Correlation between computed tomography of the chest and medical thoracoscopic findings in primary pleural tumors

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Background Malignant pleural mesothelioma (MPM) is an aggressive tumor arising from the mesothelial cells lining the pleura. It commonly presents with unilateral pleural effusion with variable degree of pleural thickening and nodularity. MPM usually develops on the parietal pleura, and involvement of the visceral pleura indicates more advanced stage. Treatment of MPM should not be started before correct diagnosis and staging with computed tomography (CT) and thoracoscopy.

Aim of the study The aim of this study was to assess the correlation between findings on chest CT and those on thoracoscopy and to evaluate the sensitivity of chest CT to identify malignant pleural lesions.

Patients and methods Patients with suspected MPM and indicated for medical thoracoscopy for diagnostic confirmation were enrolled in the present study. Twenty patients with confirmed diagnosis after tissue biopsies with medical thoracoscopy were selected. Comparison and correlation between CT findings and medical thoracoscopic findings were made.

Results Thoracoscopy showed parietal pleural invasion in all patients, whereas noncontrast chest CT showed parietal pleural lesions in 14 patients (70%). Visceral pleural involvement was evident in 13 patients (65%) on thoracoscopy, but chest CT detected only one case (5%) with visceral pleural involvement. Three patients (15%) were found to have fibrous septations on thoracoscopy, compared with only one patient (5%) on chest CT. The sensitivity of noncontrast chest CT in the detection of MPM was 70%.

Conclusion Although the sensitivity of noncontrast chest CT in the detection of MPM is high, thoracoscopy is needed not only to confirm the diagnosis but also to assess the different parts of the pleura and to allow proper staging of the disease. *Egypt J Broncho* 2014 8:32–37
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Introduction

Malignant pleural mesothelioma (MPM) is an aggressive tumor arising from the mesothelial cells lining the pleural cavity. The incidence of MPM is increasing worldwide, and it is expected to increase in the next 10–20 years as a result of widespread exposure to asbestos in the past decades [1]. MPM usually develops on the parietal pleural surface and later on spreads to the visceral pleura. Visceral pleural involvement indicates a more advanced stage of the disease and is therefore an important prognostic factor [2].

Computed tomography (CT) scans of the chest are now routinely used for diagnosing, staging, and follow-up of patients with MPM. CT features of MPM are characteristic but not pathognomonic. A variety of benign and malignant diseases may cause pleural abnormalities that resemble MPM. The most common causes are metastatic carcinoma, tuberculous pleurisy, empyema, and asbestos-related advanced pleural abnormalities. The most helpful signs in distinguishing malignant from benign pleural diseases in chest CT are pleural rind, nodular pleural thickening, pleural thickening greater than 1 cm, and mediastinal pleural involvement [3].

Key CT findings that suggest MPM include unilateral pleural effusion, nodular pleural thickening, and interlobar fissure thickening. Growth typically leads to tumoral encasement of the lung with a rind-like appearance. Calcified pleural plaques are found on CT in ~20% of patients with MPM and may become engulfed by the primary tumor, causing the tumor to mimic calcified MPM. There is also frequent contraction of the affected hemithorax with associated ipsilateral mediastinal shift, narrowed intercostal spaces, and elevation of the ipsilateral hemidiaphragm [4].

CT scan-guided cutting-needle pleural biopsy, performed by a radiologist, is a promising technique for sampling the pleura, because it can improve diagnostic sensitivity to about 80% for pleural malignancy [5].

The accurate diagnosis of mesothelioma is made on histopathological examination. However, diagnosis can be difficult because mesothelioma is a very heterogeneous cancer that creates various misleading histopathological pitfalls. Moreover, the pleura is a common site for metastatic disease [6].

Thoracoscopy is the preferred diagnostic procedure when mesothelioma is suspected; allows complete visual examination of the pleura, multiple, deep, and large biopsies (preferably including fat and/or muscle to assess tumor invasion), and provides a diagnosis in 90% of cases [1].

