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Mediastinal masses—transthoracic ultrasonography aspects

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Abstract

Mediastinal masses are usually assessed by computer tomography (CT) and magnetic resonance imaging (MRI). Transthoracic ultrasonography (TUS) can also provide useful information concerning prevascular and posterior mediastinal masses abutting the thoracic wall, but is underused for mediastinal pathology. Moreover, it provides a valuable and safe method for guiding interventional procedures in those areas, even in cases when other approaches are difficult or impossible. Considering TUS a very useful imagistic method for diagnosing mediastinal masses, we present a pictorial essay of various mediastinal diseases which can be assessed by this method.

Abbreviations: CT = computed tomography, GCT = germ cell tumors, MLN = metastatic lymph nodes, MRI = magnetic resonance imaging, NSGCT = nonseminomatous germ cell tumors, SGCT = seminomatous germ cell tumors, TUS = transthoracic ultrasonography, US = ultrasound.

Keywords: mediastinal masses, transthoracic, ultrasonography

1. Introduction

Transthoracic ultrasonography (TUS) is an underused imaging method for the diagnosis of mediastinal masses, consecrated radiological methods—computed tomography (CT) and magnetic resonance imaging (MRI)—being the preferred imaging techniques. Also, a relatively recent described method—diffusion-weighted MRI with the quantification of apparent diffusion coefficient—has shown a good accuracy for differentiation between benign and malignant tumors and lymph nodes in the mediastinum.[1] In cases of anterior (prevascular),[2] superior, and sometimes posterior mediastinal (paravertebral) masses,[2] TUS provides useful information and allows the percutaneous ultrasound (US) guided biopsy.[3,4] It is known that some intrathoracic tumors cannot be approached by CT-guided biopsy due to their superior position and the impossibility of the patient to keep the horizontal decubitus due to dyspnea.[3] In these cases, US-guided biopsies in sitting or atypical positions are salutary.

Mediastinal accessibility of the TUS is limited by bony parts of the thorax usually to the anterior and superior regions. The large masses occurring in middle mediastinum (visceral compartment) can sometimes grow anteriorly and become visible with TUS. When the masses from posterior mediastinum grow toward the paravertebral space displacing the lung, they become also visible by US examination and accessible to US-guided biopsy. Involvement of vertebral processes by tumors is also assessable by TUS. Posterior and middle mediastinal masses can be better examined by endoscopic ultrasonography—either transbronchial or transesophageal.

Due to many different types of structures and tissues located in the mediastinum, lesions that can occur in this space are also numerous and US findings are relatively nonspecific. Still, some lesions can be differentiated by US examination, for example cystic lesions, solid tumors, lymphadenopathies. US has many advantages over CT and MRI—bedside and general availability, cost, lack of irradiation, and the possibility of guiding transthoracic fine or cutting needle biopsies. In this pictorial essay we present common and rare mediastinal masses which can be assessed by TUS. Every patient admitted in our clinical hospital signed a specific informed consent allowing that some data related to the investigated pathology —without identification information—can be used in teaching purposes. The patients diagnosed with percutaneous US-guided biopsy were enrolled in a larger study concerning thoracic tumors, which has the approval of the Ethical Committee of our University.

2. Lipoma

Lipoma can occur in all mediastinal compartments (about 2% of mediastinal tumors), but is found usually anterior, near the diaphragm. It grows slowly and is usually asymptomatic. It provides a low attenuation image on CT (usually between −50 and 100 UH), without contrast uptake and good peripheral delineation.[5] As in other locations, mediastinal lipoma presents ultrasonographically as a hypoechoic, slight inhomogeneous mass, hypovascular in color Doppler mode (Fig. 1A and B).

Editor: Sergio Gonzalez Bombardiere.

The authors have no conflicts of interest to disclose.

