I know it is a thymic lesion. But what more can I say about it?
Learning objectives

Finding a potential thymic abnormality on imaging can be quite challenging for radiologists. It raises many questions about its real origin and nature.

Through this exhibit, we aim to:

1. review the embryology, normal anatomy, histology and physiology of the thymic gland;
2. demonstrate the role of imaging in the management of thymic lesions;
3. describe the different aspects of thymic lesions in both CT scan and MRI;
4. provide tools to help making the difference between a benign and malignant thymic lesion.
Background

Thymic masses constitute a heterogeneous group of lesions taking place in the anterior mediastinum. They need to be differentiated from masses from other origins (thyroid, lymph nodes, teratomas, etc…). Radiologists should be able to affirm the thymic origin of an anterior mediastinal mass, and then approach its benign or malignant nature to allow providing a better management to the patient. For this, radiologists need a prior knowledge about normal thymus.

I. Embryology of the thymus

The thymus arises bilaterally from the third and fourth branchial pouches and contains elements derived from all three germinal layers.

Development begins in the 6th gestational week.

Migration of tissue occurs during the 8th week, leading to a fusion of the bilateral lobes, with the thymus occupying its final position in the antero-superior mediastinum.

In the course of its development, until the 9th gestational week, the thymus remains purely epithelial.

By the 10th week, small lymphoid cells migrate from fetal liver and bone marrow, leading to lobulation of the gland.

Further differentiation into cortex and medulla is completed by 14-16 weeks.

Thereafter, the thymus grows rapidly and attains its greatest weight in relation to body weight before birth (average 15 g) [1].

II. Anatomy of the thymus

After reaching its greatest weight in proportion to body weight before birth, the thymus continues to grow, reaching its maximum absolute weight at puberty.

The thymus subsequently undergoes a process of involution, which is defined as a decrease in the size and weight of the gland with advancing age.

During involution, the epithelial component atrophies, resulting in scattered small lymphocytes in abundant adipose tissue.
The normal thymus is a triangular, bilobed organ residing in the anterior mediastinum. Its shape, size and composition change with age (Fig. 1 on page 7).

The left lobe is often slightly more prominent than the right, with concave or flat margins in the normal adult [1, 2].

There is great variability in the appearance of the thymus on imaging studies, including features such as size, shape, attenuation on computed tomography (CT) and signal characteristics on magnetic resonance imaging (MRI). Due to the variety of imaging appearances, it may be challenging to differentiate the normal from the diseased thymus [4].

For example, convex borders, although they are a normal finding in children and are occasionally a normal finding in young adults, may suggest the presence of thymic hyperplasia or a mass in adults [5].

Typically, the thymus is visible at CT and fills the perivascular space throughout the first 2 decades of life.

In children younger than 5 years, it typically appears quadrilateral with convex borders. As children grow, the thymus gradually becomes triangular with straight or concave borders (Fig. 2 on page 7).

At MRI, the thymus appears homogeneous, with signal intensity greater than that of muscle on T1-weighted images and signal intensity close to that of fat on T2-weighted images [2] (Fig. 3 on page 8).

The normal thymus shows homogeneous decrease in signal intensity at Dual Gradient-Echo In-Phase and Opposed-Phase (Fig. 4 on page 8) [6].

III. Histology of the thymus

The cortex is composed primarily of lymphocytes (thymocytes), with a few epithelial and mesenchymal cells, whereas the medulla is composed of more epithelial cells but fewer lymphocytes.

Epithelial cells compose the framework of the thymus; they are functionally essential for the maturation of T lymphocytes and thus are called "nurse cells".

Hassall corpuscles are the characteristic structures of the thymus and are found exclusively in the medulla.

The thymus contains a variety of other types of cells, including macrophages and myoid cells. Myoid cells are of great interest because of their potential role in the pathogenesis of myasthenia gravis.
A basic knowledge of the histologic features of the thymus is essential for understanding the various pathologic conditions that affect this gland, including thymic epithelial tumors. Familiarity with the current WHO classification scheme, which is based on histologic features, is also essential [1].

