Surg Today (2002) 32:19–25

SURGERY TODAY

Video-Assisted Thoracoscopic Surgery in the Treatment of Chronic Empyema Thoracis

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Abstract We prospectively analyzed the surgical results in chronic organizing empyema thoracis utilizing a video-assisted thoracoscopic technique, particularly in debilitated patients. From January 1999 to September 2000, ten patients with stage III empyema thoracis underwent video-assisted thoracoscopic surgery for decortication (VATD). The mean age of the patients was 53.2 years, and they included one female and nine male patients. Four patients were regarded as not suitable for open thoracotomy. After the procedure, all patients had one infusion tube and two 32-F chest tubes inserted, the former for irrigation with saline solution and the latter for drainage. The mean operation time was 178 min. There was no mortality. The mean time to remove the infusion tube was 3.3 days. The mean time to remove the first chest tube was 7.1 days and the second chest tube 9.7 days. The mean hospitalization time after the operation was 14.9 days. The mean follow-up was 14.9 months. A restoration of lung function was ascertained in nine patients, with a 17.6% mean increase in forced vital capacity. There was no recurrence of empyema during the follow-up. Nevertheless, a reaccumulation of pleural effusion occurred in one patient 1 month after the procedure, which thus necessitated further treatment. VATD is considered to be a feasible surgical modality for the treatment of stage III empyema thoracis in selected patients.

Key words Video-assisted thoracoscopic surgery · Thoracoscopy · Empyema · Decortication