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Medicine (2017) 96:49(e9082)

Received: 2 August 2017 / Received in final form: 13 November 2017 / Accepted: 14 November 2017

http://dx.doi.org/10.1097/MD.0000000000009082

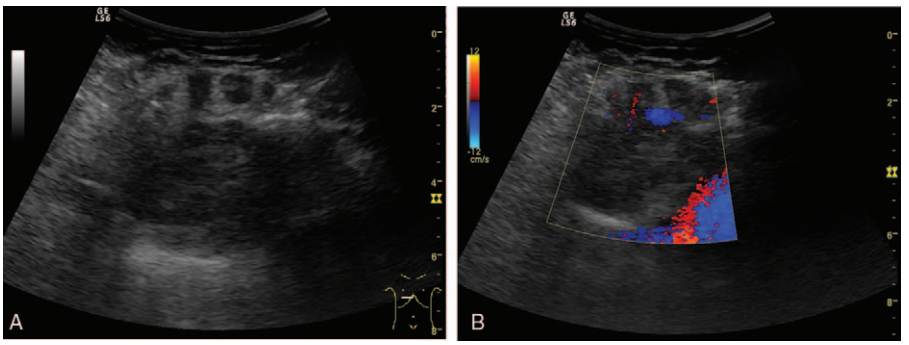

Figure 1. A, Right parasternal hypoechoic, slight inhomogeneous lesion (mediastinal lipoma). B, Hypo vascularized lipoma in color Doppler mode.

3. Thyroid goiter and cysts

Substernal goiter occurs mainly due to descending extension from the thyroid tissue (3%–6% of all mediastinal masses) (Fig. 2A).[5] Rare cases are represented by primary ectopic goiter. Diagnosis is important due to a 3% to 15% risk of malignancy and differential diagnosis with other primary prevascular mediastinal tumors.[6] Sometimes, large thyroid cysts can descend retrosternal and mimic a primary mediastinal cyst (Fig. 2B). Demonstrating the connection between normal thyroid and descending tissue is the main criterion for the diagnostic.

4. Thymic tumors

Thymus can be the origin of a large number of tumor types: epithelial (thymoma, carcinoma), lymphoma, carcinoid, germ cell tumors, sarcomas, etc. They account for 20% to 25% of mediastinal tumors, and 50% of anterior mediastinal tumors.

5. Thymoma

Thymoma represents around 20% of the tumors developed in the prevascular compartment, and differential diagnosis with thymic hyperplasia or malignant tumors is often difficult. Usually, the gland is diffusely enlarged, with regular borders, convex surface, and may be slight inhomogeneous (Fig. 3A). The architecture of the vessels is normal. CT is usually helpful in delineating and characterizing the structure of the tumor, but image-guided biopsy confirms the diagnosis. Large studies demonstrated higher rates of extrathymic tumors in this population—most frequently lymphomas, leukemia's, esophageal cancer, and lung cancer.[7]

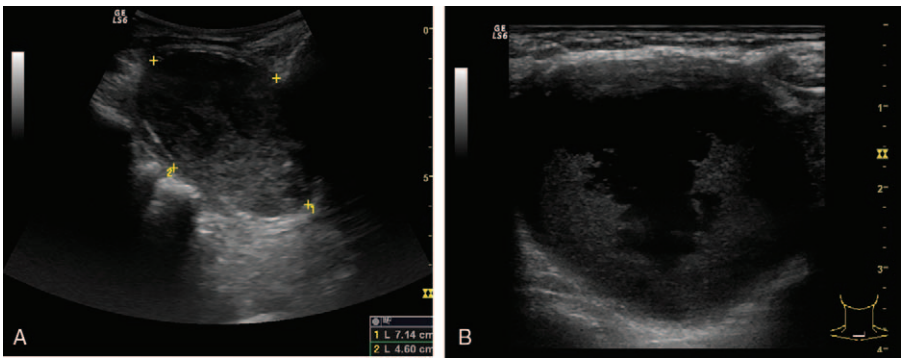

Figure 2. A, Large hypoechoic ovoid-shape image with regular borders and inhomogeneous structure—retrosternal goiter sagittal scanned with convex transducer. B, Inhomogeneous upper retrosternal cystic lesion—hemorrhagic thyroid cyst.

