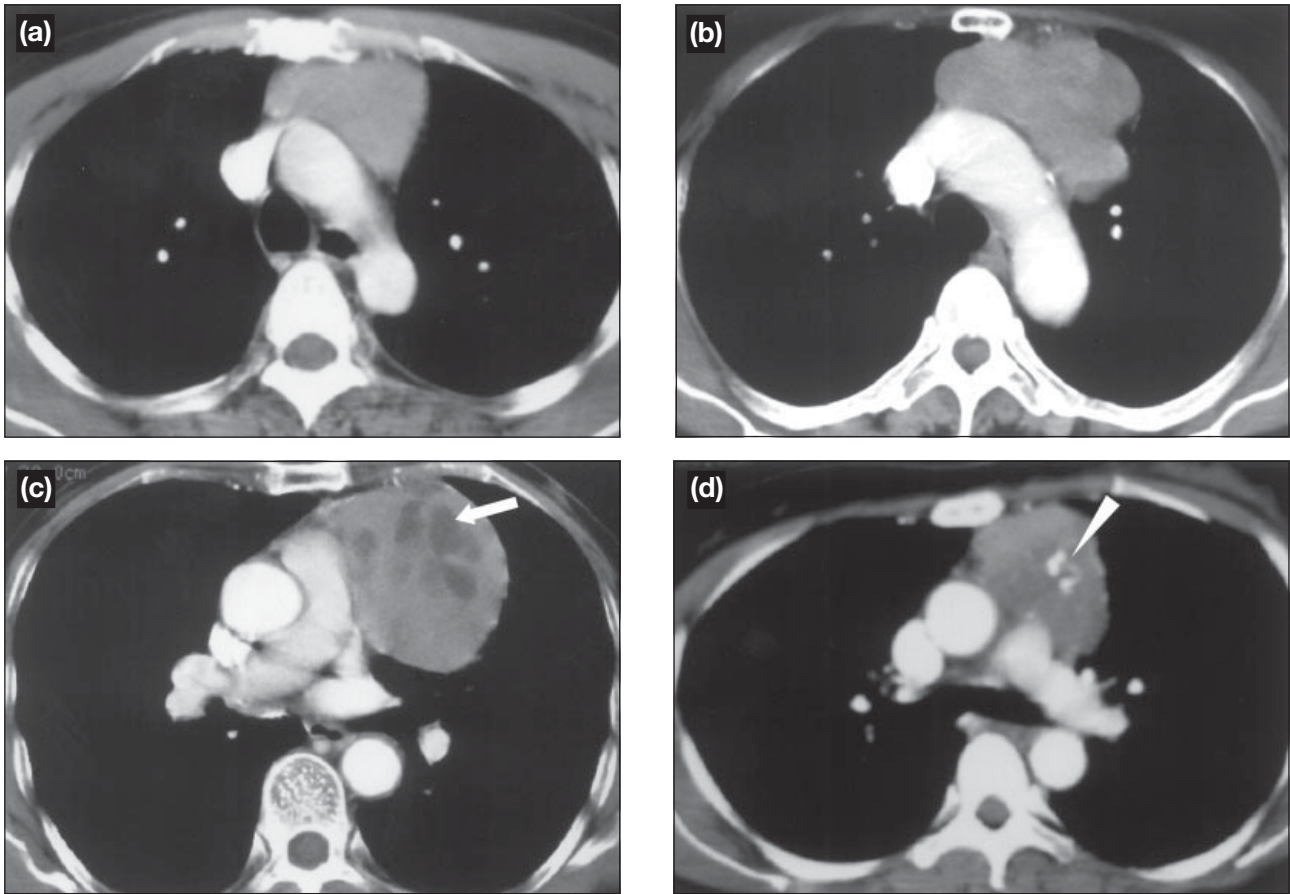


Figure 1. Four different cases of thymoma showing variable computed tomography appearance. None show histological evidence of invasion. (a) A smooth well defined homogeneously enhancing soft tissue mass in anterior mediastinum; (b) a lobulated enhancing soft tissue mass; (c) heterogeneous mass containing central cystic changes (arrow); and (d) well defined mass containing central calcifications (arrowhead).