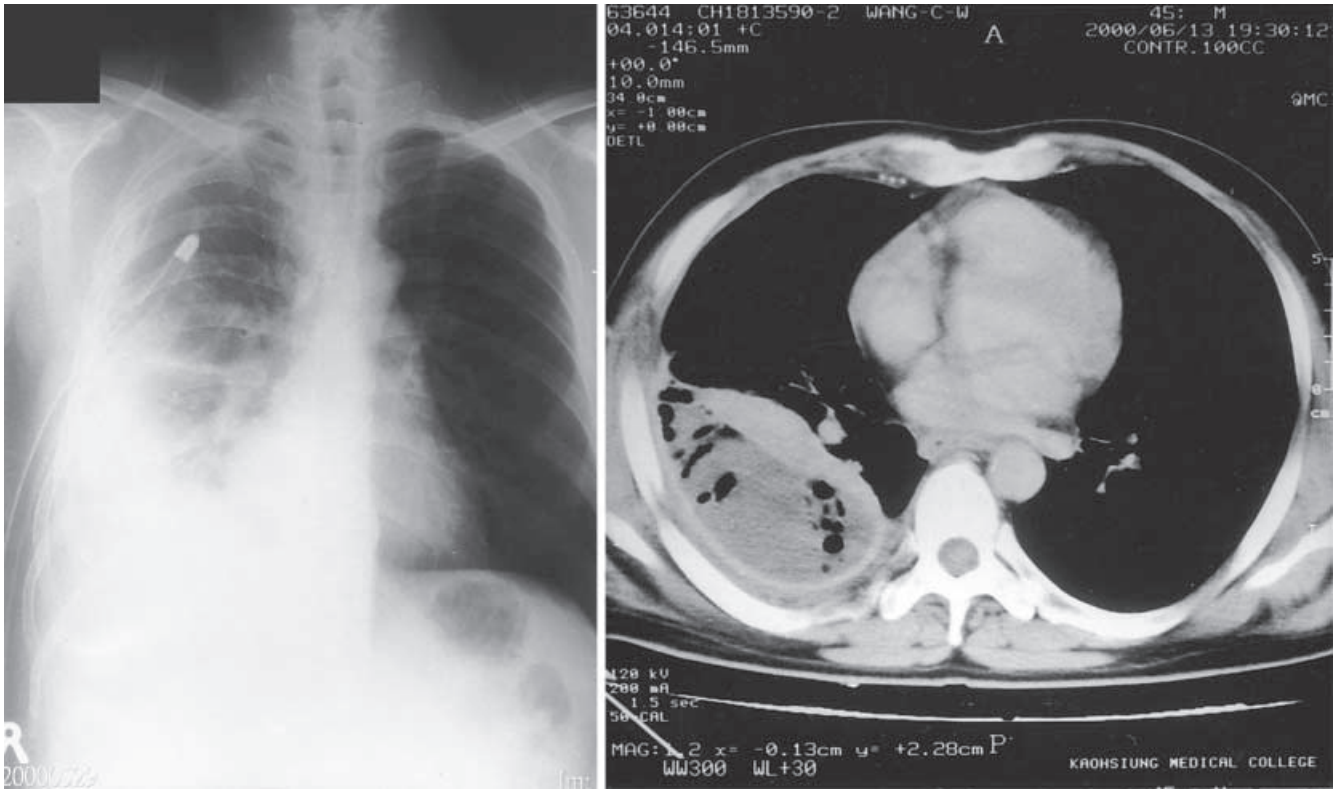
Introduction

Thoracic empyema usually occurs as an extension of an infectious process, most commonly originating from the lung.[1] It is estimated that 5% of the 1.2 million annual cases of pneumonia are complicated with the empyema.[2] For description and treatment purposes, three stages (exudative, fibrinopurulent, organizing) were defined by the American Thoracic Society in 1962.[3] The selection of the appropriate therapy for pleural infection depends on the stage of the empyema. Surgical intervention is regarded as inevitable in stage II and III patients. However, the surgical technique to treat such patients has gradually changed over time. Thanks to the advancement of video-assisted thoracoscopic surgery (VATS), many recent reports have encouraged the use of this technique to treat patients with stage II empyema instead of using a tube thoracostomy alone.[3–16] The technical difficulty caused by pleural adhesion and loculation is no longer a problem. Furthermore, as our experience accumulates, we are increasingly trying to manage patients with stage III empyema solely using VATS. We prospectively used this technique in ten patients and report our early results.

Patients and Methods

From January 1999 to September 2000, ten patients with nontuberculous stage III empyema thoracis prospectively entered the protocol so that we could evaluate the role of video-assisted thoracoscopic decortication (VATD) in chronic organizing empyema. They were all referred from the Medical Department after chest tube or pigtail drainage had failed. The mean age of the patients (1 woman and 9 men) was 53.2 years, and ranged from 31 to 78 years. Chest radiograms and computed tomography (CT) showed the lung was encased by a marked degree of fibrous peel in all patients

Reprint requests to: Y. Cheng
Received: January 22, 2001 / Accepted: July 17, 2001



a b

Fig. 1a,b. A 45-year-old man with right chronic empyema (presurgery). **a** Chest film after chest tube insertion. **b** Chest computed tomography showing thick pleura and collapsed lung

(Fig. 1). During the same period, 42 patients with empyema were admitted for treatment. Patients with an uncontrolled infection or with obvious necrotic lung parenchyma were excluded from the protocol. The patient profiles are summarized in Tables 1 and 2.

The patients were anesthetized with one-lung ventilation, and placed in the lateral decubitus position. Usually a three-port approach was adopted. One port was used for the telescope and the others for the manipulating instruments. We usually used the existing tube-thoracostomy wound as the first port site to insert the 0° thoracoscope (with an instrument channel built in). Using this thoracoscope we could insert the instrument via the channel to start debridement. A pleural space was then created which was sufficiently large for the other ports to be inserted under direct vision. We then changed the thoracoscope to a 30° telescope with an enlarged view. Using endoscopic and conventional instruments, decortication and the removal of the thickened peel were performed. The latter involved the careful dissection and removal of the fibrous tissue over the encased lung, which, in essence, is the same procedure as that used in an open thoracotomy (Fig. 2). Sometimes the concomitant removal of visceral pleura was inevitable due to the dense adhesion of the fibrous peel to the pleura, leading to mild air leakage. The final expansion of the lung could be confirmed visually with the telescope to ensure the completeness of the procedure. Two 32-F chest tubes were then inserted individually in the two port sites of the most dependent position to drain the fluid. The third port site was inserted with an infusion tube, which was actually a transfusion set (Fig. 3). Through this tube daily saline solution irrigation was performed to remove any residual fibrin debris and blood clots. No negative pressure was connected to the chest tubes. A chest radiogram was taken daily over the first 3 days. If the expansion of the lung was not sufficient, then a 50-cmH_2O negative pressure was connected to the chest tubes to improve the expansion. Irrigation was stopped and the infusion tube removed when clear drainage fluid was obtained. Finally, the chest tube was removed when the amount of drainage fluid became less than 100 ml per day.

