# Differentiation Between the Malignant Mesothelioma of Pleura and Pleural Metastasis with Contrast Enhanced CT, Is It Possible?

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## ABSTRACT

**Objective:** To compare CT findings between malignant pleural mesothelioma (MPM) and metastatic pleural disease (MPD).

**Materials and Methods:** CT chest images of 157 cases of pathologically-proven malignant pleural disease (21 MPM, 136 MPD) were retrospectively reviewed by two radiologists who were blinded to the diagnosis. Findings of interest included pleural effusion, pleural thickening, organ invasion, lymphadenopathy, dominant lung nodule, pulmonary or extra-thoracic organ metastasis, and asbestos-related disease.

**Results:** Findings commonly found in MPM compared with MPD are circumferential pleural thickening (52.4% vs 14.0%, p<0.001), pleural mass (33.3% vs 7.4%, p<0.001), organs invasion (57.1% vs 9.6%, p<0.001), and asbestos related disease (19% vs 0%, p<0.001).

**Conclusions:** Circumferential pleural thickening, pleural mass, presence of organ invasion, and CT finding of asbestos-related pleural disease were the CT findings that raise the possibility of MPM.

**Keywords:** Malignant pleural mesothelioma, pleural metastasis (Siriraj Med J 2021; 73: 594-602)

## INTRODUCTION

Malignant pleural mesothelioma (MPM), which is a tumor that arises from the mesothelial lining, is the most common primary malignancy of the pleura.[1] MPM is associated with history of asbestos exposure with a latency period of at least 20-30 years.[2,3] Metastatic pleural disease (MPD) is a secondary malignant process of the pleura that is most commonly due to lung and breast cancers, and it has a higher prevalence compared to that of MPM.[4,5] The clinical presentations of MPD, including dyspnea, chest pain, and weight loss, can also be observed in patients with MPM; however, the treatment and prognosis differ between these two conditions. Treatment for MPM is resection in patients with T1 and T2 (early-stage) disease, and the two-year survival rate is 38-46%.[6] In contrast, the treatment for MPD, which is considered an advanced disease with a median survival ranging from 3 to 12 months, is palliative care.[7,8] It is, therefore, essential that these two diseases be accurately distinguished from each other, and the gold standard method for diagnosis is histopathologic examination.[9,10] However, histopathologic diagnosis requires an adequate tissue specimen[9], and not all patients are sufficiently fit to undergo pleural biopsy. An alternative non-invasive method for differentiating

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between MPM and MPD, such as computed tomography (CT), is therefore needed. Guidelines published in 2018 by the British Thoracic Society (BTS), and in 2020 by the European Respiratory Society (ERS)/European Society of Thoracic Surgeons (ESTS)/European Association for Cardio-Thoracic Surgery (EACTS)/European Society for Radiotherapy and Oncology (ESTRO) (ESR/ESTS/EACTS/ESTRO) task force suggested the usefulness of CT for evaluating MPD, as well as for staging and guidance for tissue diagnosis of MPM.[9,11]

Several CT features have been reported as being helpful for MPM evaluation. Mediastinal pleural thickening, thickening of interlobar fissure, and chest wall or diaphragm involvement were CT features with specificity over 90%; however, the latter two had sensitivity less than 30% for MPM diagnosis.[12-16] Prior studies[17,18] evaluated the use of CT features for differentiating between MPM and MPD. Yoon, et al.[17] reported circumferential pleural thickening and pleural mass to be common features in MPM. In contrast, Mehrdad, et al.[18] reported nodular pleural thickening and contraction of involved hemithorax to be more frequently found in MPM.

The use of CT to differentiate between MPM and MPD would be beneficial due to its non-invasive nature; however, the heterogeneity of the findings and results of previous studies that investigated CT for its ability to distinguish MPM from MPD indicate that more study is needed. Accordingly, we set forth to investigate for features of contrast-enhanced CT that can distinguish MPM from MPD.

