

Utilization of a Pedicled Rectus Abdominis Muscle Flap and Intrathoracic Muscle Flap for Expedited Closure of a Bronchopleural Fistula and Eloesser Window in a Spinal Cord Injury Patient

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Received Date: Dec 18, 2019; **Accepted Date:** Jan 08, 2020; **Published Date:** Jan 12, 2020

Abstract

Many techniques exist for definitive chest closure of an open window thoracostomy performed for empyema with bronchopleural fistula. We report a case involving the novel use of a pedicled rectus abdominis flap combined with intrathoracic muscle advancement flap for closure of the fistula and partial obliteration of the residual pleural space. There was significant improvement in respiratory function and no evidence of returning sepsis in the immediate post-operative period or on one-year follow up.

Keywords: Empyema; Bronchopleural fistula; Open window thoracostomy; Rectus abdominis flap; Intrathoracic muscle flap

Introduction

Significant chest trauma with pneumothorax and hemothorax carries serious morbidity. Chest tube placement with washout and decortications in the operating room is required. If hemothoraces recur, the lung can become permanently compressed secondary to the mass effect and scarring. Bronchopleural fistulas can develop due to repeat decortications of friable lung tissue. Despite the best efforts to keep the pleural space drained, an empyema can develop. Substantial mortality is attributed to empyema. The reported 1-, 3- and 5- year mortality was 15,24, and 30% respectively [1,2]. The necrotic burden with empyema can be so high that tube thoracostomy is not sufficient. Historically, the solution to this surgical problem has been continuous egress of the infectious burden through an open window thoracostomy, e. g. the Eloesser window or first stage of the Clagett procedure. The open window thoracostomy is important for the treatment of severe pleural space infections in medically unfit patients [3]. Ultimately, if a patient does recover from the severe insult of the empyema, definitive treatment would then involve closure of the thoracostomy.

Surgeons aim to obliterate the pleural space wound cavity with chest closure. There are many techniques for achieving this. Intrathoracic muscle flap transposition involves the use of pectoralis, serratus anterior and latissimus dorsi muscles. Thoracoplasty, myothoracoplasty and second stage of the Clagett procedure (obliteration of the pleural cavity with antibiotic solution) are also options. The presence of a Bronchopleural Fistula (BPF) adds complexity to the case. Small fistulas (<0.8 cm) are often amenable to non-operative intervention [4]; they may close or granulate on their own. Larger fistulas are associated with a higher risk of aspiration of the contra lateral lung and therefore should be closed [4]. Options for closure include sutures or staples, or viable tissue such as abdominal omentum or muscle flap that can act as a plug or patch to cover the fistula.

In this case presentation, we present a unique utilization of a pedicled rectus abdominis flap in conjunction with a local intrathoracic

muscle advancement flap to achieve closure of an Eloesser window with concomitant bronchopleural fistula.

Case Presentation

The patient is a 28 year-old male who was involved in a high-speed motorcycle crash. The patient suffered T3-T4 vertebral body fractures with cord retropulsion leaving the patient paraplegic. The patient also suffered bilateral pneumothoraces and pulmonary contusions as well as orthopedic injuries. He developed pulmonary edema and subsequent respiratory failure. His condition declined precipitously requiring ECMO for a short time. Due to recurrent right-sided hemothoraces the patient underwent multiple thoracotomy and thoracoscopy procedures to evacuate the hemothoraces. Decortications were performed with minimal lung expansion. The patient developed a chronic bronchopleural fistula as well as a severe empyema. An Eloesser window was performed with partial resection of ribs 5 and 6 for continuous passive drainage of the infection. The patient was eventually transferred to our rehabilitation hospital ICU for vent weaning.

At the rehabilitation hospital, the plastic surgery team was consulted for closure of the patient's large open chest wound. On exam, the patient had a chronically scarred down lung. A large audible airleak contributed to vent requirements inconsistent with weaning. Purulence was still present in the wound cavity. After several weeks of Dakins dressings, the wound cavity was re-inspected and found to be cleaner and covered with healthy granulation tissue. From a respiratory standpoint the patient was still vent dependent but stable. White blood cell count was within normal limits. Clinically, the patient was optimized and scheduled for surgery.

