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THE RADIOLOGICAL MANIFESTATIONS OF MALIGNANT PLEURAL MESOTHELIOMA*

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MALIGNANT pleural mesotheliomas represent a small fraction of primary malignant tumors arising in the chest. Interest has been stimulated in this entity because of its apparent relationship to asbestos exposure.[2,5,9] The difficulty in establishing the correct diagnosis is attested to by the large number of reported cases in which the correct diagnosis is made only at autopsy. It is hoped that review of a representative series of cases may reveal a constellation of clinical and radiologic features which will permit the radiologist to suggest the correct diagnosis. A review of the charts and roentgenograms of 10 cases of malignant pleural mesothelioma seen at the Massachusetts General Hospital from 1960 to 1967 forms the basis of this report.

TABLE I

SUMMARY OF FINDINGS

Age. 34–74 years (average = 58 years)
Sex. 8 male, 2 female
Asbestos exposure. 6 patients

Chief complaint.		*Diagnosis established.*	
Dyspnea	6	Thoracotomy	5
Pain	4	Needle biopsy	2
Cough	2		
Weight loss	2	Autopsy	2
Hoarseness	1	Liver biopsy	1

Prognosis.

Seven dead: 5 dead within 3 months of diagnosis. Average duration from onset of symptoms was	14 mo.
Three alive: 2 with persistent tumor	8, 41 mo.
No residual tumor	44 mo.

CLINICAL FEATURES

The average patient age was 58.2 years with an age range of 34 to 74 years (Table 1). There were 8 males and 2 females. Of the 10 patients, 6 had a history of asbestos exposure and 2 of these had definite pulmonary asbestosis, 1 of whom was a woman whose exposure was obtained through washing her pipefitter husband's dusty work clothes. Five of the patients were heavy cigarette smokers, 3 did not smoke, and no smoking history was available in 2.

The most common symptom was dyspnea, which was reported by 6 of the patients. The chief complaint in 4 patients was chest pain; this was not localized to the site of the tumor and was pleuritic in type in only 2 of the patients. All patients had either pain or dyspnea, and 3 patients had both symptoms.

Physical examination was not helpful in establishing the diagnosis. The only positive findings consisted of reduced breath sounds and dullness to percussion in 3 patients.

The difficulty in establishing the diagnosis premortem was well demonstrated in the series. In 5 patients the diagnosis of mesothelioma was established by thoracotomy. An additional patient underwent 2 separate thoracotomies; the pathologic diagnosis on the specimens obtained was "dense fibrotic pleuritis." The diagnosis was finally established by liver biopsy performed through a peritoneoscope.

Needle biopsy of the pleura was performed in 3 patients with the correct diagnosis established in 2 of them. In 2 patients the correct diagnosis was only established at autopsy. One of these patients had a negative pleural biopsy; the second patient

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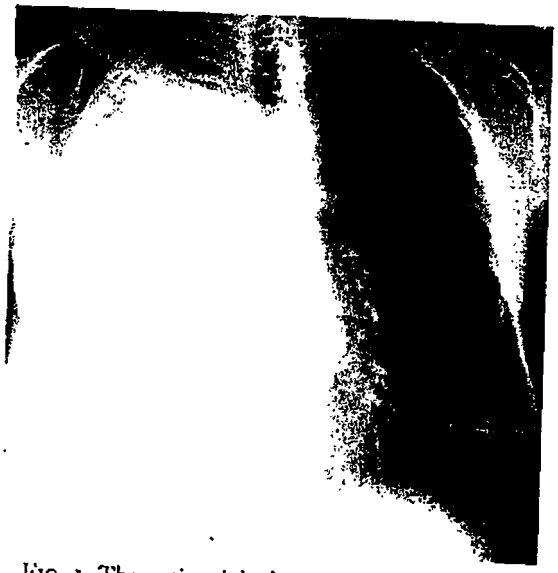


FIG. 1. The entire right hemithorax is opacified by a large pleural effusion.