## MATERIALS AND METHODS

### *Patients*

The protocol for this study was approved by the Institutional Review Board (IRB) and the requirement to obtain written informed consent was waived due to our study's retrospective design. This retrospective chart and imaging review included patients who were diagnosed at our center with pathologically confirmed MPM or MPD during January 2015 to December 2017. The MPD group was subclassified into the two following groups: 1) primary lung cancer with pleural metastasis (PL-PM); and, 2) extrapulmonary cancer with lung metastasis (EP-PM).

### *Reference standard*

Confirmation of all MPM (21 patients) diagnoses was made by histopathologic examination of pleural biopsy. Confirmation of MPD was made by either histopathologic examination of pleural biopsy (63 patients) or pleural cytology obtained from thoracocentesis (73 patients).

### *CT acquisition and imaging review*

Chest CT studies were performed using either a Siemens Dual-Source CT (Siemens Healthineers AG, Erlangen, Germany) or a GE Medical Systems LightSpeed VCT 64 (GE Medical Systems, Chicago, IL, USA). All patients had two axial scan sequences, including pre-contrast and 45-second postcontrast phases with 1.25 mm slice thickness. Coronal and sagittal reformation were also obtained.

The chest CT studies must have been performed within three months before or after the pathology report. Suboptimal imaging quality, such as no contrast medium administration or severe motion artifact, were excluded.

All CT studies were retrospectively reviewed by two thoracic radiologists with 20 and 19 years of experience, respectively. Image reviews were conducted independently, and both reviewers were blinded to the pathological results. The reviewers recorded CT features of interest, including side of lesion, site of lesion in hemithorax, pleural effusion, pleural thickening, adjacent organ invasion, coexisting pulmonary abnormality, lymphadenopathy, extra-thoracic organ metastasis, and mediastinal shift. Any disagreement in image reads that occurred between reviewers was resolved via discussion and subsequent consensus.

The amount of pleural effusion was divided into three groups by visual assessment: small, moderate, and large. Small effusion was defined as effusion occupying less than 1/3 of the hemithorax; moderate effusion was defined as effusion occupying more than 1/3, but less than 2/3 of the hemithorax; and, large effusion was defined as effusion occupying more than 2/3 of the hemithorax. The presence loculated pleural effusion was also recorded.

Pleural thickening was categorized into 4 patterns, as follows: 1) thin, 2) thick/nodular, 3) circumferential, or 4) pleural mass. Thin pleural thickening was defined as smooth pleural thickening with a maximal thickness on axial scan of less than 1 cm, and not involving more than 3/4 of the hemithorax on axial scan. Thick/nodular pleural thickening was defined as pleural thickening with a maximal thickness of greater than 1 cm, but less than 3 cm, and not involving more than 3/4 of the hemithorax on axial scan or discrete pleural nodules. Circumferential pleural thickening was defined as continuous pleural thickening that involved more than 3/4 of the hemithorax on axial scan. Pleural mass was defined as a pleural lesion with a short axis larger than 3 cm on axial CT scan (Fig 1). Site of pleural thickening included peripheral, mediastinal, diaphragmatic aspect of pleura, or interlobar fissure involvement.

