

Surgical treatment of empyema after pulmonary resection using pedicle skeletal muscle plombage, thoracoplasty, and continuous cavity ablation procedures: a report on three cases

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Abstract: We present three cases of postoperative empyema after pulmonary resection: case 1, acute empyema without fistula after lobectomy and chest wall resection; case 2, continuing empyema with fistula and total left residual lung abscess after upper divisionectomy; and case 3, chronic empyema with middle lobe bronchopleural fistula after lower lobectomy. Pedicle skeletal muscle plombage into the cavity, thoracoplasty, and continuous cavity ablation with 24-h instillation of minocycline and saline solution through drains were used for treatment. In case 2, a completion extrapleural left pneumonectomy was concurrently performed. In all three cases, the surgery was successful; however, case 2 developed a massive gastrointestinal hemorrhage, which led to blood aspiration pneumonia, renal failure, and death. Muscle plombage effectively achieves the closure of empyema cavity and thoracoplasty complements this. When a residual space remains, cavity ablation is considered to be effective. However, concurrent completion lung parenchyma resection might be excessively aggressive.

Keywords: Pulmonary resection; empyema; thoracoplasty; muscle plombage; cavity ablation

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Introduction

Empyema after pulmonary resection is a serious complication and treatment is often extremely difficult (1-5). To cure empyema, closure of the fistula and abscess cavity is crucial; therefore, the transplantation of omentum or skeletal muscles is often performed. General thoracic surgeons have recently encountered fewer cases of inflammatory pulmonary disease; therefore, for each case, the postoperative empyema management is conducted through a trial and error process. Here we present three cases of postoperative acute empyema without fistula, continuing empyema with fistula, and chronic empyema with fistula, respectively, that were all treated by a combination of pedicle skeletal muscle plombage, thoracoplasty, and continuous cavity ablation. Cases 1 and 2 were treated at the Aichi Cancer Center Aichi Hospital (Okazaki, Japan) and case 3 was managed at the Aichi Cancer

Center Hospital (Nagoya, Japan).

Case presentations

Case 1

This patient was a 70-year-old male with diabetes and emphysema. He had squamous cell carcinoma of the lung originating from the right upper lobe. He was diagnosed as having cT3N0M0 stage IIB disease with a 6-cm tumor infiltrating the second and third ribs along the anterior axillary line. Induction treatment included cisplatin and vinorelbine administration as well as concurrent radiation therapy at 40 Gy. Surgery was performed 1 month after the induction therapy. The second to the fourth ribs were resected through a 9 cm × 8 cm area via anteroaxillary thoracotomy, followed by right upper lobectomy. The