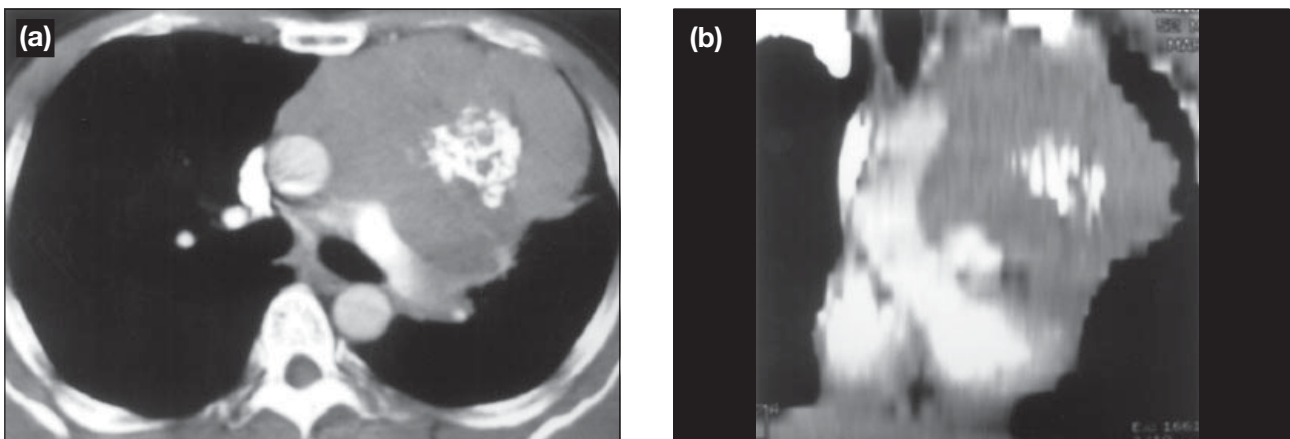


Figure 2. Invasive thymoma in a 52-year-old man. (a) Huge heterogeneous soft tissue mass containing central floccular calcifications. It encases the ascending aorta, left pulmonary artery, and left main bronchus; and (b) coronal reconstruction computed tomography shows better spatial relationship of the mass with mediastinal structures.

the risk of recurrence, patients with thymoma warrant long-term radiological follow-up.

Thymic Hyperplasia

Thymic size and shape normally change with age. Thymic hyperplasia is histologically related to germinal

centre hyperplasia, while the size of the gland may be normal or enlarged. This condition is associated with a variety of connective tissue disorders and endocrine abnormalities such as hyperthyroidism, acromegaly, and Addison's disease. Rebound hyperplasia occurs in children and young adults recovering from severe illness or

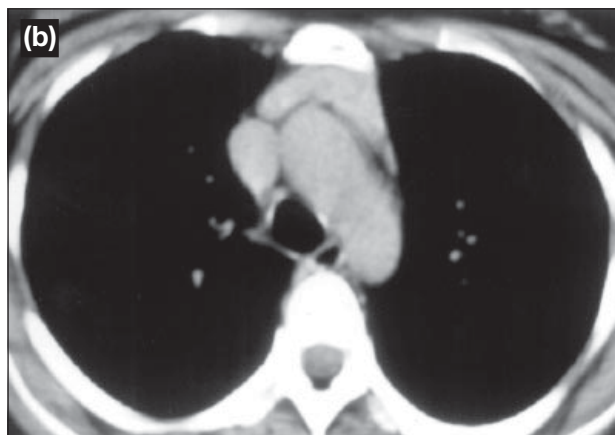
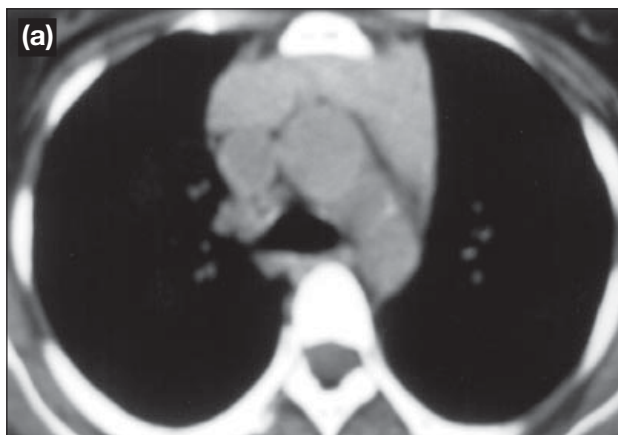


Figure 3. Thymic hyperplasia in a 21-year-old girl presenting with hyperthyroidism. (a) Initial computed tomography shows symmetrical enlargement of the thymus retaining its normal configuration. There is no local invasion. The patient becomes euthyroid after medical treatment. (b) Follow-up computed tomography 6 months later shows interval decreasing size of the thymus.