IV. Physiology of the thymus

The thymus is one of the central lymphoid organs and plays an important role in cellular immunity by generating circulating T lymphocytes.

Although the need for the thymus to generate a continuous supply of T-cells decreases with advancing age, the thymus continues to serve as the site of T-cell differentiation and maturation throughout life.

One of the major functions of the thymus, the maturation of thymocytes, has been studied extensively with molecular and cellular biology [1].

V. Differential diagnosis: what is not thymic

Differentiation of the thymus from other mediastinal structures, such as lymph nodes or the superior sinus of the pericardium, may be difficult. Therefore, it is important to be familiar with the location, shape, and size of the normal thymus [1].

With the presentation of an anterior mediastinal mass, the differential diagnosis includes, besides thymic lesions, non thymic tumors, such as lymphoma, germ cell tumor, small cell lung cancer, and mediastinal metastasis (Fig. 5 on page 9).

CT is by far the most common imaging modality used to assess an anterior mediastinal mass.

Patient age and gender and the presence of myasthenia gravis, as well as tissue composition as assessed by CT scan, and evidence of tumor invasiveness, are helpful in the differential diagnosis of anterior mediastinal masses and usually suffice for management decisions. For example, thymoma rarely presents with lymphadenopathy, pleural effusion, or extrathoracic metastases. Any of these suggest a diagnosis other than thymoma.

Some anterior mediastinal masses have a typical appearance. For example, a cystic anterior mediastinal mass with intrinsic fat attenuation is typically a mature teratoma. Malignant germ cell neoplasms almost exclusively affect men and are more common in patients younger than 40 years [7].
Although many surgeons biopsy the anterior mediastinal mass before surgery, some surgeons advocate thymectomy without biopsy for small anterior mediastinal masses suggestive of thymoma. The importance of reaching the correct diagnosis with imaging cannot be overstated with this latter approach, as treatment differs significantly among the various anterior mediastinal tumors. Early-stage thymic epithelial malignancies and mature teratoma are resected, and germ cell tumor and lymphoma are treated with chemotherapy and/or radiation therapy, whereas thymic cyst is usually watched [7].
**Fig. 1:** Drawing illustrating a normal pediatric thymus, which may extend to the inferior border of the thyroid gland. After puberty, the thymus involutes and will rarely be recognized in the thoracic inlet, although thymic lesions may occasionally occur in this cephalic location.

© Benveniste MFK et al., Role of Imaging in the Diagnosis, Staging, and Treatment of Thymoma, RadioGraphics 2011; 31:1847-1861 [3].
Fig. 2: CT scan with axial reconstructions, performed on different patients of different ages, showing the variety of normal thymus appearances (arrows). A: 4 years old patient. B: 41 years old male patient. C: 46 years old female patient.

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Fig. 3: MRI: the thymus appears homogeneous, with signal intensity close to that of fat on T2-weighted images.

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Fig. 4: Normal thymus of a 20 year old girl. In-phase (a) and opposed phase (b) of T1-weighted 2D gradient echo MR images. The thymus shows homogeneous decrease in signal intensity at opposed-phase image (b) contrast to in-phase image (a).

<table>
<thead>
<tr>
<th>Superior</th>
<th>Anterior</th>
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<tr>
<td>Thymoma</td>
<td>Lymphoma</td>
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<tr>
<td>Thyroid (substernal)</td>
<td>Teratoma</td>
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<td>Germ cell tumor</td>
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<table>
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<tr>
<th>Thyroid</th>
<th>Lymphoma</th>
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<tr>
<td>1. Thoracic inlet</td>
<td>1. Anterosuperior</td>
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<tr>
<td>2. Smooth, frequently symmetric</td>
<td>2. Smooth, homogeneous</td>
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<td></td>
<td>3. Frequently surrounds great vessels</td>
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<table>
<thead>
<tr>
<th>Teratoma</th>
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<tr>
<td>1. lower superior or anterior compartment</td>
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<td>2. May contain calcifications</td>
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**Fig. 5:** Diagnosis of anterior mediastinal tumors.