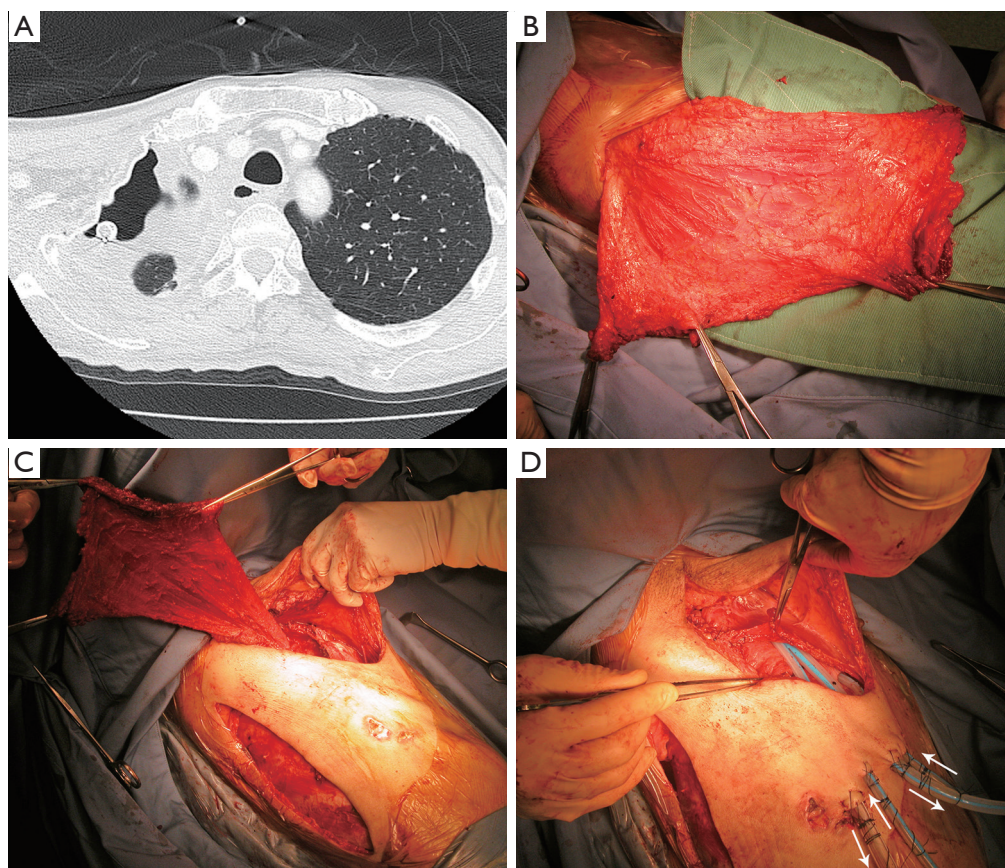


Figure 1 Case 1. (A) A large dead space is observed in the chest cavity; (B) the bundle of the pedicle from the LD and SA muscles was raised; (C) the muscles were subcutaneously introduced into the anterior part of the thorax; (D) two 19-Fr (inflow) and two 24-Fr (outflow, arrows indicating flow) elastic drains were placed at both the mediastinal and surface sides for cavity ablation. LD, Latissimus dorsi; SA, serratus anterior.

bronchial stump was covered by mediastinal fat tissue, and the chest wall was reconstructed using a Gore-Tex® dual mesh (2 mm, Gore Company, USA). The patient developed fever 7 days after surgery and was diagnosed with empyema. The bacterium was methicillin-resistant *Staphylococcus epidermidis*, which was treated with vancomycin. Because his physical condition was not stable and another thoracotomy would have been difficult, drainage was continued for 3 weeks while his recovery was monitored. Residual lung expansion was inadequate and a large space remained (Figure 1A).

Surgery to cure the empyema was performed 4 weeks after the initial surgery. We removed the mesh and performed debridement and decortication of the empyema cavity. The bronchial stump was fully covered by the pedicle of the mediastinal fat tissue and no bronchopleural fistula was present. Because remaining lung re-expansion was not expected and the chest wall defect would depress owing to the

empyema cavity being the size of two fists, muscle plompage was considered to be an effective procedure. A 14-cm long incision was made in the cranial-to-caudal direction directly on top of the latissimus dorsi (LD) muscle, and a 25 cm × 15 cm portion of the pedicle from the LD and serratus anterior (SA) muscles was raised (Figure 1B) preserving the thoracodorsal neurovascular bundle located between the two muscles. The raised portion was then subcutaneously introduced into the empyema cavity (Figure 1C). For cavity ablation and drainage, two 19-Fr (inflow) and two 24-Fr (outflow) elastic drains (Blake, Ethicon Co., USA) were inserted into the mediastinal and surface sides (Figure 1D). Continuous ablation was performed by 200 mg minocycline and 1000 mL saline solution administration for 24 h. The drainage fluid was cultured three times. The first culture was positive for bacteria, whereas subsequent cultures were negative. After 5 days of continuous washing,