Presence of adjacent organ invasion was recorded

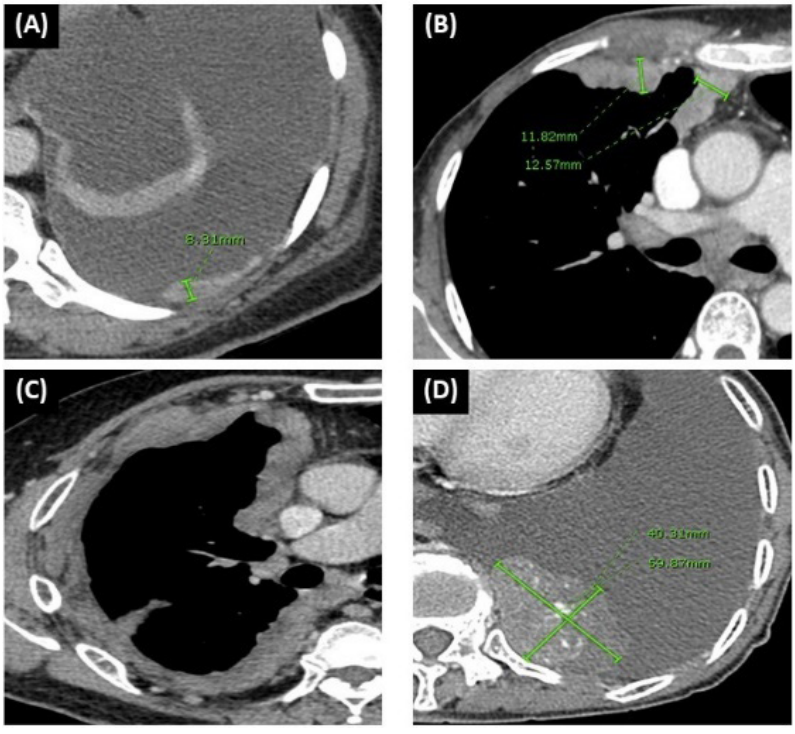


**Fig 1.** CT scan images show four patterns of pleural thickening. **(A)** *Thin pleural thickening*: smooth pleural thickening with a maximal thickness on axial scan of less than 1 cm, and involving not more than 3/4 of the hemithorax on axial scan. **(B)** *Thick/nodular pleural thickening*: pleural thickening with a maximal thickness of greater than 1 cm, but less than 3 cm, and involving not more than 3/4 of the hemithorax on axial scan or discrete pleural nodules. **(C)** *Circumferential pleural thickening*; continuous pleural thickening involving more than 3/4 of hemithorax on axial scan. **(D)** *Pleural mass:* pleural lesion with a short axis larger than 3 cm on axial CT scan.

as 1) chest wall, 2) pericardium, 3) diaphragm, or 4) other mediastinal organs.

For coexisting pulmonary abnormality, we recorded 1) dominant pulmonary nodule/mass, 2) pulmonary metastasis, 3) lymphangitic carcinomatosis, and 4) asbestos-related lung and pleural disease. Dominant pulmonary nodule was defined as the presence of a solitary pulmonary nodule or a mass with feature suspicious for primary lung cancer. Pulmonary metastasis was defined as bilateral non-calcified pulmonary nodules sized greater than 0.3 cm with a count of at least 10 nodules overall.[19,20] Asbestos-related lung and pleural disease was defined as subpleural dot-like opacities, subpleural curvilinear lines, parenchymal bands, intralobular and interlobular septal thickening, honeycomb appearance, and calcified or non-calcified pleural plaque.

Lymphadenopathy was considered for hilar, mediastinal, supraclavicular, axillary, cervical, and intra-abdominal lymph nodes larger than 1 cm, for cardiophrenic lymph nodes larger than 0.8 cm[21], and for internal mammary lymph nodes larger than 0.5 cm (all images in short axis).[22]

Presence of extra-thoracic organ metastasis was recorded, and presence of mediastinal shift was recorded and divided into ipsilateral or contralateral.

### *Statistical analysis*

SPSS Statistics version 23 (SPSS, Inc., Chicago, IL, USA) was used for all statistical analyses. Demographic data and the CT findings in the MPM, MPD, PL-PM, and EP-PM groups were compared using chi-square test or Fisher's exact test. Continuous data are shown as mean plus/minus standard deviation, and categorical data are shown as number and percentage. The significance of CT findings was analyzed using p-value, odds ratio (OR), and 95% confidence interval (CI). A p-value less than 0.05 was considered statistically significant.

## RESULTS

Of the 157 patients that were included, 21 patients were diagnosed with MPM, and 136 patients had MPD. Of the 136 patients with MPD, 66 patients had PL-PM, and 70 had EP-PM. There was no significant difference in age or gender between the MPM and MPD groups. Tumor-Node-Metastasis (TNM) staging in the MPM group is shown in Table 1. Demographic and clinical characteristics compared between the MPM and MPD groups are summarized in Table 2.

