Video-Assisted Thoracic Surgery in the Treatment of Posttraumatic Empyema

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Background: Video-assisted thoracic surgery (VATS) appears to be replacing open thoracotomy for the treatment of posttraumatic thoracic complications.

Objective: To compare operative times, complication rates, and outcomes in patients who underwent VATS vs open thoracotomy.

Design: Retrospective review.

Setting: University hospital, level I trauma center.

Patients: Trauma patients who between December 1993 and May 1997 underwent open thoracotomy or VATS to drain a persistent thoracic collection.

Methods: Medical records were reviewed for demographic data, operative times, and clinical outcomes.

Results: Of the 524 trauma patients requiring tube thoracostomy, 22 underwent 23 procedures to drain empyema (17 VATS, 6 thoracotomies [based on surgeon preference]). There were no differences in age, Injury Severity Score, or mechanism of injury between the 2 groups. Three patients who underwent VATS (18%) required conversion to open thoracotomy for adequate drainage. All remaining patients who underwent VATS had successful treatment of their empyema. Complication rates (VATS=29%, open thoracotomy=33%; P=.99), operative times (VATS=3.4 ± 1.3 hours [mean ± SD], open thoracotomy=3.0 ± 1.5 hours; P=.46), postoperative epidural catheter use (VATS=31%, open thoracotomy=50%; P=.63), duration of chest tube drainage (VATS=5.1 ± 1.7 days [mean ± SD], open thoracotomy=4.5 ± 1.5 days; P=.48), and hospital stay after the procedure (VATS=16±14 days [mean ± SD], open thoracotomy=11 ± 5 days; P=.39) were similar for both groups.

Conclusions: Video-assisted thoracic surgery was a safe and effective operative strategy for the treatment of posttraumatic empyema. Therefore, because VATS has been shown in nontrauma patients to reduce morbidity and because it provides better cosmesis, we believe that it should be the initial operative approach to trauma patients with suspected posttraumatic empyema.

Arch Surg. 1998;133:637-642

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VIDEO-ASSISTED thoracic surgery (VATS) is emerging as an alternative technique in the evaluation and treatment of posttraumatic pleural complications. In recent years, the use of minimally invasive techniques has become more prevalent in thoracic surgery. Video-assisted thoracic surgery has been reported effective in treating spontaneous pneumothoraces, evaluating solitary pulmonary nodules, performing sympathectomies, evaluating pleural masses, and treating parapneumonic empyema.1-10 In trauma patients, VATS has been advocated as a safe and effective way to evacuate persistent pleural effusions or clotted hemothoraces; however, few reports describe using VATS techniques for the drainage and decortication of posttraumatic empyema.11-14

Open thoracotomy remains the criterion standard therapy for posttraumatic empyema; however, given the success of VATS techniques in the treatment of a number of thoracic problems including parapneumonic empyema, we felt that VATS might be effective in treating posttraumatic empyema and began using this technique several years ago. The objective of this study was to determine the safety and efficacy of VATS as an alternative to open thoracotomy for the treatment of posttraumatic empyema.

RESULTS

During the 42-month study period, 524 trauma patients admitted to University of California, Davis, Medical Center re-
MATERIALS AND METHODS

We retrospectively reviewed the medical records of trauma patients admitted to the University of California, Davis, Medical Center (a regional level I trauma center) between December 1993 and May 1997 who required operative intervention (VATS or open thoracotomy) to drain a persistent thoracic collection. Medical records were reviewed for demographic data, indications for surgery, operative time, operative findings, culture results, duration of postoperative chest tube drainage, postoperative complications, pain medication requirements, and length of hospital stay.