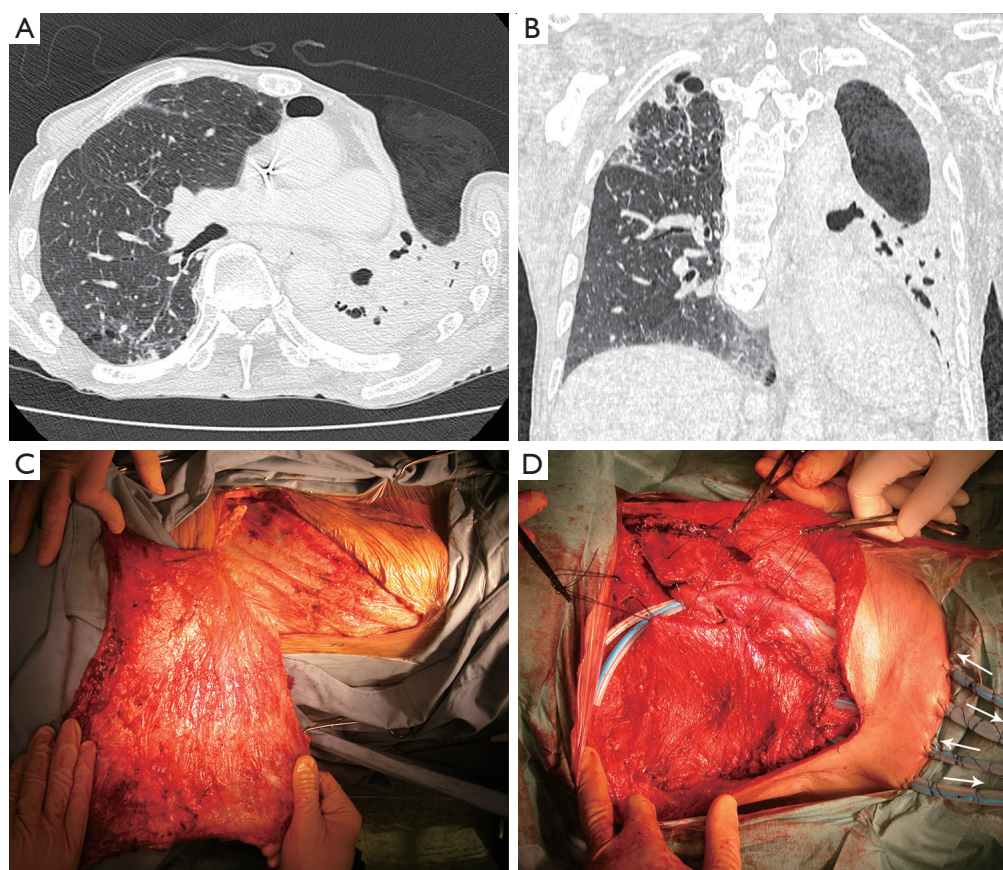


Figure 2 Case 2. (A,B) Chronic total left residual lung abscess after left upper divisionectomy and open-window thoracostomy; (C) the pedicle of the LD and SA muscles was harvested via a large posterolateral incision; (D) intraoperative view after completion extrapleural pneumonectomy, thoracoplasty, and muscle plumbage to the left thorax. LD, Latissimus dorsi; SA, serratus anterior.

all drains were removed by the 7th day. The patient recovered well and was released from hospital 3 weeks after the empyema surgery.

Case 2

This patient was a 70-year-old male with emphysema and history of partial gastric resection. He underwent left upper divisionectomy for a pneumothorax secondary to the emphysema. After 6 months, the pleural effusion in the cavity had disappeared, and a small aerial fistula was suspected. His chest condition was monitored in the outpatient department. Two years after the surgery, he developed respiratory failure and had to be hospitalized. At this point, fluid had accumulated in the left thoracic cavity, and he presented with pneumonia of the total left residual lung. First, open-window thoracostomy was performed by removing the second and third ribs in the anterior chest. A

gray purulent fluid and few bronchial fistulae on the surface of the residual lung parenchyma were observed. Culture of the pus revealed combined infection of *Aspergillus fumigatus* and *Stenotrophomonas maltophilia*. Sensitive antibiotics, such as voriconazole, were administered, and intravenous hyperalimentation and rehabilitation were prescribed. Thereafter, the empyema cavity was gradually purified; however, the left lung did not improve and progressed to a chronic abscess of the total left residual lung (Figure 2A,B).

