Primary mediastinal tumors are a heterogeneous group of tumors and account for 50% of all mediastinal masses. Thymomas are most common and can be locally invasive and associated with parathyroid syndromes. Thymic carcinomas and thymic carcinoids are rare malignancies with a propensity for local invasion and distant metastases. Thymolipomas are benign thymic tumors. The mediastinal germ cell tumors are a heterogeneous group of benign and malignant neoplasms. Mediastinal lymphangiomas are rare tumors and predominantly occur in young children. In contrast, mediastinal goiters are relatively common in adults. Mediastinal parathyroid adenomas are an uncommon cause of persistent hyperparathyroidism and rarely cause a discernible mass. The clinical, radiologic, and therapeutic aspects of the most common masses are reviewed.

Key words: germ cell tumors; goiter; lymphangioma; mediastinum; neoplasm; parathyroid adenoma; thymus

Abbreviations: AFP = α-fetoprotein; β-HCG = beta-human chorionic gonadotropin

The mediastinum is located in the central portion of the thorax, between the two pleural cavities, the diaphragm and the thoracic inlet. It is usually divided into anterior, middle, and posterior "compartments" to help categorize tumors and diseases according to their site of origin and location. However, there are no fascial or anatomic planes that separate these compartments. Although various radiologic methods have been proposed for subdividing the mediastinum, no single approach is universally applied. This review uses the classification of Fraser et al because of its simplicity. It divides the mediastinum into anterior, middle, and posterior compartments based on the lateral chest radiograph (Fig 1). The anterior mediastinum is defined as the region posterior to the sternum and anterior to the heart and brachiocephalic vessels. It extends from the thoracic inlet to the diaphragm and contains the thymus gland, fat, and lymph nodes. The middle mediastinum is defined as the space that contains the heart and pericardium to include the ascending and transverse aorta, the brachiocephalic vessels, the vena cavae, the main pulmonary arteries and veins, the trachea, bronchi, and lymph nodes. The posterior mediastinal compartment is bordered anteriorly by the heart and trachea and extends posteriorly to the thoracic vertebral margin to include the paravertebral gutters. The posterior mediastinum contains the descending thoracic aorta, esophagus, azygos veins, autonomic ganglia and nerves, thoracic duct, lymph nodes, and fat.

Primary mediastinal tumors are a heterogeneous group of neoplastic, congenital, and inflammatory conditions. Neurogenic tumors, thymomas, and benign cysts account for approximately 60% of surgically resected lesions while lymphoma, teratomas, and granulomatous diseases together comprise an additional 30%. In nonsurgical series, vascular lesions, typically aortic aneurysms, account for 10% of...
mediastinal masses. Approximately two thirds of all mediastinal tumors are benign. More than 75% of asymptomatic patients with mediastinal tumors have benign lesions, while almost two thirds of symptomatic patients with mediastinal masses have malignant lesions.4

This article will review primary anterior mediastinal tumors, which comprise approximately one half of all mediastinal masses. Anterior mediastinal neoplasms include thymoma, thymic carcinoma, thymic carcinoid, thymolipoma, germ cell tumors, and parathyroid adenoma; nonneoplastic conditions include thymic cyst, lymphangioma, and intrathoracic goiter. While lymphoma occurs in the anterior mediastinum, it will be discussed in part 2 of this series, which primarily addresses lesions of the middle and posterior mediastinal compartments.

THYMOMA

Thymoma is the most common primary tumor of the anterior mediastinum.1,5,6 Men and women are equally affected and most patients are adults older than 40 years.5,7-9 Thymomas are rare in children and adolescents. Most patients are asymptomatic, although one third experience chest pain, cough, dyspnea, and/or other symptoms related to compression or invasion of adjacent structures.10 Depending on the series, up to one half of patients suffer from one or more parathyroid syndromes, most commonly myasthenia gravis, hypogammaglobulinemia, and pure red cell aplasia.8-13 Myasthenia gravis occurs in approximately 30 to 50% of patients with thymoma. In comparison, only 15% of patients with myasthenia gravis have a thymoma.14 Because of this association, all patients with clinically suspected thymoma should have a serum anticholinesterase receptor antibody level examined to exclude myasthenia gravis prior to surgery even if they are asymptomatic.15,16 False-positive test results are rare. Approximately 25% of myasthenic patients with thymoma, particularly young women, have gradual improvement of symptoms following thymectomy.6,10,12 Uncommonly, myasthenia gravis manifests in the postthymectomy period5,6,17 and may be diagnosed by a rising titer of anticholinesterase receptor antibody. Ten percent of patients with thymoma have hypogammaglobulinemia.13,17,18 While only 5% of patients with thymoma develop pure red cell aplasia, 50% of patients with red cell aplasia have a thymoma.5,13 Thymoma is also associated with various other autoimmune disorders and tumors.4,5,9,11,13 While parathyroid syndromes can cause significant morbidity and mortality,8,10 they can also prompt the early discovery of a thymoma.5,11

