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Staple Line Coverage with a Polyglycolic Acid Sheet Plus Pleural Abrasion by Thoracoscopic Surgery for Primary Spontaneous Pneumothorax in Young Patients

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Abstract

Purpose: We investigated surgical results of staple line coverage with a polyglycolic acid sheet plus pleural abrasion by thoracoscopic surgery for treating primary spontaneous pneumothorax in young patients.

Methods: Forty-seven patients younger than 40 years underwent 48 thoracoscopic surgical procedures for spontaneous pneumothorax at the Division of Thoracic Surgery, Department of Surgery, Nippon Medical School, from May 2007 through August 2010. All patients underwent thoracoscopic bullectomy with stapling devices and pleural abrasion performed with a gauze sponge held by forceps until the pleura became petechial. Finally, the staple line was covered with a polyglycolic acid sheet (10 × 10 cm). No fibrin glue was used. We investigated both short-time results after surgery and the postoperative recurrence of pneumothorax.

Results: There was no operative mortality or morbidity, such as air leakage from staple lines or hemorrhage due to pleural abrasion. Pneumothorax recurred after surgery in 3 cases. In 2 cases, neither re-operation nor tube thoracostomy was necessary because intrapleural adhesions allowed only partial collapse of the lung. One patient underwent re-operation for an overlooked bulla facing the diaphragm in left lower lobe of the lung 2 days after the first operation. The rate of freedom from pneumothorax 4 years after surgery was 94%.

Conclusions: Staple line coverage with a polyglycolic acid sheet plus pleural abrasion by thoracoscopic surgery is a useful method for preventing morbidity and the postoperative recurrence of pneumothorax.

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Key words: spontaneous pneumothorax, thoracoscopic surgery, staple line coverage, pleural abrasion

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Introduction

Thoracoscopic surgery is frequently performed to treat spontaneous pneumothorax. Thoracoscopic surgery is beneficial in reducing pain[1,2], scarring[1], and the length of hospitalization[1–6], but the rate of postoperative recurrence of pneumothorax tends to be higher after thoracoscopic bullectomy alone than after conventional plication of bullae with axillary thoracotomy[3–9] or posterolateral thoracotomy[2]. Recently, staple line coverage with an absorbable mesh has been found to be useful for preventing air leakage and the postoperative recurrence of pneumothorax around the staple line[10]. In the present study, we prospectively investigated the effectiveness of staple line coverage with a polyglycolic acid sheet plus pleural abrasion for preventing air leakage and the postoperative recurrence of pneumothorax.

Materials and Methods

Forty-seven consecutive young patients (40 male and 7 female) underwent 48 thoracoscopic surgical procedures to treat primary spontaneous pneumothorax at the Division of Thoracic Surgery, Department of Surgery, Nippon Medical School, from May 2007 through August 2010. The median age of patients was 23 years (range, 13–37 years).

Operative procedures for thoracoscopic surgery were as follows. The patients were prepared, received anesthesia through a double-lumen endotracheal tube, and were positioned as for a standard posterolateral thoracotomy. First, 1 trocar port was placed in the 7th intercostal space along the mid axillary line. Then, a second trocar port was placed in the 4th intercostal space along the anterior axillary line. Finally, a third trocar port was placed in the 4th or 5th intercostal space along the posterior axillary line. All patients underwent thoracoscopic bullectomy with stapling devices and careful parietal pleural abrasion from the apex to the level of 7th intercostal space with a gauze sponge held by forceps until the pleura became petechial. Finally, the staple line was covered with a polyglycolic acid sheet (10 × 10 cm). No fibrin glue was used. Postoperative pain was usually controlled with epidural analgesia.

The patients gave written informed consent to be involved in the study, and the local ethics committee approved the protocol.

We investigated both short-time results after surgery and the postoperative recurrence of pneumothorax.

Statistical analysis was performed with the software program IBM SPSS Statistics version 19 (IBM SPSS Statistcs, IBM Corp., Armonk, NY, USA). Data are shown as means ± standard deviations. The rate of freedom from pneumothorax was statistically analyzed with Kaplan-Meier estimated survival curves.

Results

Thirty operations were performed for ipsilateral recurrence of pneumothorax. Seventeen operations were performed at the first episode of pneumothorax (air-leakage persisting for more than 5 days, 7 cases; contralateral pneumothorax, 5 cases; hemopneumothorax, 2 cases; and massive air leakage, 2 cases; and concurrent bilateral pneumothorax, 1 case).

The number of bullae resected was 2.5 ± 1.8 (range, 1–10). The number of stapling devices used was 3.3 ± 2.0 (range, 1–9). The operation time was 78 ± 24 minutes (range, 37–147 minutes). The volume of blood loss was 10 ± 44 mL (range, 0–300 mL). The maximal white blood cell count after surgery was 10,975 ± 2,590 in a microlitter (range, 6,800–17,400). The maximal serum level of creatinine phosphokinase after surgery was 406 ± 150 IU/L (range, 198–1,102 IU/L). The maximal level of C-reactive protein after surgery was 5.9 ± 3.6 mg/dL (range, 0.7–14.6 mg/dL). The duration of drainage after surgery was 1.2 ± 0.8 days (range, 0–5 days). The mean duration of postoperative hospital stay was 4.0 ± 1.4 days (range, 2–7 days).

