

# Adequate debridement and drainage of the mediastinum using open thoracotomy or video-assisted thoracoscopic surgery for Boerhaave's syndrome

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Received: 31 August 2010 / Accepted: 31 December 2010 / Published online: 27 February 2011  
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## Abstract

**Background** Boerhaave's syndrome has a high mortality rate (14–40%). Surgical treatment varies from a minimal approach consisting of adequate debridement with drainage of the mediastinum and pleural cavity to esophageal resection. This study compared the results between a previously preferred open minimal approach and a video-assisted thoracoscopic surgery (VATS) procedure currently considered the method of choice.

**Methods** In this study, 12 consecutive patients treated with a historical nonresectional drainage approach (1985–2001) were compared with 12 consecutive patients treated prospectively after the introduction of VATS during the period 2002–2009. Baseline characteristics were equally distributed between the two groups.

**Results** In the prospective group, 2 of the 12 patients had the VATS procedure converted to an open thoracotomy, and 2 additional patients were treated by open surgery. In the prospective group, 8 patients experienced postoperative complications compared with all 12 patients in the historical control group. Four patients (17%), two in each group, underwent reoperation. Six patients, three in each group, were readmitted to the hospital. The overall in-hospital mortality was 8% (1 patient in each group), which compares favorably with other reports (7–27%) based on drainage alone.

**Conclusions** Adequate surgical debridement with drainage of the mediastinum and pleural cavity resulted in a low mortality rate. The results for VATS in this relatively small series were comparable with those for an open thoracotomy.

**Keywords** Esophageal perforation · Esophagus · Thoracic surgery · Thoracotomy · Video-assisted

Spontaneous rupture of the esophagus, first described by Boerhaave in 1724 [1], is a life-threatening condition characterized by a disruption of the distal esophagus due to a barotrauma that results in contamination of the mediastinum and pleural cavity with gastric contents. Boerhaave's syndrome is rare, and the exact incidence is not known. Often, a significant delay occurs between perforation and treatment, leading to chemical and bacterial mediastinitis followed by sepsis and multiorgan failure.

Most studies describe a high mortality rate of 14% to 40% [2–6]. Surgical treatment still is controversial, ranging from a less invasive approach consisting of adequate debridement and drainage of the mediastinum and pleural cavity followed by continued postoperative rinsing to resection of the thoracic esophagus.

Since 1985, we have acquired a large experience with the drainage procedure, which is our preferred method [7]. Until 2001, we established drainage by mediastinal widening through an open thoracotomy. After the introduction of video-assisted thoracoscopic surgery (VATS), it was found theoretically that thoracotomy added significant surgical trauma and pain, likely impairing postoperative recovery. Therefore, when VATS emerged, we changed our already less aggressive nonresectional approach in 2002 to this less invasive technique. Since 2002, we have

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preferred VATS for treatment because it may reduce morbidity for these vulnerable patients.

In this study, we compared the early and late results of the nonresection drainage procedure between patients treated by VATS and a historical control group treated by thoracotomy.

## Materials and methods

### Patients

From January 2002 through October 2009, we prospectively treated 12 consecutive Boerhaave's syndrome patients with nonresection drainage using the VATS approach. All data were collected from the medical records according to the rules of our institutional ethics committee. Patient characteristics, pre- and intraoperative data, postoperative management, and outcome were retrospectively analyzed. This prospective group was compared with 12 patients from a previously described historical control group treated from 1985 through 2001 [7].

### Treatment strategy

The diagnosis was confirmed by chest X-ray, computed tomography (CT) of the thorax and abdomen, and occasionally, a contrast esophagographic examination. The X-rays and CT scans were evaluated for the presence of pneumomediastinum, pneumothorax, or leakage in the mediastinum or pleural cavity. Contrast studies may confirm extravasation outside the esophagus. Patients were promptly treated with broad-spectrum antibiotics, subsequently narrowed according to the results of cultures from collected mediastinal or pleural fluid obtained during puncture or surgery and from blood cultures.

During surgery, patients were intubated with a double-lumen tube for selective ventilation. Based on the perforation site and intrathoracic fluid collections, we decided to use either a left- or right-sided surgical approach. Because most patients presented with a distal rupture, the left surgical approach was commonly used. The surgical principles were more or less equal for the patients treated with thoracotomy or the VATS procedure.