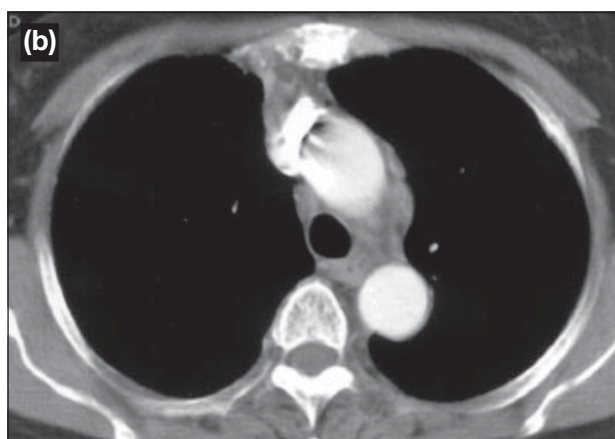
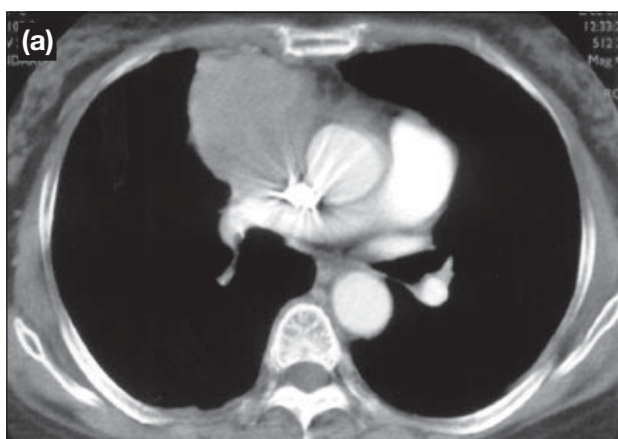


Figure 4. Thymic carcinoma. (a) Computed tomography shows large anterior mediastinal mass with ill-defined medial border. The superior vena cava is compressed. (b) Computed tomography section at a higher level shows abnormal lymph nodes in the aortopulmonary window and paratracheal region.

after treatment for Cushing's syndrome or chemotherapy. Steroid therapy reduces the size of the hyperplastic thymus. CT usually reveals diffuse symmetric enlargement of the thymus with characteristic preservation of the normal shape and smooth contour. Thymic hyperplasia consists of homogenous soft tissue with an attenuation value similar to that of the normal thymus (Figure 3).

Thymic Carcinoma

Squamous cell and lymphoepithelioma-like carcinoma are the most common histological types. These occur most commonly in middle-aged adults. The appearance is of a large poorly defined infiltrative anterior mediastinal mass (Figure 4) and it is commonly associated with pleural and pericardial effusions, and regional lymph node and distant metastasis.

Thymic Carcinoid

Thymic carcinoid is a rare thymic neoplasm. Histologically,

it is identical to carcinoid tumour elsewhere in the body. This condition mostly frequently occurs in middle-aged men. Approximately half of the patients have endocrine abnormalities, although the classic carcinoid syndrome is rarely seen. This is typically a large lobulated anterior mediastinal mass containing haemorrhage, necrosis, calcification, and contrast enhancement, and may show local invasion or distant metastasis.

Thymolipoma

Thymolipoma is an uncommon benign slow growing neoplasm of the thymus gland composed of mature adipose cells and thymic tissue. It is typically a large soft anterior mediastinal mass and is able to conform to adjacent structures simulating cardiomegaly, lobar collapse, and diaphragmatic elevation.^{3,7} Thymolipoma also changes shape in response to changes in a patient's position. CT identifies the fatty and soft tissue contents and confirms its attachment to the thymus gland (Figure 5).