In patients with only fluid appearance on CT scan, thoracoscopy should be the first method used to improve the chances for a final diagnosis. For some cases, an additional advantage of thoracoscopy is that diagnostic and therapeutic aims, such as drainage and pleurodesis, can be achieved in a single session [7].

Aim of the study

The aim of this study was to assess the correlation between findings on chest CT and those on thoracoscopy, and to evaluate the sensitivity of CT chest to identify malignant pleural lesions.

Patients and methods

This prospective study was conducted in Abbassia Chest Hospital and included 20 patients with MPM. Patients were included when MPM was suspected and the patient was made to undergo medical thoracoscopy for tissue biopsy and diagnostic confirmation. All the patients had to give informed written consent. Patients with general contraindications to thoracoscopy (e.g. unstable angina, left ventricular failure, uncontrolled hypertension, bleeding tendency, etc.) or with no confirmation of MPM after pathological examination of thoracoscopic pleural biopsies were excluded.

All patients were subjected to thorough history taking, clinical examination, routine laboratory investigations, and CT scan of the chest without contrast. Pleural fluid cytological analysis was performed and medical thoracoscopy performed under local anesthesia (using the Richard Wolf rigid thoracoscopy; Richard Wolf, Germany). CT films were reread. Comparison between findings on CT and those on medical thoracoscopy with statistical analysis was carried out.

Medical thoracoscopy

Twenty patients were given local anesthesia with 15 ml of 2% lidocaine. The procedure was performed in lateral decubitus position with the affected side upward under local anesthesia with 2% lidocaine and analgesia. The skin was sterilized, followed by incision and blunt dissection in the appropriate intercostal space to enter the pleural space. A 7 mm trocar was then inserted, and a 0° telescope was inserted through it and connected to a video camera; the pleural space was then carefully inspected through the thoracoscope (Richard Wolf

rigid thoracoscopy). Abnormal (suspicious) areas were biopsied. The appearance of the parietal and visceral pleural surfaces and the extent of their involvement were assessed visually through the thoracoscope.

Statistical analysis

Quantitative data were represented as mean (± SD) and qualitative data as number and percentage. Data entry and statistical analysis were performed using SPSS for Windows, version 20.0 (SPSS Inc., Chicago, Illinois, USA).

Results

This study enrolled 20 patients with MPM with a mean age of 62.3 ± 7.43 years; 12 patients were male (60%) and eight were female (40%); 55% of all patients were nonsmokers and 45% were smokers; history of occupational or residential exposure to asbestos was positive in 35% and negative in 65% of the patients. Demographic data of the included patients are displayed in Table 1.

Cytological examination of the pleural fluid was found to be positive for malignant cells in four patients, representing 20% of the patients, and negative in 16 patients (80%) (Table 2).

In the studied population 14 patients (70%) presented with massive pleural effusion and six patients (30%) presented with moderate pleural effusion (Table 3). The pleural effusion was considered moderate if the effusion reached the fourth intercostal space on plain chest radiograph and as massive if it reached the second space.

Table 1 Demographic characteristics of the studied group

Characteristics	*n* (%)
Age (years)	
Mean ± SD	62.3 ± 7.43
Range	46–76
Sex	
Male	12 (60)
Female	8 (40)
History of occupational or residential exposure to asbestos	
Positive	7 (35)
Negative	13 (65)
Smoking	
Smoker	9 (45)
Nonsmoker	11 (55)

Table 2 Cytological examination of pleural fluid as regards malignant cells

Cytology for malignant cells	*n* (%)
Positive	4 (20)
Negative	16 (80)

Visceral pleural lesions were detected by thoracoscopy in 13 patients with mesothelioma, but CT scan detected abnormalities in the visceral pleura in only one patient (Table 4, Fig. 1).

The thoracoscope could reveal lesions in the costal pleura in all cases of mesothelioma, but chest CT could reveal changes in the costal pleura only in 14 patients (Table 5, Figs 2 and 3).

The thoracoscope was able to show lesions in the diaphragmatic pleura in seven (40%) patients with mesothelioma, but chest CT did not show any lesions in the diaphragmatic pleura (Table 6).