After selective lung ventilation, the posterior mediastinum was opened, and a meticulous irrigation with evacuation of food debris and necrosis was accomplished. Occasionally, the rupture was sutured, but the esophagus was never resected or diverted. For continuous postoperative irrigation, an Axiom<sup>®</sup> suction drain (Sigma Medical, Apeldoorn, the Netherlands) was attached to the tip of a Foley catheter for irrigation at the perforation site in the mediastinum, and a thoracic chest tube was placed for

passive drainage. A thoracotomy usually was performed through an incision of the seventh intercostal space on the left or through the fifth intercostal space on the right.

For VATS, a total of four trocars were inserted. First, the 12-mm camera port was introduced in the seventh or eighth intercostal space at the midaxillary line. A 30° angled rigid endoscope was used. Another 12-mm port was introduced at the third or fourth intercostal space for the endoscopic retractor. Two 5-mm ports were placed more cranially, one at the midaxillary line in the fourth intercostal space and one in the subscapular area accommodating a blunt grasper and suction/irrigation device. Since 2002, a ruptured esophagus has been preferably treated by the VATS technique and converted to a thoracotomy in case of adhesions or poor visualization. All these operations were performed or supervised by a staff surgeon with experience in esophageal surgery.

Postoperatively, patients were stimulated to drink water in addition to the external irrigation process. Early enteral nutrition was started through a nasojejunal tube. The esophageal rupture was considered healed when leakage was neither found on contrast studies nor present in mediastinal drains after orally administered methylene blue dye. In case of conversion to an open procedure, a surgical jejunostomy was included. Postoperative complications, length of intensive care unit (ICU) and hospital stay, and time to esophageal healing were recorded.

### Statistical analysis

Data are presented as median and range. In case of categorical data, the number of patients are presented. Differences between categorical variables were tested with Fisher's exact test. The Mann–Whitney *U* test was performed to calculate differences in continuous variables.

## Results

### Patients and procedures

Patient characteristics are presented in Table 1. None of the 24 patients were treated by resection or cervical esophagostomy. No significant differences in demographic data were found between the two groups. Referrals from another hospital included 9 of the 12 patients in the prospective group and 5 of the 12 patients in the control group. As shown, some of the patients had a long delay between the start of symptoms and surgery. The apparent reasons for this delay were the diagnosis and referral of patients with Boerhaave's syndrome.

In the prospective group, 10 patients were treated by VATS. Two of these patients underwent conversion to a thoracotomy because of inadequate visualization. For

**Table 1** Patient characteristics and intraoperative data

Period	1987–2001	2002–2009	<i>p</i> Value
No. of patients	12	12	
Median age: years (range)	51 (27–70)	62 (45–70)	0.241
Males	7	11	0.417
Median time between start of symptoms and surgery: h (range)	72 (10–1344) <sup>a</sup>	44 (9–264)	0.426
No. of patients receiving surgery in <24 h	4 <sup>a</sup>	5	0.480
Intraoperative data			
Right sided perforations	5	5	
Left sided perforations	7	7	

The differences were not significant

<sup>a</sup> Data not available for 3 patients

another two patients, VATS was not performed as the primary treatment method. In one patient, the rupture was more caudal at the abdominal esophagus and amenable by laparotomy and transhiatal access to the posterior mediastinum. Chest tubes were inserted separately. The remaining patient was treated by a left thoracoabdominal approach because the operating surgeon did not have sufficient experience with the VATS technique.

Primary closure of the esophageal perforation was performed for two patients in the historical control group, both within 12 h after initial symptoms. It was successful for the one patient, but the other patient experienced osteomyelitis with fistula, leading to several reoperations.

In the historical control group, four patients were treated initially by conservative measures consisting of broad-spectrum antibiotics, cessation of oral intake, nasogastric aspiration for gastric decompression, and chest drainage of the pleural cavity. This treatment failed for all these patients after 3, 4, 6 and 57 days because of pleural empyema, and they subsequently underwent thoracotomy. Unfortunately, one of these patients died of sepsis.

Postoperative complications, reinterventions, and readmissions

Postoperative data are presented in Table 2. Table 3 presents postoperative complications and readmissions. Four patients underwent reoperation, two in each group. One of these patients in the prospective group had a relaparotomy because of leakage from the jejunostomy that was oversewn after performance of a new jejunostomy. For the remaining patient in this group, a right-sided VATS procedure was performed 11 days after an initial left-sided thoracotomy because of inadequate drainage. In the historical control group, one patient experienced a fistula with osteomyelitis of the rib. After debridement and fistulectomy had been performed, a costal resection with a latissimus dorsi reconstruction was needed. The remaining patient experienced pleural empyema followed by a rethoracotomy with chest drainage.