Results

The mean duration of disease before the operation was 28.4 days, with a range of 16–78 days. The mean operation time was 178 min, with a range of 90–270 min. The

Table 1. Patient profiles before surgery

Patient no.	Sex/age (y)	Disease duration (days)[a]	FEV_1 (l)	FVC (l)	Management before surgery	Cause of disease[b]
1[c]	F/78	78	0.91	1.05	Pigtail drainage	DM, PN
2	M/31	16	1.21	1.50	Chest tube drainage	Trauma
3	M/45	20	1.18	1.49	Pigtail drainage	PN
4	M/44	19	1.10	1.41	Chest tube drainage	PN
5[c]	M/51	20	0.93	1.10	Pigtail drainage	PN
6	M/37	20	1.31	1.55	Pigtail drainage	PN
7[c]	M/72	19	0.87	0.99	Pigtail drainage	DM, PN
8[d]	M/72	40	1.22	1.47	Chest tube drainage	Trauma
9[c]	M/57	30	0.95	1.33	Chest tube drainage	DM, HD, PN
10	M/45	22	1.51	2.00	Chest tube drainage	Alcoholism, PN

FEV_1, forced expiratory volume in the first second; FVC, forced vital capacity; DM, diabetes mellitus; PN, pneumonia; HD, hemodialysis due to renal failure before lung disease
[a] The duration of disease before surgery
[b] The cause of the empyema or the combined disease
[c] These patients were regarded as not suitable for open thoracotomy
[d] This patient experienced reaccumulation of effusion

Table 2. Findings of computed tomography (CT) before surgery

Patient	Size of empyema Space[a]	Side	Thickened pleura	Pulmonary consolidation	Pneumonitis or atelectasis	Lung abscess	Other findings
1	1/3 hemithorax	R	+	+	−	−	Contralateral pleural effusion
2	1/3	L	+	−	+	−	Liver laceration
3	1/5	R	+	−	+	−	
4	1/3	L	+	−	+	−	Calcified spots in bilateral upper lobes
5	1/3	L	+	−	+	+	Hepatomegaly
6	1/5	R	+	+	−	−	
7	1/2	R	+	−	−	−	
8	1/3	L	+	−	+	−	
9	1/2	R	+	−	+	−	
10	1/3	R	+	+	−	−	

R, right-sided pleural empyema; L, left-sided pleural empyema
[a] The size of the empyema space is estimated based on the CT data and is designated as the ratio of the volume of the empyema space to the volume of the ipsilateral hemithorax

mean blood loss was 247 ml, ranging from 100 to 500 ml. There was no mortality throughout the course of this study. Air leakage was observed in all cases but it was short-lived, with a mean duration of 2.2 days, ranging from 1 to 5 days. The mean time to remove the infusion line was 3.3 days, ranging from 3 to 5 days. The mean time to remove the first chest tube was 7.1 days, ranging from 4 to 15 days, and the second chest tube, 9.7 days, ranging from 5 to 20 days. The mean hospitalization time after the operation was 14.9 days, ranging from 7 to 34 days. The mean follow-up was 14.9 months, ranging from 10 to 24 months. The lung function test was performed before surgery and 3 months thereafter. An accumulation of effusion, due to continuous pleural oozing, resulting in a partial lung collapse was noted in one patient (11%) 1 month after the operation. Exertion dyspnea was also noted in this patient, and an open thoracotomy was recommended. The remaining nine patients had no recurrence (Fig. 4), with a 17.6% mean improvement in forced vital capacity, ranging from 12% to 40%. The results are summarized in Table 3.

Discussion

Delays in appropriate referral for surgical drainage of empyema continue to cause a significant prolongation in the recovery from these infectious problems.[17,18] A high rate (24.2%) of chronic empyema has been reported in one series of 338 patients with intrathoracic suppuration.[19] The successful management of thoracic empyema requires prompt treatment with drainage and antibiotics.[14] To attain an acceptable cure rate, antibiotics alone are not sufficient to treat empyema in the