We diagnosed empyema when the results of intraoperative pleural cultures were positive for organisms. All other collections were classified as persistent effusions. Operative time was defined as the time from skin incision to skin closure. The interval to treatment was defined as the time between injury and operative drainage of the pleural cavity. Complications occurring after surgical drainage of the pleural cavity were categorized as wound infection, pneumonia, inadequate drainage of the pleural cavity, and other. Wound infections were diagnosed when an abscess required incision and drainage. Pneumonia was diagnosed if Gram stain of the patient’s sputum showed a large number of white blood cells and if results of a respiratory culture were positive for a predominant organism and or more of the following criteria: (1) a new infiltrate on chest radiograph; (2) signs of systemic infection, ie, leukocytosis, a body temperature of 38.5°C or higher or lower than 36°C, or positive fluid balance greater than 2.5 L/24 h; (3) increased tracheobronchial secretions; and/or (4) a deterioration in pulmonary status as manifested by respiratory failure requiring intubation or sustained increase in ventilator support. Pleural drainage was defined as inadequate when a second operative intervention was required to drain the pleural cavity. Therapy was considered successful if no other procedure was required to evacuate the pleural cavity and the pleural process resolved.

Persistent thoracic collections were drained operatively when thoracostomy tubes were ineffective at draining large collections in the early postinjury period (suspected clotted hemothorax of ≥500 mL) or when the patient had persistent, loculated pleural collections and signs of infection (suspected empyema).

The decision to perform either VATS or open thoracotomy was based entirely on the attending surgeon’s preference (not all surgeons at our institution perform VATS).

All patients who underwent either VATS or open thoracotomy were managed intraoperatively with a dual-lumen endotracheal tube and were placed with the affected side up in the lateral decubitus position. We performed VATS drainage of the pleural cavity by removing all thoracostomy tubes and inserting a 23° videolaryngoscope through one of the tube sites. If no thoracostomy tube site was available, the camera was introduced in the fifth intercostal space in the midaxillary line. Two to 3 ports were inserted under direct vision for additional access to the pleural cavity. These ports were strategically placed to access the entire chest cavity and whenever possible they were placed along a line that could be used for a thoracotomy incision should the conversion to open thoracotomy be required. The pleural cavity was evacuated by breaking up loculations and debriding any pleural peel using ring forceps. Once adequately debrided, we irrigated the pleural cavity and inserted 1 to 2 thoracostomy tubes through the portals. The remaining access ports were closed. Patients who underwent open thoracotomy had a standard posterolateral thoracotomy incision through the fifth intercostal space. After debridement, the pleural cavity was drained with 2 thoracostomy tubes.

The goal of postoperative pain management was to provide patients with adequate analgesia so that they could take deep breaths, cough, and ambulate. The efficacy of pain therapy was monitored frequently and the pain control strategy used was adjusted based on patient performance. The following pain management strategies were used in ascending order of intensity: oral analgesics, intravenous narcotics, patient-controlled analgesia, and epidural analgesia through a thoracic or lumbar catheter. Postoperative pain was assessed by comparing postoperative analgesic requirements between the 2 groups. Because most patients were already receiving pain medications prior to their operation, we compared the number of patients from each group who had an increase in their pain control regimen based on the above-described strategies. The use of postoperative epidural catheters was compared in the 2 groups.

Thoracostomy tubes were maintained on suction until 24 hours after any air leak had resolved, and they were removed once drainage decreased below 2 mL/kg per 24 hours.

Results are reported as means ± SDs. Continuous variables were analyzed using Student t test and dichotomous variables were compared using the χ² or Fisher exact test. Statistical significance was defined as P<.05.
Table 1 are reported on an intent-to-treat basis; patients initially treated with VATS who required conversion to open thoracotomy are included in the VATS group. Outcome as measured by operative times (mean time for VATS group includes time for open thoracotomy in patients requiring conversion), pain treatment, duration of postoperative thoracostomy tube drainage, complication rates, and postoperative hospital stay was similar for the 2 groups (Table 1). We found no differences in the use of postoperative epidural analgesia in the 2 groups (VATS=5 [31%], thoracotomy=3 [50%]; P=.63). Three patients (18%) who underwent VATS required conversion to open thoracotomy to assure adequate drainage. The remaining 13 patients who underwent VATS had 14 empyemas definitively treated via the minimally invasive approach.