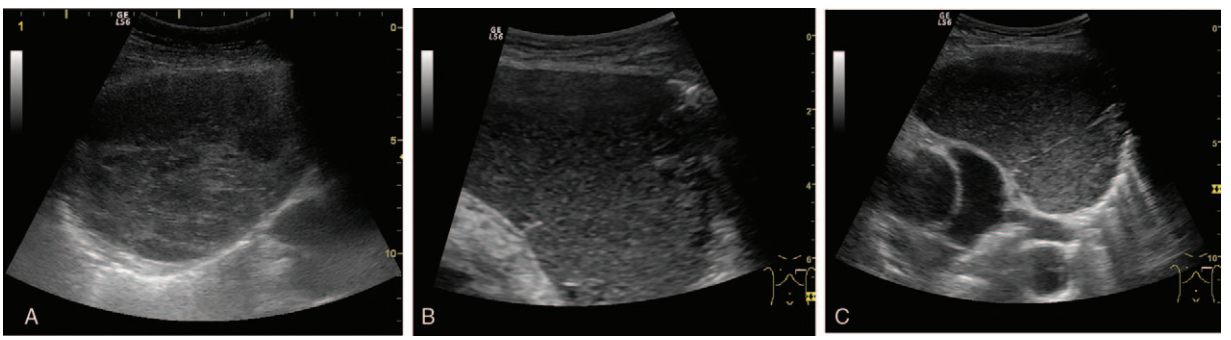

Figure 3. A, Ovoid-shape slight inhomogeneous hypoechoic tumor surrounded by ventilated lung—right parasternal approach of timoma. B and C, Cystic lesion with floating echoes, thin walls, and small hypoechoic solid component—cystic timoma adjacent to the pulmonary trunk and left pulmonary artery.

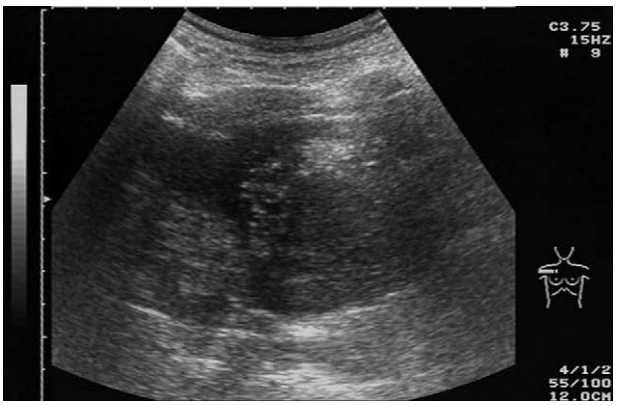

Figure 4. Large irregular shape inhomogeneous prevascular mediastinal compartment tumor with necrotic areas—invasive thymoma.

Sometimes, cystic thymoma with minor solid components can occur, usually vascularized in color Doppler mode (Fig. 3B and C), when differential diagnosis with lymphangioma and mature teratoma is more difficult.

6. Thymic carcinoma

Malignant tumors of the thymus show irregular shapes and anarchic distribution of vascularization, cystic areas, or necrotic component. Also an infiltrative behavior and sometimes intrathoracic metastasis can be present in invasive thymoma.[8] TUS reveals those features of a prevascular compartment tumor (Fig. 4).

6.1. Mediastinal cysts

Acquired or congenital mediastinal cysts are relatively rare lesions (12%–20% of mediastinal masses)[9,10], and can be of various origins—thymic, pancreatic, cystic teratoma, pleuropericardial, bronchogenic, or duplication cysts.[11] TUS allows visualization of echo-free lesions, well defined superficially, but much less into deep, due to interposition of ventilated lung and bony parts of the thorax (Fig. 5A). Some of them can be multiloculated, with different walls thickness, or can have a hypoechoic content (Fig. 5B). In this setting, multilocular thymic cysts, cystic teratoma, lymphangioma, and cystic thymoma must be considered if located in prevascular mediastinal compartment.[2] CT allows a better delineation of the cystic lesions and characterization of the neighboring organs.

