Pleurodesis with a 50% Glucose Solution in Patients with Spontaneous Pneumothorax in Whom an Operation is Contraindicated

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Purpose: Pleurodesis continues to play a central role in the management of pneumothorax. In our institute, a 50% glucose solution is used for pleurodesis. We retrospectively analysed the treatment effects of pleurodesis in patients with spontaneous pneumothorax in whom an operation was contraindicated because of underlying disease.

Methods: 13 patients (18 cases) with spontaneous pneumothorax were treated with pleurodesis with a 50% glucose solution. After local anesthesia of parietal pleura, 200 to 500 mL of a 50% glucose solution was instilled into the pleural space. Pleurodesis was repeated two or three times, until the air leakage stopped.

Results: Air leakage stopped in all cases and there were no treatment-related deaths. Overall survival rates at 1, 2, and 3 years after treatment were 83%, 74%, and 49%, respectively. Post-treatment recurrence was observed in six cases. Four cases of recurrence were treated with pleurodesis with a 50% glucose solution. All cases of recurrence occurred within 3 months after pleurodesis.

Conclusion: Pleurodesis with a 50% glucose solution is effective and safe in patients with pneumothorax. This procedure can be performed in patients with recurrent pneumothorax as well as patients with a first episode of pneumothorax in whom prolonged air leakage is predicted.

Keywords: pleurodesis, pneumothorax, 50% glucose solution

Introduction

Operative treatment is undertaken in patients with recurrent pneumothorax and in patients with first-time pneumothorax who have prolonged air leakage. However, operative treatment is contraindicated in some patients with pneumothorax because of severe underlying disease, and these patients are treated by thoracic drainage with pleurodesis.1

Bronchial occlusion therapy has been reported to be effective in the treatment of patients with pneumothorax,2 but is not available at every institution, because it requires advanced facilities and techniques. Thoracoscopic surgery under local anaesthesia has been performed in high-risk patients with intractable pneumothorax.3 However, patients cannot be effectively treated under local anaesthesia when a causative bulla is not detected preoperatively, or there is adhesion in the pleural space. Even though it is performed under local anaesthesia, thoracoscopic surgery may be categorized as invasive, and beyond the standard treatment for pneumothorax. Pleurodesis continues to play a central role in the management of pneumothorax in patients in whom operative treatment is contraindicated.
At our institute, a 50% glucose solution is used for pleurodesis because it is a low-cost, easy-to-perform treatment strategy and is reported to be highly effective. We retrospectively analysed the treatment effects of pleurodesis with a 50% glucose solution in patients with spontaneous pneumothorax in whom operation was contraindicated because of severe underlying disease.

Materials and Methods

Informed consent was obtained from all patients included in this study. The Institutional Review Board of Bell Land General Hospital approved this treatment strategy. From April 2006 to December 2011, 280 cases of spontaneous pneumothorax were treated at the Bell Land General Hospital, Sakai, Japan. Among them, 18 cases of spontaneous pneumothorax in 13 patients, in whom air leakage was prolonged and operative treatment was contraindicated because of severe underlying disease, were treated by pleurodesis with a 50% glucose solution.

Operative treatment was considered to be contraindicated in patients with performance status 3 or 4, active pulmonary disease, domiciliary oxygen therapy, or inability to tolerate one-lung ventilation. Thoracic drainage was performed with an 18Fr double-lumen chest tube, and patients with air leakage for longer than 7 days were identified as candidates for pleurodesis. The degree of lung expansion was not an important criterion for pleurodesis. Before the start of pleurodesis, saline was instilled into the pleural space through the chest tube to rule out regurgitation and aspiration of pleural fluid. Local anaesthesia of the parietal pleura was achieved by instilling 10 mL of 1% lidocaine with 100 mL of saline into the pleural space, after which 200–500 mL of a 50% glucose solution was instilled into the pleural space, and patients were asked to change their position on the bed every 10 minutes for 2 hours. The chest tube was connected to a water seal during pleurodesis, and continuous aspiration was started after pleurodesis. In cases with prolonged air leakage, pleurodesis with a 50% glucose solution was repeated two or three times, until the air leakage stopped. The criteria for removal of the chest tube were: fully expanded lungs, no further air leakage, and a daily volume of pleural effusion of <200 mL.