During the study period, 14 patients underwent surgical drainage of a persistent pleural effusion. Nine patients underwent 10 VATS procedures. One patient underwent bilateral VATS to drain bilateral chylothoraces secondary to a transmediastinal gunshot wound that injured her thoracic duct. This patient underwent successful ligation of her thoracic duct during the VATS. Only 1 patient who underwent VATS for persistent pleural effusion was converted to open thoracotomy. Thoracotomy was performed to drain persistent pleural effusions in 5 patients. Demographic and outcome data for patients with persistent pleural effusions are found in Table 2. No differences were detected in any of the parameters analyzed.

Only 4 (15%) of the 27 VATS procedures performed (17 empyemas, 10 persistent effusions) were converted to open thoracotomy (Table 3). We converted nearly twice as many VATS procedures performed for empyema (18%) as we did VATS procedures performed for persistent pleural effusion (10%). In 2 patients with empyema, the procedure was converted because of inadequate exposure of the thoracic cavity: one because of double-lumen endotracheal tube failure and the other because of dense pleural adhesions. Only one patient with empyema was converted to open thoracotomy for decortication despite adequate exposure. One patient with persistent pleural effusion was converted to open thoracotomy to repair a previously undiagnosed diaphragmatic laceration.

We found no differences in the complication rates between patients who underwent VATS and those who underwent open thoracotomy (Table 4). Five complications (29%) occurred in patients who underwent VATS for empyema and 2 complications (33%) occurred in patients who underwent open thoracotomy for empyema. One patient who required being converted from the VATS to open thoracotomy procedure developed a pneumothorax after his thoracostomy tubes were removed. Because thoracostomy tube removal is inherent to both VATS and thoracotomy and because he had both procedures performed, his complication was not included in the calculation of the complication rates for the individual groups. Two patients required open thoracotomy after VATS. One patient who underwent VATS for empyema had persistent bleeding postoperatively and required open thoracotomy. At reoperation he was found to have diffuse oozing from the chest wall and lung surfaces that had undergone decortication; however, the decortication was adequate. The other patient underwent open thoracotomy for a persistent effusion after VATS that was presumed to be a persistent empyema. At reoperation his decortication was found to be adequate and only a scant amount of fluid was drained. The yields from pleural fluid cultures obtained at operation were found to be sterile.
Recent improvements in camera technology have led to the resurgence of minimal access thoracic surgery. Thoracoscopic evaluation of thoracic trauma and thoracoscopic treatment of empyema have been reported and advocated prior to the development of the new videoscopic equipment, but thoracoscopy was not widely used.2,12,16 Since the introduction of the new technology, VATS has become widely accepted in thoracic surgery. Not only is VATS effective but several studies have reported several advantages of VATS over open thoracotomy for a number of conditions. These proposed benefits include less pain, shorter hospital stays, and better cosmetic results for patients who undergo VATS.1-10

We found VATS to be a safe alternative to open thoracotomy for the management of posttraumatic empyema. Furthermore, not only was VATS safe, but the conversion rate to open thoracotomy was low (3/17 [18%]). Overall, 11 (70%) of 16 patients who underwent VATS were successfully treated without open thoracotomy. Concerns that optimal decortication of empyema peels could not be achieved using VATS techniques were not supported by our experience. Adequate decortication of empyema was achieved via VATS in 14 (100%) of 14 patients who did not require an intraoperative conversion to open thoracotomy. The most common reason for conversion to open thoracotomy was inadequate exposure. We were unable to define any preoperative characteristics or risk factors that could identify patients who required open thoracotomy to treat their pleural process. Because VATS was successful in treating most pleural effusions and empyemas and because we were unable to determine preoperatively which patients would require an open thoracotomy, we recommend that trauma patients with sizable, persistent pleural effusions have their conditions evaluated using VATS. Both patient and surgeon should be prepared to convert to open thoracotomy when VATS is unsuccessful.

Unlike studies of VATS in nontrauma populations, we were unable to identify specific improvements in outcome parameters such as a reduction in pain as measured by analgesic requirements or a decrease in length of hospital stay. This can be explained by the presence of other injuries that require analgesia and hospitalization in our trauma patients. In our patient population, the benefits of VATS may be difficult to discern because of the confounding variables introduced by concomitant injuries.

