Serial CT and FDG-PET/CT findings of pleural change after talc pleurodesis in patients with history of malignancy

Poster No.: C-2552
Congress: ECR 2013
Type: Scientific Exhibit
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Keywords: Inflammation, Foreign bodies, Cancer, Contrast agent-intravenous, PET-CT, CT, Thorax
DOI: 10.1594/ecr2013/C-2552

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Purpose

Pleurodesis is defined as the symphysis between the visceral and parietal pleura that prevents the accumulation of either air or liquid in the pleural space. Pleurodesis is performed by installation of sclerosing agents into the pleural cavity or by surgical abrasion of the pleura. Although a number of sclerosing agents have been used for pleurodesis, talc is considered the best sclerosant regarding the rate of success. Talc induces an intrapleural inflammatory response and plural fibrosis which obliterates the pleural space.

Pleural changes after talc pleurodesis have been described. These include the formation of pleural masses, pleural thickening, pleural nodularity, residual effusion, loss of costophrenic angle. Focal area of high attenuation with the pleural changes representing talc deposition and dystrophic calcification can also be seen on CT. Moreover, recent reports have documented talc related FDG uptake within the high attenuation area. Pleural changes after talc pleurodesis also make difficult to distinguish between benign inflammatory processes and neoplastic progression, particularly in patients of history of malignancy.

The purpose of our study is to characterize the serial CT and FDG-PET/CT findings of pleural change after talc pleurodesis in patients with history of underlying malignancy.
Methods and Materials

1. Patients

From January 2004 to December 2011, 194 patients who had undergone talc pleurodesis at our institution were retrospectively reviewed. Of these patients, 23 patients had both a history of malignancy and serial follow-up CT and FDG-PET/CT scans. Among them, 6 patients consequentially enrolled in our study, except for the 17 patients who had evidence of residual or recurrent malignant pleural lesion in the radiologic and clinical follow-up. Our institutional review board approved our research study and did not require patient informed consent for the retrospective study.

2. CT scanning

CT scans were acquired by means of a helical technique, a Somatom Plus-4 (Siemens Medical Solutions, Erlangen, Germany) or a Somatom Sensation 64 (Siemens Medical Solutions, Erlangen, Germany) scanner. Scanning was performed from the lower part of the neck to the level of the middle portion of the kidneys. All image scanning was performed after IV administration of contrast medium (140 mL Iopamidol, Pamiray 300, Dongkuk Pharm., Seoul, Korea) with an injection rate of 2.5 mL/sec with a power injector (Mallinckrodt, Tyco and Vistrion CT, Medrad). The scanning parameters were 120kVp; 90 and 150mA; beam width, 2.5 mm; table speed, 15 mm per rotation. Data were interfaced directly to a PACS, which displayed all image data on monitors (two monitors, 1,536 x 2.048 image matrices, 8 bit viewable gray scale, 60-foot-lambert luminescence). Scans were viewed with both mediastinal (window width, 400H; window level, 20H) and lung (window width, 1,500H; window level, -700H) window settings.

3. PET/CT Scanning

All patients fasted for at least 6 hours and had a serum glucose level less than 140 mg/dL before the IV injection of FDG. Scanning was performed 60 minutes after administration. Scans were acquired with a PET/CT system (CTI, Knoxville, Tennessee, U.S.A.), which consisted of a full-ring PET scanner and an Dual-detector-row spiral CT scanner (Somatom Emotion duo, Biograph, Erlangen, Germany). CT was performed from head to the pelvic floor according to a standard protocol with the following settings: 130kVp; 30 mA; tube rotation time, 0.8 seconds per rotation; pitch, 6; section thickness, 5mm to match the PET section thickness. Immediately after nonenhanced CT, PET was performed in the identical transverse field of view. PET data sets were obtained with an iterative reconstruction with an ordered subset expectation maximization algorithm and by application of segmented attenuation correction (two iterations, 28 subsets) to CT data. Coregistered scans were displayed with software, which enabled image fusion and analysis.
4. Imaging analysis

Imaging analyses were performed by morphologic characteristics with location and appearance of pleural lesions, including shape, maximum thickness and multiplicity. Measurement of average attenuation (HU) was determined by the elliptical region of interest (ROI) around the high density pleural lesion and the degree of enhancement was recorded using attenuation difference between the enhanced and unenhanced images. Highest metabolic activity was evaluated with measurement of maximum standard uptake value (SUVmax) within same ROI as for average attenuation measurement was obtained. When patient had 2 or more discontinuous lesions, imaging analysis were separately evaluated for each lesion. All measured values were compared between first and last follow-up studies.

5. Statistical analysis

Measurements of categorical variable were assessed using calculation of central tendency (mean, range). The difference of pleural thickness between first and last follow-up scans was assessed using Wilcoxon signed rank test. Paired samples t-test was used for the comparison of attenuation, contrast enhancement and SUVmax between first and last follow-up scans. A P-value of less than 0.05 was considered to be significant. Statistical analysis was performed using the statistical package SPSS (IBM, Chicago, USA) for Windows, release 20.0.0.
Results

1. Clinical characteristics

There were 4 men and 2 women in the study group. Their mean age was 60 years (range, 52 to 72 years). All patients had a history of malignancy, 5 patients had lung cancer (adenocarcinoma, 4; squamous cell carcinoma, 1) and one had treated cervical cancer. The histopathologic confirmation of the pleural lesion was made in percutaneous needle biopsy in 2 patients. All patients had at least 2 follow-up CT and FDG-PET/CT scans: 3 patients had 2 scans, 2 had 3 scans, and one had 4 scans. Mean interval between the talc pleurodesis and the first follow-up study was 15 months (range 6 to 23 months). Mean total follow-up period was 45 months (range 17 to 71 months).