Changes in blood glucose levels after instillation of a 50% glucose solution into the pleural space were investigated. Blood glucose levels were not measured in the 13 patients with pneumothorax in whom operative treatment was contraindicated. From November 2011 to December 2011, seven patients with spontaneous pneumothorax underwent surgical treatment at our institute. None of these patients had glucose intolerance. The patients underwent bullectomy and intraoperative mechanical and chemical pleurodesis. We instilled 500 mL of a 50% glucose solution into the pleural space, followed by intraoperative mechanical pleurodesis via abrasion of the parietal pleura from the apex to the diaphragm at the end of surgery. Perioperative blood glucose levels were measured in these patients.

Treatment efficacy was evaluated by survival and the presence or absence of pneumothorax recurrence. The Kaplan-Meier Method was used to analyse overall and recurrence-free survival rates.

Result

The characteristics of the 13 patients (18 cases of pneumothorax) are shown in Table 1. The 13 patients comprised 10 men and 3 women, with a mean age of 78 years (range, 65–87 years). Of these, three patients had one recurrence and one patient had two recurrences after pleurodesis. The most common underlying disease contraindicating operation was pulmonary emphysema. Two patients developed ipsilateral bacterial pleuritis, and one patient developed pneumonia due to aspiration of food. The mean period of thoracic drainage was 21 days (range, 5–41 days). The mean period of hospitalization was 36 days (range, 8–118 days). There were no treatment-related deaths. Thirteen cases returned home, and five cases were transferred to other institute after removal of the chest tube (Table 1). The mean post-treatment follow-up period was 23 months (range, 4–42 months). Nine patients were alive at the time of the latest follow-up. Two patients died of respiratory failure due to the progression of their underlying disease, one patient died of colon cancer, and one patient died in an accident (Table 1). Overall survival rates at 1, 2, and 3 years after treatment were 83%, 74%, and 49%, respectively (Fig. 1). Post-treatment recurrence was observed in six cases. Four cases of recurrence were treated with pleurodesis with a 50% glucose solution, and two cases were treated with thoracic drainage alone. All cases of recurrence occurred within 3 months after pleurodesis (Fig. 2).
Table 1 The characteristics of the 13 patients (18 cases) in this study

<table>
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<tr>
<th>Case</th>
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<th>gender</th>
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<th>PS</th>
<th>Domiciliary oxygen therapy</th>
<th>Side</th>
<th>Number of onsets</th>
<th>Volume of 50% glucose solution (ml)</th>
<th>Complication</th>
<th>Outcome</th>
<th>Cause of death</th>
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PS: performance status
The treatment of Case 7 is shown. A 76-year-old man was admitted to our institute with his fourth episode of right pneumothorax. He had hypoxemia due to advanced pulmonary emphysema, and was treated with domiciliary oxygen therapy. Air leakage was prolonged, and pleurodesis with 500 mL of a 50% glucose solution was performed 10 days after insertion of the thoracic drain. Because air leakage continued after the initial treatment, pleurodesis with 500 mL of a 50% glucose solution was repeated at 15 and 22 days after insertion of the thoracic drain. The volume of pleural effusion recorded on the days of pleurodesis excluded the 500 mL of 50% glucose solution and 110 mL of local anaesthesia, instilled. The volume of pleural effusion was elevated on the days of pleurodesis. Post-treatment fever and pain were well controlled by oral nonsteroidal anti-inflammatory drugs (Fig. 3). After the third pleurodesis, air leakage stopped, and he returned home. The total period of thoracic drainage was 37 days, and the period of hospitalization was 40 days. No recurrence occurred during follow-up of 185 days.

Blood glucose levels after instillation of a 50% glucose solution into the pleural space were investigated in seven patients. These seven patients comprised six men and one woman, with a mean age of 34 years (range, 17–55 years). Blood glucose levels increased to 361 ± 46 mg/dL at the end of the operation and then decreased gradually (Fig. 4). Blood glucose levels 2, 8, and 16 hours after operation were 141 ± 50, 95 ± 16, and 93 ± 12 mg/dL, respectively.

**Discussion**

We report the effectiveness of pleurodesis with a 50% glucose solution in patients with spontaneous pneumothorax in whom operative treatment is contraindicated. Chen, et al. reported successful treatment of chylothorax after oesophagectomy by instillation of a 50% glucose solution into the pleural space. The mechanism of pleurodesis with a 50% glucose solution remains unclear. Pleural mesothelial cells and resident pleural macrophages secrete several growth factors into the pleural effusion in cases of pleural inflammation. Both tetracycline and talc stimulate pleural mesothelial cells to produce and release fibroblast growth factor. Released fibroblast growth factor might play a critical role in the development of pleural fibrosis. Instillation of a 50% glucose solution into the pleural cavity exposes pleural mesothelial cells and resident pleural macrophages to hyperosmotic stress, which may cause them to secrete growth factors into the pleural effusion. Growth factors may then stimulate inflammatory cells and fibroblasts, which induce collagen deposition.

