Diagnosis of Extrathoracic Metastases to the Lung

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At present, the standard diagnostic imaging modalities for detection of metastases to the lungs include the chest radiograph and thoracic computed tomography (CT). Rates of detecting thoracic metastases have great variability at autopsy. Early detection of pulmonary metastases during a patient's clinical course may ultimately affect tumor staging and treatment planning. However, it is also important to avoid subjecting patients to unnecessary procedures on the basis of low likelihood of positive yield. For these reasons, it is reasonable to assess the utility of other modalities that may be valuable in detecting metastases. These include positron emission tomography (PET) and magnetic resonance imaging (MRI).

There are a variety of factors that may help determine which tests will be most useful in demonstrating pulmonary metastases from extrathoracic primary tumors: mechanisms of hematogenous tumor spread, the likelihood of distant metastasis versus spread to nearby lymph nodes, and the probability of distant metastasis with the presence of local invasion. Depending on the tumor type and the extent of local disease, different radiologic modalities may be necessary for optimal screening for detection of metastatic disease.

Cancers That Metastasize to the Lung
Primary tumors that have a high propensity for pulmonary metastases include melanomas, choriocarcinomas, sarcomas, and carcinomas of the head and neck, testis, and adrenal gland, as well as certain types of thyroid cancer. Primary tumors that are not as likely to metastasize to the lung but are found in high prevalence in the population include adenocarcinoma of the breast, colorectum, stomach, and pancreas.

Patterns of Metastases
Depending on the primary tumor type and location, the patterns of hematogenous spread follow a multi-step cascade process, that help explain the likelihood of metastasis to each organ system. The authors summarize this in a table, as shown below:

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Examples</th>
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<tbody>
<tr>
<td>Group I: Lungs as first site of metastasis</td>
<td>Sarcomas, melanomas, choriocarcinomas, thyroid carcinomas, adrenal gland tumors, testicular carcinomas, head and neck tumors</td>
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<td>Group II: Metastasis to the lung only after initial seeding of liver</td>
<td>Adenocarcinomas of the stomach, colon, and pancreas</td>
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<td>Group III: Simultaneous seeding of multiple organs, including the lung</td>
<td>Transitional cell carcinoma (bladder, ureter), renal cell carcinoma, uterine and cervical cancers</td>
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<td>Group IV: Metastasize first to bone; infrequently to lung</td>
<td>Prostate cancer</td>
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<td>Group V: Complicated pattern of metastasis; first site may be the lung, liver, or bone</td>
<td>Breast cancer</td>
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Radiographic Technologies and Their Utility in Screening.

Standard Chest Radiograph: The standard PA and lateral chest radiograph is the most fundamental screening tool for pulmonary metastatic disease. It may be used for staging and follow-up.

Thoracic CT: Chest CT scans, especially spiral techniques, are highly sensitive for the detection pulmonary nodules, but with less specificity. For malignancies that do not usually metastasize to the lung, the yield of thoracic CT for metastatic disease...
without metastatic disease elsewhere, is low. However, the chest CT is more likely to demonstrate very small lesions (< 1 cm) that are not detected by standard chest radiography.

Positron Emission Tomography: Unlike most radiographic imaging modalities which rely on morphologic features for the detection of disease, PET is a functional imaging technique that relies on the metabolic characteristics of tissue for diagnosis. Furthermore, it has a relatively high spatial resolution in comparison to other functional nuclear medicine techniques, making it especially useful for assessing small, indeterminate pulmonary lesions. It may also be useful for selecting patients for resection, when whole-body PET is utilized.

Magnetic Resonance Imaging: MRI has high-contrast resolution and sensitivity to flowing blood. It is especially useful in assessing the extent of tumor invasion of the mediastinum and great vessels, for studying vascular lesions within the chest, and in evaluation fibrosis or atelectasis. It is, however, limited in imaging lung parenchyma, and its resolution is further compromised by respiratory motion. An advantage of MRI over CT is multiplanar imaging capabilities, which may be especially helpful in the assessment of vascular structures, the chest wall, or the brachial plexus.

Summary

The choice of imaging modalities in the staging, detection, and surveillance of cancer patients should be governed by the natural behavior of the primary tumor and how the results would impact management of the disease. Such an approach should be individually made, relying on tumor behavior, treatment options, and utility of the diagnostic modality. Finally, cost-effectiveness considerations when the techniques are utilized in the appropriate settings should help to yield a balanced treatment approach for the patient.