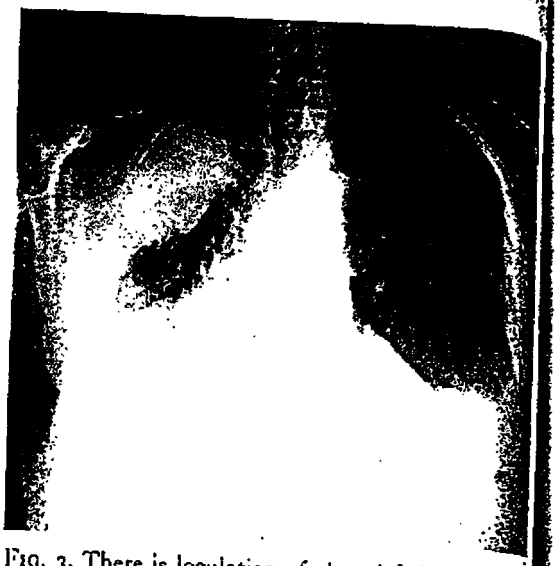


FIG. 3. There is loculation of pleural fluid along the right superolateral chest wall. Fluid is also evident in the right and left costophrenic angles.

had an incorrect diagnosis of adenocarcinoma made from a specimen obtained at bronchoscopy.

The results of therapy, consisting of surgery, radiation therapy, or both, have been disappointing. Seven of the patients have died, 5 within 3 months of diagnosis. The average duration of illness from onset of symptoms until death was 14 months. Three patients are living, but 2 have known persistent disease. The sole survivor without disease has lived 44 months following local excision of a small lesion.

RADIOLOGIC FINDINGS

Review of the initial chest roentgenograms revealed 3 patterns: (1) pleural effusion (in 4 patients); (2) irregularly

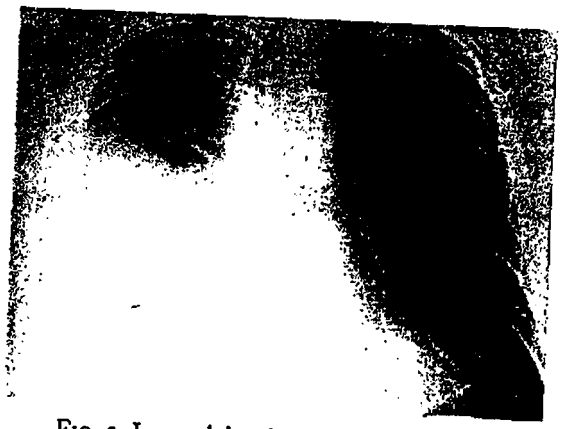


FIG. 2. Large right pleural effusion with a convex superior border.



FIG. 4. Pneumothorax demonstrating thickened pleura along the lateral chest wall.

thickened pleura (in 4 patients); and (3) mass lesions that appeared pulmonary rather than pleural (in 2 patients).

The pleural effusions varied in amount and configuration. Two cases had small bilateral pleural effusions which progressed during the illness. There was opacification of the total hemithorax (Fig. 1) in 1 patient and opacification of one-half the hemithorax in the other. The effusions were somewhat atypical; in 1 case the fluid was convex superiorly (Fig. 2), while in the other the lateral border of the fluid formed a more vertical line with the lateral chest wall than is usually seen in uncomplicated pleural effusion. The pleural fluid was often loculated (Fig. 3). Two patients developed pneumothoraces following thoracentesis, and irregularly thickened pleura was then readily demonstrable (Fig. 4). In one of these cases, tumor could be seen involving the partial pleura along the lateral chest wall and the visceral pleura over the partially collapsed lung (Fig. 5).



FIG. 5. Pneumothorax demonstrating thickened, nodular parietal and visceral pleura.

The second group of 4 cases presented with irregularly thickened, nodular pleura. In 2 cases the entire right lateral chest wall showed irregular pleural thickening which extended over the apex of the lung as well as over the diaphragm (Fig. 6, *A* and *B*). In 1 of the cases, a patient with



FIG. 6. Mesothelioma with asbestosis (1963). (*A*) Thickened pleura along the lateral chest wall with extension over the right hemidiaphragm and lung apex. Interstitial fibrosis is apparent. (*B*) Detailed view of the thickened, nodular pleura.