Two patients (two cases of pneumothorax) developed ipsilateral bacterial pleuritis. One of these patients was admitted with their first episode of pneumothorax. The thoracic drainage period before pleurodesis was 12 days, and the total thoracic drainage period was 35 days. The other patient was admitted with their second episode of pneumothorax. This patient was treated with pleurodesis three times, with a total
drainage before pleurodesis and between episodes of thoracic drainage period of 25 days. The risk of pleural infection may not be increased by the instillation of a 50% glucose solution, as this solution is hyperosmotic. However, prolonged thoracic drainage might increase the risk of infection. Both patients were successfully treated with antibiotic therapy. For reduction of the risk of pleural infection, the need for pleurodesis should be determined quickly, and the period of thoracic drainage before pleurodesis and between episodes of pleurodesis should be shortened. As a large volume of pleural effusion was secreted on the days of pleurodesis, patients were asked to record their fluid intake, and some required intravenous fluid supplementation until the day after pleurodesis. The pleural effusion volumes decreased on the day after pleurodesis, and continuation of fluid therapy was not required.

In patients who underwent intraoperative pleurodesis, blood glucose levels increased transiently after instillation of a 50% glucose solution, and returned to preoperative levels within 8 hours. In patients who underwent pleurodesis without operation, glucose absorption from the pleural space may have been less, because abrasion of the parietal pleura was not performed. Elevation of blood glucose levels may, therefore, have been less in these patients. In patients with normal glucose tolerance, additional treatment might not be needed for the glucose absorbed from the pleural space.

The degree of lung expansion was not an important criterion for pleurodesis in this study. Only regurgitation and aspiration of pleural fluid was considered a contraindication. Even in cases of incomplete lung expansion, increased exudative pleural effusion might promote pleural fibrosis and healing of the ruptured visceral pleura. Pleurodesis with a 50% glucose solution could safely be repeated, resulting in decreased air leakage and increased lung expansion. The chest tube could be removed in all cases after the disappearance of air leakage.

Fig. 3 The treatment of Case 7 is shown. The volume of pleural effusion recorded on the days of pleurodesis excludes the 500 mL of a 50% glucose solution and 110 mL of local anesthesia, instilled. The volume of pleural effusion was elevated on the days of pleurodesis. The patient did not develop any fever during treatment.

Fig. 4 Perioperative blood glucose levels of seven patients with spontaneous pneumothorax, who were treated by bullectomy and intraoperative chemical pleurodesis with a 50% glucose solution. All values are presented as mean ± standard deviation.
Six patients had pneumothorax recurrence after pleurodesis with a 50% glucose solution. Pleurodesis was repeated in four of these cases, and air leakage subsequently stopped. Pleurodesis could be performed safely and effectively in patients with posttreatment recurrent pneumothorax. All recurrences occurred within 3 months after pleurodesis. The process from pleuritis to pleural fibrosis induced by instillation of a 50% glucose solution might be completed in about 3 months. Careful posttreatment observation for 3 months is, therefore, necessary. The 1-year mortality rate in older patients with pneumothorax and several comorbidities has been reported to be 11%–45%. In patients with pulmonary emphysema, each occurrence of pneumothorax has been reported to increase the chances of dying, fourfold. The post-treatment 1-year survival rate was 83% in this study. Pleurodesis with a 50% glucose solution might be an acceptable treatment for pneumothorax. However, this study was a retrospective observation report. For the avoidance of selection bias, a prospective randomized trial should be performed. One patient died of respiratory failure within 1 year after pleurodesis. It is possible that pleurodesis might cause restrictive pulmonary dysfunction. Further investigations of the impact of this method of pleurodesis on posttreatment respiratory function also should be undertaken.

Conclusion

This study showed that pleurodesis with a 50% glucose solution is effective and safe in patients with pneumothorax in whom surgery is contraindicated. This procedure can be performed in patients with recurrent pneumothorax as well as patients with a first episode of pneumothorax in whom prolonged air leakage is predicted.

Disclosure Statement

The authors of this manuscript have no relevant financial or other potential conflict of interest.

References