Findings and procedure details

The thymic gland knows physiological variations depending on patient's age. A benign hypertrophy can also be observed in some specific cases. Thymic masses are seen more frequently in adults. They can be benign or malignant but they are generally dominated by thymomas. Thymic carcinoma, sarcoma, lymphoma, germ cell tumors, neuroendocrine tumors and secondary thymic tumors can also be found. Imaging plays a capital role in thymic lesions identification, staging and in follow-up monitoring for recurrence.

I. Available imaging modalities

Initial investigation of thymic lesions starts with a chest radiograph, which is followed by a chest CT scan for further characterization and staging.

CT scan is not only more user friendly, with better spatial resolution compared with magnetic resonance imaging (MRI), but CT was shown to be equal or superior to MRI in the diagnosis of thymic lesions, except for thymic cysts.

In the future, MRI and positron emission tomography (PET)/CT may play a greater role in the managing of thymic lesions [7].

The radiologist must be familiar with the advantages and disadvantages of each imaging modality, and the information it may offer with respect to thymoma staging and treatment planning [3].

II. Abnormal thymus

A. Thymic hyperplasia

There are two types of thymic hyperplasia, lymphoid follicular hyperplasia and true hyperplasia.

Lymphoid follicular hyperplasia, also known as autoimmune thymitis, is characterized by normal size and weight of the thymus with chronic inflammation and proliferation of lymphoid follicles, active germinal centers and increased numbers of lymphocytes and epithelial cells. Follicular hyperplasia is seen in about two-thirds of patients with myasthenia gravis; it may also be associated with autoimmune diseases or endocrine diseases such as systemic lupus erythematosus, thyrotoxicosis and Addison's disease.
In lymphoid follicular hyperplasia, the thymic gland usually retains its normal shape, but it may be either of normal size or enlarged, and occasionally there may be a focal mass. In a patient with myasthenia gravis, enlargement or a focal mass may represent either lymphoid hyperplasia or thymoma.

True thymic hyperplasia is much less common than lymphoid follicular hyperplasia and is sometimes seen in association with thyrotoxicosis, Graves' disease, acromegaly and red cell aplasia. True hyperplasia generally manifests as diffuse, symmetric enlargement of the gland, involving both the cortex and the medulla.

On imaging studies, the gland is diffusely enlarged and preserves its normal shape, showing a homogenous appearance similar to normal thymic tissue at both CT and MR (Fig. 6 on page 18, Fig. 7 on page 18).

Thymic rebound represents a form of true thymic hyperplasia that may be seen after resolution of a stressful event, for example, after cessation of chemotherapy; this entity is most often encountered in children and young adults (Fig. 8 on page 19). Thymic rebound must be strongly considered when there is an enlarging anterior mediastinal mass in a patient with lymphoma who has recently completed chemotherapy [4].

B. Thymic Cysts

Congenital thymic cysts originate from embryonic remnants and may be found along the thymopharyngeal duct, which extends from the upper neck to the anterior mediastinum and are usually unicocular and generally small. Congenital thymic cysts occur rarely in the posterior mediastinum or near the diaphragm.

Acquired thymic cysts have been reported to occur before and after chemotherapy for non-Hodgkin or Hodgkin lymphoma, after thoracotomy, and in about 40% of patients with thymomas (Fig. 9 on page 20). Cystic changes can be seen in a variety of thymic tumors, including thymic epithelial tumors, Hodgkin and non-Hodgkin lymphomas, germ cell tumors, and thymic carcinomas.