There are several limitations to our study. First, it is a retrospective series, and, thus, it is subject to the inherent disadvantages of such a review. Second, patients

| Table 3. Indication for VATS, Demographic Characteristics, Interval Between Injury and Surgery, and Reason for Intraoperative Conversion From VATS to Open Thoracotomy* |
|-----------------|-----------------|-----------------|-----------------|-----------------
<table>
<thead>
<tr>
<th>Indication for Surgery</th>
<th>Demographic Characteristics</th>
<th>No. of Days From Injury to Surgery</th>
<th>Reason for Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persistent effusion</td>
<td>23/F/blunt/13</td>
<td>4</td>
<td>Converted to repair previously undiagnosed diaphragmatic laceration</td>
</tr>
<tr>
<td>Empyema</td>
<td>60/M/blunt/9</td>
<td>16</td>
<td>Unable to collapse lung and visualize pleural cavity</td>
</tr>
<tr>
<td>Empyema</td>
<td>47/M/blunt/38</td>
<td>16</td>
<td>Unable to perform adequate decortication of thick pleural peel</td>
</tr>
<tr>
<td>Empyema</td>
<td>40/M/penetrating/9</td>
<td>5</td>
<td>Unable to visualize pleural cavity because of extensive, dense, chronic pleural adhesions</td>
</tr>
</tbody>
</table>

*VATS indicates video-assisted thoracic surgery; ISS, Injury Severity Score.

| Table 4. Complications After VATS and Thoracotomy for the Treatment of Persistent Collections in Trauma Patients* |
|-----------------|-----------------|-----------------|-----------------|-----------------
<table>
<thead>
<tr>
<th>Group</th>
<th>Indication for Procedure</th>
<th>Demographic Characteristics</th>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>VATS</td>
<td>Empyema</td>
<td>38/F/blunt/20</td>
<td>Respiratory depression due to overmedication while using patient-controlled analgesia; required brief period of ventilatory support</td>
</tr>
<tr>
<td>VATS</td>
<td>Empyema</td>
<td>28/M/penetrating/9</td>
<td>Deep venous thrombosis; patient found to be proteins C and S deficient</td>
</tr>
<tr>
<td>VATS</td>
<td>Empyema</td>
<td>52/M/blunt/24</td>
<td>Underwent thoracotomy to control bleeding after VATS</td>
</tr>
<tr>
<td>VATS</td>
<td>Empyema</td>
<td>18/F/blunt/17</td>
<td>Thoracotomy tube site abscess; treated with drainage and antibiotics</td>
</tr>
<tr>
<td>VATS</td>
<td>Empyema</td>
<td>36/M/penetrating/9</td>
<td>Thoracotomy after VATS for presumed persistent empyema; only a small amount of pleural fluid was found; results of pleural cultures were negative for organisms</td>
</tr>
<tr>
<td>VATS</td>
<td>Pleural effusion</td>
<td>20/F/penetrating/16</td>
<td>Pneumonia</td>
</tr>
<tr>
<td>OT</td>
<td>Empyema</td>
<td>38/F/penetrating/9</td>
<td>Persistent empyema that required repeated thoracotomy; results of cultures positive for Staphylococcus aureus</td>
</tr>
<tr>
<td>OT</td>
<td>Empyema</td>
<td>48/M/blunt/16</td>
<td>Pneumonia</td>
</tr>
<tr>
<td>OT</td>
<td>Pleural effusion</td>
<td>65/M/blunt/29</td>
<td>Recurrent clotted hemothorax</td>
</tr>
<tr>
<td>OT</td>
<td>Pleural effusion</td>
<td>50/M/penetrating/13</td>
<td>Thoracotomy tube sites abscess; treated with drainage and antibiotics</td>
</tr>
</tbody>
</table>

*VATS indicates video-assisted thoracic surgery; OT, open thoracotomy; and ISS, Injury Severity Score.

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were not randomly assigned to the groups. However, since no differences were identified in any of the demographic variables analyzed, we inferred that no obvious bias or selection advantage existed in either group. Third, we had a small sample size.

