Open Thoracic Window: A Useful Alternative for Retained Infected Pleural Collections in Critically Ill Trauma Patients

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Historically, tube thoracostomy, image-guided drainage, or an open thoracotomy has been indicated as the standard procedure for the management of patients with retained infected pleural collections (RIPC). These infections can be a debilitating and potentially lethal complication in already critically ill trauma patients. The purpose of this review was to evaluate the usefulness of an open thoracic window (OTW) as definitive therapy for the management of RIPC refractory to conventional therapies. The medical records of patients who underwent an OTW for RIPC were reviewed for the following: demographic data, primary diagnosis, clinical findings that explained the failure of the conventional management, bacteriology of the retained collection, and final outcome. Over a 3-year period, eight critically ill trauma patients who had sustained multiple system trauma and developed a RIPC were identified (six males and two females; average age, 47 years). Of the eight patients identified, six collections were in the right and two in the left pleural cavity. Staphylococcus aureus and Acinetobacter were the two most common bacterial isolates from these collections. All patients had undergone multiple and unsuccessful drainage attempts by thoracostomy tubes. Additionally, two of the patients also underwent image-guided drainage procedures, which proved to be unsuccessful. After creation of the OTW, all patients had complete resolution of the RIPC, and all were discharged alive from the hospital. During outpatient follow up, the OTW was found to have completely healed and required no further surgical intervention. The creation of long-term pleural drainage, with an OTW, facilitates and expedites the resolution of persistent infected pleural collections by providing more efficient surgical drainage and mechanical débridement. Our experience also shows this uncommon operation to be an effective alternative when conventional measures have failed.

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drain the RIPC and can be associated with significant morbidity.\(^5\)

An open thoracic window (OTW) with rib resection, in the vicinity of the retained pleural infection, along with the creation of a skin flap provides better local infection control by allowing for daily irrigation and packing of the infected cavity. Paying careful attention to local wound care, selective use of antimicrobials, and meticulous skin protection will allow this open space or cavity to eventually close by progressive fibrosis and contraction. Despite the OTW being a simple, well-tolerated procedure, indications for use, even in the critically ill, remain few and occasionally controversial (Table 1). The OTW is a valuable option for the treatment of patients with persistent RIPC, especially in those patients in whom other conventional measures of treatment have failed and in whom prolonged drainage from the chest cavity is warranted.

The purpose of this review is to present our experience using an OTW to achieve successful and definitive treatment for a retained infected pleural collection by achieving: 1) local infection control; 2) adequate drainage; 3) obliteration of the pleural space; and 4) spontaneous closure of the infected cavity.

**Patients and Methods**

**Patients**

Over a 3-year period ending in December 2007, the OTW was evaluated as a surgical alternative for the treatment of patients who developed a RIPC as a result of blunt or penetrating trauma at Memorial Regional Hospital, a state-designated Level I trauma center in Hollywood, Florida. Demographic information, primary diagnosis, clinical findings, if any, explaining the failure of initial conventional management, bacteriology of the infected collection, and final outcome were collected and analyzed. For purposes of this review, a retained infected pleural collection was defined as follows: a pleural collection attributable, in part, to improper initial management of a hemothorax and, because of multiple attempts at drainage, became a localized infected collection unable to be drained by chest tube thoracostomy or even image-guided drainage.\(^1, 2\)

**Anesthesia and Surgical Technique**

General anesthesia was used during the OTW for all eight patients. Six patients had their airways managed with a previously placed tracheostomy tube placement and the remaining two patients were managed with previously placed endotracheal tubes. Pleural adhesions, which prevented lung deflation, were present in all of the patients, thereby eliminating the possibility of double-lumen endotracheal tube ventilation.

There are multiple descriptions of the surgical techniques that have been used to provide adequate pleural drainage. The classic approach to an open flap procedure is to suture the skin edges to the pleura creating a skin-lined fistula. This fistula facilitates drainage without the use of thoracostomy tubes. To accomplish this, a U-shaped incision is made over the most dependent portion of the collection, portions of the underlying ribs are resected, the skin flap is then sutured to the pleura, and the remaining edges of skin are sutured together. This technique was initially described by Robinson from the Mayo Clinic in Rochester, Minnesota, in 1915\(^6\) and later modified by Eoeser in 1937\(^7\) and again by Clagett in 1963.\(^8\) Since the early 1960s, no significant modifications in the OTW technique have been described nor have the indications been changed. With the availability of more efficient antituberculous drugs and more efficacious antibiotics, these procedures became obsolete.