Three patients (15%) were found to have fibrous septations between visceral and parietal pleura on thoracoscopy, whereas in only one of these patients (5%) fibrous septations were detected on chest CT (Table 7, Fig. 4).
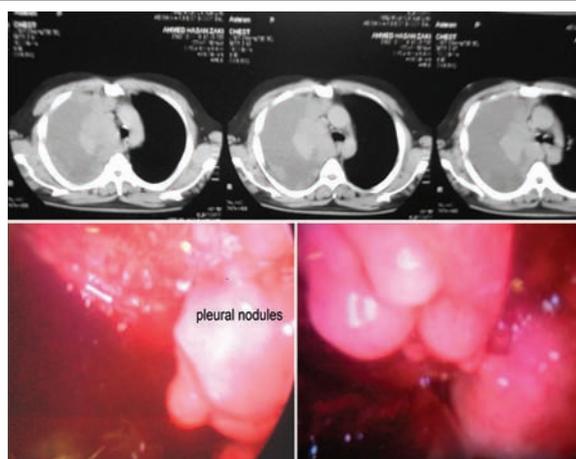
Pleural abnormalities suggestive of malignancy that were detected by chest CT were circumferential pleural thickening (50%), nodular pleural thickening (20%), pleural thickening greater than 1 cm (20%), and mediastinal involvement (25%) (Table 8).

The sensitivity of noncontrast CT scan of the chest for the detection of mesothelioma in this study was 70%; CT was able to detect pleural lesions suggestive of malignancy in 14 cases (Table 9).

Discussion

The frequency of MPM has greatly increased in the past three decades; it is a tumor of great clinical, epidemiologic, and therapeutical interest. Therapy should not be started before the tumor has been

Table 3 Size of pleural effusion of the studied group

Size	n (%)
Massive	14 (70)
Moderate	6 (30)

Table 4 Comparison between thoracoscopic and computed tomographic findings of the visceral pleura in the studied group

Pleural findings	n (%)	
	Thoracoscope	CT
Visceral pleura		
Nodules	13 (65%)	0 (0%)
Calcification	0 (0%)	0 (0%)
Thickening	3 (15%)	1 (5%)

CT, computed tomography.

Table 5 Comparison between thoracoscopic and computed tomographic findings of the costal pleura in the studied group

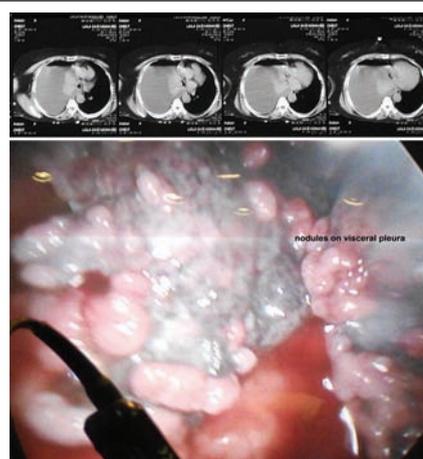| Pleural findings	n (%)	
	Thoracoscope	CT
Costal pleura		
Nodules	20 (100)	4 (20)
Calcification	1 (5)	1 (5)
Thickening	16 (80)	14 (70)

CT, computed tomography.

Table 6 Comparison between thoracoscopic and computed tomographic findings of the diaphragmatic pleura in the studied group

Pleural findings	n (%)	
	Thoracoscope	CT
Diaphragmatic pleura		
Nodules	7 (35)	0 (0)
Calcification	1 (5)	1 (5)
Thickening	1 (5)	0 (0)

CT, computed tomography.

Fig. 1

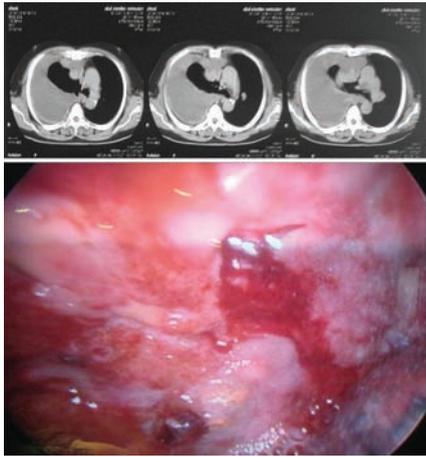Visceral pleural nodules seen by medical thoracoscopy and not detected by computed tomography scan of the chest.