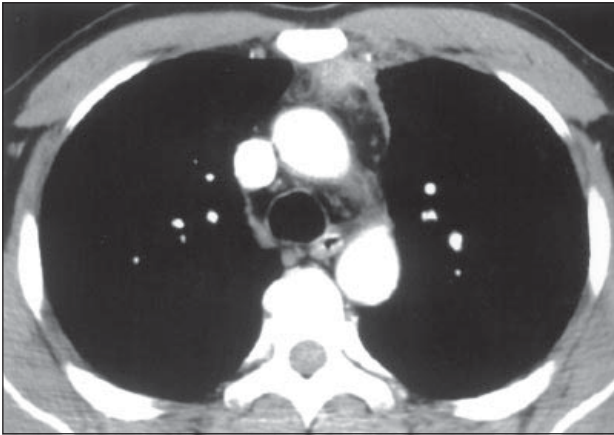


Figure 5. Thymolipoma — well defined anterior mediastinal mass contains both soft tissue and fatty components.

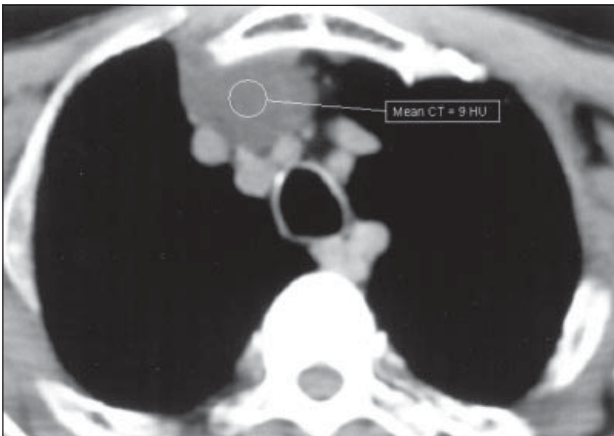


Figure 6. Thymic cyst — plain computed tomography scan shows a unilocular anterior mediastinal mass containing near-water density contents. There is no abnormal contrast enhancement. There is mass effect displacing great vessels posteriorly but no evidence of local invasions.

Non-neoplastic Thymic Cyst

Non-neoplastic thymic cyst may be congenital or acquired secondary to inflammation. It is seen as a well-circumscribed anterosuperior mediastinal mass with low attenuation contents. The cystic mass may be uni- or multiloculated and may show curvilinear calcification of the cystic wall or septa (Figure 6).

Thyroid Mass With Retrosternal Extension

Cervical goitre descending into the thorax represents one of the most commonly seen masses in this region. It often causes deviation or indentation of trachea. A mass of thyroid origin shows typical continuity with the thyroid gland in the neck. Thyroid mass demonstrates high CT density on plain scan due to the iodine content as well as intense and sustained intravenous contrast enhancement (Figure 7). Goitre may also contain cystic or calcific foci.

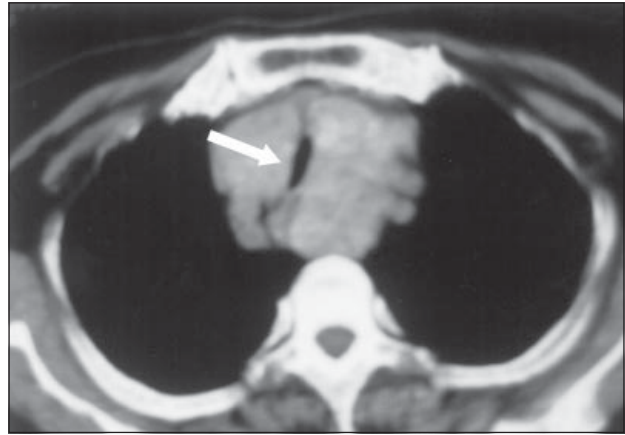


Figure 7. Retrosternal goitre displaces and compresses the trachea (arrow). Note that thyroid tissue is hyperdense on plain computed tomography. There is intense enhancement after intravenous contrast (not shown).

Germ Cell Tumour

Extragonadal germ cell tumours most commonly occur in the mediastinum. These tumours account for approximately 20% of all mediastinal tumours.⁵ Most of them occur near or within the thymus. Malignant germ cell tumours secrete lactic dehydrogenase, α -fetoprotein (α -FP) and β -human chorionic gonadotropin (β -HCG). These tumour markers are useful for the diagnosis and follow-up of the disease.