On radiographs, thymic cysts usually appear as homogeneous circumscribed masses that may have calcified rims. Their opacity is usually in the range of water, although this may vary depending on the presence of blood products or fat. At CT, thymic cysts are unremarkable, have thin walls and no solid component, and show no contrast enhancement [2].

Differentiation of thymic cysts from solid lesions is more readily and consistently achieved with MRI. Hyperdense thymic cysts are often misinterpreted as solid on CT. Generally, thymic cysts are T1-hypointense; however, their T1 signal can vary depending on their contents (hemorrhage, lipid, and protein increase internal T1 intensity). Thymic cysts can spontaneously hemorrhage.
Unenhanced and contrast-enhanced dynamic imaging (with post processed subtraction if needed) is definitive because a complete lack of enhancement proves the presence of a cyst and does not expose the patient to the double dose of radiation that unenhanced and contrast-enhanced CT would require to make the same determination [9].

Although some cysts develop after irradiation of the mediastinum or following chemotherapy (64), thymic cyst can coexist with Hodgkin’s disease, unrelated to therapy. If the cyst is multilocular, thick-walled, or associated with a soft tissue, biopsy or surgical resection may be indicated to exclude malignancy [6].

C. Thymic tumors

Thymic tumors are relatively uncommon, and a diverse spectrum of pathologic processes can affect the thymus [10].

1. Thymic epithelial neoplasms

a. Classification

The histologic typing of thymoma is complex and has been the source of controversy for many years. Thymomas are composed of neoplastic epithelial cells and nonneoplastic lymphocytes and exhibit marked histologic variability. The World Health Organization (WHO) classification scheme is the most used (Fig. 10 on page 20). This scheme has been shown to correlate with the invasiveness and clinical behavior of tumors and with prognosis, has important preoperative implications for treatment strategy [1].

But things aren’t that simple. In fact, certain types of thymoma do not fall into any of the categories in the WHO scheme. To complicate matters, several WHO subtypes often coexist in the same tumor, which makes classification challenging—particularly at needle biopsy, which may not yield a sample of the predominant tumor subtype. Currently, the histologic classification of thymoma has no clinical implications, and management decisions rest primarily on the stage of disease and the completeness of resection [3].

b. Staging

Many different staging systems for thymoma have been proposed. The Masaoka-Koga clinical-pathologic staging system, based on invasiveness of the tumor at surgery, is the most commonly used, since it has been shown to correlate with 5-year survival rates. Masaoka-Koga staging is based on the gross and microscopic properties of the tumor (Fig. 11 on page 20) [1, 3].
c. CT scan

Typically, thymomas present on the CT scan as a spherical or ovoid, smooth, anterior mediastinal mass (Fig. 12 on page 21). They have been described as ranging from a few millimeters to 34 cm in diameter. They are usually closely related to the superior pericardium, although they may present anywhere from the thoracic inlet to the cardiophrenic border. The tumor enhances homogenously (Fig. 13 on page 21). It may present with lobulated borders (Fig. 14 on page 22) or may be heterogeneous (Fig. 15 on page 22) or even cystic (Fig. 16 on page 23) because of areas of hemorrhage and necrosis (Fig. 17 on page 23). The tumor can be partially or completely outlined by fat and may contain punctuate (Fig. 18 on page 24), coarse, or curvilinear calcifications (Fig. 19 on page 24).

Intravenous contrast is not needed for identification of a thymic mass, but it is necessary for staging of thymoma.

Typical CT findings for stage III disease with vascular involvement include an irregular vessel lumen contour, endoluminal soft tissue, and vascular encasement (Fig. 20 on page 25).

Ipsilateral pleural nodules are suggestive of stage IVa disease. Unfortunately, the majority of stage III thymomas present without an effect on the vessel lumen and with no direct CT sign.