Operative technique

The patient was brought to the operating room and placed under general anesthesia. Initially the patient was placed in the left lateral decubitus position to access the right latissimus dorsi. However this position compromised ventilation as the patient was compressing the

left lung, also scarred and non-compliant from previous bouts of ARDS. The patient had numerous scars from previous thoracic procedures in the area of the right latissimus dorsi so this was abandoned as a flap source. The pectoralis muscle was far from the location of the chest wound and also lacked sufficient bulk. Both the serratus anterior and the rectus abdominis were available. Therefore the patient was placed in a modified supine position with a bump under the right chest. This position maintained tidal volumes, adequate exposure of the chest wound, and access to the serratus anterior and the rectus abdominis.

First, the chest wound cavity was debrided. Unhealthy skin and subcutaneous tissue were removed circumferentially around the Eloesser window. Granulation tissue on the interior of the cavity was curetted to a healthy, bleeding surface. Figure 1A-B shows the Eloesser window before and after debridement. To harvest the right rectus abdominis, a paramedian incision was made in the abdomen from the xiphoid process to the pubic symphysis. The incision was carried down until the anterior rectus fascia was revealed. This fascia was incised and dissected from the rectus abdominis bluntly. The distal insertion of the rectus into the pubic symphysis was divided. While raising the muscle, perforators were sacrificed but the most proximal pedicle of the superior epigastric branch of the internal mammary was preserved. Figure 2A shows the rectus abdominis flap donor site. A tunnel was created between the chest wound and the abdominal incision, two fingerbreadths wide through which the muscle belly passed easily without compression. With the muscle placed over the exposed right lung parenchyma, the air leak disappeared and there was a significant improvement in tidal volumes. Figures 2B and 2C show the rectus abdominis muscle raised and inset into the wound cavity. The muscle flap was secured with interrupted O vicryl to the chest wall being careful to avoid puncturing the lung parenchyma and diaphragm.

As the serratus anterior was intact, we based our flap closure of the superficial portion of the chest wound on this muscle. From the lateral edge of the wound cavity an incision was extended and carried down through the fascia overlying the serratus anterior. The serratus was left attached to the flap as this would promote viability of the overlying skin and provide filler for the dead space of the wound cavity. This flap was raised and mobilized and was found to cover the superficial defect nicely (see Figure 2D). A chest tube was placed in the remaining portion of the wound cavity that was not obliterated. The flap was then advanced over the chest wound and closed in layers: the dermis was closed with interrupted O vicryl, the epidermis with running 2-0 biosyn and then oversewn with O-prolene. The rectus abdominis

flap donor site was also closed in layers. Figure 3 shows the surgical incisions completely closed.

Postoperative course

After surgery, a vent weaning protocol was initiated. The patient's tolerance for spontaneous breathing improved daily. Daily chest x-rays were performed to monitor for seroma formation; no fluid level could be appreciated. Figures 4A-C depict the patient's preoperative and postoperative chest x-rays. There was only minimal serosanguinous drainage from the chest tube without evidence of airleak. The patient also presented with a Stage IV sacral pressure ulcer. As the patient's respiratory status had improved significantly, the patient was taken back to the operating room on POD #24 from closure of the Eloesser window for local myocutaneous flap closure of the pressure ulcer. There were no issues with ventilation during this case. The right chest tube was removed shortly after closure of the pressure ulcer. Eventually the patient was able to tolerate capping of the tracheostomy and breathe independently on room air. With his chest and sacral wounds closed and healed, the patient met criteria for transfer to a spinal cord injury rehabilitation program. The patient has returned to our plastic surgery clinic several times for follow up and has not had any pulmonary issues.