Mediastinal teratoma is the most common histological type and is usually benign. It occurs in children and young adults with no sex predilection. On CT, the teratoma appears as a multi-locular cystic tumour with walls of variable thickness. The combination of fluid, soft tissue, calcium, and fat attenuation in an anterior mediastinal mass is a highly specific finding that allows the prospective diagnosis of mature teratoma (Figure 8). A fat-fluid level produced by high lipid content in the cyst fluid is a rare but diagnostic sign.

Mediastinal seminoma typically occurs in white males in their 3rd and 4th decades of life and is usually symptomatic. Ten percent of patients may have an elevated β -HCG but never have elevated α -FP.^{5,7} The lesion appears as a large bulky lobulated homogenous anterior mediastinal mass, which may invade adjacent structures or metastasise to the lungs. Seminoma is highly sensitive to both radiotherapy and chemotherapy.

Mediastinal non-seminomatous malignant germ cell tumour is a heterogeneous group of tumours including embryonal cell carcinoma, endodermal sinus tumour, choriocarcinoma, or mixed germ cell tumours composed

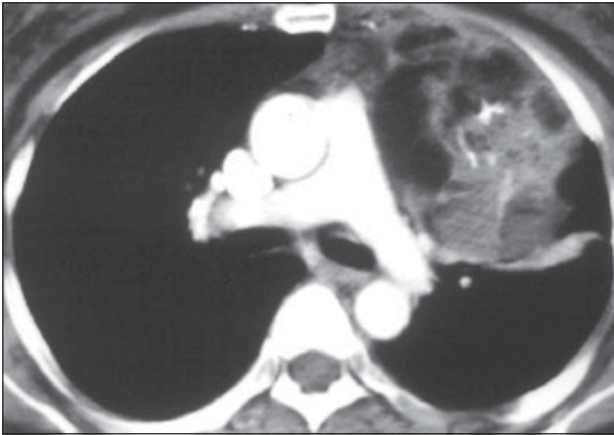


Figure 8. Anterior mediastinal teratoma — a large left anterior mediastinal mass extends from the level of aortic arch to the cardiophrenic angle. It is heterogeneous and contains soft tissue, fatty and calcific components. Mild compression of mediastinal vessels and adjacent lung parenchyma is evident.

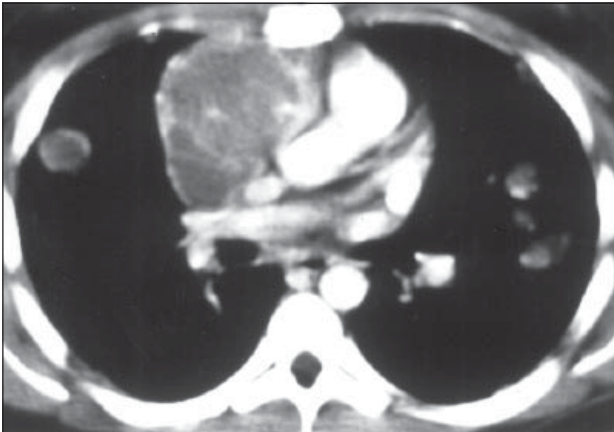
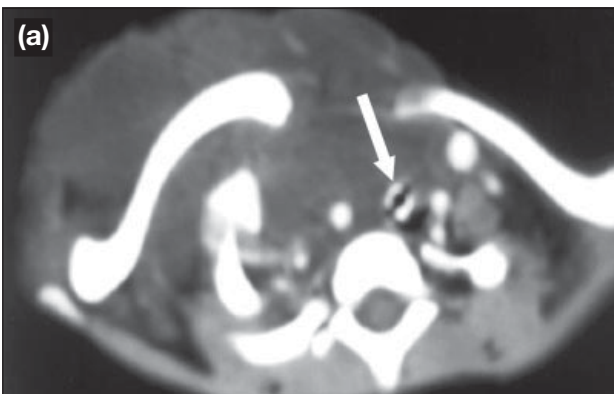


Figure 9. Non-seminomatous germ cell tumour — a large anterior mediastinal mass shows extensive central necrosis and heterogeneous peripheral enhancement. Compression and invasion of adjacent mediastinal structures are present. Multiple 'cannon ball' lesions represent pulmonary metastasis.



of multiple histological features. These tumours are malignant and typically cause symptoms in young adult men. Lactate dehydrogenase, α -FP, and β -HCG are frequently elevated. Gynaecomastia may be obvious on physical exam or CT in patients with malignant germ cell tumours that secrete β -HCG. These neoplasms are associated with haematological malignances and Klinefelter's syndrome. They are often large irregular anterior mediastinal masses showing extensive central heterogenous areas of low attenuation due to necrosis, haemorrhage, cyst formation, and peripheral contrast enhancement (Figure 9). They show local invasion, and nodal and distant metastasis. Pleural and pericardial effusions are also common.