Improvements in outcome associated with VATS in trauma patients may be modest and difficult to document. In addition, empyema is a relatively uncommon complication after thoracic trauma. In our series, during the 42-month study period, only 22 patients had empyema confirmed by findings from intraoperative cultures. Given the low incidence of postruamatic empyema, a multi-institutional trial would be necessary to enroll the number of patients needed to document any incremental reduction in morbidity.

Video-assisted thoracic surgery has several advantages when compared with open thoracotomy. Prospective trials have demonstrated improved pulmonary function, decreased analgesic requirements, and reduction in postoperative hospital stay in patients treated for spontaneous pneumothoraces and decreased postoperative pain, improved pulmonary function, and decreased shoulder dysfunction after pulmonary resection. In a prospective randomized trial, VATS was found to be more effective than pleuropulmonary resection. Postoperative pain-related morbidity: video-assisted thoracic surgery versus thoracotomy. Ann Thorac Surg. 1993;56:1285-1289.


J. David Richardson, MD, Louisville, Ky: I am in complete agreement with their conclusions that the video-assisted thoracoscopic techniques are very useful for patients with empyema, particularly following trauma. Our group has been very interested in this problem and recently reported on our results with the technique. We have had excellent results as have others with VATS for retained hemothorax and other collections as the authors have noted in their experience as well.

Our results with established empyema have not been as good as the authors have reported. We have used an open thoracotomy in a higher percentage of patients. Probably that is due in some part to a lack of patience on my part in perhaps not persisting as long with the video-assisted technique as perhaps the authors did. When I convert patients to an open thoracotomy, I usually use a very small incision and I think by using the combination of a small open incision in

CONCLUSIONS

We have shown that VATS is safe and effective for treating posttraumatic empyema. We believe that trauma patients with persistent thoracic collections unresponsive to thoracotomy tube drainage should be treated with VATS techniques; however, the patient and surgeon should be prepared to proceed with open thoracotomy if adequate drainage of the pleural cavity or adequate decortication of the empyema peel cannot be achieved. This will reduce the number of open thoracostomies performed and conversion of a VATS procedure to an open thoracotomy procedure will add little to the morbidity of the patient.

REFERENCES


DISCUSSION


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which one can then put in a lung clamp and the scope, that you can really avoid putting in a chest spreader in a large percentage of patients. In terms of pain management, I use the routine use of an epidural in all of the open [thoracotomy] patients and generally have found it to be helpful even in the patients with the thoracoscopic technique alone because the one thing you don’t want is to have chest splinting and poor inspiratory efforts, so I use virtually 100% epidural in both those groups.

**Dr Battistella:** With respect to patience in the operating room, Dr Richardson noted that he lacks the patience to remain in the operating room for prolonged periods of time. We have found that the operating times for the 2 groups (VATS vs thoracotomy) were actually very similar. It’s just a matter of what you spend your time doing. With open thoracotomy, a lot of the time is devoted to opening and closing the chest wall, whereas this becomes a very simple task with the VATS procedure. On the other hand, decorticating the chest cavity takes much longer with the video-assisted technique than with the open technique. So it does require quite a bit more patience during that portion of the operation.

With respect to some of the technical difficulties in terms of developing air leaks during the decortication, we certainly did see a number of small air leaks, but all of those resolved very quickly, frequently even before the patient reached the recovery room.

You mentioned that you tend to favor the use of minithoracotomy without spreading the ribs. In many ways we are probably doing the same operation. We do not insert a port into all of the small incisions that we make. Rather, we insert the instrument directly through the incision, so that we are actually manipulating the instrument much the same way we would had we made a larger incision. We agree with you that spreading the ribs probably makes a huge difference in the postoperative discomfort experienced by these patients.

I agree wholeheartedly with respect to the importance of aggressive pain management in these patients. It is critical to maintain adequate expansion of the lung. We also are aggressive in using epidural analgesia in all of these patients. We were a bit surprised because we thought that we might be able to demonstrate some differences in pain. Subjectively, we feel that patients who undergo VATS do better in terms of their post-operative pain compared with those who undergo thoracotomy. The multiple injuries present in these trauma patients made it difficult to show any differences in their pain medication requirements.