There was no operative mortality and morbidity, such as air leakage from staple lines and hemorrhage due to pleural abrasion. The follow-up period was 2.6 ± 1.1 years (range, 1.0–4.2 years).

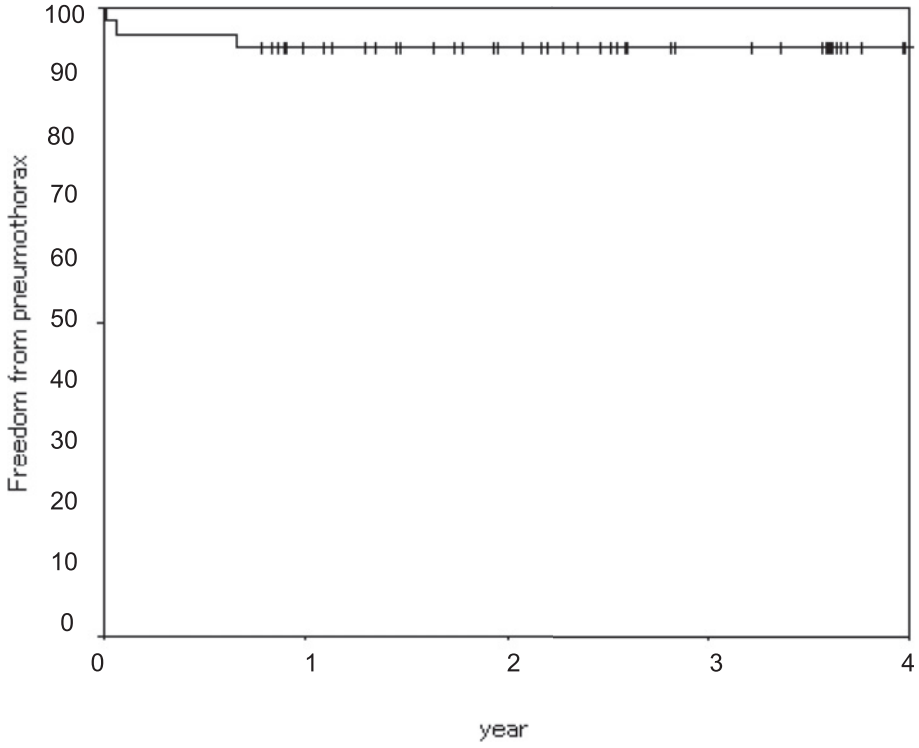

Fig. 1 The rate of freedom from pneumothorax after surgery

Pneumothorax recurred after surgery in 3 cases. In 2 cases, pneumothorax recurred 1.2 months and 8.4 months after surgery. However, neither re-operation nor tube thoracostomy was necessary because intrapleural adhesions allowed only partial collapse of the lung. One patient underwent re-operation for an overlooked bulla facing the diaphragm in left lower lobe of the lung 2 days after the first operation. The rate of freedom from pneumothorax 4 years after surgery was 94% **(Fig. 1)**. None of the patients complained of dyspnea on exertion.

Discussion

Thoracoscopic surgery has been a standard procedure for the treatment of primary spontaneous pneumothorax and is performed in 90% of cases in Japan[11]. However, a high rate of postoperative recurrence undermines the patient's benefits from thoracoscopic surgery. The postoperative pneumothorax recurrence rate in 4 years after surgery has decreased from 16.1% in our previous report[12] to 6.0% in the present study. We have suggested that collapsed emphysematous bullae during unilateral ventilation and insufficient observation of rarely diseased areas, and inappropriate visualization of the diseased areas in the mediastinal side lead to postoperative recurrence of pneumothorax and have reported that rupture of emphysematous bullae located around the old staple lines cause spontaneous pneumothorax in some cases[12]. We have also reported that blebs and bullae contain abnormal elastic fibers, which have probably degraded owing to an imbalance between elastase and alpha1-antitrypsin[9–13,14] and which are responsible for the protrusion and rupture into pleural cavities[13]. In addition, some blebs and bullae contain extensively degraded circumferential elastic fibers whose incomplete resection may lead to the formation of new blebs and bullae. On the basis of intra-operative and pathological findings, re-growth of residual emphysematous bullae due to incomplete resection cannot be differentiated from new formation of emphysematous bullae[12]. Bullectomy with a sufficient margin of normal pleurae and pulmonary parenchyma is ideal, but extensive pulmonary resection is limited by stapling devices. Therefore, staple line coverage with an absorbable mesh to reinforce the visceral pleura was performed in the present study. Recently, Sakamoto et al. have

reported that staple line coverage with a Vicryl mesh was useful for preventing air leakage and postoperative recurrence of pneumothorax around the staple line and have suggested that the thickened and fibrotic visceral pleura formed as a result of mesh absorption might help prevent postoperative recurrence of pneumothorax[10]. In the present study, we used a polyglycolic acid sheet that has also been reported to thicken the visceral pleura during absorption and to promote adhesions[15]. In the present study pneumothorax recurred postoperatively in 2 patients, but neither re-operation nor tube thoracostomy was necessary because intrapleural adhesions allowed only partial collapse of the lung.

In conclusion, staple line coverage with a polyglycolic acid sheet plus pleural abrasion by thoracoscopic surgery is a useful method for preventing morbidity and postoperative recurrence of pneumothorax.

Conflict of Interest Statement: We, or members of our immediate family, have no relevant financial interests in this manuscript.

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