An Audit of Medical Thoracoscopy and Talc Poudrage for Pneumothorax Prevention in Advanced COPD*

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Objectives: To prospectively study all patients with COPD and spontaneous pneumothorax (SP) who underwent thoracoscopic talc poudrage (TP) under local anesthesia to determine its efficacy and safety in recurrence prevention.

Methods: Data on clinical measurements, complications, duration of chest tube drainage, length of hospital stay, and outcome were collected.

Results: Forty-one patients (38 men and 3 women) with a mean (± SD) age of 70.7 ± 7.2 years were treated. All patients had COPD, with a mean FEV₁ of 41 ± 14% predicted. The majority of SPs measured 20 to 50% in size, and 34% were recurrent. Three grams of talc were insufflated into the pleural cavity without complications. Thirteen patients (32%) complained of pain, 5 (12%) developed fever, 27 (66%) had subcutaneous emphysema, and 7 (17%) had prolonged air leaks. Postoperative chest tube drainage and hospital stay were 4 and 5 days, respectively. Success was 95% after a median follow-up of 35 months. Four patients with FEV₁ of < 40% predicted died within 30 days of the procedure, yielding a mortality rate of 10%. FEV₁ (in liters), FEV₁ (in % predicted), and ischemic heart disease were risk factors that influenced early mortality.

Conclusion: Thoracoscopic TP is effective for pneumothorax prevention and can be performed with acceptable mortality in patients with advanced COPD.

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Key words: COPD; pneumothorax; poudrage; talc; thoracoscopy

Abbreviations: ASA = American Society of Anesthesiology; BMI = body mass index; CXR = chest radiograph; IHD = ischemic heart disease; MT = medical thoracoscopy; NYHA = New York Heart Association; SaO₂ = arterial oxygen saturation; SP = spontaneous pneumothorax; TP = talc poudrage; VATS = video-assisted thoracoscopic surgery

Spontaneous pneumothorax (SP), which occurs without trauma to the thorax, is a significant problem.¹,² Primary SP affects a patient with no underlying lung disease, while secondary SP often occurs as a complication of COPD.³ The likelihood of having recurrent pneumothorax during the next 5 years is 30 to 50% if the patient is not subjected to pleurodesis or pleural abrasion,⁴ and recurrence rates are higher for secondary SP and for patients with at least one recurrence.¹,⁵ The estimated first recurrence rate for SP in COPD is 43%.³

Secondary SP can be life-threatening. Age-matched patients with COPD have a 3.5-fold increase in relative mortality with each SP occurrence,⁶ and there is one study⁷ that has demonstrated that 5% of these patients die before chest tube placement. Although subsequent studies⁵,⁸ have shown lower mortality rates, the American College of Chest Physicians consensus statement⁹ recommends a more aggressive approach to secondary SP management, which includes chest tube insertion and treatment aimed at recurrence prevention.

Although surgical bullectomy and parietal pleural abrasion or pleurectomy¹⁰ via thoracotomy or video-assisted thoracoscopic surgery (VATS) is advocated for definitive SP recurrence prevention, both techniques require general anesthesia, double-lumen endotracheal intubation, and single-lung ventilation,
and are associated with significant morbidity and mortality. Moreover, in our pulmonary practice we often encounter patients with SP who are considered to be at risk for general anesthesia and surgery due to their underlying COPD and associated comorbidity but require treatment for recurrence prevention. We therefore conducted a prospective study of a group of patients with moderate-to-severe COPD and SP who underwent medical thoracoscopy (MT) and talc poudrage (TP) under local anesthesia to determine their safety and efficacy in recurrence prevention. The study protocol was conducted in accordance with the 1975 Helsinki Declaration.