The technique currently used in our institution is as follows. After securing the previously placed airway, the patient is properly positioned and secured with proper restraints in a full lateral decubitus or modified lateral position on a “bean bag” (thoracic support device). If not contraindicated, the operating table is flexed 30° between the nipples and the umbilicus to open the intercostal spaces. Care is taken to secure the patient’s arm in a fashion that will prevent any neurologic injury during the procedure. Adequate positioning of the patient and proper identification of the exact location of the RIPC is crucial to facilitate maximal exposure and optimize positioning of the OTW. Coordination between surgical and anesthesia staff is critical to minimize unexpected events during the procedure. We routinely obtain a preoperative CT of the chest for precise identification of the actual

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**Table 1. Indications for an Open Thoracic Window in Patients with RIPC**

| 1. Persistent retained pleural collection after multiple attempts for drainage have failed |
| a. Image-guided procedures |
| b. Multiple thoracostomy chest tubes |
| c. Documented infected retained intrapleural collection |
| 2. Postpneumonectomy empyema with or without bronchopleural fistula |
| 3. Critically ill patients too debilitated for a major lung decortication or a complete thoracotomy |
| 4. Posterior collections where proper chest tube placement will be uncomfortable |
| 5. Long-term drainage is expected |

RIPC, retained infected pleural collection.
location and size of the RIPC (Fig. 1). Before the surgical incision is made, a needle aspiration is performed to better identify the location of the collection. It is important to emphasize that the goal of the surgical procedure is not to perform a complete lung decortication, but to promote direct drainage of the retained infected pleural collection.

After a sterile field is properly placed over the incision site, an incision is made along the rib of the most dependent portion of the RIPC, and a segment (10 to 15 cm) of the underlying rib is resected. The muscle planes are then sutured to the pleura, paying careful attention not to suture the skin edges to the pleura, thereby minimizing the risk for a chronic pleural fistula. This modification of the original technique creates a well-formed fistula, thus creating a very efficient drainage site for the retained infected pleural collection. We place two No. 40 French thoracostomy tubes and pack the cavity with sterile dressing (Iodoform Packing Strip, Curity@; Tyco/Healthcare, Mansfield, MA). The dressing and thoracostomy tubes are removed within 48 hours and we begin twice-a-day irrigation and packing of the cavity with plain sterile dressing. The type of irrigation solution used (sodium hypochlorite 0.25% and boric acid 4% [Dakin’s solution] or acetic acid) is dependent on the bacterial isolate found in the collection.

Our experience is similar to what was initially reported by Eloesser in 1935, in that lung collapse, as a result of the OTW, does not happen for the following reasons: 1) positive pressure ventilation prevents lung collapse; 2) air escapes throughout the opening (window) more readily than it enters; 3) extensive pleural adhesions are usually present in all these patients preventing lung collapse; and 4) as the infection resolves and the overall condition of the patient improves, underlying lung tissue expands until reaching the chest wall, slowly sealing the inner opening of the cavity and eventually obliterating the cavity.7

Results

Over a 3-year period, eight critically ill trauma patients who had sustained multiple system trauma and developed a RIPC were identified (six males and two females; average age, 45 years [Table 2]). Of the eight patients identified, six collections were in the right and two in the left pleural cavity respectively. Microbiologic isolates included *Staphylococcus aureus* (six patients), *Acinetobacter* (two patients), with one of the patients having a combination of both *Staphylococcus aureus* and *Proteus* sp. All patients had undergone multiple and unsuccessful drainage attempts by thoracostomy tubes. Additionally, two of the patients also underwent image-guided drainage procedures, which proved to be unsuccessful. Another patient who had a bronchopleural fistula and a RIPC, resulting from an emergency right pneumonectomy after a gunshot wound to the pulmonary hilum, was well controlled after the OTW procedure (Table 3). After creation of an OTW, all patients had complete resolution of the infected pleural collections, and all patients were discharged alive from the hospital. During outpatient follow-up, the OTW was found to have completely healed and required no further surgical interventions.

Complications and Mortality

There were no significant clinical complications associated with or as a result of the OTW. The procedure consistently and successfully controlled the RIPC in all patients. One patient required several.

| Table 2. Demographics of Patients Who Underwent OTW |
|----------------------------------------|--------|--------|
| Gender | No. | Per cent |
| Male | 6 | 75 |
| Female | 2 | 25 |

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<th>Anatomic region*</th>
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<tr>
<th>Injury Severity Score</th>
<th>(mean)</th>
<th>Range, 4–75</th>
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* Combined injuries were common.