Fig. 2

Parietal pleural nodules detected by computed tomography scan of the chest and confirmed by medical thoracoscopy.

Fig. 3

Computed tomography scan of the chest showing right parietal pleural thickening and medical thoracoscopy showing thickened nodular parietal pleura.

Table 7 Comparison between thoracoscopic and computed tomographic findings as regards fibrous septation

Finding	n (%)	
	Thoracoscope	CT
Fibrous septation	3 (15)	1 (5)

CT, computed tomography.

Table 8 Different types of pleural thickening suggestive of malignancy detected by computed tomography

Feature	Definition	n (%)
Circumferential pleural thickening	>75% chest wall pleura involved	10 (50)
Nodular pleural thickening	Focal, discrete, well demarcated area	4 (20)
Mediastinal involvement	Pleural involvement extends across mediastinum	5 (25)
Thickening>1 cm	Part of pleura>1 cm	4 (20)

Table 9 Computed tomography prediction of mesothelioma

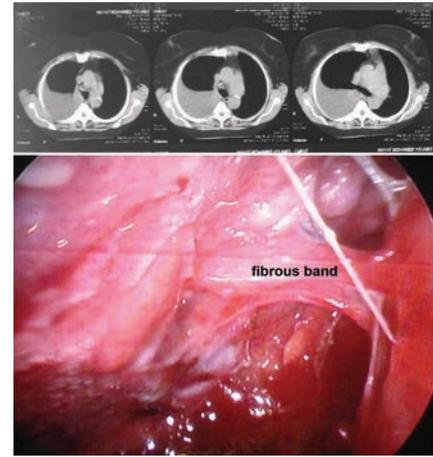|	Pathology	
	Positive	Negative
CT criteria positive	14	0
CT criteria negative	6	0
	20	0

CT, computed tomography.

correctly diagnosed and staged with thoracoscopy and CT [8].

Medical thoracoscopy has proved to be a safe tool in establishing diagnosis in patients with undiagnosed exudative pleural effusions [9].

Thoracoscopy allows the operator the advantage of visualizing the pleural cavity, including the diaphragmatic and visceral pleura, as well as the lung, which gives a chance to gain good information on the extent of the disease; in addition, it allows adequate tissue sampling [10].

Fig. 4

Pleural adhesions detected by medical thoracoscopy and not seen by chest computed tomography.

Our study included 20 patients with MPM with confirmed pathological diagnosis: 12 male and eight female patients. Fourteen patients presented with massive pleural effusion and six had moderate pleural effusion. CT findings in these patients were analyzed. The results were compared with the findings on medical thoracoscopy.

Visceral pleural abnormalities were detected by chest CT in one patient (5%). Medical thoracoscopy showed visceral pleural nodules in 13 cases (65%) and thickening in three cases (15%).

This is in accordance with the results of the study by Bergonzini *et al.* [8], which was conducted on 26 patients with CT findings of MPM. In this study the authors compared thoracoscopy and CT findings in the assessment of neoplastic spread to the parietal (stage IA) and/or visceral (stage IB) pleura and reported that, if the suspected MPM is classified as stage II, III, or IV, thoracoscopy should be used only for histologic confirmation. Conversely, in stages IA and IB, thoracoscopy, besides histology, should be used to confirm malignant spread to the visceral pleura [8].

Similar results were found in the study by Boutin *et al.* [2], which was conducted in Marseille, France, on 188 patients with MPM between 1973 and 1990, and aimed to assess the main prognostic factors of the disease. All patients had undergone thoracoscopy with endoscopic description of the lesions, and multiple biopsies were taken. Analysis of the main clinical, histopathological, endoscopic, and radiological (including CT scan) parameters was performed. He demonstrated that thoracoscopy allowed early diagnosis of the disease and a subdivision of stage I into stage IA (with normal visceral pleura) and stage IB (with invaded visceral pleural): Median survivals are 32.7 and 7 months,

respectively. Therefore, thoracoscopy is necessary in the staging of malignant mesothelioma [11].