Materials and Methods

Patients

Included in this study were all patients with moderate-to-severe COPD and SP who underwent MT-TP from November 1997 to December 2001. The classification of SPs into < 20%, 20 to 50%, and > 50% was based on the average interpleural distance obtained from frontal and lateral chest radiograph (CXR). \(^{12} \) While COPD severity was derived from values of postbronchodilator FEV\(_1\) (in liters), FEV\(_1\) (% predicted), and FEV\(_1\)/FVC ratio (%) within a year prior to MT-TP. Moderate COPD was defined as an FEV\(_1\)/FVC ratio of < 70%, and FEV\(_1\) values of ≥ 30 and < 50% predicted, while severe COPD was defined as an FEV\(_1\)/FVC ratio of < 70%, and FEV\(_1\) values of < 30% predicted. \(^{13} \) Clinical severity of exertional dyspnea as well as fitness for MT-TP were assessed according to the New York Heart Association (NYHA) grading system and the American Society of Anesthesiologists (ASA) physical status classification. All patients gave written informed consent prior to the procedure and were prospectively followed until December 2002. Data on demographics, procedure-related complications, duration of chest tube drainage, length of hospital stay, and outcomes were collected.

Analysis

Comparisons between two groups were performed by \(\chi^2\) test, Fisher exact test, and Mann-Whitney U test. A \(p\) value of \(\leq 0.05\) was considered to be significant.

Procedure

All patients received oxygen at a rate of 2 L/min by nasal cannula, and IM injections of pethidine, 50 mg, and atropine, 0.6 mg. Midazolam, between 1 and 5 mg, was administered IV at the start of procedure and was titrated for comfort under the careful supervision of a pulmonary fellow together with continuous ECG, BP, and percutaneous oximetry monitoring.

MT was performed in the operating room with a single-puncture technique. Patients were placed in the lateral decubitus position with the lateral area of chest cleaned and draped, and 1% lidocaine administered to the selected interspace for local anesthesia. Between 500 and 600 mL air was injected into the pleural cavity via chest tube to collapse the lung partially, and a 7-mm trocar, consisting of an obturator, cannula, and insufflation stopcock, was inserted in the fourth or fifth intercostal space, midaxillary line. A straight-on 0° rigid telescope attached to a video camera and monitor, optical and coagulating forceps (Wolf Medical Instruments Corp; Vernon Hills, IL) were used to inspect the pleural cavity, to stage the lung macroscopically according to Vanderschueren, \(^{14} \) as well as to lyse any pleuropulmonary adhesion. No stapling of bulla or repair of air leaks was performed.

TP was achieved by insufflating 3 g asbestos-free, sterilized talc (Merck; Darmstadt, Germany) into the pleural cavity with a bulb syringe and catheter. The uniform distribution of talc over visceral and parietal pleural surfaces was verified by thorascopic inspection, followed by placement of a 28F chest tube connected to an underwater seal suction at negative 20 cm H\(_2\)O for 2 days, or until the air leak had ceased. CXR was performed postoperatively to confirm tube position and reexpansion of lung, and oral synthetic morphine analogs (tramadol) were prescribed for postoperative pain.

RESULTS

Forty-one patients with SP underwent MT-TP and were prospectively observed for 35 months (range, 18.5 to 47 months). The mean (± SD) age was 70.7 ± 7.2 years, and there were 38 men and 3 women. All patients cited a significant mean smoking history of 52.8 ± 22.3 pack-years, 24 patients (59%) had experienced a previous tuberculosis infection, and 12 patients (29%) had ischemic heart disease (IHD). Thirty patients (73%) had moderate COPD, while the remaining 11 patients (27%) had severe COPD. Their mean FEV\(_1\) was 0.88 ± 0.28 L, and their mean body mass index (BMI) was 17.2 ± 3.0 kg/m\(^2\). Fifteen patients (37%) were classified as NYHA grade III or ASA grade 3, and 26 patients (63%) were classified as NYHA grade IV or ASA grade 4.

The majority of patients presented to the emergency department with pleuritic chest pain (30 patients; 73%) and worsening dyspnea (41 patients; 100%). Twenty-seven SPs (66%) measured 20 to 50%, 9 SPs (22%) measured > 50%, and 5 SPs (12%) measured ≤ 20% in size. Fourteen SPs (34%) were recurrent, for which no definitive treatment had been administered in the past. All patients received chest tubes and supplemental oxygen therapy as initial management (Table 1).