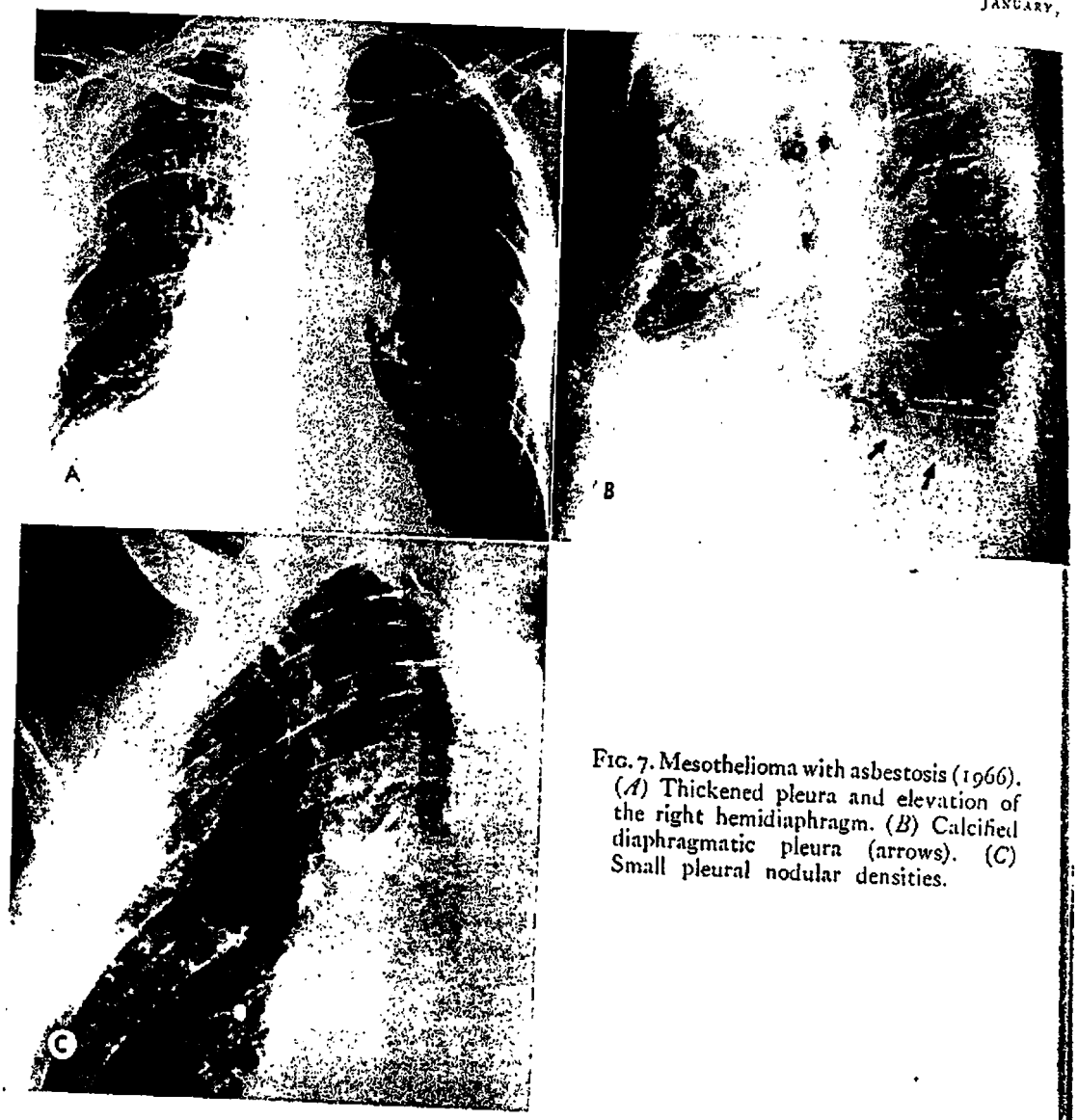


FIG. 7. Mesothelioma with asbestosis (1966). (*A*) Thickened pleura and elevation of the right hemidiaphragm. (*B*) Calcified diaphragmatic pleura (arrows). (*C*) Small pleural nodular densities.

asbestosis, the diaphragmatic leaf appeared elevated and was fixed at fluoroscopy (Fig. 7*A*); and dense linear bands of calcification were present in the pleura over the right leaf of the diaphragm (Fig. 7*B*). There were multiple small nodular densities that appeared to be pulmonary, but at autopsy were found to be pleural metastases (Fig. 7*C*). In both cases the lung fields revealed a moderate amount of diffuse fibrosis.