In the present study and in the assessment of costal and diaphragmatic pleural invasion, chest CT detected 14 patients with costal pleural thickening (70%) and four patients with costal pleural nodules (20%). Medical thoracoscopy detected 16 patients (80%) with costal pleural thickening and 20 patients with pleural nodules (100%). With regard to diaphragmatic pleura, there were seven cases with diaphragmatic pleural nodules (35%) and one case with diaphragmatic pleural thickening (5%) detected by medical thoracoscopy, whereas chest CT was not able to identify any diaphragmatic pleural lesions. CT was able to detect 14/16 patients with costal pleural thickening (87.5%). But there was a significant difference between CT and medical thoracoscopy in the detection of abnormalities in the diaphragmatic pleura.

These results correlate with those of Metintas et al. [3], whose study was conducted in the Department of Chest Diseases, Osmangazi University, Turkey, on 215 patients: 99 with MPM, 39 with metastatic pleural disease, and 77 with benign pleural disease. In the chest CT of patients with MPM, pleural nodules were detected in 28% of the studied group and pleural thickening in 46%.

In another study conducted by Maasilta et al. [12] in the Department of Pulmonary Medicine, Helsinki University, Finland, 35 CT scans with contrast medium enhancement of the thorax and upper abdomen of patients with MPM were correlated with the findings on thoracotomy (28 patients), thoracoscopy (two patients), or autopsy (five patients). It showed that CT scans of all patients showed pleural thickening with contrast medium enhancement (100%), whereas in our study it was detected in only 70% [12].

In the present study chest CT detected one case with fibrous septations between the visceral and the parietal pleura (5%), whereas medical thoracoscopy identified three cases (15%) with pleural adhesions. The sensitivity of CT scan of the chest for detection of pleural septations was only 33% in our series.

Thoracic CT has been studied by Mason et al. [13] to predict pleural adhesions. They reported a limited accuracy of CT scans, with a sensitivity of 46% and specificity of 38% on a lesion-by-lesion basis [13].

The CT findings of the 20 patients included in this study were reviewed by a radiologist blinded to the pathological diagnosis in an attempt to assess the sensitivity of the noncontrast chest CT to identify malignant pleural lesions through detection of one or more of the following features:

(a) Circumferential pleural thickening,
(b) Nodular pleural thickening,
(c) Parietal pleural thickening greater than 1 cm, and
(d) Mediastinal pleural involvement.

The results were 50, 20, 25, and 20%, respectively, and the sensitivity was 70%.

This is similar to the study by Leung et al. [4] conducted between May 1985 and March 1989 in the University of British Columbia. Seventy-four patients were selected by reviewing their medical records and CT reports. Without knowledge of clinical or pathological data, they reviewed the CT findings of 74 consecutive patients with proved diffuse pleural disease (39 malignant and 35 benign). Features that were helpful in distinguishing malignant from benign pleural diseases were:

(a) Circumferential pleural thickening,
(b) Nodular pleural thickening,
(c) Parietal pleural thickening greater than 1 cm, and
(d) Mediastinal pleural involvement.

The specificities of these findings were 100, 94, 94, and 88%, respectively, and the sensitivities were 41, 51, 36, and 56%, respectively. Twenty-eight of 39 malignant cases (sensitivity, 72%; specificity, 83%) were identified correctly by the presence of one or more of these criteria [4].

This is also in accordance with the study by Yilmaz et al. [14], which was conducted in Izmir (Turkey). The aim of that study was to determine the significance of different CT findings for the differential diagnosis of benign and malignant pleural diseases. CT findings of 146 patients with proven pleural diseases were reviewed; 59 cases were malignant and 87 had benign pleural disease. CT findings that were helpful in distinguishing malignant from benign pleural disease were:

(a) Pleural nodularity,
(b) Rind,
(c) Mediastinal pleural involvement, and
(d) Pleural thickening greater than 1 cm.

The sensitivities and specificities were 37%/97%, 22%/97%, 31%/85%, and 35%/87%, respectively [14].

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