Most patients underwent MT-TP within 4 days of hospitalization and required 2 mg midazolam for sedation. Twenty-one patients (51%) had endoscopically healthy lungs (stage I), 2 patients (5%) had pleuropulmonary adhesions (stage II), 5 patients (12%) had blebs and bullae of < 2 cm (stage III), and 13 patients (32%) had bullae of > 2 cm (stage IV). Three grams of talc was administered without a fall in arterial oxygen saturation to < 90%, respiratory failure, or severe bronchospasm necessitating endotracheal intubation and mechanical ventilation.

Twenty-six patients (63%) developed cough during MT, 13 patients (32%) complained of pain...
immediately after undergoing TP, 5 patients (12%) who were culture-negative developed fevers (defined as a temperature of $\geq 38^\circ C$) within 48 h of undergoing the procedure, and 27 patients (66%) had subcutaneous emphysema that did not require surgical intervention. There were no major perioperative complications requiring thoracotomy or blood transfusion, and immediate success, defined as the complete reexpansion of the lungs, was observed in all patients after MT-TP (Table 2).

Seven patients (stage I, three patients; stage II, one patient; and stage III, three patients) had air leaks for > 1 week that resolved with tube thoracotomy and suction. Of these patients, two had air leaks for 23 and 24 days due to lung injury from the first chest tube, and postoperatively required two tubes for drainage. They were 84 and 72 years of age, had IHD and hypertension, as well as FEV$_1$ values of 0.81 and 1.21 L. Both patients refused surgical repair of the air leak and were managed conservatively. They were subsequently discharged from the hospital well and were alive without SP recurrence during the study period.

Our 30-day mortality rate was 10%, and the deaths were attributed to acute myocardial infarction in one patient within 24 h of MT-TP, to pneumonia in two patients, and to COPD in one patient 2 weeks after the procedure. These four patients were elderly men with $> 20\%$ SP, incapacitating severe COPD, and IHD (Table 3). Absolute FEV$_1$ (in liters), FEV$_1$ (% predicted), and IHD were identified risk factors ($p \leq 0.05$) contributing to the increased mortality observed in the early postoperative period (Table 4 and Fig 1). The mortality rate at 1 year was 17% (seven deaths), and these deaths were due to pneumonia (four patients), COPD (two patients), and acute myocardial infarction (one patient).

Outcome data were available for all patients who returned at regular intervals for their COPD treatment. The long-term success of MT-TP, which was defined as the proportion of patients who did not require further intervention at any time, was 95% after a median follow-up of 35 months (range, 19 to 47 months). Two SP recurrences were observed in two patients, occurring at 3 and 6 months following MT-TP, and they were successfully treated with the instillation of talc slurry via chest tube. Although the majority of patients (35 patients; 93%) had radiologic obliteration of the costophrenic angle, repeat pulmonary function test results performed in 34 patients who were alive at 1 year did not show restriction (Table 5).

### Discussion
COPD is a major public health problem worldwide$^{15}$ and is a leading cause of mortality, with
deaths occurring as result of acute respiratory failure, pneumothorax, pneumonia, pulmonary embolism, and cardiac arrhythmias. The goals of SP management in patients with underlying COPD should not only include drainage of intrapleural air to facilitate reexpansion of lung and pleural healing, but, more importantly, attempts at permanent pleurodesis must be considered. Although in recent years VATS has evolved rapidly to become a relatively safe procedure even for the elderly, owing to improved instrumentation and increasing application by thoracic surgeons, it is still performed with general anesthesia, double-lumen endotracheal intubation, and single-lung ventilation. MT, on the other hand, is carried out with the patient under local anesthesia and spontaneously breathing. The choice of VATS or MT-TP for the treatment of SP is dependent on several variable factors. Young patients with recurrent SP may benefit from VATS, staple bullectomy if bulla is visualized, and pleural abrasion. For the elderly with secondary SP and comorbidity that place them at risk for general anesthesia, MT can be performed to detect emphysematous lesions, and TP can be carried out for pleurodesis. The reported efficacy of TP in achieving permanent pleurodesis is comparable to mechanical pleural abrasion, full or apical pleurectomy, and talc slurry. In fact, a study by Colt et al in animals showed that thoracoscopic TP produced better and more widespread pleurodesis than mechanical abrasion with pleural abrader or talc slurry, which affected mostly gravity-dependent areas of the pleural cavity.

