Malignant pleural mesothelioma: radiologic and pathologic findings.

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Learning objectives

To describe the most common radiologic and pathologic findings and limitations for diagnosis and staging of mesothelioma.

Background

Malignant pleural mesothelioma (MPM) is a rare neoplasm representing less than 5% of pleural malignancies. Its incidence, however, has been increasing in the last 20 years. It is more frequent in men and the peak age presentation is between 40 and 70 years old.

The association between MPM and asbestos exposure is well documented. More than 50 of cases can be attributed to this relation. Latency period for development of mesothelioma after exposure is long, in the order of 20-40 years. The risk of mesothelioma is related to the type of fiber to which patients are exposed. Crocidolite appears to have greater risk for development of mesothelioma than either amosite or chrysotile, but the latter one is the most common form (95%) and is, therefore, related to most cases of diffuse mesothelioma Fig. 1 on page 3.

Other causes have also been related to MPM development, such as exposure to erionite and prior thoracic irradiation.

Approximately 80% of mesotheliomas are pleural and only 20% are peritoneal.

The diagnosis of MPM is a challenging medical problem. The radiologist plays an important role in improving detection and determining appropriate treatment options for these patients.

An important problem in diagnosing MPM is the difficulty in distinguishing between MPM and other malignant tumors, such as metastatic adenocarcinoma, malignant thymoma and lymphoma, as well as differentiating it from benign conditions such as mesothelial hyperplasia, tuberculous pleural thickening, asbestos related benign pleural effusion and pleural plaques.

The prognosis is still poor, with a median survival time of 12 months after diagnosis.
Images for this section:

Figure 1. Asbestos types.

Chrysotile
“white asbestos”

Crocidolite
“blue asbestos”

Amosite
“brown asbestos”

Fig. 1
CT is the first imaging modality used for diagnosis and staging in MPM.

Pleural thickening, pleural effusion and fissural involvement are the most common findings.

Pleural thickening is classified into three different types: minimal, rind-like and nodular. The pleura is divided into three levels: upper, medium and lower. The upper level extends from the apex of the lung to the inferior margin of the arch of the aorta; the medium level includes pleura between the upper and lower levels; and the lower level involves pleura including the first image in which the atrium is seen. It is important to measure the thickness in the three different levels Fig. 2 on page 6.

Pleural effusion is seen in up to 80% of cases; it is more frequently unilateral but bilateral cases are also seen Fig. 3 on page 6. Sometimes the pleural effusion is very large and obscures the pleural masses on chest radiographies Fig. 4 on page 7. Cytological confirmation is recommended, with a biopsy of the pleura being necessary in most cases.

The tumor often runs into the fissures, but this fissural involvement is sometimes difficult to determine due to collapse of the lung by pleural effusion.

Calcified pleural plaques are seen in 20% of cases. Non calcified pleural plaques can also be present.

MPM is locally aggressive. Invasion of mediastinum, pericardium, chest wall, lung parenchyma and diaphragm is frequent.

Pericardial invasion may be due to local spread of the tumor itself or as pericardial effusion Fig. 5 on page 8. Pericardial effusion is considered malignant when its thickness is superior to 3 mm Fig. 6 on page 9.

Invasion into the chest wall must distinguish between whether it involves just the pleura and endothoracic fascia, fascia and chest wall muscles or whether it is more aggressive and involves the chest wall and ribs Fig. 7 on page 10. It is important to indicate if it is a simple focus, diffuse or multifocal involvement.
Lung parenchyma invasion is sometimes difficult to determine Fig. 8 on page 11. The pleural tumor can grow eccentrically towards lung parenchyma producing a compression effect with no invasion.

Determining involvement of the diaphragm is sometimes difficult on CT. A clear fat plane between the diaphragm and adjacent abdominal organs and a smooth diaphragmatic contour indicate that the tumor is limited to the thorax Fig. 9 on page 12.

Heart muscle, oesophagus Fig. 10 on page 13 and spine can also be involved.

Lymphatic and hematogenous metastases are usually late manifestations, generally silent.

Hilar and mediastinal lymph nodes metastases are frequent. CT can overestimate their diagnosis; it is important to bear in mind that enlarged nodes do not prove nodal involvement. All thoracic nodal stations must be examined meticulously Fig. 11 on page 14: supraclavicular, upper mediastinal, aorto-pulmonary, lower mediastinal, subcarinal, hilar, peripheral, internal mammary, intercostal, pericardial, peridiaphragmatic and retrocrural stations can all be affected Fig. 12 on page 15.

Distant metastases can be seen, more frequently in contralateral pleura, lung parenchyma or retroperitoneum Fig. 13 on page 16. It is important to identify them and describe whether they are single or multiple and their locations. In the case of lung parenchyma metastases, diffuse miliare nodes is a pattern more frequently seen than nodules or masses.