The most crucial question facing the clinician and radiologist trying to stage thymoma is the distinction between early disease (stages I and II) and more advanced disease (stages III and IV) requiring neoadjuvant chemotherapy. Some morphologic features of the primary tumor are predictive of advanced disease, including large tumor size (Fig. 20 on page 25). Lobulated contours and infiltration of surrounding mediastinal fat (Fig. 21 on page 25) [7].

d. MRI

MRI has been insufficiently studied in the staging of thymoma and follow-up monitoring of patients with the disease, despite the relative youth of the thymoma patient population and the necessity for repeated imaging for follow-up surveillance. However, MRI does play a major role in the investigation of the anterior mediastinal mass and in the staging of thymoma in patients with iodine allergy or with renal failure, as evaluation of the mediastinal vessels is crucial for this staging (Fig. 22 on page 26).

Thymoma manifests with low to intermediate signal intensity on T1-weighted images and with high signal intensity on T2-weighted images. Signal intensity is heterogeneous in tumors with necrosis, hemorrhage, or cystic change. The better contrast resolution of MRI as compared with CT is advantageous in the patient with a cystic anterior mediastinal mass when distinction between a congenital cyst and cystic thymoma should be made.
Fibrous septa and/or mural nodules are typically present in cystic thymoma but absent from a congenital cyst. These septa and nodules are often not appreciated on CT but are seen readily on T2-weighted MRI images. Similarly, with the good contrast resolution of MRI, septa and the tumor capsule are sometimes appreciated within solid tumors as well. Their visualization was shown to be associated with a less aggressive histologic classification. Predominance of a necrotic or cystic component and heterogeneous enhancement are signs of aggressiveness and are much more common with thymic cancer than with thymoma.

Hemorrhage within the tumor may vary in its MRI appearance with the age of the hemorrhage; hemosiderin deposition may appear as low signal intensity on T1-weighted and T2-weighted images. MRI is inferior to CT in demonstrating calcification within thymomas [7].

2. Thymic carcinoma

Thymic carcinomas account for about 20% of thymic epithelial tumors. The mean age of patients with thymic carcinomas is 50 years. It is difficult to distinguish thymic carcinomas from thymomas on the sole basis of imaging findings. On imaging, aggressive features such as central necrosis, vascular encasement, pleural/pericardial invasion, distant metastasis or mediastinal lymphadenopathy suggest thymic carcinoma (Fig. 23 on page 27). Features of vascular invasion are irregular contours of the contrast-filled vascular lumen and frank endoluminal soft tissue (Fig. 24 on page 27). Unlike thymomas, thymic carcinomas rarely cause paraneoplastic syndromes [12].

3. Uncommon Thymic Neoplasms

a. Thymolipoma

Thymolipoma is a rare, benign, slow-growing tumor. It occurs most frequently in young adults and has no sex predilection.

Thymolipoma is usually asymptomatic and manifests as a large anterior mediastinal mass. At histologic analysis, it is composed of mature fat and thymic tissue. Because of its soft and pliable nature, thymolipoma typically drapes itself around the heart and adjacent mediastinal structures, often becoming quite large before coming to clinical attention. It is usually detected incidentally at routine chest radiography and may occasionally mimic cardiac enlargement or an elevated hemidiaphragm. At CT and MR imaging, thymolipoma manifests as a fatty mass with fibrous septa.

Our cases of thymolipoma were smaller than those reported in the literature (Fig. 25 on page 27, Fig. 26 on page 28).
Association with myasthenia gravis, Graves disease, aplastic anemia, and other hematologic disorders has been reported [1, 13].

b. Thymic Neuroendocrine Neoplasm

Previously known as thymic carcinoid, it is a rare primary malignant thymic neoplasm that occurs over a wide patient age range (median age, 43 years) and has a male predilection of 3:1. One third of these tumors are functionally active, causing endocrinologic disorders such as Cushing syndrome or multiple endocrine neoplasia. At imaging, a thymic carcinoid usually manifests as a large anterior mediastinal mass, often with invasion of adjacent structures and metastasis. Differentiation between thymic carcinoids and invasive thymic epithelial tumors may be difficult on the basis of imaging findings alone. Thymic carcinoid has a poor prognosis due to a high prevalence of recurrence and metastasis [1].

c. Lymphoma

Lymphoma may involve the thymus as part of disseminated disease or sometimes as an isolated site. Hodgkin disease accounts for the majority of thymic lymphomas, with nodular sclerosis being the most common histologic finding identified in the thymus. The major imaging findings include thymic enlargement, sometimes with single or multiple masses (Fig. 27 on page 28).