Although there is much literature on the efficacy of talc slurry and VATS, largely in primary SPs, to our knowledge, there is no study that determines the efficacy and safety of MT-TP in patients with moderate-to-severe COPD in which SP recurrence prevention is important. Our study showed that MT was relatively safe and did not lead to any major adverse event that necessitated open surgical “bail out.” It was also effective, with a long-term success rate of 95%. Twenty-one patients (51%) were observed to have endoscopically healthy lungs (stage I) during MT, but the actual prevalence of blebs and bullae might have been underestimated. In 18 patients with blebs and bullae (stages III and IV), our immediate and 2-year success rates were 100% and 94%, respectively. Similarly, for those with bullae measuring \( >2 \) cm (stage IV) in whom staple bullectomy was advocated, our 1-year and 2-year success rates following MT-TP were 92%. These results concurred with those reported by Liu et al., of a group of 13 patients (age range, 55 to 71 years) with diffuse emphysematous lung disease and persistent SP who were treated with thoracoscopic talc insufflation without bullectomy, and were observed for 22 months. In addition, the duration of tube drainage, length of hospital stay, and immediate and long-term success were comparable with those after treatment with VATS and staple bullectomy, as well as limited thoracotomy.

Although fever was observed within 48 h of undergoing MT-TP in five patients (12%), blood culture findings were negative, and there was no occurrence of postoperative empyema. Subcutaneous emphysema was more frequently observed in our study than in others, and this minor adverse effect, which resolved without intervention, was attributed to coughing during parietal pleural manipulation. The instillation of lidocaine 0.5% into the pleural space prior to trocar insertion can be considered to avoid this complication.

ARDS has been associated with TP and is postulated to be consequent to talc entering the pleural cavity. However, in our study, although ARDS occurred in 13 patients (25%) less than in other studies, only one patient died with ARDS. There was no significant difference in mortality rates in patients with ARDS, aspirin use, or a history of allergy compared with patients without ARDS. Three patients (5%) were readmitted to the hospital within 30 days of MT-TP, two of whom had developed pulmonary fibrosis and one with emphysema and recurrent SP.

### Table 3—Clinical Features of Four Patients Who Died Within 30 Days of MT-TP*

<table>
<thead>
<tr>
<th>Patient No./Sex/Age/yr</th>
<th>FEV₁, L</th>
<th>IHD</th>
<th>NYHA/ASA</th>
<th>BMI</th>
<th>SP size, %</th>
<th>Smoking, pack-yr</th>
<th>Cause of Death</th>
<th>Days Post-MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/M/70</td>
<td>0.50</td>
<td>Yes</td>
<td>4/4</td>
<td>15.2</td>
<td>20–50</td>
<td>100</td>
<td>AMI</td>
<td>1</td>
</tr>
<tr>
<td>2/M/77</td>
<td>0.70</td>
<td>Yes</td>
<td>4/4</td>
<td>15.8</td>
<td>&gt;50</td>
<td>120</td>
<td>Pneumonia</td>
<td>13</td>
</tr>
<tr>
<td>3/M/69</td>
<td>0.55</td>
<td>Yes</td>
<td>4/4</td>
<td>18.2</td>
<td>20–50</td>
<td>40</td>
<td>COPD</td>
<td>14</td>
</tr>
<tr>
<td>4/M/76</td>
<td>0.60</td>
<td>Yes</td>
<td>4/4</td>
<td>15.0</td>
<td>20–50</td>
<td>40</td>
<td>Pneumonia</td>
<td>17</td>
</tr>
</tbody>
</table>

*AMI = acute myocardial infarction; M = male.