Table 3 presents the findings of CT imaging compared between the MPM and MPD groups. The odds ratios (OR) [and their respective 95% confidence intervals (CI)] of CT findings are shown in Table 4. We found no significant difference between groups for side of lesion, site of lesion in hemithorax, and amount or appearance of pleural effusion.

All patterns of pleural thickening were found significantly more often in MPM than in MPD (p<0.001-0.004). Circumferential pleural thickening and pleural mass were more common patterns in the MPM group than in the MPD group. (52.4% vs. 14.0%, and 33.3% vs.

**TABLE 1.** TNM staging of 21 patients with malignant pleural mesothelioma (8th edition AJCC/UICC for malignant mesothelioma).

| T | N | M | Stage |
|---|---|---|---|
| T1: 3 | N0: 6 | M0: 19 | IA: 0 |
| T2: 2 | N1: 12 | M1: 2 | IB: 1 |
| T3: 7 | N2: 3 | | II: 4 |
| T4: 9 | | | IIIA: 4 |
| | | | IIIB: 10 |
| | | | IV: 2 |

**TABLE 2.** Characteristic of patient in malignant pleural mesothelioma (MPM) and metastatic pleural disease (MPD) groups.

| Characteristic | MPM (n = 21) | MPD (n = 136) | P-value |
|---|---|---|---|
| **Age, years** (Mean ± SD) | 58.1 (±11.6) | 60.5 (±14.2) | 0.47 |
| **Sex** (M/F) | 10/11 | 38/98 | 0.069 |
| **Histologic subtype of MPM** | | | |
| - Epithelioid | 10 (47.6%) | | |
| - Desmoplastic | 4 (19.0%) | | |
| - Sarcomatoid | 1 (4.8%) | | |
| - Unspecified | 6 (28.6%) | | |
| **Primary cancer of MPD** | | | |
| - Non small cell lung cancer | | 64 (47.1%) | |
| - Small cell lung cancer | | 2 (1.5%) | |
| - Breast cancer | | 42 (30.9%) | |
| - Gastrointestinal cancer | | 7 (5.1%) | |
| - Genitourinary cancer | | 6 (4.4 %) | |
| - Head and neck cancer | | 4 (2.9%) | |
| - Malignant thymoma | | 5 (3.7%) | |
| - Soft tissue sarcoma | | 4 (2.9%) | |
| - Hematologic malignancy | | 2 (1.5%) | |

**Abbreviations:** SD: Standard deviation, M: Male, F: Female
Except where otherwise indicated, data were reported in frequency with percentage in parentheses.

**TABLE 3.** Comparison of CT findings of malignant pleural mesothelioma (MPM) and metastatic pleural disease (MPD) divided into primary lung cancer with pleural metastasis (PL-PM) and extrapulmonary cancer (EP-PM) with pleural metastasis subgroups.