Pathologically, thymomas are epithelial neoplasms characterized by an admixture of epithelial cells and mature lymphocytes.5 Most are solid neoplasms, but up to one third exhibit necrosis, hemorrhage, and cystic areas.5,10 Most thymomas are completely surrounded by a fibrous capsule. However, 34%, regardless of size, may invade through the capsule and extend directly into the mediastinal fat, pleura, pericardium, great vessels, right atrium, and/or the lung.6,8,11,19-21 Because invasive thymomas lack histologic features of malignancy and are microscopically identical to encapsulated thymomas,5,7 the term invasive thymoma is preferred over “malignant thymoma.”19 Transdiaphragmatic extension into the abdomen and retroperitoneum and drop metastases to the ipsilateral pleura and pericardium may also occur.6,11,19 Lymph node and hematogenous metastases are rare7,8,10 and may occur both with invasive or encapsulated thymomas.

Radiologically, thymoma is a well-defined, rounded, or lobulated anterior-superior mediastinal mass that typically arises from one of the thymic lobes and grows toward one side of the midline.22

\[\text{FIGURE 1. Lateral chest radiograph. Using the classification of Fraser et al.}^2\text{ the anterior mediastinal compartment is defined as the region anterior to a line (arrowheads) drawn along the anterior aspect of the heart and brachiocephalic vessels. The middle and posterior mediastinal compartments are divided by a line (arrows) placed along the posterior tracheal wall and posterior heart border.}\]
Less commonly, bilateral tumor extension occurs. While thymoma usually resides just anterior to the aortic root,\(^9\) it can occur anywhere from the neck to the cardiophrenic angle.\(^5,11\) Most measure 5 to 10 cm with a reported size range from <1 cm to 34 cm\(^5,8\) (Fig 2). Radiographically detectable calcifications are infrequent and are usually small, curvilinear, or punctate.\(^5,8,22\) On CT, an encapsulated thymoma is a well-defined, homogeneous, or heterogeneous soft-tissue mass depending on the presence of hemorrhage, necrosis, or cyst formation\(^22\) (Fig 3). Focal areas of low attenuation can be a dominant feature in large tumors.\(^9\) While subtle invasion may be difficult to detect on CT, an infiltrative appearance, obvious vascular compromise, and/or an irregular interface with the adjacent lung are highly suggestive findings of invasion\(^22\) (Fig 4). Thymoma can seed the pleural space, may progress to circumferentially encase the lung, and can mimic the appearance of a diffuse malignant mesothelioma\(^5,19,23\) (Fig 5). Even with extensive pleural involvement, pleural effusions are uncommon.\(^11\) Thoracic CT for the evaluation of thymoma should extend through the upper abdomen to exclude transdiaphragmatic extension.\(^19,24\) On MRI, thymomas have intermediate signal intensity similar to or greater than that of skeletal muscle on T\(_1\)-weighted images and increased signal intensity on T\(_2\)-weighted images.\(^9,22,25\) Cystic areas with high fluid content characteristically have low signal intensity on T\(_1\)-weighted images and high signal intensity on T\(_2\)-weighted images. Tumor lobules and fibrous septa are occasionally demonstrated.\(^25\) MRI excels in noninvasive evaluation of vascular structures to exclude invasion. Owing to the risk of recurrence, thymomas warrant long-term radiologic follow-up.\(^6,8,9,12\)