7. Lymphoma

Lymphoma represent about 20% of the mediastinal tumors in adults (50% in children). Hodgkin lymphoma is slightly more frequent (50%–70%) than non-Hodgkin type.[12] Enlarged lymphatic nodes are hypoechoic and fuse in large masses displacing or engulfing mediastinal structures (Fig. 6A). In some cases, parasternal infiltration of the thoracic wall, compression of the superior vena cava, pleural effusion—including chylothorax can be associated with large tumors (Fig. 6B). Percutaneous biopsy under US guidance has very good diagnostic accuracy and many other advantages, without irradiation implied by CT

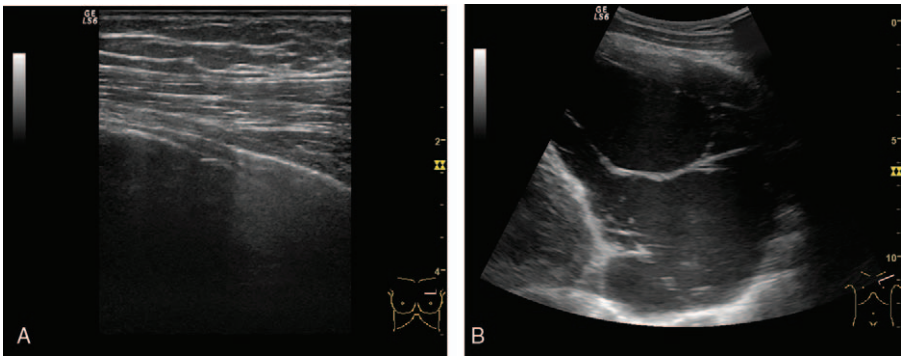

Figure 5. A, Left parasternal echo free lesion with thin wall displacing laterally the ventilated lung—mediastinal cyst. B, Large left parasternal echo free lesion with thin septa and walls—mediastinal cyst.

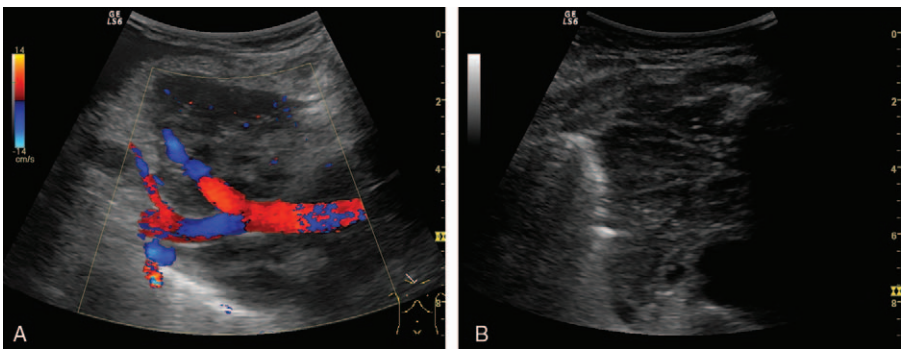

Figure 6. A, Large hypoechoic irregular tumor engulfing brachiocephalic trunk and its branches (color Doppler mode)—right parasternal approach of a large B cell mediastinal lymphoma. B, Hypoechoic irregular shape inhomogeneous tumor, invading the anterior thoracic wall—B cell lymphoma.