Five months after the thoracostomy, a curative operation, which comprised completion extrapleural left pneumonectomy, muscle plumbage, and thoracoplasty, was performed. Because the mediastinum was shifted to the left, the pericardium was approached at a distance of two thumb widths to the left of the mediastinum, and the left main pulmonary artery and bronchus were cut in the dorsal position. Next, the patient was turned to the right decubitus position, and a pedicle of the LD and SA

muscles was harvested via a large posterolateral incision (*Figure 2C*). The fifth, sixth, and seventh ribs were removed, and completion partial extrapleural pneumonectomy was performed. Thoracoplasty for the removal of the fourth to eighth ribs, debridement of the empyema cavity, and muscle plombage to the left thoracic cavity were also performed. For continuous ablation, thoracic tubes were placed similar to those placed in case 1 (*Figure 2D*). The thoracostomy window was closed by gathering the surrounding tissue. There was 2,300 mL of blood loss, and the operating time was 19 h. Continuous ablation was performed for 24 h via two thoracic tubes by instillation of 100 mg minocycline and 500 mL saline solution into the thoracic cavity. The patient was recovering until 7 days after the surgery. Three separate cultures of the drain effusion revealed the absence of bacteria, the purulent sputum ceased, and he was expected to recover from the severe empyema and total left lung abscess. However, on the 8th day, he developed massive hematemesis and gastrointestinal hemorrhage. Endoscopic hemostasis was performed; however, on the following day, he developed hemorrhagic shock, blood aspiration pneumonitis of the right lung, and renal failure. Fourteen days after surgery, he died from multiple organ failure.

Case 3

This patient was a 59-year-old female who, 9 years previously, had undergone lower right lobectomy for a metastatic pulmonary tumor originating in the tongue. She was hospitalized as an emergency case after worsening respiratory failure and 3 months of fever. Accumulation of pleural effusion and the presence of a space were confirmed in the right thorax (*Figure 3A*). After inserting a drainage tube, purulent effusion and air leaks were confirmed. The infecting microorganisms were a mix of Friedlander bacillus, anaerobic bacteria, and *Candida*, and she was diagnosed as having empyema with fistula. Drainage and appropriate antibiotic administration for 2 weeks rendered the effusion free of microbes. On imaging studies, two bronchioles with fistulae were observed in the middle lobe. The space was large, indicating the need to perform an open window thoracostomy; however, because the empyema cavity was free of microbes and her physical condition was good, we opted for surgical closure of the fistula and cavity.

The curative surgery was performed with an alteration of the vertical muscle sparing incision, preserving the LD muscle. After harvesting a pedicle of the LD muscle, the SA muscle was raised. The eighth and ninth ribs were removed,

followed by the sixth and seventh ribs. Subsequently, a bundle of pedicle from the 6–7th intercostal muscles was raised (*Figure 3B*). After debridement, the bronchial fistulae were closed by sewing the muscles to the fistula and plombage to the cavity (*Figure 3C*). Similar to cases 1 and 2, continuous ablation via thoracic tubes was performed for 5 days. Postoperative infection was not exacerbated, and the patient was released from hospital 3 weeks after surgery. One year after surgery, the muscle engrafted to the cavity completely filled the space (*Figure 3D*).

Discussion

Recently, general thoracic surgeons encounter fewer cases of inflammatory pulmonary disease. Sharing clinical experiences of postoperative empyema is important because, in many cases, it is difficult to manage. Various clinical conditions exist in cases of empyema, requiring case-specific or individualized treatment. In each of the three cases described above, the treatment that was considered as best suited for each patient was chosen; however, there are many points for reflection. Here we elaborate on the choices made and points for consideration in each case management, in particular, pedicle skeletal muscle plombage and continuous thoracic cavity ablation.