Cystic Hygroma/Lymphangioma

Cystic hygroma/lymphangioma is a benign proliferation of interconnecting lymphatic vessels and sacs that may grow in an infiltrative fashion. This condition most commonly affects young children. Mediastinal lymphangioma typically occurs in the superior aspect of the anterior mediastinum and is usually contiguous with a cervical or axillary component. The mass usually appears as rounded, lobulated, multicystic tumour that can reach a massive size. It tends to surround and displace mediastinal structures and may infiltrate across tissue planes. The thin or thick septa may enhance minimally after contrast administration (Figure 10). Due to its infiltrating nature, complete surgical resection may be difficult and close follow-up is needed to check for recurrence.⁵

Lymphoma

Lymphoma is one of the most common mediastinal neoplasms and may affect any mediastinal location.

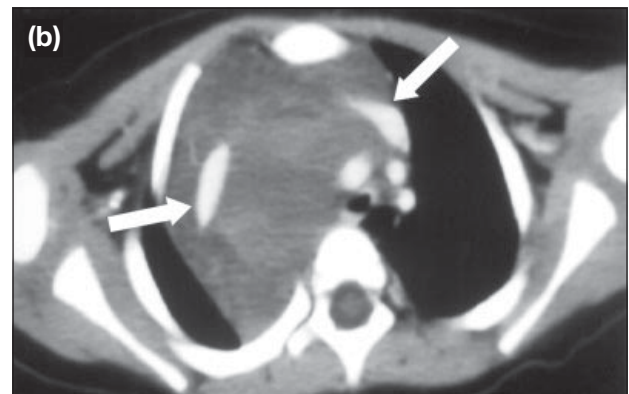


Figure 10. Cystic hygroma in a 1-year-old baby boy with respiratory distress. (a) The baby is intubated and artificially ventilated (arrows show endotracheal tube and trachea). Contrast computed tomography shows a huge septated multilocular near-water density mass over the right neck extending through the thoracic inlet down to the mediastinum. The lower portion of the mass contains higher density content which is believed to represent either intralesional bleeding or infiltration into the thymus tissue. (b) The mass is infiltrating into the adjacent organs. The great vessels are encased and displaced although they are all patent. There is no evidence of superior vena cava obstruction (arrows show the brachiocephalic veins).

Non-Hodgkin's lymphoma usually manifests as generalised disease whereas Hodgkin's disease tends to present as primary mediastinal lesions.

Hodgkin's disease can exhibit as multiple rounded soft tissue masses, a dominant bulky soft tissue mass, or a discrete or infiltrating thymic mass. It has a characteristic tendency to spread contiguously along lymph node chains, with the prevascular and paratracheal nodes being the most commonly affected groups. There may be associated mediastinal infiltration and displacement, compression, or invasion of vascular structures, pericardium, heart, and/or the tracheobronchial tree, with or without direct invasion of the pleura, lungs, and chest wall. Staging of Hodgkin's disease according to the modified Ann Arbor Classification distinguishes patients benefiting from radiation therapy alone from those requiring systemic treatment.⁸ Lesions may comprise homogenous or heterogeneous soft tissue attenuation depending on the presence of necrosis, haemorrhage, or cystic degeneration. Foci of calcifications may be seen post-therapy. Approximately 12% of patients show evidence of direct invasion of the lungs and these are mostly associated with hilar adenopathy.⁹ A new or enlarging mediastinal mass in a treated patient may represent recurrent disease, a post-therapeutic thymic cyst, or thymic hyperplasia.⁸

Non-Hodgkin's lymphoma is associated with extranodal disease and has a greater predilection for non-contiguous and/or haematogenous spread to thoracic and distant nodal and extranodal sites as well as middle and posterior mediastinal paracardiac and retrocrural lymph node groups.⁹ Isolated pulmonary, pleural, or pericardial disease also occurs. Thoracic CT is useful for showing the extent of the disease in patients with localised disease, for defining radiation portals in patients with abnormal X-rays but no extrathoracic disease, and for determining recurrence in treated patients with questionable X-rays (Figure 11). CT has little utility for untreated patients with advanced disease or treated patients with normal X-rays.⁹