2. Location and shape

All patients had pleural abnormality. Total number of pleural lesions was 10 in 6 patients and mean number of the lesion was approximately 1.7 (range, 1 to 3). 7 lesions were located in upper thorax and 3 lesions were located in lower thorax. 4 lesions were located in anterior and 6 lesions were located in posterior pleural surface (Table 1). Shapes of lesion were nodular in 2, linear elongated in 5, and patchy in 3 (Figure 1). The number of lesions was unchanged in follow-up studies. The location and shape of lesions also showed no significant interval change during the follow-up (Figure 2).

<table>
<thead>
<tr>
<th>Location</th>
<th>Upper thorax</th>
<th>Lower thorax</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior thorax</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Posterior thorax</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td><strong>7</strong></td>
<td><strong>3</strong></td>
<td><strong>10 (Total)</strong></td>
</tr>
</tbody>
</table>

Table 1: Table 1. Locations of the lesions.

References: Diagnostic radiology, Kosin university gospel - Busan/KR
Fig. 1: Figure 1. Non-enhanced CT scans in 53-year-old-man with a left lower lobectomy due to adenocarcinoma of the lung. He underwent talc pleurodesis in 18 months earlier because of persistent air leak after surgery. Focal area of high attenuation with nodular pleural thickening was seen in the left upper thorax (A, arrow). Additionally, diffuse pleural thickening with linear high attenuation area was seen in the left lower posterior thorax, near the posterior costophrenic angle (B, arrows).

References: Diagnostic radiology, Kosin university gospel - Busan/KR

Fig. 2: Figure 2. A 65-year-old man with a history of adenocarcinoma of the right upper lung and he underwent talc pleurodesis for persistent air leak. A calcific pleural lesion in the right upper thorax showed no significant interval change from 12 months (A) to 17 months (B) after talc pleurodesis.

References: Diagnostic radiology, Kosin university gospel - Busan/KR

3. Pleural thickening
All patients showed variable thickness of pleural lesion. The mean thickness of pleural lesions was 11.8mm (range, 7.0 to 16.9mm) and 10.3 (range, 7.0 to 17.6mm) in first and last follow-up studies, respectively. There was no statistically significant change (P = 0.240) (Figure 2).

4. CT attenuation and enhancement

All pleural abnormalities showed area of high attenuation within the lesions. The mean attenuation of pleural lesions was 157.2 HU (range, 65 to 251 HU) in first follow-up CT scan and 150.1 (range, 78 to 249 HU) in last follow-up CT scans. There was no statistically significant change (P = 0.393). However, the degree of enhancement of pleural lesions in the last follow-up CT scan significantly higher compared with those obtained in first follow up CT scan (P = 0.020) (Figure 3). Enhancement value was 29.13 HU (range, 5 to 62 HU) and 47.50 HU (range, -4 to 52 HU) in first and last follow-up CT scans, respectively.

![Fig. 3](image)

Fig. 3: Figure 3. A 57-year-old man with right upper lobectomy due to adenocarcinoma of the lung. He underwent talc pleurodesis after surgery. Non-enhanced and enhanced CT scans and FDG-PET/CT scan in 6 months after talc pleurodesis (A) showed elongated linear area of high attenuation along the lower posterior thorax. The area of highest FDG uptake corresponded to the high attenuation area. The degree of contrast enhancement was 34 HU. Images obtained in 39 months after talc pleurodesis (B) showed more conspicuous contrast enhancement (63 HU).

References: Diagnostic radiology, Kosin university gospel - Busan/KR

5. SUVmax
The areas of SUVmax corresponded to high attenuation pleural abnormality in all 10 lesions. The SUVmax of pleural lesions in last follow-up PET/CT scan was no statistical difference with those obtained in first follow-up PET/CT scan, although 6 lesions showed increased value. The SUVmax was 10.89 (range, 7.74 to 18.25) and 12.27 (range, 6.44 to 18.88) in first and last follow-up CT scans, respectively (P = 0.341). The changes of pleural thickness, CT attenuation, enhancement and SUVmax during the follow-up are summarized in Table 2.

<table>
<thead>
<tr>
<th></th>
<th>Thickness (mm)</th>
<th>Attenuation (HU)</th>
<th>Enhancement (HU)</th>
<th>SUVmax</th>
</tr>
</thead>
<tbody>
<tr>
<td>First F/U</td>
<td>11.77±3.37</td>
<td>157.20±50.64</td>
<td>29.38±17.30</td>
<td>10.89±3.54</td>
</tr>
<tr>
<td>Last F/U</td>
<td>10.27±4.12</td>
<td>150.10±52.26</td>
<td>47.25±14.86</td>
<td>12.27±4.6</td>
</tr>
<tr>
<td>Difference</td>
<td>1.50±3.77</td>
<td>-7.10±25.02</td>
<td>17.88±17.64</td>
<td>1.38±4.33</td>
</tr>
<tr>
<td>P-value</td>
<td>0.24</td>
<td>0.393</td>
<td>0.02</td>
<td>0.341</td>
</tr>
</tbody>
</table>

Table 2: Table 2. Differences between the first and the last follow-up studies.

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Conclusion

When we are faced with an abnormal pleural FDG uptake in patient with a history of malignancy, it is important to know about characteristic CT and PET/CT findings after talc pleurodesis. The typical finding after talc pleurodesis is the presence of linear or focal plural thickening with high attenuation area, contrast enhancement, and FDG uptake. These changes may be persistent or fluctuated in the follow up studies. Awareness of this characteristic pleural change at CT and FDG-PET/CT scan and careful correlation with the patient's clinical history of talc pleurodesis may help to distinguish this benign inflammatory process from pleural malignancy.
References