In case 1, it can be argued that once the empyema was confirmed, the chest wall artifact should have been removed instead of insertion of a drainage tube. The physical condition of this patient was poor because of chest wall resection after induction chemoradiotherapy; therefore, a second, immediate open-chest surgery was not desirable. Instead, it was decided to manage the recovery under drainage before the second open-chest surgery. Next, the use of muscle plombage over removal of the chest wall artifact and debridement may be questioned. The reasons for performing the muscle plombage procedure are that the bronchial stump covered by the mediastinal fat tissue faced into the empyema cavity, the cavity was large, the residual lung expansion was not expected, and the skin depression because of the chest wall defect was large.

In case 2, the patient had empyema with fistula complicated by residual lung abscess; this was a patient we could not rescue. How do you manage this critical condition? We regret that open-window thoracostomy could not be performed when the aerial fistula was small and only empyema was present. Although there are some reports on treating empyema with fistula by extrapleural pneumonectomy (3–5), these studies represent only

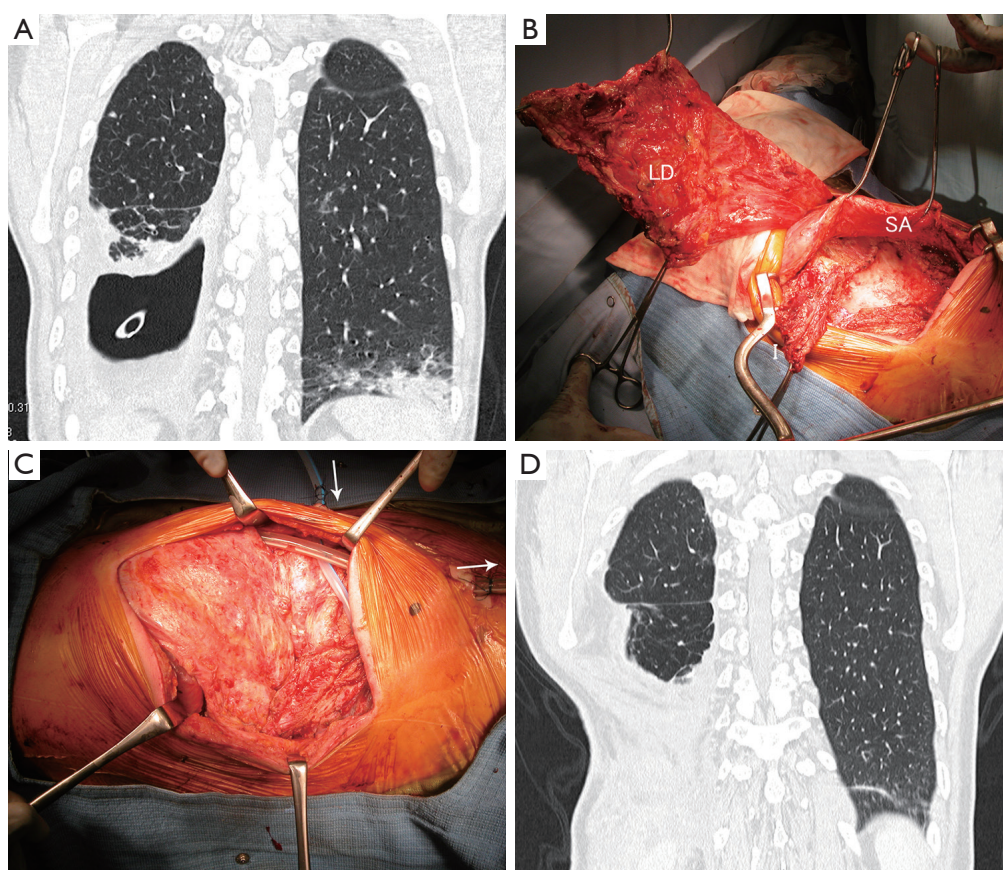


Figure 3 Case 3. (A) A large empyema cavity after right lower lobectomy performed 9 years earlier; (B) LD, SA, and the bundle of pedicle from the 6–7th intercostal (I) muscles harvested via an alteration of vertical muscle sparing incision; (C) muscle plumbage to the cavity; (D) the muscles engrafted to the cavity completely filled the thoracic space. LD, Latissimus dorsi; SA, serratus anterior.