| CT characteristic | MPM (n = 21) | MPD (n = 136) | MPD PL-PM (n = 66) | EP-PM (n = 70) | p* | p+ | p∞ |
|---|---|---|---|---|---|---|---|
| **Side** | | | | | 0.105 | 0.847 | |
| Right | 9 (42.9%) | 59 (43.4%) | 33 (50.0%) | 26 (37.1%) | | | |
| Left | 11 (52.4%) | 51 (37.5%) | 30 (45.5%) | 21 (30.0%) | | | |
| Bilateral | 1 (4.8%) | 26 (19.1%) | 3 (4.5%) | 23 (32.9%) | | | *0.010* |
| **Pleural thickening** | | | | | | | |
| Thin | 2 (9.5%) | 58 (42.6%) | 31 (47.0%) | 27 (38.6%) | *0.004* | *0.002* | *0.012* |
| Thick/Nodular | 1 (4.8%) | 49 (36.0%) | 19 (28.8%) | 30 (42.9%) | *0.004* | *0.023* | *0.001* |
| Circumferential | 11 (52.4%) | 19 (14.0%) | 13 (19.7%) | 6 (8.6%) | *<0.001* | *0.004* | *<0.001* |
| Mass | 7 (33.3%) | 10 (7.4%) | 3 (4.5%) | 7 (10.0%) | *<0.001* | *<0.001* | *<0.001* |
| **Location** | | | | | | | |
| Periphery | 19 (90.5%) | 127 (93.4%) | 58 (87.9%) | 69 (98.6%) | 0.627 | 0.745 | 0.068 |
| Mediastinal | 15 (71.4%) | 91 (66.9%) | 40 (60.6%) | 51 (72.9%) | 0.681 | 0.370 | 0.898 |
| Diaphragm | 17 (81.0%) | 113 (83.1%) | 54 (81.8%) | 59 (84.3%) | 0.809 | 0.929 | 0.718 |
| Fissure | 11 (52.4%) | 68 (50.0%) | 28 (42.4%) | 40 (57.1%) | 0.839 | 0.424 | 0.700 |
| **Pleural effusion** | | | | | | | |
| Appearance | | | | | | | |
| Free | 4 (19%) | 47 (34.6%) | 18 (23.7%) | 29 (41.4%) | 0.158 | 1.000 | 0.061 |
| Loculated | 13 (61.9%) | 84 (61.8%) | 48 (72.7%) | 36 (51.4%) | | | |
| Amount | | | | | | | |
| Small | 7 (33.3%) | 46 (33.8%) | 25 (37.9%) | 21 (30.0%) | 0.068 | 0.194 | 0.151 |
| Moderate | 4 (19%) | 54 (39.7%) | 29 (43.9%) | 25 (35.7%) | | | |
| Large | 6 (28.6%) | 32 (23.5%) | 12 (18.2%) | 20 (28.6%) | | | |
| **Organ invasion** | 12 (57.1%) | 13 (9.6%) | 7 (10.6%) | 6 (8.6%) | *<0.001* | *<0.001* | *<0.001* |
| Chest wall | 8 (38.1%) | 8 (5.9%) | 3 (4.5%) | 5 (7.1%) | *<0.001* | *<0.001* | *<0.001* |
| Pericardium | 4 (19.0%) | 4 (2.9%) | 4 (6.1%) | 0 | *0.002* | *0.073* | *<0.001* |
| Diaphragm | 5 (23.8%) | 2 (1.5%) | 2 (3.0%) | 0 | *<0.001* | *0.002* | *<0.001* |
| Other mediastinal organs | 6 (28.6%) | 4 (2.9%) | 1 (1.5%) | 3 (4.3%) | *<0.001* | *<0.001* | *0.001* |
| **Pulmonary Abnormality** | | | | | | | |
| Dominant nodule/mass | 2 (9.5%) | 79 (58.1%) | 64 (97.0%) | 15 (21.4%) | *<0.001* | *<0.001* | *0.220* |
| Pulmonary metastasis | 0 | 82 (60.3%) | 37 (56.1%) | 45 (64.3%) | *<0.001* | *<0.001* | *<0.001* |
| Lymphangitic carcinomatosis | 2 (9.5%) | 58 (42.6%) | 29 (43.9%) | 29 (41.4%) | *0.004* | *0.004* | *0.007* |
| Asbestos related disease | 4 (19.0%) | 0 | 0 | 0 | *<0.001* | *<0.001* | *<0.001* |
| **Lymphadenopathy** | | | | | | | |
| Hilar | 4 (19.0%) | 60 (44.1%) | 34 (51.5%) | 26 (37.1%) | *0.033* | *0.011* | 0.185 |
| Mediastinum | 8 (38.1%) | 83 (61.0%) | 40 (60.6%) | 43 (61.4%) | *0.048* | 0.071 | 0.059 |
| Supraclavicular | 1 (4.8%) | 25 (18.4%) | 11 (16.7%) | 14 (20.0%) | 0.118 | 0.168 | 0.099 |
| Internal mammary | 6 (28.6%) | 45 (33.1%) | 25 (37.9%) | 20 (28.6%) | 0.681 | 0.438 | 1.000 |
| Cardiophrenic | 4 (19.0%) | 48 (35.3%) | 21 (31.8%) | 27 (38.6%) | 0.212 | 0.406 | 0.120 |
| Others# | 0 | 23 (16.9%) | 8 (12.1%) | 15 (21.4%) | *0.041* | 0.094 | *0.020* |
| **Extra-thoracic organ metastasis** | 0 | 37 (27.2%) | 7 (10.6%) | 30 (42.9%) | *0.006* | 0.120 | *<0.001* |
| **Mediastinal shift** | | | | | 0.353 | 0.492 | 0.106 |
| Ipsilateral | 3 (14.3%) | 15 (11.0%) | 10 (15.2%) | 5 (7.1%) | | | |
| Contralateral | 6 (28.6%) | 23 (16.9%) | 14 (21.2%) | 9 (12.9%) | | | |