To minimize the potential for invasion and to improve survival, complete surgical excision is attempted in most cases of thymoma.\(^5,6,12\) Tumor invasiveness is determined by surgical findings of invasion supported by histologic evidence of tumor cells outside the confines of the tumor capsule.\(^7,8\) While patients with encapsulated thymoma have the best prognosis and are almost always cured by complete surgical resection, 2 to 12% of resected encapsulated thymomas recur, sometimes months or years following excision.\(^8,12\) In a series of 283 patients from Mayo Clinic,\(^5\) 32% had locally invasive tumors, including 6% with metastases to the pleura or lung. The overall 5- and 10-year survivals were 67% and 53%, respectively. In those patients without invasive tumors, the 5- and 10-year survivals were 75% and 63%, respectively, vs 50% and 30%, respectively, in those with invasive thymomas. Forty-six percent had myasthenia but it was not associated with a worse survival (\(p=0.35\)). Radiation therapy is usually recommended for invasive or incompletely excised tumors.\(^26\) Invasive thymoma is chemosensitive. Numerous reports have documented responses to various chemotherapeutic regimens, especially those utilizing cisplatin. In a recent report by Loehrer et al,\(^27\) 29 patients with metastatic or recurrent thy-

![Figure 2. Posteroanterior (left) and lateral (right) chest radiographs. A 10×7-cm sharply margined thymoma (arrows) in the anterior mediastinum has been displaced inferiorly by its large weight.](image-url)
moma were treated with cisplatin, doxorubicin, and cyclophosphamide. The overall response rate was approximately 50% with three complete responses and 12 partial responses. The median duration of response was 12 months with a median survival of 38 months and a 5-year survival of 30%.

Thymic Carcinoma

The thymic carcinomas are a heterogeneous group of aggressive epithelial malignancies that have a strong propensity for early local invasion and widespread metastases. Squamous cell carcinoma and lymphoepithelioma-like carcinoma are the most common cell types and usually occur in middle-aged men with a mean age of 46 years. Their malignant cytologic features distinguish them from both encapsulated and invasive thymomas as the latter are cytologically benign. An occult primary lung malignancy metastatic to the thymus must be excluded because the histologic types resemble those found more typically in the lung. Thymic carcinoma is locally invasive and, unlike thymoma, frequently metastasizes to regional lymph nodes and distant sites. Radiologically, thymic carcinomas commonly manifest as large, poorly defined, infiltrative anterior mediastinal masses and are frequently associated with pleural and pericardial effusions, although pleural implants are uncommon (Fig 6). Like thymoma, thymic carcinoma may exhibit cystic changes on cross-sectional imaging studies.

Therapy and prognosis depend on tumor histologic condition and stage at presentation. Suster and Rosai reported a clinicopathologic series of 60 patients with thymic carcinoma. Although their series was unable to document efficacy of the various treatment modalities, complete and partial response
of thymic carcinoma to cisplatin-based chemotherapy has been reported.\textsuperscript{33} Combination chemotherapy with etoposide and cisplatin and concurrent radiotherapy is considered a reasonable treatment approach. When patients are unable to tolerate simultaneous chemoradiotherapy, sequential therapy is used.\textsuperscript{26,27,33} The 3- and 5-year survival rates are 40\% and 33\%, respectively. The 5-year survival for high-grade tumors (defined as those with lobular growth patterns, severe cytologic atypia, extensive necrosis, and high mitotic activity) was 15 to 20\% as opposed to 90\% for low-grade tumors, thus documenting the prognostic importance of histologic grade.

**Thymic Carcinoid**

Thymic carcinoid is a rare malignancy that is histologically identical to carcinoid tumors at other sites. It typically affects men in the fourth to fifth decades of life.\textsuperscript{34,35} Approximately 50\% of patients have endocrine abnormalities, most commonly Cushing syndrome due to ectopic adrenocorticotropic hormone production or multiple endocrine neoplasia syndrome.\textsuperscript{5,34} The classic carcinoid syndrome is rarely associated with thymic carcinoid.\textsuperscript{36} Patients may also be asymptomatic or experience symptoms of compression and/or invasion.\textsuperscript{35} Regional lymph node and distant metastases, including osteoblastic bone metastases, are reported in up to 73\% of cases and can occur late.\textsuperscript{34,36} Thymic carcinoid manifests as a large, lobulated, and usually invasive anterior mediastinal mass that may exhibit areas of hemorrhage and necrosis.\textsuperscript{5,34} Punctate and dystrophic calcification\textsuperscript{34} and contrast enhancement on CT\textsuperscript{37} may also be seen. Complete surgical excision is the treatment of choice. Local spread to regional nodes, local tumor invasion, and distant metastases have been treated with radiotherapy and chemotherapy, but this tumor is highly resistant to these modalities.\textsuperscript{34,36}