successful cases and many other failed attempts may not have been reported. This patient's general condition was poor because of hemorrhaging from the lung abscess and large amounts of purulent sputum. Because combined extrapleural pneumonectomy, muscle plumbage, and thoracoplasty were performed at the same time, the nature of the surgery was excessively aggressive, and the patient did not survive the perioperative period. The attending surgeon (N.S.) consulted many experts (indicated in "Acknowledgements") on the possibility of recovery after surgery, and as a result, many opinions, including those pertaining to the operability and suitability of the surgery, were raised. The patient's preoperative Eastern Cooperative Oncology Group performance status was 3, and there was no other treatment option other than removal of the lung abscess. Because the empyema and lung abscess seemed to be controlled after surgery, there is a possibility that these procedures deserve consideration for the treatment

of empyema with severe lung abscess. Intercostal arterial embolus or multistage surgery may also be considered to reduce the excessive invasiveness of multiple surgical procedures.

Case 3 represents a case in which primary closure would have been possible if sterility of the empyema cavity could have been attained, even when a chronic bronchopleural fistula existed. Another possible treatment was open-window surgery to reduce the empyema cavity followed by curative plastic surgery (2).

Regarding engrafting the pedicle soft tissue, the omentum is rich in blood and contains immune cells that enable wound healing in the defective site; alternatively, the aim of skeletal muscle plumbage is to physically fill the empyema cavity (6). The proportion of thorax that can be closed by various types of pedicle muscle flaps is 30–40% for LD muscles, 20–30% for SA muscles, and 5–15% for abdominal rectus muscles (1,7). In case 1, the LD muscle

fitted the empyema cavity that was the size of two fists after upper lobectomy. In case 2, although there were insufficient muscles to fill the entire thoracic cavity, the muscles filled two thirds of the thorax, and consecutive thoracoplasty by removing the ribs enabled us to achieve full plombage with only a small residual cavity. In case 3, a bundle of pedicle from the intercostal muscles was used in addition to the LD and SA muscles to achieve filling of the cavity. In all three cases, the LD muscle could be used because it was preserved in the first surgery. This reminded us of the importance of this muscle in cases of postoperative empyema. If the LD muscle has been cut, a retrograde muscle flap supplied by the posterior paraspinal perforating branch can be used, although the volume of muscle is smaller (8).

When deciding to perform muscle transplantation, consultation with a plastic surgeon who is familiar with the treatment of empyema is desirable; however, this is not always possible. Therefore, it is necessary for general thoracic surgeons to become familiar with these procedures. Simple pedicle transplants involving familiar muscle flaps, such as pectoralis major, LD, and SA muscles, can be performed using textbook explanations on empyema treatment (9).

There is no established method for purifying the thoracic cavity formed during empyema; however, compared with intravenous administration, the direct instillation of antibiotics sensitive to the causative bacteria may be more effective in the cavity (10). Considering that some space might have existed after muscle plombage, thoracic ablation was performed in all three cases. Minocycline is often used during pleurodesis, and we continuously administered it into the thoracic cavity after confirming its sensitivity to the causative microorganisms. Theoretically, if the cavity is too large, purification of the empyema cavity is difficult and ablation is considered to be effective when plombage has been performed to some extent. To further decrease the cavity, adequate thoracoplasty, which is sometimes considered to be excessively aggressive, is required.

Muscle plombage effectively achieves the closure of empyema cavity and thoracoplasty complements this. When a residual space remains, cavity ablation may be effective. However, deliberate consideration is required for procedures that include concurrent completion lung parenchyma resection, because such procedures might be excessively aggressive. Although we cannot always or easily perform these procedures in severe cases, the methods are applicable to a wide variety of conditions associated with empyema.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Informed Consent: Each patient was informed that his clinical data could be used for various clinical studies, and written informed consent for this report was obtained on this basis.

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