p*: p value, Chi-square test-comparison MPM versus overall MPD, p+: p value, Chi-square test-comparison MPM versus PL-PM, p∞: p value, Chi-square test-comparison MPM versus EP-PM, #Extra-thoracic stations included axillary, cervical and intra-abdominal lymphadenopathy.
**Abbreviations:** CT, Computed tomography
Data were reported in frequency with percentage in parentheses.

**TABLE 4.** Odd ratio (OR) of CT findings in malignant pleural mesothelioma.

| CT Characteristics | OR (95% CI) |
|---|---|
| **Pleural thickening** | |
| Thin | 0.14 (0.03-0.63) |
| Thick/Nodular | 0.09 (0.01-0.68) |
| Circumferential | 6.77 (2.53-18.12) |
| Mass | 6.30 (2.07-19.17) |
| **Organ invasion** | 12.62 (4.48-35.56) |
| Chest wall | 9.85 (3.17-30.60) |
| Pericardium | 7.77 (1.78-33.94) |
| Diaphragm | 20.94 (3.75-116.91) |
| Mediastinal organs | 13.20 (3.34-52.12) |
| **Pulmonary Abnormality** | |
| Dominant nodule/mass | 0.08 (0.02-0.34) |
| Pulmonary metastasis | NA |
| Lymphangitic carcinomatosis | 0.14 (0.03-0.63) |
| Asbestos related disease | NA |
| **Lymphadenopathy** | |
| Hilar | 0.29 [0.09-0.93] |
| Mediastinum | 0.39 [0.15-1.01] |
| Others[#] | NA |

[#]Extra-thoracic stations included axillary, cervical and intra-abdominal lymphadenopathy
**Abbreviations:** CT, Computed tomography; CI, Confidence interval; NA, Not applicable

7.4%, respectively). In contrast, thin and thick/nodular pleural thickening were less frequently observed in MPM group patients compared to MPD group patients (9.5% vs. 42.6%, and 4.8% vs. 36.0%, respectively).

Overall adjacent organ invasion was significantly more commonly seen in MPM patients than in MPD patients (57.1% vs. 9.6%, p<0.001). Invasion to the chest wall, diaphragm, and pericardium was found in 38.1%, 23.8%, and 19.0% of patients, respectively.

Presence of asbestos-related disease was also significantly higher in the MPM group than in the MPD group (19% vs. 0%, p<0.001). In contrast, other pulmonary abnormalities, including dominant lung nodule/mass, pulmonary metastasis, and lymphangitic carcinomatosis, were significantly less often observed in the MPM group (9.5 vs. 58.1%, p<0.001; 0% vs. 60.3%, p<0.001; and, 9.5% vs. 42.6%, p=0.004, respectively).

Presence of lymphadenopathy at the hilar, mediastinal, and extra-thoracic (i.e., axillary, cervical, or intra-abdominal) locations was significantly less frequently found in the MPM group compared to the MPD group (19.0 vs. 44.1, p=0.033; 38.1 vs. 61%, p=0.048; and, 0% vs. 16.9, p=0.041, respectively).

Presence of extra-thoracic organ metastasis was also significantly lower in the MPM group than in the MPD group (0% vs. 27.2%, p=0.006). Mediastinal shift showed no significant difference between the MPM and MPD groups.