Discussion

Our case describes a trauma patient with spinal cord injury whose chest pathology was analogous to that of a Post Pneumonectomy Empyema (PPE) with Bronchopleural Fistula (BPF). Surgical management of PPE with BPF involves the satisfaction of the following goals: 1) immediate drainage of the pleural space 2) sterilization of the pleural space and elimination of infectious sources including BPF, and 3) obliteration of the residual pleural space [4].

Large BPF (> 0.8 cm) post pneumonectomy can be closed directly. For a bronchus whose tissue is too delicate for closure with suture or staples, local viable flap can be used. Gastric omentum is a common choice that can be accessed via a laparotomy incision and transferred to the chest *via* incision in the diaphragm. Other options for BPF closure are available depending on the location in the chest. Intrathoracic muscle, intercostal muscle, pericardium and mediastinal tissue have all been used. In our case there was a defect in the right lung parenchyma communicating with a sub-segmental bronchus. The pedicled rectus abdominis reached the wound cavity with only a minimal amount of volume sacrificed in tunneling; the majority of the flap was effective in closing the BPF and also provided partial obliteration of the pleural space.

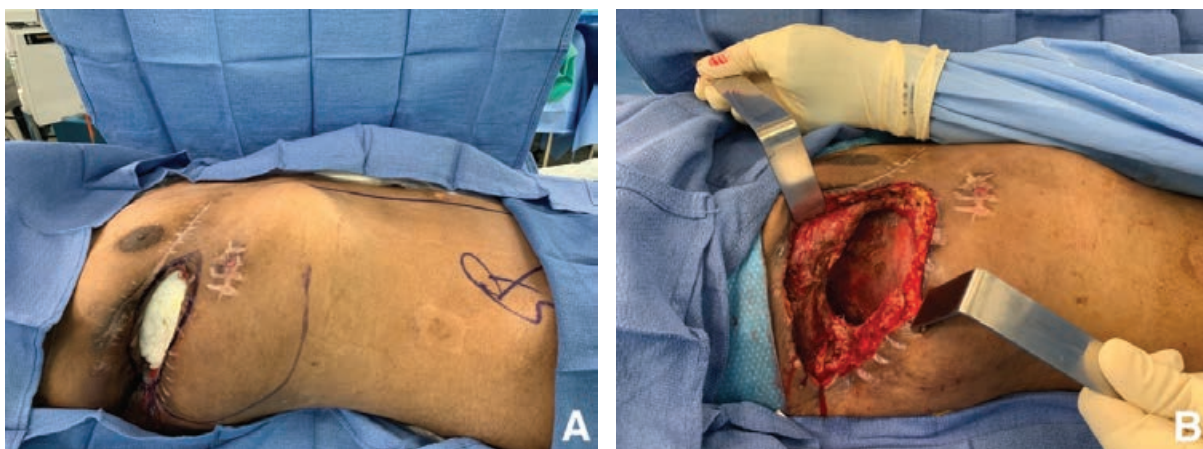


Figure 1: A – Right chest Eloesser window with packing. B – The Eloesser window after debridement

