VIDEO-ASSISTED THORACOSCOPY IN THE TREATMENT OF PLEURAL EMPYEMA: STAGE-BASED MANAGEMENT AND OUTCOME

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Objective: **Despite modern diagnostic methods and appropriate treatment, pleural empyema remains a serious problem. Our purpose was to assess the feasibility and efficacy of the video-assisted thoracoscopic surgery in the management of nontuberculous fibrinopurulent pleural empyema after chest tube drainage treatment had failed to achieve the proper results.** ***Methods:*** **We present a prospective selected single institution series including 45 patients with pleural empyema who underwent an operation between March 1993 and December 1996. Mean preoperative length of conservative management was 37 days (range, 8–82 days). All patients were assessed by chest computed tomography and ultrasonography and underwent video-assisted thoracoscopic debridement of the empyema and postoperative irrigation of the pleural cavity.** ***Results:*** **In 37 patients (82%), video-assisted thoracoscopic debridement was successful. In 8 cases, decortication by standard thoracotomy was necessary. There were no complications during video-assisted thoracic operations. The mean duration of chest tube drainage was 7.1 days (range, 4–140 days). At follow-up (n = 35) with pulmonary function tests, 86% of the patients treated by video-assisted thoracic operation showed normal values; 14% had a moderate obstruction and restriction without impairment of exercise capacity, and no relapse of empyema was observed.** ***Conclusions:*** **Video-assisted thoracoscopic debridement represents a suitable treatment for fibrinopurulent empyema when chest tube drainage and fibrinolytics have failed to achieve the proper results. In an early organizing phase, indication for video-assisted thoracic operation should be considered in due time to ensure a definitive therapy with a minimally invasive intervention. For pleural empyema in a later organizing phase, full thoracotomy with decortication remains the treatment of choice. (J Thorac Cardiovasc Surg 1999;117:234-8)**

Despite the introduction of broad-spectrum antibiotics and the declining incidence of tuberculosis, thoracic empyema remains a serious problem. Empyema begins with an exudate (stage I),[1] which is caused by an increased capillary permeability of the pleura in response to contamination. Because of its low viscosity, the lung remains mobile within the fluid. In this stage, the therapy of choice is closed-chest drainage and antibiotics. During the fibrinopurulent phase (stage II) frank pus accumulates, and fibrin deposits will produce a pleural peel and loculation of fluid. Expansion of the lung is restricted, and simple treatment with closed-chest drainage is no longer effective. Without surgical intervention, the empyema will progress to the so-called organizing phase (stage III). This stage is characterized by a migration of fibroblasts from the pleura with deposits of collagen fibers and a thickening of the layers (peel), further restricting the movement of the lung, chest wall, and diaphragm. Rib resection and pleural drainage in the fibrinopurulent phase (stage II) and decortication in the organizing phase (stage III) has been the common surgical treatment.[2] Satisfactory results in the management of empyema have been reported in the recent literature with the use of video-

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assisted thoracoscopic surgery (VATS).[3-8] In this prospective study, we report about our experience with VATS on 45 patients with nontuberculous empyema after chest tube drainage and antibiotic because primary therapeutic interventions had failed. We analyze the difference between computed tomography (CT) and ultrasonography in clinical staging of empyema with relevance to the decision-making process, and we propose new treatment guidelines for thoracic empyema.

Patients and methods

From March 1993 to December 1996, 52 patients were referred to our institution with the clinical and radiologic diagnosis of nontuberculous empyema persisting after initial treatment with closed-chest tube drainage and antibiotics. At admission, 7 of these 52 patients showed a marked functional disturbance, and radiologically an encased lung with a thick fibrous peel was evident (stage III empyema). These patients were not considered for VATS because they required decortication by standard thoracotomy and were excluded from this prospective evaluation.