**Thymolipoma**

Thymolipoma is a rare benign slow-growing neoplasm of the thymus that affects male and female subjects equally over a wide age range. However, young adults (with a mean age of 27 years) are most commonly afflicted.\textsuperscript{38} Approximately half of the patients are asymptomatic.

Thymolipoma is a large, soft, encapsulated mass composed of mature adipose cells and thymic tissue.\textsuperscript{5} Twenty-five percent of tumors weigh more than 2 kg. Radiologically, thymolipoma is a large anterior mediastinal mass that frequently droops into the anterior inferior mediastinum and may occupy one or both hemithoraces. It is characterized by its ability to conform to adjacent structures simulating cardiomegaly and diaphragmatic elevation and by changes in shape that follow changes in patient position.\textsuperscript{38} CT and MRI demonstrate the classic combination of fat and soft-tissue elements and establish the tumor attachment to the anatomic region of the thymus (Fig 7). Some thymolipomas are of predominant fat attenuation and may resemble mediastinal lipomas. Surgical excision is curative.

**Nonneoplastic Thymic Cysts**

Thymic cysts are rare and represent approximately 3\% of all anterior mediastinal masses.\textsuperscript{4} Their etiology is controversial. Thymic cysts may be congenital\textsuperscript{39} or acquired, either due to inflammation or in association with an inflammatory neoplasm such as Hodgkin’s lymphoma, seminoma, or thymic carcinoma.\textsuperscript{40,41} Congenital thymic cysts are thought to be remnants of the thymopharyngeal duct and can be found anywhere along the embryologic course of the thymus as it migrates from the neck into the anterior mediastinum.\textsuperscript{39} The origin of inflammatory thymic cysts is less clear. They probably arise from inflamed thymic parenchyma through secondary cystic dilatation of epithelial-derived structures and contain areas of inflammation and fibrosis. Approximately 50\% of congenital thymic cysts are incidentally discovered in the first two decades of life,\textsuperscript{39} while inflammatory thymic cysts usually occur in asymptomatic adult men.\textsuperscript{40} Thymic cysts associated with neoplasia are more likely to cause symptoms. Most congenital cysts
measure <6 cm, are usually rounded and uniloculated or multiloculated, and have thin walls without inflammatory change. Acquired thymic cysts range in size from 3 to 17 cm, are usually multiloculated, and have a variable wall thickness. Because inflammatory thymic cysts may have microscopic and gross features identical to those of cystic thymic neoplasms, thorough specimen sampling and examination of the cyst wall are mandatory to exclude neoplasia. Radiologically, thymic cysts typically manifest as well-circumscribed anterior superior mediastinal masses. They may be uniloculated or multiloculated and usually have low attenuation contents, with occasional visualization of septa and linear

Figure 7. Posteroanterior (top left) and lateral (top right) chest radiographs. A large thymolipoma (arrows) droops into the right inferior portion of the anterior mediastinum and conforms to the heart and right hemidiaphragm. Bottom, enhanced CT scans through the lower thorax. The thymolipoma arises from the anterior mediastinum, extends into the right hemithorax, and contains characteristic whorls of fat and thymic soft tissue.
wall calcification. Surgical excision is the therapy of choice.\textsuperscript{41} Acquired lesions may recur after excision.\textsuperscript{40}