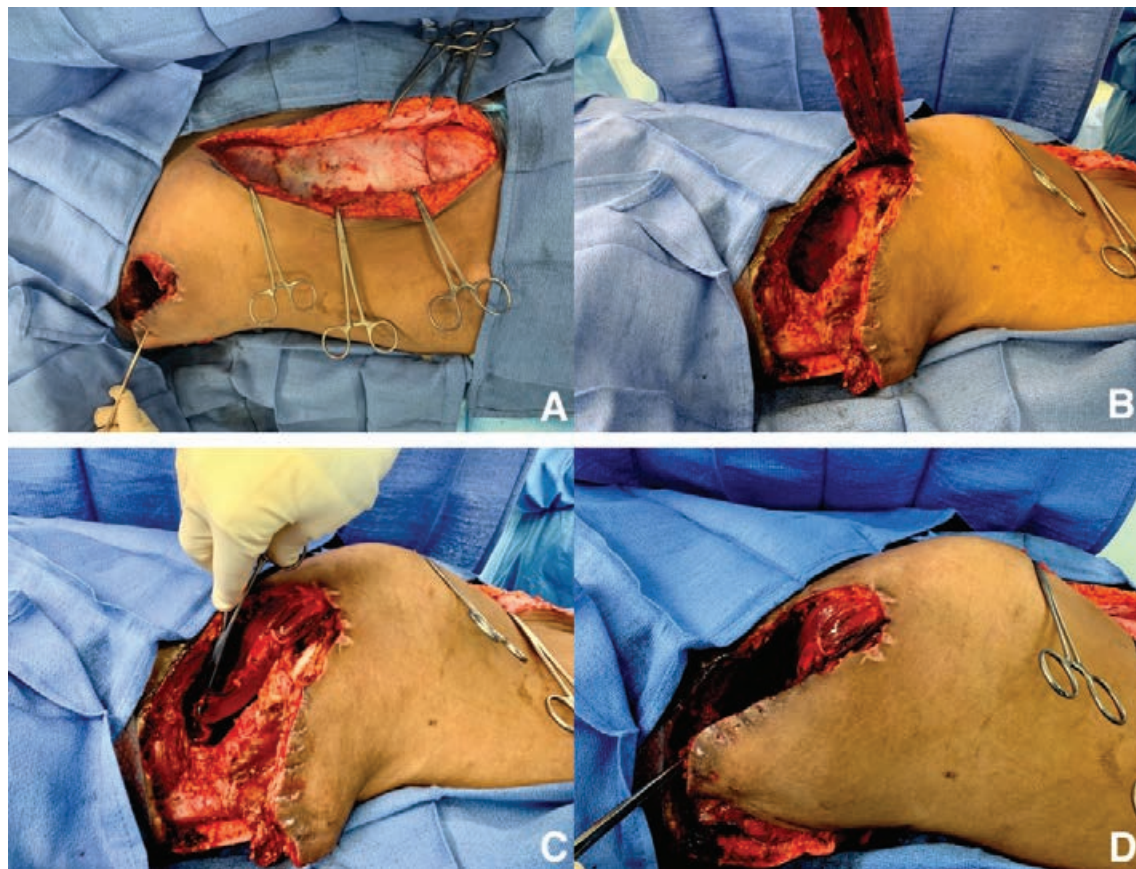


Figure 2: A – The rectus abdominis flap donor site is shown; crile clamps are attached to the anterior rectus fascia. B – The rectus abdominis muscle is raised and tunneled. C – The rectus abdominis muscle is inset into the wound cavity. D – The serratus anterior muscle flap is advanced to cover the cavity.



Figure 3: The flap donor site and the chest wound cavity are closed.

Management of the residual pleural space may be non-operative in patients who cannot tolerate further procedures in the OR. The open window thoracostomy is left to heal by secondary intention. The patient is then resigned to months of dressing changes. Thourani et al. report required dressing changes of at least 3 months [3,5]. Recently Vacuum-Assisted Closure (VAC) devices have been used to augment closure. Wound healing is promoted through different mechanisms including acceleration of granulation tissue formation, decreased wound bacterial load, removal of excessive interstitial fluid, improvement of

tissue oxygenation and wound volume reduction [6]. Perentes et al. report the safety and efficacy of the VAC in chest closure of infected postpneumonectomy chest cavity. The median duration of treatment was 23 days (range 4-61 days) [6]. VAC can also be used to prepare the wound cavity and achieve dead space reduction prior to muscle flap transposition.

In the appropriate patient that can tolerate surgery, an expeditious way to obliterate the chest cavity and skin closure is intrathoracic muscle flap transposition. Use of local options such as pectoralis major, serratus anterior or latissimus dorsi depends on the location of the space to be filled as well as on previous operations [7]. For example, a previously divided latissimus dorsi will survive in situ, but the entire muscle will not survive as a proximally based muscle flap [7,8]. The use of the pedicled rectus abdominis for cavity obliteration is uncommon. Jiang et al. report use of a free rectus abdominis musculocutaneous flap for chronic postoperative empyema [9]. In their series, wet gauze dressing changes over several months achieved significant granulation prior to use of the free flap for obliteration of the remaining cavity.