The remaining 45 patients (25 male, 20 female; average age, 52 years [range, 13–86 years]) had a mean of 37 days (range, 8–82 days) from the onset of symptoms until referral to our institution. However, chest tube drainage plus fibrinolytic agents and parenteral antibiotics were insufficient treatment for these empyemas, demonstrated by persisting clinical symptoms (fever) and the ultrasonographic findings of multiloculated pleural fluid on admission. Clinical data, including symptoms, cause of empyema, associated diseases, or predisposing conditions were recorded. In addition, all patients had standard posteroanterior and lateral chest radiographs and CT (axial, 10-mm thick contiguous slices after the administration of iodinated contrast agent) and ultrasonography of the chest (intercostal transverse sections with a 3.5 MHz curved-array transducer). The diagnosis of empyema was based on grossly purulent fluid at thoracentesis, positive pleural fluid cultures, or positive Gram stain. All patients underwent VATS debridement with general anesthesia and double-lumen intubation (Carlens tube). Patients were placed in lateral decubitus position. A 2-cm skin incision was performed at the level of the largest fluid collection, as determined by ultrasonography. The intercostal muscles were divided, and biopsy specimens of the the parietal pleura were obtained for histopathologic examination. After the fluid had been evacuated and sent for immediate Gram stain and culture, adhesions between the lung and the chest wall were broken, and the video thoracoscope was inserted through a 10-mm trocar. The second trocar was placed under direct vision of the camera. Loculated fluid collections were disrupted both bluntly and by sharp preparation until the entire cavity was freed. After irrigation with saline solution, the remaining areas of debris were dislodged. Irrigation was repeated until the cavity was clean. The instruments were removed, and the lung was ventilated with a pressure of 30 to 40 cm H_2O to check for leaks, residual cavities, and the efficacy of lung expansion. Two 32F chest tubes were finally inserted through the thoracoscopy sites. If one of the sites was at an unfavorable location for draining, the chest tube was inserted through a separate incision.

Table I. *Causes of empyema in 45 patients treated by VATS*

Secondary to bronchopulmonary infection	39
Previous minor surgical intervention	3
Spontaneous pneumothorax and bronchopleural fistula	2
Idiopathic	1
Total	45

The pleural cavity was irrigated daily with 1000 mL saline solution. The solution was injected with a 50-mL syringe through the apical 32F chest drain. During the procedure, which lasted 15 minutes, the fluid was drained through the caudal chest tube where a 30–cm H_2O aspiration was applied. After the procedure both chest tubes were connected to the suction system. Antibiotics were not added to the saline solution because the irrigation was aimed to remove debris of fibrin and blood clots from the pleural cavity, making use of its mechanical action. When the effluent fluid clarified (normally 3–5 days after VATS) and daily fluid cultures remained sterile, chest drains were removed and the administration of antibiotics was discontinued. Because it takes 2 days for bacterial cultures to yield a result, the duration of chest tube placement turns out to be 2 days longer than necessary. During this time, irrigation is performed. Subsequently, each patient participated in a mandatory and intensive program of general mobilization and specific respiratory therapy. At least 3 months after the patient's discharge, we performed a follow-up check that included a clinical examination, chest radiography, and pulmonary function tests. Patients whose condition required a secondary intervention, such as decortication, lung resection, or thoracostomy, were not considered for follow-up.

Results

The causes of nontuberculous empyema of the 45 patients treated by VATS are shown in Table I. In 39 cases (87%) empyema was due to bronchopulmonary infection. Two patients with idiopathic spontaneous pneumothorax experienced an empyema because of bronchopleural fistula. Complications of minor surgical procedures, such as infected thoracentesis and hemothorax after chest tube drainage, caused 3 empyemas. Twenty-seven patients (60%) had associated diseases or predisposing conditions (ie, chronic obstructive pulmonary disease, bronchiectasis, malnutrition, and alcoholism**).** Fever and chest pain were leading symptoms in 27 patients (60%), followed by dyspnea (n = 21, 47%), and cough (n = 14, 31%). The empyema cavity was multiloculated in 30 patients (67%) and

Table II. *Current world literature survey on thoracoscopic treatment of empyema*