In the third case there were large lobulations measuring up to 3.5 cm. in width which extended along the lower two-thirds of the right lateral chest wall (Fig. 8*A*). The diaphragmatic leaf also had a lobulated contour, and there was obliteration of the vertebrophrenic angle. The underlying lung showed minimal but definite fibrosis, and there was destruction of the right third and fourth ribs anteriorly (Fig. 8*B*).

The fourth case demonstrated a 1 cm. oblong mass adjacent to and eroding the superior surface of the right sixth anterior rib.

Solitary masses that appeared to be in the left upper lobe were present in 2 patients. One of the masses measured 2.5 cm. in diameter and was thought to be a large



FIG. 8. (*A*) Large lobulated pleural mass. (*B*) Detailed view showing rib destruction (arrow).

bronchiogenic carcinoma (Fig. 9, *A* and *B*). The other mass, measuring 3 cm. in diameter, was thought to be in the peripheral lung parenchyma (Fig. 10*A*). The margins of both masses were irregular but distinct, and no cavitation or calcification was present within them. In spite of laminagraphy (Fig. 10*B*) and chest fluoroscopy, it was not apparent that these masses arose from the pleura rather than lung.

DISCUSSION

Pleural mesothelioma is a tumor that occurs predominantly in the adult male population after the age of 40 years.[4,5] The most common symptom is dyspnea, fol-



FIG. 9. (*A* and *B*) A large lobulated mass is present at the left apex. The left second posterior rib is destroyed.

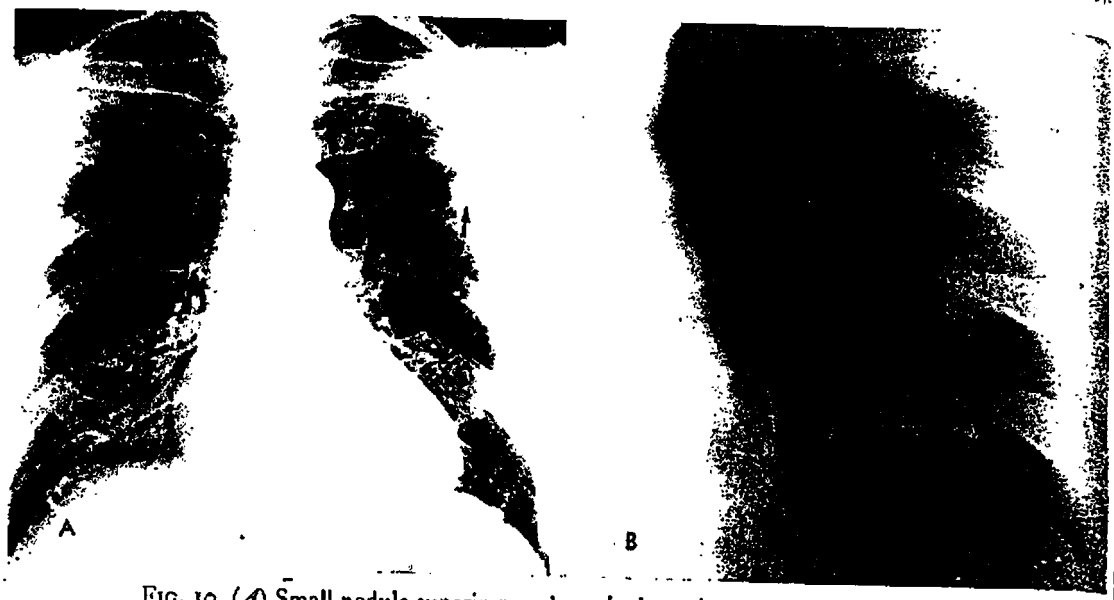


FIG. 10. (*A*) Small nodule superimposed on the lateral aspect of the left posterior fifth interspace (arrow). (*B*) Laminagram demonstrates the nodule.

lowed in frequency by nonspecific chest pain. The pain may be severe when associated with bone destruction.