Pericardial Cyst

Pericardial cyst is developmental in origin, occurring most commonly in adults, and is asymptomatic. It is seen as a well marginated, spherical, or teardrop shaped mass that characteristically abuts the heart, the anterior chest wall, and the diaphragm. The right anterior cardiophrenic angle is the most common site.¹⁰ A pericardial cyst is typically shown as a unilocular

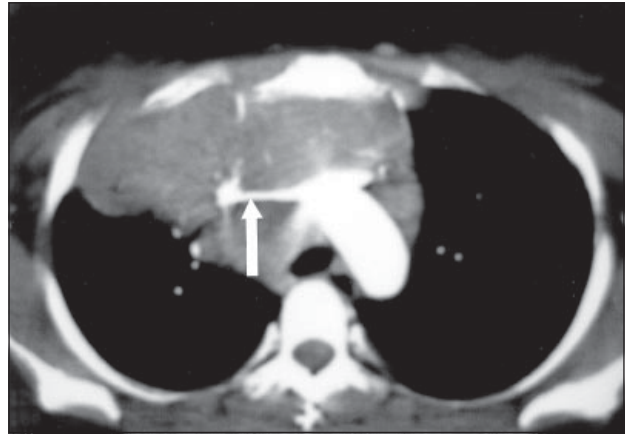


Figure 11. Non-Hodgkin's lymphoma — computed tomography reveals a huge anterior mediastinal mass showing heterogeneous contrast enhancement. The bronchiocephalic veins (arrow) as well as the superior vena cava are encased and compressed by the mass.

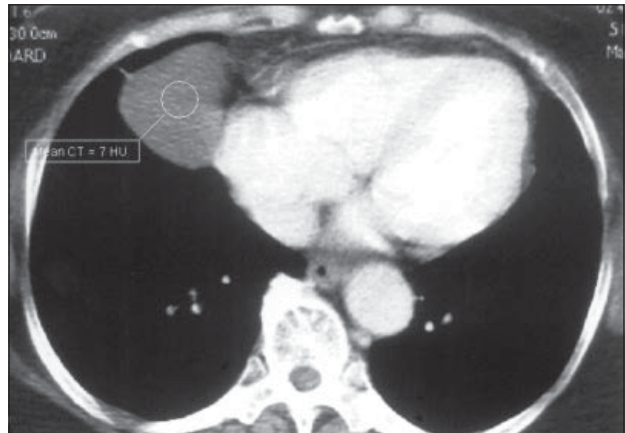


Figure 12. Pericardial cyst — a well defined unilocular non-enhancing mass with water attenuation contents is situated over right cardiophrenic angle.

non-enhancing mass with water attenuation contents and an imperceptible wall (Figure 12). It can be followed up clinically and radiologically. If there are associated symptoms or atypical imaging features, surgical resection should be performed to exclude a foregut cyst or cystic mediastinal neoplasm.

Diaphragmatic Hernia

Abdominal fat may herniate through the foramen of Morgagni. The fatty mediastinal lesion usually contains streaky thin tubular structures due to omental vessels. Abdominal contents such as the stomach, colon, small bowel or liver may also be herniated depending on the site and size of the hernial orifice.

CONCLUSIONS

Anterior mediastinal masses include lesions of diverse origin and aetiologies. Their diagnosis requires a

Table 1. Typical clinical and computed tomography features of common anterior mediastinal masses.