Despite the use of two muscle groups, only partial obliteration of the cavity was achieved in our case. We were cognizant of the possibility of infected seroma formation. However, in closing the BPF and the skin with muscle flaps, this would provide the benefit of achieving an airtight closure and eliminate environmental sources of infection. It has been reported that muscle flaps play an important role in infection control and stimulate neoangiogenesis [7]. Chest tube drainage was minimal, serosanguinous, and without purulence. Postoperatively, the patient did not show any clinical signs of sepsis. We were able to attain

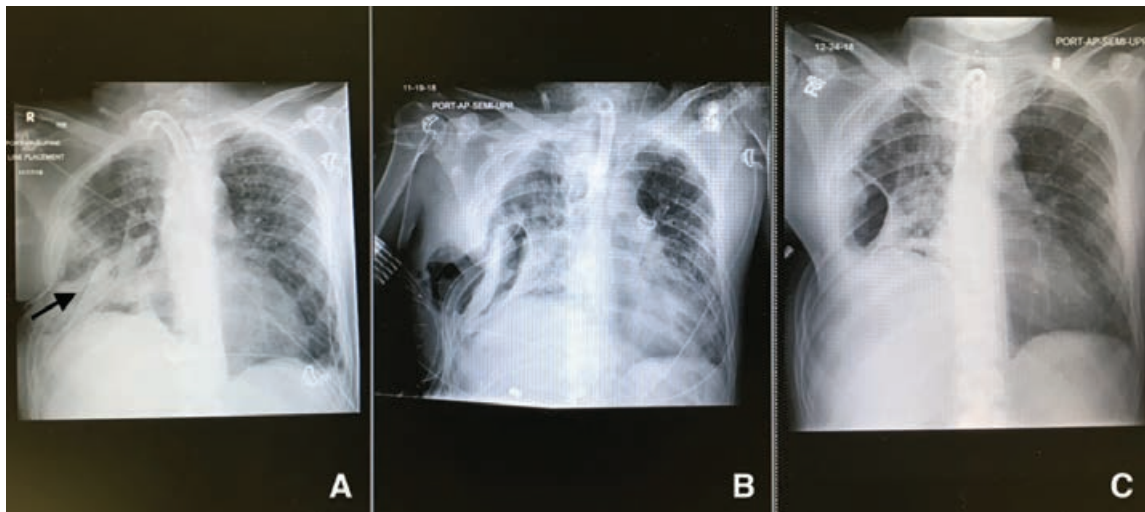


Figure 4: A – Pre-operative chest x-ray; the arrow points to the wound cavity which contains kerlix packing. B – POD #1 Chest x-ray; subcutaneous air is present. A small chest tube is in the residual pleural space and there is no appreciable air-fluid level. C – POD #32 chest x-ray.

an acceptable clinical outcome with partial obliteration. We anticipate continued granulation of the remaining space over time. Fukui et al. performed a simple chest closure without muscle transposition of an open window thoracostomy for postpneumonectomy empyema after a large lung cancer. The residual cavity filled with pleural effusion containing *P. aeruginosa*; the patient did not develop any symptoms of infection [10]. Therefore, accepting the presence of the residual pleural cavity may be an option for chest closure provided that the space is covered with healthy granulation tissue and no BPF is noted [10].

Conclusion

There are many options to surgically close an open window thoracostomy performed after empyema with BPF. In the appropriate patient, local muscle harvest of the pedicled rectus abdominis is a viable option for coverage of a bronchopleural fistula and can dually provide (partial) obliteration of the chest wound cavity. This muscle flap can be used in combination with a local advancement flap based on intrathoracic muscle such as the serratus anterior to close large defects of the chest. Also, partial obliteration of the residual pleural space may be an option in select patients.

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