**Mediastinal Germ Cell Tumors**

Mediastinal germ cell tumors (teratomas, seminomas, and nonseminomatous malignant germ cell tumors) are a heterogeneous group of benign and malignant neoplasms thought to originate from primitive germ cells “misplaced” in the mediastinum during early embryogenesis.\textsuperscript{42,43} The anterior mediastinum, especially the anterosuperior portion, is the most common extragonadal primary site.\textsuperscript{42,44} Mediastinal germ cell tumors represent approximately 10 to 15\% of adult anterior mediastinal tumors\textsuperscript{1,42} and are histologically identical to their gonadal counterparts.\textsuperscript{44,45} Patients are usually young adults with a mean age of 27 years.\textsuperscript{42,46} While mature teratomas occur with approximately equal frequency in male and female subjects, >90\% of malignant germ cell tumors occur in male subjects.\textsuperscript{42} When a malignant mediastinal germ cell tumor is diagnosed, a primary gonadal malignancy (although rarely metastatic solely to the anterior mediastinum) must be excluded.\textsuperscript{45,47,48} Serologic evaluation for α-fetoprotein (AFP) and β-human chorionic gonadotropin (β-HCG) is helpful in the evaluation of patients with clinically suspected malignant mediastinal germ cell tumor.

**Mediastinal Teratomas**

Teratomas are the most common mediastinal germ cell tumors.\textsuperscript{42,44} They are composed of tissues that arise from more than one of the three primitive germ cell layers\textsuperscript{42,45} and are “foreign” to the anatomic site in which they occur.\textsuperscript{45} The vast majority are mature teratomas that are histologically well differentiated and benign.\textsuperscript{42} A teratoma rarely contains fetal tissue and is then classified as an immature teratoma, which has a good prognosis in children but may recur or metastasize.\textsuperscript{45} Rarely, a mature teratoma can contain a focus of carcinoma, sarcoma, or malignant germ cell tumor; when it does, it is then termed a “malignant teratoma”\textsuperscript{45} or “teratocarcinoma.”

Mature teratoma represents approximately 60 to 70\% of mediastinal germ cell tumors.\textsuperscript{42} It occurs most frequently in children and young adults, with male and female subjects equally affected. Patients are usually asymptomatic, but large tumors may cause chest pain, dyspnea, cough, or other symptoms of compression.\textsuperscript{46} Digestive enzymes secreted by intestinal mucosa or pancreatic tissue in the tumor can precipitate rupture into the bronchi, pleura, pericardium, or lung.\textsuperscript{42,45,46,49,50} Expectoration of hair (trichoptysis) or sebum is a rare but pathognomonic sign of ruptured mediastinal teratoma.\textsuperscript{46,50} Mature teratoma is an encapsulated mass characterized by the presence of cystic and solid areas.\textsuperscript{46} The tumor may attempt organ formation\textsuperscript{45} and can contain teeth, skin, and hair (ectodermal derivatives); cartilage and bone (mesodermal derivatives); and/or bronchial, intestinal, and pancreatic tissue (endodermal derivatives).\textsuperscript{45,46,49} Radiologically, these are rounded to lobulated, well-defined anterior mediastinal masses that usually protrude to one side of midline and can reach large sizes.\textsuperscript{46} On chest radiographs, up to 26\% exhibit calcification and may rarely display recognizable bone or teeth.\textsuperscript{46} On CT, these are typically multilocular cystic tumors with walls of variable thickness.\textsuperscript{51} The combination of fluid, soft tissue, calcium, and/or fat attenuation in an anterior mediastinal mass is a highly specific finding that allows the prospective diagnosis of mature teratoma (Fig 8). Fat-fluid levels produced by high lipid content in the cyst fluid are diagnostic but rare findings. Surgical excision is curative.

**Mediastinal Seminoma**

Seminoma represents 40\% of malignant germ cell tumors of single histology.\textsuperscript{47} White men in their third and fourth decades of life are most commonly afflicted and are usually symptomatic. Approximately 10\% of patients with pure seminoma may have an elevated β-HCG level, but never an elevated AFP level. Radiologically, seminoma manifests as a bulky lobulated homogeneous anterior mediastinal mass,\textsuperscript{47} which uncommonly invades adjacent structures,\textsuperscript{42,52} but can metastasize to regional lymph nodes and bone.\textsuperscript{47,53} Calcification is rare.\textsuperscript{54} Mediastinal semino-
mas are highly sensitive to both radiation and systemic chemotherapy.\textsuperscript{55} Treatment is somewhat controversial. Small localized tumors may be treated with primary resection followed by radiotherapy. In patients with locally advanced disease, the preferred treatment is systemic chemotherapy (see nonseminomatous germ cell tumors) followed by surgical resection of any residual disease. Therapy should be curative in most patients. Long-term survival is 60 to 80%.\textsuperscript{42,55}