In general, it is difficult to distinguish lymphoma from other thymic masses, especially thymoma, on the basis of imaging findings alone. Distinguishing prominent but normal thymus in young patients and thymic hyperplasia from lymphomatous involvement of the thymus is also problematic [1].

d. Thymic Sarcoma

Sarcomas of the thymus are extremely rare, and imaging findings have been reported in only a few cases. Thymic sarcomas have a nonspecific appearance at cross-sectional imaging and carry a grave outcome [2].

e. Secondary Tumors of the Thymus

A wide range of primary tumors can involve the thymus. Lung carcinoma can invade the thymus by direct extension, while cancers of the head and neck, abdomen, and pelvis can involve the thymus via lymphatic pathways [2].

D. Differential diagnosis: benign versus malignant
Both thymic hyperplasia and thymoma are common in patients with myasthenia gravis. Usually, the two can be differentiated by their CT appearance: thymic hyperplasia appears as diffuse enlargement of the thymus while maintaining its arrowhead morphology, whereas thymoma presents as an eccentric mass. However, thymic hyperplasia does present rarely as a mass-like enlargement. In this case, MRI can be useful to approach the right diagnosis. The use of chemical shift MRI sequences (in-phase and out-of-phase gradient echo sequences) can be helpful in distinguishing thymoma from thymic hyperplasia in such cases. This technique identifies the normal fatty infiltration of the normal or hyperplastic thymus, which manifests as homogenous signal decrease on out-of-phase images relative to in-phase images, whereas signal decrease is absent in thymoma [7].

Findings more frequently found in **benign** thymic lesions [10]:

- Smaller size.
- Intralesional fat.
- Midline location.
- Triangular thymic shape.
- Lack of infiltration of the mediastinal fat.
- Younger patient age.

Findings more common in **high-risk thymomas** and **thymic carcinomas** [1, 2, 10]:

- Lobulated contours.
- Irregular interface between the mass and lung parenchyma.
- Mediastinal fat invasion.
- Great vessel invasion.
- Encasement of mediastinal structures.
- Large mass.
- Older age.

Findings associated with a significantly greater prevalence of **recurrence** and **metastasis** [1, 2]:

- Lobulated or irregular contours.
- Oval shape.
- Mediastinal fat invasion or great vessel invasion.
- Pleural seeding.
Images for this section:

**Fig. 6:** Real thymic hyperplasia in a 27 years old female patient, presenting with a 15 months history of myasthenia gravis. CT scan shows an increasing in the volume and density of the thymus that remains triangular but with convex borders. It shows also separate thymic nodules in the mediastinal fat (arrows).

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**Fig. 7:** Thymic hyperplasia In T1-weighted 2D gradient echo MR images the hyperplastic thymus shows homogeneous decrease in signal on opposed-phase (b) contrast to in phase (a) due to fatty degeneration.


**Fig. 8:** Thymic rebound hyperplasia (arrows) in a 45 years old female patient who had chemotherapy for breast cancer.
Fig. 9: A 42 years old woman had chemotherapy for a thymoma. Thoracic radiograph shows a homogeneous circumscribed right paracardiac mass (arrow). Enhanced CT scan shows a cystic lesion containing thin septa, compatible with a transformation of the thymoma into an acquired thymic cyst.