OTW, open thoracic window.
transfusions and returned to the operating room for
wound revision after postoperative hemorrhage from
the skin incision on postoperative Day 3. The frequent
packing of the wound and delicate technique used for
the dressing changes avoided any local complications
such as air leak or local bleeding. There were no deaths
documented in this group of patients and all patients
were discharged from the intensive care unit. Seven
were discharged directly home, and one patient was
discharged to a rehabilitation facility.

Discussion

According to the American Thoracic Society, there
are three stages for empyema formation: 1) an acute
or exudative phase; 2) a transitional or fibrinopurulent
stage; and 3) a chronic or organizing stage. Clinical
experience in most trauma centers indicates that the
acute or exudative phase is rarely recognized. In fact,
studies have proven that in trauma patients, improper
initial management of thoracostomy tubes is the usual
precipitating factor in the formation of a RIPC. As one would expect, the pathogenic mechanism of
secondary bacterial contamination of a retained
hemothorax is altogether different from that of a par-
apneumonic empyema.

For years, it has been speculated that a retained
hemothorax will liquefy and become potentially drain-
able, although clinical experience has shown that in most
cases, it does not happen. Usually, a retained hemothorax
will become a thick, organized, and potentially infected
dense fibrinous collection that cannot be drained through
a chest tube and certainly not by thoracentesis. Video-
assisted thoracoscopic surgery (VATS) has been pro-
duced as an alternative to drain retained hemothoraces in
the pleural space. The reported data, although limited,
demonstrate that VATS is not a good alternative for the
evacuation of RIPC. However, it has been shown to be an
extremely useful alternative to drain retained hemothoraces and prevent retained infected pleural collections
when initiated early in the disease process.

Another well-described technique is guided percuta-
neous drainage to minimize the morbidity associated
with open thoracotomy and decortication. Block and
associates, from the University of Miami, reported on
12 patients with excellent results and stated that in select
cases, the guided percutaneous drainage technique is
superior to decortication. We used this approach in two
patients reported in this series without success. It has also
been shown that because of the presence of well-organ-
ized fibrinopurulent rinds, postprocedure, the drains tend
to become obstructed as a result of the presence of the
thick fibrin and protein-rich fluid being drained. We
prefer to use the guided percutaneous drainage technique
as a complementary procedure after an open thoracot-
omy and decortication.

According to Deslauriers and associates from Laval
University in Quebec City, Quebec, Canada, the OTW is
a simple and well-tolerated procedure that is well indi-
cated when long-term or permanent pleural drainage
is necessary. These authors also recommend an OTW in
patients who are too debilitated to undergo a formal lung
decortication. In addition, they propose using this
technique in patients whose RIPC is located posteriorly
or in an apical location. Finally, they firmly recommend
this procedure in patients with postpneumonectomy
empyemas with or without bronchopleural fistulas.

An advantage of our technique is that there is no need
for further surgical reconstruction of the chest wall,
because the skin is not sutured to the parietal pleura;
therefore, a chronic nonhealing wound is avoided (Fig.
2). We suture the intercostal muscle to the parietal
pleura creating a window that will facilitate wound care
and drainage of the RIPC. When the infection has
resolved, the normal lung tissue will slowly begin filling
the cavity until it is completely obliterated and will
create spontaneous closure at that point, negating fur-
ther surgical intervention of the intrathoracic cavity, as
has been proposed by other authors.

Horrigan and Pairolero have best summarized the
philosophical principles of management of RIPC with
the following tenets: "although management of the
chronically infected pleural space has changed over the
years, the goals of therapy remain the same; to conserve
the patient's life with a healed chest cavity without
evidence of infection. Determination of which techni-
quies are necessary to achieve these goals must be tail-
ored to the individual patient." In summary, our results suggest that in patients with
RIPC, who have been unresponsive to conventional
treatment, OTW is a safe and reliable surgical
FIG. 2. Technique of the open thoracic window. The surgical incision is shown with a segment of rib resected. The intercostal muscle is sutured with 2-0 polydioxanone monofilament suture PDS® (Ethicon, Inc., Piscataway, NJ) that is left in place until spontaneously dissolves (arrow). The open thoracic window facilitates access to the retained infected pleural collection for irrigation and packing resulting in: 1) good local infection control; 2) obliteration of the pleural space; and 3) spontaneous wound closure.

alternative. In the patients reported in this series, OTW was 100 per cent effective in controlling the RIPC, obliterating the pleural space, and expediting patient recovery. We believe that OTW is an excellent alternative in a highly selected population of patients with RIPC, in which other treatment modalities have failed.

REFERENCES