Subgroup analysis between the MPM and PL-PM groups, and between the MPM and EP-PM groups, showed results consistent those from comparison between MPM and MPD, except for bilateral disease involvement, which was significantly more commonly found in the EP-PM subgroup (p=0.01) (Table 3).

## DISCUSSION

In the present study, we found several CT features that were statistically significantly suggestive of MPM compared to MPD. Although MPM is a rare pleural tumor with poor prognostic outcome, patients with early-stage

disease can be treated by resection[6], which is in contrast to the palliative care treatment strategy that is used to manage patients with MPD. Precise diagnosis between these two entities must be confirmed by histopathologic study; however, CT can be used as a first-line imaging tool for differential diagnosis, staging, and tissue sampling guidance.[9,11]

Presence of circumferential pleural thickening was found to be a common CT feature that had a strong correlation with MPM (OR: 6.77). This pattern was found in 52.4% of patients with MPM, which is in agreement with prior studies that reported prevalence rates ranging within 31-72%.[13-17,23] In smaller percentage, we also observed circumferential pleural thickening in MPD cases that was caused by primary lung cancer or breast cancer (Fig 2). Pleural mass was another common pattern that was observed in 33.3% patients with MPM. This prevalence rate is similar to those from prior studies (range: 8-38%).[16,17,23] In our study, thin and thick/nodular pleural thickening patterns were uncommon in MPM patients, but were common in MPD patients. This result is similar to that reported by Yoon, et al.[17], but different from other studies that reported a prevalence in MPM patients ranging from 21% to 86%.[12,14,16]

Organ invasion was another significant CT characteristic found to be associated with MPM (57.1%, OR: 12.62), and the two most commonly involved organs were chest wall and diaphragm. This demonstrated the locally aggressive behavior of MPM, which was also observed in prior studies.[14,17,18] Concerning location, some prior studies[16-18] suggested that interlobar fissure involvement was more related with MPM. However, we did not find this in the present study. This difference between studies may be due to the use thin-slice CT with multiplanar reconstruction images that increase the detection of MPD lesions at interlobar fissures.

In the present study, all of the MPM cases that were suspicious for asbestos-related disease had pleural plaque (19%), while there was no pleural plaque found in the MPD group. Pleural plaque is the most common radiographic finding for asbestos exposure[2,3,24], and the reported prevalence of pleural plaque in MPM patients ranged from 21% to 66%.[12,14,16,17] Based on this finding, we propose that the presence of pleural plaque should increase suspicion for MPM (Fig 3).

Regarding the types of MPD, primary lung cancer is one of the most common causes of pleural metastasis accounting for 40%.[25,26] Other malignancies that have

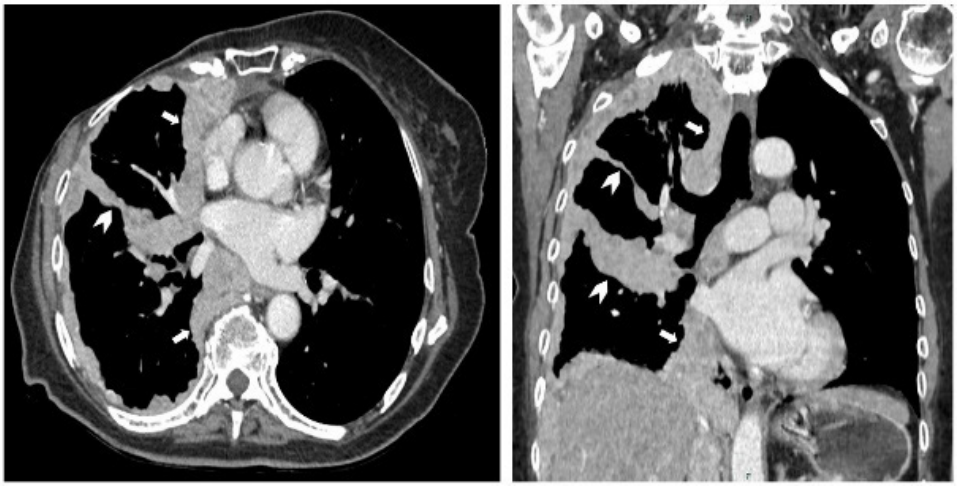

**Fig 2.** CT scan of a patient diagnosed with right breast cancer and post-right mastectomy. Axial and coronal CT scan shows circumferential pleural thickening at right hemithorax. Involvement of mediastinal pleura (arrow) and interlobar fissure (arrow head) are also demonstrated.