MR imaging can provide additional staging information, above all in determining chest wall and diaphragm involvement due to its excellent contrast resolution.

PET-CT provides both anatomic and metabolic information about a lesion, and is useful in the staging and preoperative evaluation of MPM, showing areas of metabolic activity in pleural thickening Fig. 14 on page 17, mediastinal or distal nodes. It is also important in determining prognosis: the higher the FDG uptake, the shorter the survival.

As we said, the diagnosis is not always easy. Bronchogenic carcinoma Fig. 15 on page 18, malignant thymoma and lymphoma can have similar imaging findings to mesothelioma.
A histologic diagnosis is required once MPM is suspected radiologically. Histologically, MPM are divided into epithelial, mesenchymal (fibrous or sarcomatous) or mixed tumors, the epithelial type being the one with better prognosis after surgical treatment Fig. 16 on page 19.

Immunohistochemistry has an important role in making the diagnosis between carcinoma (TTF1, policlonal CEA, B72.3) and mesothelioma (Calretin, CK5/6, WT1). Sometimes it is also difficult to distinguish mesothelioma from other benign pleural conditions Fig. 17 on page 20.

Images for this section:

Figure 2. 81 y.o woman with a history of vulva neoplasm presents with pleural effusion. Axial contrast CT scan shows the pleural thickening in the three different levels (upper, middle and lower). Epithelial mesothelioma.

Fig. 2
Figure 3. Pleural effusion.

A. 66 y.o man with history of contact with asbestos presents with right thoracic pain and loss of weight. Axial non contrast CT demonstrates unilateral pleural effusion. Note calcified bilateral pleural plaques. Epithelial mesothelioma.

B. 65 y.o man with history of right hepatectomy due to hydatid abscessed cyst. Axial contrast CT demonstrates bilateral pleural effusion. Epithelial mesothelioma.
Figure 4. 82 y.o man with dyspnea and loss of weight in the last 2 months. Chest PA radiograph shows important pleural unilateral effusion that obscures any possible pleural masses. Epithelial mesothelioma.

**Fig. 4**
Figure 5. Same patient as in figure 2. Pericardium is affected by local extension of the tumor itself (*) and pericardial effusion is also seen (arrow).

Fig. 5
Figure 6. Same patient as in figure 4. Axial contrast CT demonstrates left pleural and pericardial effusions (*). Note also tromboembolism in the main right pulmonary artery that extends through the superior lobar right artery (arrow).

Fig. 6
Figure 7. Same patient as in figure 2. Axial and coronal planes demonstrating chest wall involvement, including fascia, muscles and rib destruction (arrows).

Fig. 7
Figure 8. 62 y.o woman with history of right pleuritis. PA chest radiograph shows right paratracheal mass. CT demonstrates paratracheal mass protruding on lung parenchyma. Invasion of lung parenchyma is difficult to determine. Epithelial mesothelioma.

Fig. 8
Figure 9. Same patient as in figure 2. Axial contrast CT shows an irregular and nodular left diaphragm (arrows).
Figure 10. Same patient as in figure 2. Three different levels showing the oesophagus invaded by the tumor. Note wall thickness and decrease in lumen size (arrows).

Fig. 10
Figure 11. Same patient as in figure 2. CT shows lymphatic metastases affecting left supraclavicular, upper mediastinal, pericardial, hilar, subcarinal, lower mediastinal and intercostal stations, respectively (arrows).

Fig. 11
Figure 12. 62 y.o woman with history of ocular lymphoma and recidivant pneumothorax. Axial contrast CT demonstrates right nodular pleural thickness and lymph node afectation in the upper mediastinal, right internal mammary (arrow) and subcarinal zones. Epithelial mesothelioma.

Fig. 12
Figure 13. Same patient as in figure 2. Axial abdominal contrast CT shows heterogeneous nodular left adrenal and enlarged retroperitoneum lymph nodes (arrows).
Figure 14. 43 y.o man with history of pneumotorax. PET-CT demonstrates a hypermetabolical pleural thickness. Epithelial mesothelioma.
Figure 15. 79 y.o man with right thoracic pain. Chest radiograph shows nodular masses, confirmed on CT and PET-CT where we see hypermetabolic nodular masses in right parietal and mediastinic pleura. Biopsy demonstrated pleural invasion by small cell carcinoma.

Fig. 15
Figure 16. Epithelial MPM. Pleural infiltration with cell agrupations. Large nuclei with well defined nucleoli and citoplasm.
Figure 17. Pleuritis that permeates the entire pleura, mesothelial reaction.
Conclusion

The incidence of MPM has been increasing in recent years. Understanding the radiologic and pathologic findings is important to improve detection. Prompt diagnosis and accurate staging determine the appropriate treatment options for these patients.

Personal Information

References