**Mediastinal Nonseminomatous Malignant Germ Cell Tumors**

The nonseminomatous malignant germ cell tumors include embryonal cell carcinoma, endodermal sinus tumor, choriocarcinoma, or mixed germ cell tumors composed of multiple histologic features. These are malignant and typically cause symptoms in young adult men.\textsuperscript{42} Lactate dehydrogenase and serologic markers such as AFP and \( \beta \)-HCG are frequently positive. In a series of patients with extragonadal germ cell tumors, 20 of 28 (71\%) patients with nonseminomatous tumors had an elevated AFP level and 15 of 28 (54\%) had an elevated \( \beta \)-HCG level.\textsuperscript{55} In comparison, none of the 11 patients with seminoma had an elevated AFP level and 2 of 11 had an elevated \( \beta \)-HCG level. Nonseminomatous malignant germ cell tumors are uniquely associated with hematologic malignancies\textsuperscript{43,56} and approximately 20\% of patients have Klinefelter’s syndrome.\textsuperscript{43,57} Radiologically, these are large, irregular, anterior mediastinal masses, often with extensive, central, irregular, and heterogeneous areas of low attenuation due to necrosis, hemorrhage, and/or cyst formation.\textsuperscript{52} Invasion of adjacent structures, including the chest wall, may occur as well as metastases to regional lymph nodes and distant sites\textsuperscript{56,59} (Fig 9). Pleural and pericardial effusions are common.\textsuperscript{42,52}

Bukowski and associates\textsuperscript{55} of the Southwest Oncology Group treated 41 patients with extragonadal seminoma or nonseminomatous malignant germ cell tumors with four cycles of chemotherapy containing bleomycin and cisplatin and various other agents followed by surgical resection. Twenty-four of 41 patients had mediastinal tumors while 15 had retroperitoneal tumors and 2 had unknown primary sites. The 2- and 5-year survivals for the patients in this series were 67\% and 60\%, respectively.\textsuperscript{55} Currently, the standard treatment for a primary mediastinal malignant germ cell tumor is four cycles of bleomycin, etoposide, and cisplatin. Surgical resection of a residual mass is indicated, especially if the tumor markers are negative.\textsuperscript{55} While surgical excision should not be the initial treatment, a tissue diagnosis is necessary before starting chemotherapy.

**Mediastinal Lymphangioma**

Mediastinal lymphangioma (cystic hygroma) is a histologically benign\textsuperscript{60} proliferation of interconnecting lymphatic vessels and sacs that may grow in an infiltrative fashion.\textsuperscript{61} Its etiology is controversial; some authors suggest it is a developmental lesion\textsuperscript{61} while others postulate it has a hamartomatous or neoplastic origin.\textsuperscript{60,61} Lymphangioma is typically a tumor of very young children. Fifty percent are present at birth and 90\% are discovered by 2 years of age.\textsuperscript{60,62} Ninety-five percent involve the neck or axilla and 10\% extend into the superior aspect of the anterior mediastinum\textsuperscript{63} or, less commonly, other mediastinal compartments.\textsuperscript{64} Rarely, lymphangiomas occur as primary mediastinal tumors in adults or as a generalized lymphangiomatosis with extensive multifocal involvement of multiple organ systems.\textsuperscript{61,62}

Pathologically, the dilated lymph spaces can range in caliber from capillary size to several centimeters in dimension.\textsuperscript{61} Mediastinal lymphangioma typically occurs in the superior aspect of the anterior mediastinum and is usually contiguous with a cervical or axillary component.\textsuperscript{62} Radiologically, these are rounded, lobulated, multicystic tumors that can reach massive sizes and may infiltrate across tissue planes\textsuperscript{63} (Fig 10). They may surround or displace mediastinal structures\textsuperscript{63,64} On CT, “cysts” (representing the large vascular spaces) vary in diameter from 1 to 2 mm to several centimeters, are usually
near water attenuation, and display thin or thick septa that may enhance minimally after contrast administration.63 Because of its insinuating nature, complete surgical resection of lymphangiomas may be difficult and surveillance is needed to exclude recurrence.60,62

**Mediastinal Goiter**

While mediastinal goiter represents only 10% of mediastinal masses in surgical series,1 it is one of the most commonly seen in clinical practice. Twenty percent of cervical goiters descend into the thorax, usually into the left anterior superior mediastinum.65 Infrequently, they can extend behind the trachea and involve the middle and posterior mediastinal compartments. Primary intrathoracic goiters without a cervical component are very rare.66 These tumors rarely contain loci of malignancy. Mediastinal goiters occur most commonly in asymptomatic women with a palpable cervical goiter. Occasionally patients have symptoms of compression or pain.