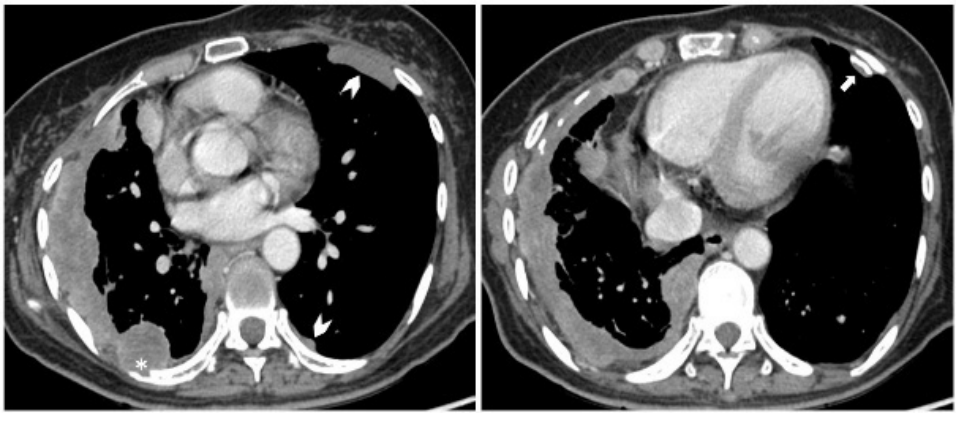

**Fig 3.** CT scan of a patient diagnosed with MPM. Axial CT scan shows circumferential pleural thickening at right hemithorax with rib destruction (*). A few calcified (arrow) and non-calcified (arrow head) pleural plaques at left hemithorax are also demonstrated.

a propensity for pleural metastasis are breast, gastrointestinal, genitourinary, and hematologic malignancies.[25,26] In subgroup analysis comparing MPM and EP-PM, we found bilateral pleural involvement, pulmonary metastasis, lymphangitic carcinomatosis, extra-thoracic lymphadenopathy, and extra-thoracic organ metastasis to be more common in the EP-PM group, which confirms the concept of extensive dissemination of tumor via hematogenous and lymphatic routes in advanced-stage cancers.[27,28]

The lymphatic drainage of pleura is a complex system. The visceral pleura and the lung parenchyma drain via lymphatic vessels in the interlobular septa toward pulmonary hilar and mediastinum. In contrast, the parietal pleura drains toward different lymph node stations, such as the internal mammary and cardiophrenic lymph nodes.[29,30] We found hilar and mediastinal lymphadenopathy to be less commonly found in MPM compared to MPD. Prior study[31] suggested that the mechanism of the spread of MPM to hilar lymph nodes may be via lung invasion rather than direct spreading of the pleura. The presence of these nodes may be due to primary lung cancer and coexisting pulmonary metastasis in the MPD group.

### Limitations

This study has some mentionable limitations. First, the retrospective nature of this study renders it vulnerable to both incomplete data and selection bias. Second, this study was conducted at a large tertiary care center where complicated cases were routinely referred. Thus, our findings may not be generalizable to other patient care settings. Third, we had a small number of patients in the MPM group, which could have limited the statistical power of our study to identify all significant differences and associations between groups. A multi-center study with long-term follow-up is needed to confirm the results of this study.

## CONCLUSION

Several CT features were found to be significantly different between the MPM and MPD groups. Circumferential pleural thickening, pleural mass, adjacent organ invasion, and presence of asbestos-related disease were significantly more commonly observed in MPM compared to MPD.

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