### Table 4—Risk Factors Influencing Early (30-day) Mortality Rate*

<table>
<thead>
<tr>
<th>Variables</th>
<th>Death (n = 4)</th>
<th>Alive (n = 37)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>73 ± 4</td>
<td>70 ± 7</td>
<td>0.36</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>16.1 ± 1.5</td>
<td>17.4 ± 3.1</td>
<td>0.30</td>
</tr>
<tr>
<td>FEV₁, L</td>
<td>0.58 ± 0.12</td>
<td>0.91 ± 0.27</td>
<td>0.03†</td>
</tr>
<tr>
<td>% predicted</td>
<td>26 ± 7</td>
<td>43 ± 13</td>
<td>0.02†</td>
</tr>
<tr>
<td>Patients with IHD, No.</td>
<td>4 (100%)</td>
<td>8 (22%)</td>
<td>0.001†</td>
</tr>
<tr>
<td>Patients (NYHA class)</td>
<td>4 (4)</td>
<td>15 (3)/22 (4)</td>
<td>0.28</td>
</tr>
<tr>
<td>Patients (ASA grade)</td>
<td>4 (4)</td>
<td>15 (3)/22 (4)</td>
<td>0.28</td>
</tr>
</tbody>
</table>

Values given as mean ± SD, unless otherwise indicated.

†p ≤0.05.
systemic circulation. The dose of talc,\textsuperscript{32} particle size,\textsuperscript{33} and different talc preparations as well as biopsy of pleura\textsuperscript{34} are possible etiologies. All of our patients received talc with a particle size of $< 50 \mu m$, but neither of them, nor the two patients who were given additional talc slurry for recurrent SP, developed respiratory failure or bilateral infiltrates seen on CXR. Despite radiologic evidence of pleural thickening, they also did not manifest any restrictive lung disease at 1 year or mesothelioma during their follow-up.

Our 30-day mortality rate was higher than those reported in most studies,\textsuperscript{10,22,35,36} which could be attributed to the severity of underlying disease, as these four patients had low BMIs, FEV\textsubscript{1} values of $< 40\%$ predicted, and had been classified as being in NYHA grade IV and ASA grade 4. Although Jaklitsch et al\textsuperscript{36} demonstrated an overall mortality rate of $< 1\%$ for VATS in the elderly, their patients’ FEV\textsubscript{1} was $> 1.6$ L, while our patients’ median FEV\textsubscript{1} was $0.58$ L. Moreover, they had IHD, which was observed as another risk factor accounting for higher early postoperative mortality. Thus, we caution against the use of MT-TP for all COPD patients, especially those with FEV\textsubscript{1} values of $\leq 0.7$ L and comorbid IHD. In this group, the intrapleural instillation of talc slurry via chest tube might represent a safer option.

With rapidly evolving technology, and an improved safety profile for anesthetic drugs and ventilatory strategies, future studies addressing the safety and efficacy of each therapeutic intervention are required to optimally stratify patients with secondary SP to limited thoracotomy, VATS, MT-TP, or intrapleural talc slurry instillation.

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**REFERENCES**
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**Table 5—Spirometry Before and 1 Year After MT-TP\textsuperscript{*}**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Before MT-TP (n = 34)</th>
<th>1 Year After MT-TP (n = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEV\textsubscript{1}</td>
<td>0.92 ± 0.27</td>
<td>0.86 ± 0.25</td>
</tr>
<tr>
<td>% predicted</td>
<td>43 ± 14</td>
<td>39 ± 12</td>
</tr>
<tr>
<td>FVC</td>
<td>1.70 ± 0.43</td>
<td>1.69 ± 0.43</td>
</tr>
<tr>
<td>% predicted</td>
<td>60 ± 14</td>
<td>59 ± 14</td>
</tr>
<tr>
<td>FEV\textsubscript{1}/FVC, %</td>
<td>54 ± 12</td>
<td>52 ± 11</td>
</tr>
</tbody>
</table>

\textsuperscript{*}Values given as mean ± SD.


12 Rhea JT, DeLuca SA, Greene RE. Determining the size of pneumothorax in the upright patient. Radiology 1982; 144:733–736