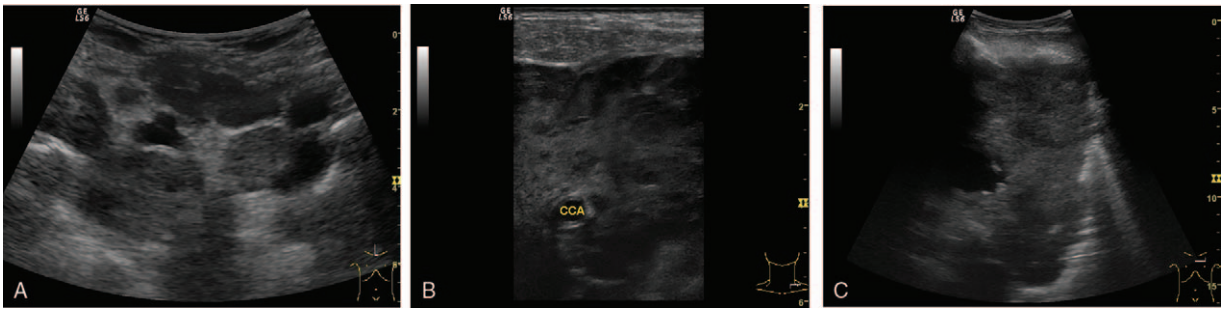

Figure 7. A, Multiple hypoechoic enlarged lymph nodes, ovoid, or sphere-shaped, with malignant aspect at sagittal supra/retrosternal approach—metastatic embryonal rhabdomyosarcoma. B, Large hypoechoic mass surrounding left common carotid artery in patient with NSCLC with cervical lymph nodes metastasis. C, Large hypoechoic mediastino-pulmonary mass in a patient with left NSCLC invading the mediastinum.

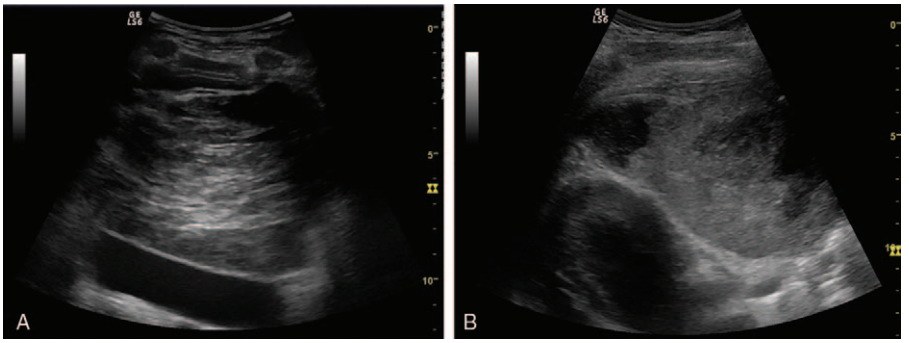

Figure 8. A, Parasternal sagittal approach of an inhomogeneous tumor (hypoechoic peripherally and hyperechoic centrally) adjacent to descending thoracic aorta —SGCT. B, Large left prevascular mediastinal tumor with mixed structure—multiple hypoechoic necrotic intratumoral areas—Yolk sac tumor (NGCST).

approach. US-guided biopsy with cutting needles offers better samples compared with fine needle aspiration allowing histological diagnosis with subtyping.

8. Metastatic lymph nodes

Enlarged metastatic lymph nodes (MLN) are visible if they are located in the prevascular mediastinum and can also be characterized by TUS. There can be many primary tumors with MLN, which do not have a specific appearance and in these cases percutaneous US-guided biopsy of the lymph nodes can provide the diagnosis (Fig. 7A). In lung cancer patients, evaluation and histological diagnosis of lower cervical and retrosternal enlarged lymph nodes is of paramount importance, changing the stage and management of the disease (Fig. 7B). In some cases, lung cancer invades the mediastinum, rising difficult differential imagistic diagnosis with primary mediastinal tumors (Fig. 7C).

9. Germ cell tumors (GCT)

Aberrant migration of primordial germ cells in the mediastinum leads to the development of extragonadal germ cell tumors which represents 15% of mediastinal masses in adults (most common in anterior compartment, under 40 years of age, and males—more than 90%).[13,14] There are 3 categories of germ cell tumors—teratoma (benign), seminomatous (SGCT), and nonseminomatous germ cell tumors (NSGCT). The latter contains teratocarcinoma, yolk sac tumor, choriocarcinoma, and embryonal carcinoma. High serological levels of beta-HCG or alfa-fetoprotein are usually present in NSGCT (more than 90% of cases).[15] SGCT are lobulated, homogeneous, large tumors (Fig. 8A), but NSGCT are heterogeneous, with large necrotic areas, irregular shaped, and infiltrative (Fig. 8B).