Authors	*n*	*Duration (days)*	*Stage*	*Chest tube (days)*	*Hospital stay (days)*	*Success (%)*	*Conversion (%)*	*Complications (%)*	*Deaths (%)*
Angelillo et al[3]	31	11	II	4.1	6.7	90	10	16	3
Hornick et al[4]	14	19	II	—	7.8	71	29	7	0
Landreneau et al[5]	76	9	II/III	3.3	7.4	83	17	3	6.6
Ridley and Braimbridge[14]	30	—	II/III	10.7	—	60	40	—	13
Sendt et al[6]	10	—	—	8.5	16.3	100	0	10	0
Striffeler et al[7]	67	<21	II	4.1	12.3	72	28	4	4
Wait et al[8]	11	—	II	5.8	8.7	91	0	0	9
Present study	45	37	II/III	7.1	10.7	82	18	11	0

uniloculated in 15 patients (33%). Bacteria could be isolated in the empyema fluid of 21 patients (47%). There were no intraoperative complications. Mean duration of chest tube drainage was 7.1 days (range, 4-140 days); the average hospital stay 10.7 days (range, 6-140 days), including a program of general mobilization and specific respiratory therapy. Five patients (11%) had postoperative complications. Two patients experienced a prolonged air leak (>7 days) that was treated conservatively. A pneumothorax after chest tube removal had to be treated by the reinsertion of a chest tube at the bedside; one case of pneumonia was treated with antibiotics and resolved in 1 week. One patient experienced the development of endocarditis 4 weeks after VATS, which led to septic emboli in the brain and upper and lower extremities. This patient required mechanical ventilation for several weeks and showed residual hemiplegia 6 months after the operation.

In 8 cases the lung failed to expand during VATS because of a thick fibrous peel; the empyema was therefore upstaged and full thoracotomy was performed. In 2 cases lung resection was added to decortication because of destroyed lobes with persistent bronchopleural fistulae. One patient in poor condition required thoracostomy.

CT findings and surgical staging of empyema correlated in 28 patients (62%). In 17 of 45 cases (38%), the empyema was understaged because the CT was unable to detect loculations or because the thick fibrous peel encasing the lung was not visualized. Ultrasonography was able to properly stage 37 of 45 patients (82%). In 8 cases (18%) gas inclusions in the pleural fluid prohibited a satisfactory ultrasonographic examination leading to incorrect staging.

At follow-up 35 patients were examined. Eight patients whose conditions required secondary surgical measures (ie, thoracotomy) were not considered; 2 additional patients with uneventful recovery who left in good condition with normal findings on chest radiography could not be reached. The average time at follow-up was 20.1 months after hospital discharge (range, 3–48 months). None of the patients required surgical treatment after discharge or complained of serious problems related to the empyema or its therapy. In 7 cases (20%) examination of the chest radiograph revealed a moderate fibrothorax. In 5 of these 7 patients, pulmonary function tests demonstrated a moderate obstruction (mean forced expiratory volume in 1 second, 76% of predicted value; range, 56%–88%) and restriction (mean vital capacity, 72% of predicted value; range, 51%–83%) without impairment of the exercise capacity. The remaining 30 patients (86%) showed normal static lung volumes (vital capacity, 90% or more of predicted value), normal forced expiratory volume in 1 second (90% or more of predicted value) and normal exercise capacity.

Discussion

Successful management of thoracic empyema requires prompt treatment with drainage and antibiotics. Early recognition and aggressive treatment should be adopted by all physicians to prevent chronicity of the disease. Surgical intervention should be considered for patients with loculated effusion, particularly if the lung does not expand under drainage. Even if our series is lacking comparative groups, the present results emphasize the efficacy of VATS in the treatment of pleural empyema when drainage and fibrinolytics have failed and standard thoracotomy represents the only suitable therapeutic alternative. With the advantage of a less invasive surgical technique, VATS ensures equal results to standard thoracotomy because it allows a precise inspection of the whole pleural cavity and a debridement can be performed under direct vision. In our series, no empyema relapse or complication occurred. Functional intermediate term results show that 86% of the patients treated by VATS had normal pulmonary function tests and that chest radiographs were normal in 80% of cases. The remaining patients had a moderate obstructive and restrictive ventilatory deficit.