Radiologically, mediastinal goiter is an encapsulated, lobulated, heterogeneous tumor.66,67 The diagnostic radiologic feature is the continuity between the cervical and mediastinal components that is usually evident on cross-sectional imaging (Fig 11). Well-defined areas of low attenuation on an unenhanced chest CT can reflect hemorrhage and cyst formation while areas of increased attenuation relative to adjacent soft-tissue structures represent intrinsic iodine within the gland.66,67 Coarse, punctate, or ring-like calcifications are common65 (Fig 12). After IV contrast administration, the goiter frequently demonstrates intense and sustained enhancement.67 Radioactive iodine 131 and 123 scintigraphy can be diagnostic when functioning thyroid tissue is present.65 The treatment of choice for symptomatic or potentially symptomatic lesions is surgical resection. Most can be excised through a cervical incision but occasionally a sternotomy is required.

**Mediastinal Parathyroid Adenoma**

A parathyroid adenoma is a benign functioning neoplasm that occurs most commonly in the neck.
Ten percent of tumors are ectopic, and almost half occur in the anterior mediastinum, usually near or within the thymus due to a common embryologic origin from the third and fourth brachial pouches. Older women are most commonly affected and present with signs and symptoms of hyperparathyroidism that persist following cervical parathyroidectomy.

Pathologically, mediastinal parathyroid adenomas are identical to cervical parathyroid adenomas. They are encapsulated and rounded and usually measure <3 cm. Because of their small size, they are rarely detected on chest radiographs. On unenhanced CT, they can resemble a lymph node and only 25% demonstrate perceptible enhancement after IV contrast administration. Parathyroid adenomas can avidly take up radioactive 99mTc and 201Tl. For localizing parathyroid adenomas, 99mTc-sestamibi scintigraphy with a sensitivity of 88 to 100% is superior to dual isotope imaging using 99mTc-per-technetate and 201Tl which has a sensitivity of 55 to 100%. On MRI, parathyroid adenomas have increased signal intensity on T2*-weighted images and on gadolinium-enhanced T1-weighted images. Fifty to 75% of abnormal parathyroid glands in patients with persistent or recurrent hyperparathyroidism can be detected with MRI.

CONCLUSION

Many mediastinal masses are serendipitously discovered on chest radiographs obtained for other reasons. Some patients will come to clinical attention with vague chest complaints or with signs and symptoms related to compression or invasion of mediastinal structures.

The most common primary anterior mediastinal tumors are thymoma, teratoma, substernal goiter, and lymphoma. All other lesions are extremely rare. Patients with anterior mediastinal masses should be evaluated preoperatively for myasthenia gravis that could result in respiratory failure in the postoperative period if untreated. Neck palpation should be performed to exclude the mediastinal extension of a cervical goiter and to detect occult generalized lymphadenopathy.

The radiologic evaluation of these patients begins with the chest radiograph and is followed by cross-sectional imaging with CT. CT is useful in excluding vascular causes and some benign causes of mediastinal widening such as lipomatos. In addition, confident diagnosis of some lesions such as mature teratoma and mediastinal goiter can be accomplished as well as evaluation of adjacent structures to exclude evidence of mass effect or invasion.

In addition to basic laboratory tests, serologic evaluation for detection of antiacetylcholine receptor antibodies, AFP and β-HCG should be performed to exclude myasthenia gravis and nonseminomatous malignant germ cell tumors, respectively.

Patients with primary mediastinal masses and cysts will usually undergo surgical resection. The presence of lymphadenopathy (in the case of lymphoma and metastatic disease) or positive AFP or β-HCG serologic test results should prompt limited biopsy specimens of the lesion followed by oncologic consultation and chemotherapy or radiotherapy when appropriate. Resection of residual tumor will follow in some cases.

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