**Table 2** Postoperative data

Period	1987–2001	2002–2009	<i>p</i> Value
No. of patients	12	12	
Postoperative data: median (range)			
APACHE-II score <sup>a</sup>	NA	9 (3–16)	–
Days of mechanical ventilation	6 (0–12) <sup>b</sup>	8 (0–77)	0.219
Days of hemodynamic support <sup>c</sup>	NA	1 (0–23)	–
Days to spontaneous closure	21 (1–326)	30 (17–231)	0.197
ICU stay (days)	9 (1–26)	13 (0–78)	0.151
Hospital stay (days)	46 (9–165)	52 (22–121)	0.949

APACHE acute physiology and chronic health evaluation, NA not available

The differences were not significant. Data were not available for 3 patients in the historical control group

<sup>a</sup> APACHE-II [15]. For one patient of the prospective group, this was not available because the patient was not admitted to the intensive care unit (ICU)

<sup>b</sup> Data not available for 3 patients

<sup>c</sup> Number of days the patient needed hemodynamic support by nor-epinephrine or dopamine, for example

In the prospective group; 8 of the 12 patients experienced one or more complications. The complications resulted in death for one patient with a Karnofsky score of 50%, pneumonia for two ICU patients, readmission for one patient, and postoperative delirium for three patients. Pleural empyema occurred for three patients, followed by a re-VATS for one of the patients to drain the empyema. For two patients, CT-guided drainage could be performed. One patient had leakage of the surgical jejunostomy.

All patients in the historical group experienced one or more complications, including sepsis and death for one patient, pneumonia for three patients leading to ICU readmission for one patient, pleural empyema for one patient, postoperative delirium for five patients, peptic

**Table 3** Postoperative complications, reoperations, and readmissions

Period	1987–2001	2002–2009
No. of patients	12	12
Postoperative complications <sup>a</sup>		
Reoperation	2	2
Pleural empyema	1	3
Pneumonia	3	2
Delirium	5	3
Esophagus fistula	1	0
Others	3	1
Total patients with complications	12	8
Readmissions	3	3

<sup>a</sup> Data are presented as number of patients. Some patients experienced more than one complication

ulcer bleeding for one patient and esophageal fistula and renal failure for one patient.

Six patients were readmitted after discharge, three in each group. In the prospective group, two patients had fever and pleural empyema, and a CT-guided drainage was performed. The remaining patient had fever and an obstructed drain, which was changed. In the historical control group, one patient was readmitted four times for successful treatment of an esophagus fistula with osteomyelitis. One patient was readmitted with pneumonia, and antibiotic treatment was given. Another patient experienced pleural empyema followed by a successful reoperation.

In all the patients, the esophageal rupture healed with drainage only. One patient in the prospective group had active human immunodeficiency virus (HIV) (CD4  $0.73 \times 10^9/l$ , reference value 0.40–1.30 and CD8  $1.14 \times 10^9/l$ , reference value 0.20–0.70), and healing was accomplished after 33 weeks. For one patient with osteomyelitis in the historical group, the esophageal fistula closed spontaneously after 45 weeks.

#### Mortality and follow-up evaluation

The in-hospital mortality was 8% (2 patients). In the prospective group, one patient died of respiratory failure shortly after discharge from the ICU on postoperative day 39. She had a poor Karnofsky performance score [8] of less than 50% and a history of myocardial infarction, cerebrovascular disease, and diabetes mellitus. The remaining patient in the historical group died of septic shock 2 days after surgery when initial conservative treatment failed. Additionally, one patient in the prospective group died of a hepatocellular carcinoma during the follow-up period 29 months after discharge, and one patient in the historical group died of a lymphoma 15 years later. In the historical

control group, one patient experienced esophageal stricture, which was treated by several dilations. No other long-term complications were observed.

#### Discussion

This study shows that adequate surgical drainage of the mediastinum and pleural cavity is the main treatment for Boerhaave's syndrome. The relatively low in-hospital mortality of 8% compares favorably with the 14% to 40% mentioned in the literature [2–6]. Although the complication rate in this study still was relatively high, the results of VATS were comparable with those for open thoracotomy.