Of the 10 cases studied, 2 had pulmonary asbestosis, while 4 others had exposure to asbestos. Reports in the literature indicate a pathogenetic relationship between exposure to asbestos and development of pleural mesothelioma.[3] The diagnosis of pulmonary asbestosis is confirmed by the presence of asbestos bodies in the lung (Fig. 11), pleura, or occasionally in the mesothelioma. Fibrosis in the lower lung fields associated with pleural thickening and, in some instances, pleural calcification are important parameters in the radiologic diagnosis of asbestosis.[7]

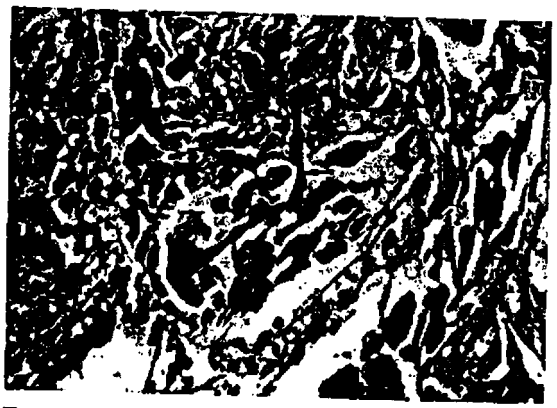


FIG. 11. Clubbed, segmented asbestos body (arrow).

The correct diagnosis is often established by needle biopsy or open thoracotomy. However, in a large number of cases, the diagnosis is not established during life, but at autopsy. In these cases, the diagnosis may not be suspected during life, or the amount of tissue obtained from a needle biopsy is too small. In one case, 2 biopsy specimens were interpreted as "fibrous pleuritis," indicating that each time thickened pleura, rather than tumor, was biopsied.

The entity of mesothelioma is well accepted among pathologists, although it may be difficult to distinguish between a mesothelioma and an anaplastic cancer of the lung. Two broad categories are generally recognized—the epithelial and the fibrosarcomatous type. In some cases there may be a combination of both.[5]

Mesothelioma can invade the lung parenchyma. When the tumor progresses, it may encase the entire thoracic cavity. Extension of tumor occurs to the mediastinum, pericardium, liver, and occasionally into the opposite pleural cavity. Hilar and mediastinal lymph nodes may be in-

volved, but this is usually a late finding and not recognized on the chest roentgenogram. Metastases to distant organs such as bones, lymph nodes, or brain have been encountered. Most of these metastatic deposits are found at autopsy.

Mesothelioma is manifested radiologically in 3 ways—by pleural effusion, by irregular pleural thickening, or as a nodular mass lesion.

In pleural effusions, the inner margin of the fluid is often irregular and a convex hump may be seen. Loculation of fluid is demonstrated when upright and decubitus roentgenograms are obtained. Following paracentesis, the fluid may recur and may opacify the entire hemithorax. The fluid is usually bloody, but a serous effusion may be found.

Irregular nodular thickening of the pleura may extend along the entire pleural cavity or may be confined to a limited area. If nodularity is present, it is highly suggestive of the diagnosis, particularly when associated with chest pain. Bone destruction in the area of thickened pleura is strong radiologic evidence of the diagnosis.

The third type of mesothelioma manifests as a nodular density, often in the peripheral lung, and is sometimes mistaken for a lung tumor. Only by surgery and pathologic examination can the correct diagnosis be established. Laminagraphy may solve the problem, but occasionally even this method cannot differentiate a lung tumor from a tumor originating in the pleura.

The prognosis in these described cases is poor: 7 of our 10 cases have died; 2 are alive with recurrent disease following surgery and radiation therapy; and only 1 patient is cured 44 months following excision. It is of interest that in the latter case the patient was asymptomatic and the lesion was nodular and small in size.

SUMMARY

Pleural mesothelioma is a frequent enough tumor to be considered in the differential diagnosis of chest tumors. The most characteristic symptoms are pain and dyspnea. A history of asbestos exposure or pulmonary asbestosis should alert the radiologist to the possibility of an existing or developing pleural mesothelioma.

The important radiologic manifestations are: (1) pleural effusion, often recurrent; (2) irregular, nodular pleural thickening, with or without bone destruction; and (3) a nodular density, frequently in the peripheral portion of the lung.

The prognosis is poor. Of the 10 patients studied, 7 died; 2 are alive but have persistent disease; and 1 patient, with a small nodular lesion, is cured 44 months following surgery.

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