They did, however, not have an impairment of exercise capacity.

Conservative treatment of the empyema with intrapleural fibrinolytics was demonstrated to be a valid therapeutic option for patients with loculated effusions not older than 12 days.[9] The success rate decreased to 61% if the empyema was 20 days old.[10] There is no experience on the efficacy of fibrinolytic agents for older empyemas. In our opinion, this treatment alone is unsuited if symptoms of empyema last for more than 4 weeks as in our series.

In our series of 45 patients with an average onset of symptoms of 37 days before operation, 8 patients (18%) needed secondary interventions in the form of a decortication by standard thoracotomy, and no patients died. Reports in the literature on the suitability of VATS for empyema in this stage are poor.[5] Success rates between 60% and 100% of cases were reported, but results were better if the length of the preoperative medical management did not exceed 2 weeks (Table II).

Reexpansion of the lung, which is of great importance for outcome, can be checked by VATS at the end of the intervention. If the lung is still entrapped and the patient's general condition allows, an immediate decortication by standard thoracotomy during the same anesthesia should be performed. In all cases of incomplete re-expansion of the lung, important postoperative supportive measures include constant aspiration of the drainages and specific respiratory therapy for the diaphragm.

Because of the introduction and improvement of VATS, the currently used empyema classification does not seem to add substantial information to the decision-making process. An early organizing phase could be successfully treated by VATS according to our experience and the literature, whereas a later organizing phase would usually require thoracotomy and decortication. Therefore clinical staging of empyema still remains a challenge.

History, clinical examination, and bacteriologic findings are of good diagnostic value but of little value for empyema staging. Extreme values of pleural fluid chemistry (pH < 7.2; glucose < 40 mg/dL; lactate dehydrogenase > 1000 IU/L; protein > 5.0 mg/dL) correlate with loculated effusions but not with empyema.[11] In accordance with the literature,[7,11-13] we experienced that the CT scan provides insufficient information to distinguish between a loculated pleural effusion, as in an early organizing phase, and a pleural peel requiring some amount of decortication, as in a later organizing phase (Fig 1, *A*). Conversely, ultrasonography in experienced hands provides major additional information with this regard. It clearly detects loculations, and the thickness of the fibrinous deposits encasing the lung can be precisely visualized (Fig 1, *B*). In contrast to CT assessment of the underlying lung, parenchyma is not possible, and gas inclusions in the pleural fluid may disable a satisfactory ultrasonographic exploration. Empyema assessment by ultrasonography requires considerable experience; when the chest is shrunk after empyema, the intercostal spaces are often too narrow to allow a satisfactory examination. Therefore ultrasonography should be performed in all patients with pleural empyema in combination with rather than instead of CT. Morphologic information provided by thoracic ultrasonography and the versatility of VATS require the reconsideration of the current staging proposed in 1962 and the restructuring of treatment guidelines for thoracic empyema. Patients without loculated fluid collec-

