Extended Abstract

Imaging the small mediastinal lesion: extended abstract

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Mediastinal tumors are uncommon in the general population. Most mediastinal tumors occur in the prevascular (anterior) compartment and these lesions demonstrate substantial heterogeneity in clinical and histologic features. Laboratory test selection, method of biopsy and whether to perform it or to go to immediate surgery, follow-up imaging or order further imaging investigation varies between clinicians, and patients' clinical features and have been discussed elsewhere (1,2). The use of computed tomography (CT) has flourished over the last decade. With this increased use of CT imaging, an increasing amount of incidental prevascular mediastinal lesions is encountered. Lesions which are often smaller than those encountered in symptomatic patients.

There is no consensus as to what constitutes a 'small' mediastinal lesion. For the surgeon, this may be a lesion, which could be ignored as it is too small, or it could be a lesion, which could be approached with minimally invasive surgery. For the radiologist, this usually constitutes a lesion, which is too small to characterize, often, a lesion which is smaller than 1 cm. In several CT screening studies of asymptomatic healthy individuals, of both smokers and never smokers, the prevalence of an incidental prevascular mediastinal lesion ranged from 0.44% to 1.48% (3-6). These studies however varied in minimal threshold definitions for the mediastinal lesion and in imaging technique. Although it was shown that lesions larger than 3 cm represented a thymic epithelial malignancy (4), to date there is insufficient data on the smaller lesions due to lack of follow-up. Of particular interest is the third generation Framingham study (3) which provided data on 35% of patients who were found to have incidental prevascular lesions with historical comparisons dating back to a median of 6.5 years. Although 75% of those lesions with a long-term follow-up showed growth over the years, there is no data as to their etiology.

There are two main tasks for the radiologist when encountering an incidental prevascular lesion. The most important role of the radiologist is to correctly identify a "no touch lesion": a benign lesion or normal variant that should not be treated. The second task is to diagnose correctly a lesion or at least narrow the differential so that the diagnostic approach is tailored to minimize any harm in the process.

Of the cross sectional modalities, clinicians and radiologists are most familiar with CT. CT is the imaging modality of choice for identifying, localizing, and characterizing most mediastinal masses. CT has the best spatial resolution as compared to other cross sectional imaging modalities. CT can accurately locate and identify soft tissue consistencies such as bone, calcification, fat and fluid. Some of the prevascular mediastinal lesions have a pathognomonic appearance on CT. When encountered this may obviate the need for a biopsy. The most common of these masses is a goiter but also mature teratoma or thymolipoma may have a pathognomonic appearance by CT. However, CT has disadvantages: a relatively large amount of ionizing radiation with its potential carcinogenic effect, and it is inferior as compared to magnetic resonance imaging (MRI) in tissue characterization. Tissue characterization is key when trying to differentiate for example a benign prevascular cyst from a cystic thymoma. CT may have a limited ability to differentiate the soft tissue nodules or thickened septum within a cystic thymoma, leading to an erroneous interpretation of a benign cyst. Similarly, benign mediastinal cysts may contain proteinaceous fluid. When measured by CT, this proteinaceous content increases the Hounsfield Units resembling soft tissue rather than fluid,

leading to an erroneous interpretation of a solid mass rather than a cyst. With its improved contrast resolution, MRI overcomes these issues.

In recent years, there has been an increased use of MRI as the initial imaging modality for evaluation of mediastinal masses, in particularly in young patients presenting with myasthenia gravis, or in patients with an absolute contraindication to iodinated contrast injection. However, in most scenarios, MRI is used as a problem-solving tool for abnormalities identified by CT. The most common scenarios in which MRI is used as a problem solving tool is: distinguishing a proteinaceous thymic cyst from a solid mass, demonstrating nodules or septa in cystic lesions, identifying cystic or necrotic components within solid lesions, and distinguishing thymic hyperplasia from soft tissue tumors.

When characterizing a lesion, whether by using MRI or CT, the process involves placing a region of interest (ROI) within the lesion and measuring its intensity or density.

For the measurement to be accurate, the ROI should include a sufficient amount of pixels, perhaps about 1 cm in diameter, yet not including surrounding tissues, which will lead to an erroneous measurement. It is because of this, that in small lesions, smaller than 1 cm, the density/intensity cannot be accurately measured. MRI perhaps best demonstrates the importance of careful placement of the ROI when trying to distinguish thymic hyperplasia from a soft tissue malignancy. This is performed using chemical shift imaging (7). The diagnosis of thymic hyperplasia by chemical shift imaging relies on the measurement of a drop of signal, which occurs in thymic hyperplasia due to the presence of soft tissue and fat in the same voxel. A fine line of signal drop occurs with such imaging, at the interface of any mediastinal mass with the surrounding mediastinal fat. When a soft tissue lesion in the prevascular mediastinum is too small, the ROI will include this interface with the dropped signal leading to a mistaken diagnosis of thymic hyperplasia, as with such small lesions, there is an insufficient amount of tissue centrally for accurate measurement.

Fluorodeoxyglucose (FDG) positron emission tomography (PET) integrated with CT is commonly used in staging many malignancies. It has a limited role in differentiating benign from malignant mediastinal masses. This is because some benign entities, such as thymic hyperplasia may be FDG avid, whereas some malignancies, such as some types of thymoma, are sometimes not FDG avid (8). Even when a highly FDG avid prevascular mediastinal mass is encountered, the amount of FDG uptake cannot distinguish one malignancy from another as many of the prevascular malignancies, such as non-seminomatous germ cell tumor, thymic carcinoma or paraganglioma, show similar FDG uptake (9,10). In addition, the spatial resolution of PET is much lower than CT or MRI, so that small lesions, those smaller than 1 cm, are not accurately assessed by this modality (11).

To try to clarify an approach, the American College of Radiology produced a white paper suggesting that if the diagnosis is uncertain, MRI should be used to assess if the lesion is a benign cyst. In addition to use chemical shift (opposed-phase) MR imaging to exclude thymic hyperplasia before any further investigation is considered, for preventing futile surgery (12). They also suggested that if the clinician prefers to perform a follow-up CT in 3 months as a reasonable alternative. This approach should identify very aggressive lesions for rapid growth. Though the length of follow-up once this initial imaging approach has not been defined. One should also identify that smaller than 1 cm lesions are usually insufficiently categorized as benign *vs.* malignant with sufficient certainty at this time.

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