10. Neurogenic tumors

Most common paravertebral compartment masses are neurogenic neoplasms, accounting for 20% of mediastinal tumors.[16] Majority of those are benign (70%–80%), represented by schwannoma and neurofibroma. Usually, they are homogeneous (Fig. 9), but can

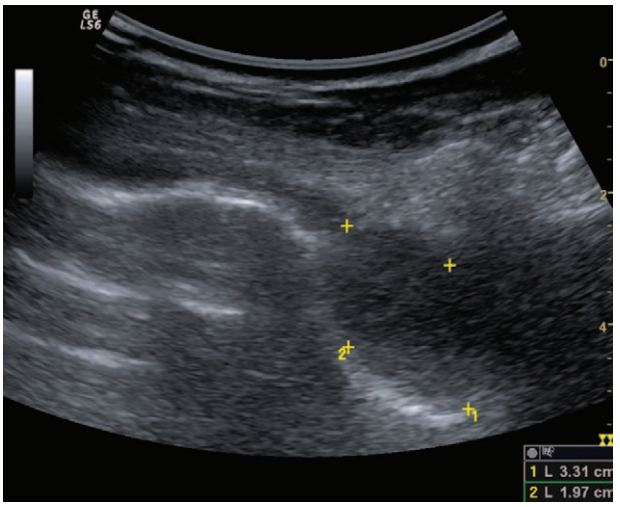

Figure 9. Hypoechoic left paravertebral ovoid-shaped regular contoured tumor—schwannoma.

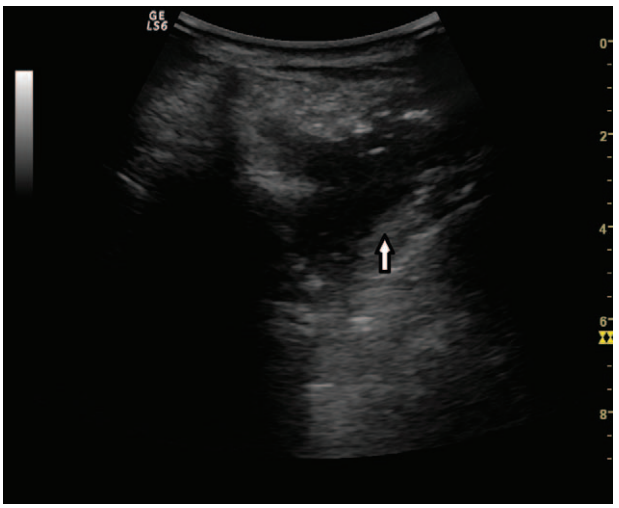

Figure 10. Paravertebral approach—hypoechoic irregular shaped lytic lesion of a vertebral transverse process (white arrow) —squamous carcinoma metastasis.

present echopoor areas—of cystic change or hemorrhage (more frequent in schwannoma). Malignant transformation must be considered when a previously stable benign lesion enlarges rapidly or develops structural heterogeneity or infiltrates other tissues.

11. Vertebral tumors

Vertebrae can be affected by primary tumors, or more common by metastatic cancers. Lytic lesions can be seen by US when disrupt the bony structure and expand into adjacent soft tissues. Examination is usually guided by locally intense pain and reveals hypoechoic tissue displacing transverse or spinal processes or vertebral body, growing into paravertebral structures (Fig. 10) sometimes with bony fragments inside.

12. Conclusions

Transthoracic US can provide useful information in the complex assessment of the mediastinal masses occurring in the anterior (prevascular) and posterior compartments of the mediastinum. It offers also the possibility of guiding biopsies in those clinical scenarios, with many advantages over CT guidance.

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