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<table>
<thead>
<tr>
<th>Tumor type</th>
<th>Description</th>
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<tbody>
<tr>
<td>A</td>
<td>Medullary</td>
</tr>
<tr>
<td>AB</td>
<td>Mixed</td>
</tr>
<tr>
<td>B1</td>
<td>Lymphocyte rich, predominantly cortical</td>
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<tr>
<td>B2</td>
<td>Cortical</td>
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<tr>
<td>B3</td>
<td>Epithelial (well-differentiated thymic carcinoma)</td>
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<tr>
<td>C</td>
<td>Thymic carcinoma</td>
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Fig. 10: WHO Classification Scheme for Thymic Epithelial Tumors.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Definition</th>
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<tbody>
<tr>
<td>I</td>
<td>Macroscopically and microscopically completely encapsulated</td>
</tr>
<tr>
<td>IIA</td>
<td>Microscopic transcapsular invasion</td>
</tr>
<tr>
<td>IIIB</td>
<td>Macroscopic invasion into surrounding fatty tissue or grossly adherent to but not through mediastinal pleura or pericardium</td>
</tr>
<tr>
<td>III</td>
<td>Macroscopic invasion into neighboring organs (ie, pericardium, great vessels, or lung)</td>
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<tr>
<td>IVA</td>
<td>Pleural or pericardial dissemination</td>
</tr>
<tr>
<td>IVB</td>
<td>Lymphogenous or hematogenous metastasis</td>
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**Fig. 11:** Modified Masaoka-Koga clinical staging of thymoma.

© Marom EM, Advances in Thymoma Imaging, J Thorac Imaging 2013; 28(2): 69-83 [7].

**Fig. 12:** Thymoma in a 47 years old patient, presenting with an 18 months history of myasthenia gravis. CT scan shows an anterior mediastinal ovoide formation, hypodense homogeneous and has regular well defined contours. It is totally surrounded by mediastinal fat.

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**Fig. 13:** Type B3 Thymoma in a 48 years old patient, with a 12 months history of myasthenia gravis. Enhanced CT scan shows an anterior mediastinal ovoide formation, hypodense homogeneous and has regular contours. Thymectomy showed a grade II tumour (Masaoka).

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**Fig. 14:** Type B2 thymoma (WHO classification) in 58 years old patient with thoracic pain, productive cough and poor general status. Unenhanced and enhanced CT scan with multiplanar reconstructions show an anterior mediastinal mass (*), hypodense, heterogeneous, containing a few calcifications. The contours are lobulated and poorly defined which suggests capsular effraction.

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**Fig. 15:** Type B2 thymoma (WHO classification) in 34 years old patient with a 6 months story of myasthenia gravis. Enhanced CT scan with axial and coronal reconstructions show a hypodense, slightly heterogeneous anterior mediastinal mass.

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**Fig. 16:** Type B1 Thymoma in a 42 years old patient, with superior vena cava syndrome. Chest radiograph shows signs of bilateral pleural effusion associated with mediastinal enlargement. Enhanced CT scan shows the presence of a solidocystic anterior mediastinal mass, having a mass effect on the superior vena cava (arrow). It also shows bilateral pleural effusion (same patient as in figure 9, before chemotherapy).

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**Fig. 17:** Type A thymoma (WHO classification) in a 63 years old patient with thoracic pain. The initial CT scan (first line of images) shows an anterior mediastinal mass, hypodense, heterogeneous, containing necrosis areas and a few calcifications. The CT scan performed after chemotherapy, 3 months later (second line) shows a discrete decrease in the volume of the mass with a little increase of the necrosis areas. The CT scan performed after the end of chemotherapy, 18 months later, shows a significant decrease in the volume of the mass with large zones of necrosis. Thymectomy was then performed.

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**Fig. 18:** Type A thymoma in a 60 years old patient, presenting with a 9 months history of myasthenia gravis. Enhanced CT scan shows an anterior mediastinal ovoid formation, hypodense slightly heterogeneous, has regular contours and contains punctuate calcifications. The fatty limit with the vessels is preserved.