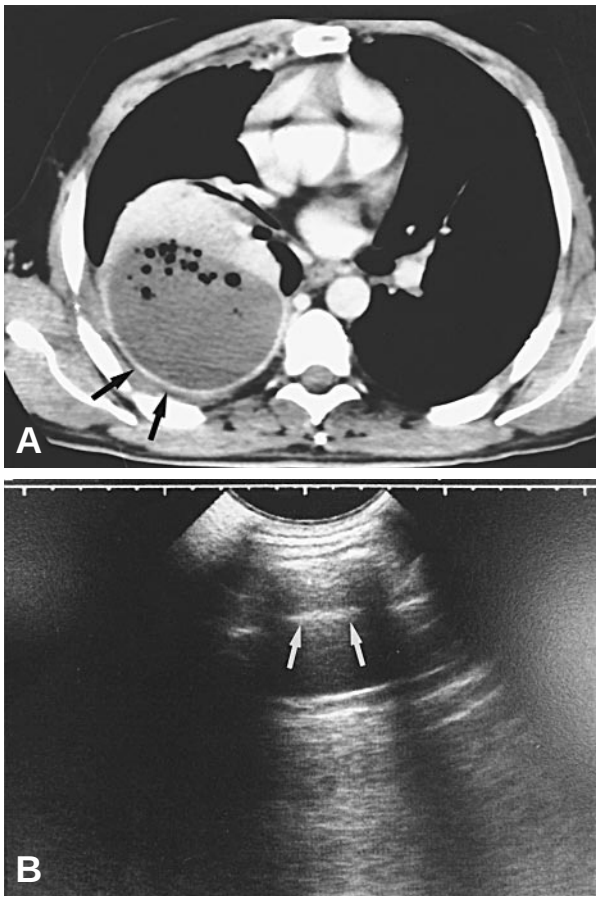

Fig 1. A, Axial contrast-enhanced CT of the chest at the floor of the left atrium shows gas inclusions, thickening, and increased contrast uptake of the parietal pleura (*arrows*) in a 42-year-old patient with stage II empyema. No loculations are detectable. **B**, Chest ultrasonography of the same patient as in **A** reveals loculations (*arrow*) and a thickened visceral pleura. These findings were subsequently confirmed at video thoracoscopy.

tion are treated at bedside by chest tube drainage. If the lung does not expand with drainage and fibrinolytics or ultrasonography shows a loculated fluid collection, the patient should be treated with minimally invasive techniques. If ultrasonography demonstrates an encased lung or the lung fails to expand during VATS, the patient should undergo decortication by full thoracotomy.

In addition to the advantages of a less invasive surgical procedure, the favorable functional results at the intermediate term substantiate the authenticity of the VATS procedure as an alternative to the previous "gold standard" in the treatment of fibrinopurulent and early organizing empyema. Decortication by standard thoracotomy remains the treatment of choice for more advanced empyemas, when the lung is entrapped by a thick fibrous peel. Previous VATS debridement does not rule out a secondary surgical measure, but it may represent a bridging measure in septic patients until they can undergo safe decortication.

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Commentary

Cassina and associates have reported on 37 patients in whom video-thoracoscopic (VATS) debridement of parapneumonic fibrinopurulent empyemas was successful. It is their contention that VATS represents a suitable therapeutic option when conservative measures such as thoracentesis, tube drainage, or fibrinolytics have failed. VATS is advocated over early thoracotomy or rib resection drainage because it can be performed with low mortality and fewer complications. In addition, 86% of patients treated by VATS showed good functional recovery, as evidenced by follow-up pulmonary function testing.

Although this series supports the principle of early surgical intervention, it raises important questions concerning the timing of surgery in relation to the stage of empyema. How does one differentiate simple inflammatory reaction likely to respond to antibiotics and drainage from early organization? How does one differentiate between the very acute stage where pleural fluid is thin and the purulent stage where fibrin is deposited over pleural surfaces? Since the duration and severity of illness are often unreliable determinants, what are the roles of imaging (free-flowing fluid versus loculations), fluid biochemistry (pH < or > 7.0), or fluid bacteriology? These difficult issues are still unresolved, although some clarification may come from a panel of experts currently working with the American College of Chest Physicians to review and redefine the terminology used to stage empyemas, as well as the role of the various treatment strategies. This task is difficult, however, because of the lack of experimental data, as well as the lack of prospective randomized trials looking at one therapy versus another.

As pointed out by the authors of this article, VATS is a straightforward technique that can achieve the goals of evacuation of pus, debridement, disruption of loculations containing fibrin clots and membranes, full lung expansion, adequate dependent drainage, and space obliteration. Because it is minimally invasive, VATS is also an ideal procedure for many of these critically ill patients who are at high surgical risk because of their illness, prior debilitating conditions, or immunosuppressed status. It is probably true to say that, to date, debridement of fibrinopurulent empyemas represents one of the true indications for therapeutic VATS techniques.

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