Lesion	Age	Clinical features	Computed tomography features
Thymic masses			
Thymoma (benign or invasive)	Middle age	Asymptomatic, ± parathymic syndromes	Well defined solid mass, homogenous or heterogeneous with necrosis or calcification, irregular margin, infiltrative appearance, pleural invasion, and vascular involvement signify 'invasive' nature. Homogenous thymic enlargement
Thymic hyperplasia	Children, young adults	Asymptomatic, associated connective tissue disease, endocrine abnormalities	
Thymic carcinoma	Middle age	Symptoms related to primary tumour or metastasis	Large poorly defined mass with local invasion, nodal or distant metastasis
Thymic carcinoid	Middle age	± Chest symptoms, ± endocrine abnormality	Large lobulated heterogeneous mass, ± local invasion or metastasis
Thymolipoma	Young adults	Asymptomatic	Fatty and soft tissue components, pliable mass attaching to the thymus
Non-neoplastic thymic cyst	Children or adults	Asymptomatic	Uni- or multiloculated well defined mass of low attenuation
Thyroid mass			
	Adults	Asymptomatic, ± mass effect	Continuity with the thyroid gland, mass effect over the trachea, high attenuation on plain computed tomography ± cyst or calcifications, intense and sustained enhancement
Germ cell tumour			
Teratoma	Children, young adults	Asymptomatic, ± chest symptoms	Mass containing fluid, soft tissue, calcification and fat, ± fat-fluid level
Seminoma	Middle age	± Chest symptoms, ± elevated β-HCG but never an elevated α-FP	Large homogenous soft tissue mass, ± local invasion
NSMM-GCT	Young adult	± Chest symptoms, ± elevated β-HCG, α-FP, LDH	Large irregular heterogeneous mass, ± local invasion, ± nodal and distant metastasis
Cystic hygroma			
	Children	Cosmetic or mass effect	Large rounded or lobulated, multicystic low density mass, tends to surround and displace mediastinal structures
Lymphoma			
Hodgkin's disease and non-Hodgkin's lymphoma	Young adult	Constitutional symptoms, palpable lymph nodes, chest symptoms	Hodgkin's disease — diffuse mediastinal enlargement, nodes, thymic mass, contiguous spread. Non-Hodgkin's lymphoma — large invasive mass ± necrosis.
Pericardial cyst			
	Adult	Asymptomatic	Well defined homogenous water density mass abutting the pericardium, anterior chest wall and diaphragm. Most commonly situated over the right cardiophrenic angle.
Diaphragmatic hernia (foramen of Morgagni)			
	Adult	Asymptomatic	Fatty component contains omental vessels and other abdominal organs. Often found over the right cardiophrenic angle.

Abbreviations: NSMM-GCT = non-seminomatous malignant germ cell tumour; α-FP = α-fetoprotein; β-HCG = β-human chorionic gonadotropin; LDH = lactate dehydrogenase.

logical and practical strategy, recruiting as much clinical and radiological information as possible. CT is the usual imaging modality for evaluation of these lesions. Their typical features are summarised in Table 1. Familiarity with the prevalence and pathological characteristics of various anterior mediastinal masses as well as the their typical CT findings is the key towards correct diagnosis and proper management.

REFERENCES

1. Wychulis AR, Payne WS, Clagett OT, Woolner LB. Surgical treatment of mediastinal tumours. *J Thoracic Cardiovasc Surg* 1972;62:379-391.
2. Morgenthaler TI, Brown LR, Colby TV, et al. Thymoma. *Mayo Clin Proc* 1993;68:1110-1123.
3. Lennon VA, Jones G, Howard F, et al. Auto antibodies to acetylcholine receptors in myasthenia gravis. *N Engl J Med* 1983;308:402-403.
4. Ellis K, Austin JH, Jaretzki A. Radiologic detection of thymoma in patients with myasthenia gravis. *Am J Roentgenol* 1988;151:873-881.
5. Strollo DC, Rosado-de-Christenson LCML, Jett JR. Primary mediastinal tumours. Part I. Tumours of the anterior mediastinum. *Chest* 1997;112:511-522.
6. Kuhlman J. Mediastinal tumours. In: Husband JES, Reznick RH, editors. *Imaging in oncology. Vol I.* Oxford: ISIS Medical Media; 1998:67-78.
7. Armstrong P, Wilson AG, Dee P, Hansell DM. *Imaging of disease of the chest.* 3rd ed. London: Mosby; 2000:789-792.
8. Strollo DC, Rosado-de-Christenson LCML, Jett JR. Primary mediastinal tumours. Part II. Tumours of the middle and posterior mediastinum. *Chest* 1997;112:1344-57.
9. Hopper KD, Diehl LF, Lesar M, et al. Hodgkin disease: clinical utility of CT in initial staging and treatment. *Radiology* 1988;169:17-22.
10. Snyder ME, Luck SR, Hernandez R, et al. Diagnostic dilemmas of mediastinal cysts. *J Pediatr Surg* 1985;20:810-815.