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**Fig. 19:** Type B2 thymoma (WHO classification) in 65 years old patient with retrosternal thoracic pain, dry cough and dyspnea. Unenhanced and enhanced CT scan with multiplanar reconstructions show an anterior mediastinal mass, hypodense, heterogeneous, with calcified rims (arrows). No evidence of vascular invasion.

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**Fig. 20:** Invasive thymoma in a 30 years old patient admitted in ICU for a respiratory distress. Chest radiograph shows left hemithorax white-out with mediastinal shift to the contralateral side. Enhanced CT scan (multiplanar reconstructions) shows a large hypodense, heterogeneous mass, having a considerable mass effect on surrounding anatomical structures with a probable invasion of the left pulmonary artery and ipsilateral primary bronchus.

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Fig. 21: Type B2 Thymoma in a 76 years old patient, with a 2 months story of myasthenia gravis. The initial CT scan (first line of images) shows the presence of an anterior mediastinal heterogeneous mass with a cystic central zone having a calcified rim. It has lobulated contours and signs of mediastinal fat invasion are found (arrow). The second CT scan, performed after biopsy, 2 months later (second line) shows a worsening of the radiological aspect with appearing of bilateral pleural effusion.

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Fig. 22: Axial (a) and coronal multiplanar reconstruction (b) of a non contrast-enhanced CT scan of a 57-year-old man allergic to iodine with a thymoma. A solid lobulated thymic mass (*) with clumps of calcifications within (arrowhead) is identified. Note the absence of a fat plane between the tumor and the aorta (open arrow). (d) Coronal T2-weighted MR image shows a typical signal hyper intensity of the tumor lesion (*). (c) Axial contrast-enhanced fat-suppressed T1-weighted MR image reveals a homogeneously enhanced solid tumor (*) which arises from the thymus. Although MRI demonstrates the presence of fat cleavage plane between ascending aorta and the tumor, a thymoma (WHO type A) with microscopic transcapsular invasion (Masaoka stage II) was confirmed after surgical resection.
Fig. 23: Thymic carcinoma in a 60 years old patient presenting with a cervical mass in a context of poor general status. Enhanced CT scan (multiplanar reconstructions) shows a right cervico mediastinal aggressive, hypodense and heterogeneous mass. This mass invades the surrounding vessels and is responsible of a mass effect on the trachea and osteolysis (bone window).

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Fig. 24: Thymic carcinoma in a 25 years old patient presenting with dyspnea. Enhanced CT scan (multiplanar reconstructions) shows an antero-superior mediastinal hypodense and heterogeneous mass with irregular contours. This mass englobes the ascending aorta and the superior vena cava that has an endoluminal thrombus with a dilated Azygos vein.

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Fig. 25: Thymolipoma in a 50 years old patient, discovered accidently on CT scan performed for chest pain. CT scan shows a small well defined nodule, containing fat and hypodense tissue with no signs of aggressiveness.

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Fig. 26: Thymolipoma in a 26 years old patient, discovered accidently on CT scan performed for a chronic cough. CT scan shows an anterior mediastinal mass containing fat and hypodense tissue with no signs of aggressiveness.

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Fig. 27: Large B-cell lymphoma in a 26 years old presenting with thoracic pain, dyspnea and dysphagia. Enhanced CT scan shows in the anterior mediastinum, a large hypodense heterogeneous mass, with peripheral enhancement delimiting central necrosis zones. Mass effect on vessels but no sign of endovascular invasion.

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Conclusion

Cross-sectional imaging modalities allow approaching the benign or malignant nature of thymic lesion through a specific semeiology that we tried to discuss in this work. Imaging is also useful to establish the differential diagnostic between a thymic origin for an anterior mediastinal mass and other etiologies possible in this region. These are crucial points for the radiologist and the surgeon as treatment differs significantly among those different entities.
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