Treating patients with a Boerhaave's syndrome is commonly associated with a high complication rate. Often, there is delay in the diagnosis, so these patients frequently are in a septic condition at surgery. In our opinion, adequate surgical drainage with removal of food remnants and necrotic tissue from the mediastinum and pleural cavity is the mainstay of treatment. To minimize additional surgical trauma for these already critically ill patients, no attempt should be made either to suture the rupture or to resect the esophagus with cervical esophagostomy. After surgery, irrigation of the chest is initiated.

In the historical control group, we initiated conservative, nonoperative treatment by drainage of only the pleural cavity with a thoracic drain for three patients, but this strategy failed. One of these patients died of septic shock shortly after surgery.

Other authors also have described results for nonsurgical treatment of patients with Boerhaave's syndrome [3, 9]. The mortality rates in the two cited studies ranged from 7% to 27%. In the study by Vogel et al. [9], 3 of 13 patients treated conservatively by radiologic chest tube drainage underwent delayed surgical drainage.

We believe removal of food particles and debris is best performed by surgery at an early stage. To abandon surgical drainage and perform radiologic drainage is conceivable only for patients with iatrogenic perforation of the esophagus but no gross contamination of the mediastinum with large food particles. Generally, these circumstances are not present in Boerhaave's syndrome. Another option is to seal the perforation site with a covered metallic stent.

Siersema et al. [10] described five patients with Boerhaave's syndrome treated by esophageal stenting and drainage of the mediastinum by chest tubes. One of these patients had a very complicated course, with four reoperations, resulting in esophageal resection with colon interposition [10].

We think that stenting of the esophagus alone could be a good option for iatrogenic perforation. However, in case of a contaminated mediastinum and pleural cavity with food

particles as in Boerhaave patients, we recommend combining stenting with an adequate surgical drainage of the mediastinum and pleural cavity.

Many authors advise suturing the esophagus in case of early surgery (<12–48 h). It should be kept in mind that this approach has a relatively high chance of suture line leakage because of the already necrotic region at the perforation edges. In case of delayed surgery, other authors advise complete resection of the esophagus with esophagostomy, gastrostomy, and delayed reconstruction [5, 6, 11, 12].

In our opinion, esophageal resection for these critically ill patients increases the surgical trauma and subsequent inflammatory response, leading to more short- and long-term complications. Furthermore, the additional delayed nonphysiologic reconstructive surgery certainly is not a minor procedure and could have an adverse effect on the daily life of these patients.

Our experience with VATS for adequate surgical debridement and drainage of the mediastinum shows that this approach is effective by minimizing additional surgical trauma in these already very ill patients. Previous studies investigating VATS included only patients with iatrogenic esophageal perforations [13, 14]. However, it is known that iatrogenic perforations generally have fewer complications than Boerhaave's syndrome because the mediastinum and pleural cavity are less severely contaminated.

Our study showed that VATS could be used as the first choice for Boerhaave's syndrome. It is a safe procedure with a complication rate and results the same as those for open surgery. Because this report describes our initial experience with VATS for Boerhaave's syndrome, the number of conversions to open surgery and the number of patients with Boerhaave's syndrome still treated with thoracotomy likely will decline with increasing experience, which may show the theoretical advantages of VATS over thoracotomy. To our knowledge, this is the first study to describe VATS treatment of patients with Boerhaave's syndrome.

Our study had its limitations. Because 13 of the patients were referred from another hospital to our center, a selection bias may have favored only relatively fit patients who could be transported. Furthermore, Boerhaave's syndrome is a relatively rare condition, so only a small number of patients could be included in our analysis. Still, the morbidity of the 24 patients treated with nonresectional debridement and drainage compares favorably with that of series including resection. The absence of significant differences between VATS and treatment by thoracotomy in our study may reflect the low number of patients included. The rarity of the pathology limits the number of patients that can be included in any prospective randomized study. Therefore comparison of VATS and thoracotomy is possible only against a historical cohort.

In conclusion, spontaneous esophageal perforation (Boerhaave's syndrome) can be managed adequately with a low mortality by debridement and drainage of the mediastinum and pleural cavity using thoracotomy or VATS. More prospective studies are warranted to emphasize the advantages of VATS in the treatment of this syndrome.

**Disclosures** Jan Willem Haveman, Vincent B. Nieuwenhuijs, Jeroen P. Muller Kobold, Gooitzen M. van Dam, John Th. Plukker, and H. Sijbrand Hofker have no conflicts of interest or financial ties to disclose.

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