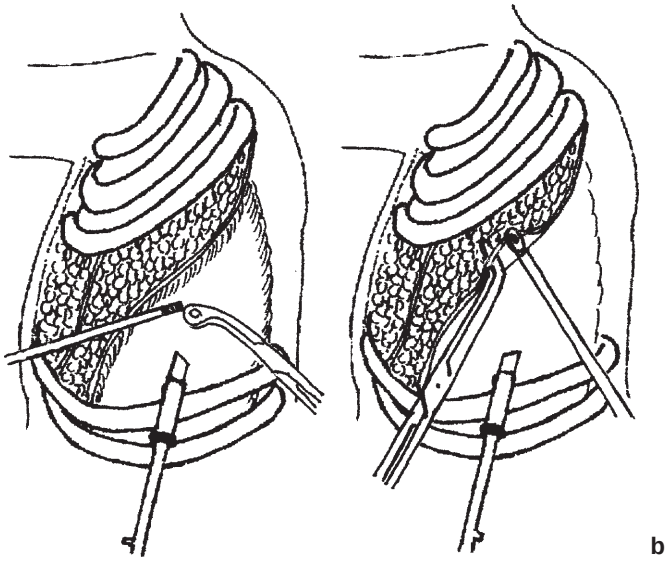


Fig. 2. a Using conventional ring forceps and a suction-irrigation tube, we can eradicate any pleural debris. **b** Using the conventional right-angled dissecting forceps and endoscopic grasping forceps, we can dissect the visceral peel

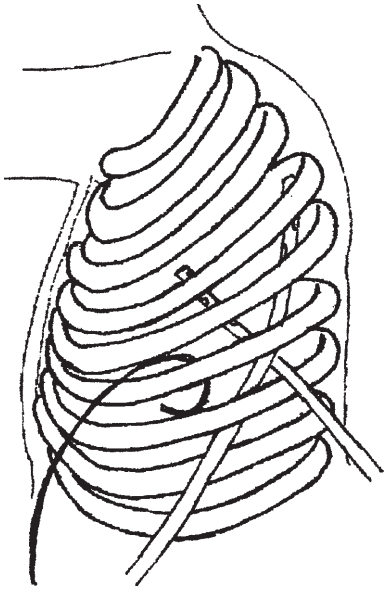


Fig. 3. Two 32-F chest tubes and one infusion tube were inserted after completing the surgery

exudative stage.[20] A large-bore chest drainage tube is mandatory to prevent progression of the disease. If fibrinopurulent empyema occurs after antibiotics and simple drainage fail to achieve satisfactory results, then VATS is the best way to debride the pleural space. Fibrinolytic agents have been demonstrated to be useful in treating multiloculated empyema in some reports, with a success rate ranging from 67% to 90%.[21–29] This is

Fig. 4. A chest film of the same patient in Fig. 1, 2 months after surgery, shows full expansion of the right lung

therefore another useful treatment for stage II empyema in addition to VATS, although Wait et al. reported a higher efficacy for VATS than for fibrinolytic therapy.[11] Once chronic organizing empyema with thick fibrous peel is encountered, then decortication with open thoracotomy is considered the gold standard in all reports on chronic empyema therapy.[1,10–16,20,27,30–32] However, we consider VATD to be another useful treatment modality.

Although a thoracoscopic evacuation of empyema can eradicate the pleural infections, as seen in the favorable result of VATS in treating the patients for fibrinopurulent empyema, the addition of peel removal on the lung surface in chronic empyema may sometimes cause lung damage,[7] which can aggravate the infection in these morbid patients.[20] Since the removal of peel and, sometimes, a visceral pleurectomy are mandatory when using this procedure, patients with an uncontrolled current infection must be excluded from this protocol.

The main technical challenge of VATD depends on the degree to which surgeons can reduce the residual

Table 3. Profile of operative results

Patient	Operation duration (min)	Air leak (days)	Infusion tube (days)[a]	1st chest tube (days)[a]	2nd chest tubes (days)[a]	Hospital stay (days)	Functional outcome (%)[b]
1	225	2	3	4	5	11	12
2	180	1	3	5	8	16	12
3	210	2	3	7	11	14	15
4	180	1	3	4	6	7	18
5	150	3	5	9	10	13	15
6	90	1	3	4	5	8	5
7	135	3	3	9	13	21	40
8	270	3	3	8	11	14	Nil
9	145	5	3	15	20	34[c]	12
10	195	1	4	6	8	11	20
Mean	178	2.2	3.3	7.1	9.7	14.9	17.6

[a] Number of days before removing the infusion tube, first chest tube, and second chest tube
[b] Improvement in forced vital capacity
[c] The long hospital stay was due to other associated diseases in this patient

pleural space and hence achieve maximal pulmonary expansion. The removal of dense pleural peel is a technical problem when performing VATD in stage III empyema. Meticulous dissection and time-consuming piece-by-piece peeling are mandatory in the procedure, which is why the surgery takes a long time. However, due to improvements in the thoracoscopic technique in our latest cases, a shorter operation time was achieved.

The condition of the lung parenchyma that must be expanded determines the success of the procedure. Both bronchoscopy and chest CT are essential tools to evaluate the possibility of reexpanding the lung. An endobronchial obstruction can be detected by bronchoscopy, which precludes lung expansion.[10] The CT findings of thickening and the increased contrast uptake of the parietal pleura, thickening and an increased density of the subcostal tissues, as well as an encapsulated and biconvex shape of effusion, are highly suggestive of pleural empyema.[33,34] The "split-pleural" sign is useful for identifying the organizing phase of empyema.[35] The "retraction index" is also useful for predicting the chronicity of the empyema when the volume of the diseased hemithorax is smaller than that of the healthy one.[18] However, there is no single criterion that can predict the expansion of the lung after this procedure. In our protocol, the CT findings of solid pneumonitis with cavity formation in the lung parenchyma exclude the patients from undergoing this protocol (Table 4). This is not always reliable. During surgery a direct examination of the pleura endoscopically with the simultaneous inflation of the lung in an effort to promote its expansion is much more informative.[7,30,31] In patients with an unresolved residual pleural space, the existence of a dead space after radical surgery can basically be permitted in all cases.[36] However, VATD coupled with endoscopically harvested muscle or omental flaps is another possible future option.[15,36]

Table 4. Criteria for selecting patients for video-assisted thoracoscopic decortication

1. The patient can tolerate general anesthesia with one-lung ventilation
2. Any concurrent pleural infection is under control
3. There is no endobronchial lesion that might cause an infection
4. The computed tomography findings of a solid pneumonitis with cavity formation in the lung parenchyma rule out such patients
5. Patients with evidence of a pulmonary tuberculosis infection are ruled out

The irrigation of the pleural cavity after this procedure is necessary to ensure that there will be no reaccumulation of fibrin debris and blood clots, as demonstrated in previous reports.[14,32,34,37] No antibiotics are added to the irrigation solution since infection control is not our main concern. The criteria for when to remove the infusion and drainage tubes are still under evaluation. Unfortunately, using the criteria mentioned above, we had one occurrence of massive pleural effusion after an initial nearly complete lung expansion, which may have been caused by continuous pleural oozing. Stricter criteria for removing the chest tubes may thus be needed to avoid such events. In one report, irrigation was continued until three consecutive cultures of irrigation fluid had become sterile.[37] Therefore, the duration of irrigation, 14 days, was longer, and the chest tubes were left in place for 20 days.[37] The use of talc in selected patients, which can cause pleurodesis and thus prevent the reaccumulation of pus, as reported by Weissberg and Colleagues,[30,38,39] is another potential treatment method.

The reported extents of lung function restored by open thoracotomy decortication vary greatly, from a 10% to 90% increase in vital capacity.[40–45] In one of the

studies of open decortication with prospective data and statistical evaluations, the reported 14.5% increase in vital capacity is compatible with our results of a 17.6% increase.[46]

The mean operation time for the thoracoscopic treatment of fibrinopurulent pleural empyema was reported to range from 82 to 119 min.[8,13] The operation time for VATD is somewhat longer, and it is also longer than that of the open method. This is the weak point of VATD at present. However, with experience the time differential is expected to decrease quickly. Our intraoperative blood loss was less than the reported 325 ml in VATS for fibrinopurulent empyema.[15] No shortened hospitalization using the VATS technique was seen in our cases, based on the reported mean hospitalization time of 6.7–12.3 days.[8,13,15] The reason for this may be partly due to the poor condition of our patients, who were not strong enough to undergo open decortication, and thus needed a longer time to recover after surgery. Therefore, the operability of these debilitated patients outweighs the previous two problems.

In conclusion, the treatment of late-stage empyema requires a case-by-case decision-making process. If the patient selection is suitable and the surgeons performing VATS have sufficient expertise and experience, then the VATD modality is considered to be an appropriate treatment method for patients with stage III empyema thoracis, especially in debilitated patients for whom open thoracotomy is not indicated. Finally, in the case of fibrothorax, thoracoscopic management is not indicated due to the existence of the VATS technique at present.

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