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Original article

Sealing of esophageal perforation or ruptures with expandable metallic stents: A prospective controlled study on treatment efficacy and limitations

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SUMMARY. **Esophageal perforations are surgical emergencies with high mortality rates. A variety of treatment strategies have been advocated. No single strategy has however, been fully applicable to deal with most situations. The aim of this study was to investigate if treatment with covered expandable metallic stents could offer a feasible option for the management of a leaking esophagus regardless of cause. Twenty-two consecutive patients with perforation or leakage from the intrathoracic esophagus were endoscopically treated with placement of a covered expandable metallic stent. Nine patients had esophageal cancer and 13 had benign underlying disease of whom two had a leakage from a surgical anastomosis. The leakage could be sealed in all but one patient. This patient died after an open esophageal diversion procedure. Twelve patients had an uneventful recovery, whereas three patients needed percutanous drainage of abscesses and one drainage of the pleural cavity through a small thoracotomy. One patient required a conventional thoracotomy to drain the mediastinum. In total five (23%) patients died from the perforation within 30 days. Two of the deaths were unrelated and three (14%) related to the perforation. In patients with benign disease stents were removed or replaced after 3 weeks. In total 17 stents were successfully removed. Leakage from a damage esophagus can be effectively covered by expandable metallic stents seemingly regardless of the underlying cause and is likely to offer a good chance of survival even in severely ill patients.**

KEY WORDS: **device removal, endoscopy, esophageal perforation, mediastinitis, stents.**

INTRODUCTION

Penetrating damage to the wall of the intrathoracic esophagus is a life-threatening condition. A number of factors have been defined that add to the subsequent risk profile, although the time from infliction of the esophagus until effective therapy is started is of paramount importance.[1–3] Traditionally, operative intervention has taken a central role in the recommended treatment strategy, where the magnitude of relevant procedures is determined by the severity of the clinical situation. Two commonly used surgical strategies for treatment of transmural intrathoracic esophageal perforations are primary repair with or without reinforcement and an esophageal diversion. Both these strategies include major surgery with thoracotomy which may be hazardous to perform in elderly patients and patients with concomitant diseases. Surgical management is associated with a complicated prolonged clinical course even in a situation when an instrumental perforation has been recognized and treated promptly.[4–7]

During recent years a new and minimally invasive therapeutic concept has been introduced, that is endoscopic placement of covered self-expandable metallic stents (SEMS) to bridge and seal the damage. We and others have presented studies demonstrating the feasibility of this treatment concept.[8–13] However, most of these studies are not consecutive and include only a small number of selected perforations which can influence the reported success rate.

Many important clinical issues remain to be further elucidated, to determine the role, the usefulness and limitations of this endoscopic treatment strategy for such a life-threatening condition. In this prospective case study we present the clinical outcome of treatment with covered SEMS in a consecutive series, including all patients with esophageal perforations regardless of cause.

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MATERIAL AND METHODS

During the period January 1998 to September 2004 all patients with esophageal perforation or rupture ($n = 22$) referred to our institution were treated with a covered SEMS (Ultraflex™, Boston Scientific™). All patients had transmural perforation of the esophagus. The perforation was diagnosed either at the time of injury with the unmistakable endoscopic view of mediastinal structures or pleural cavity or through leakage of contrast medium outside the esophagus through CT scan or by a conventional esophageal contrast swallowing study. All cases where the perforation was diagnosed endoscopically at the time of perforation had mediastinal air or pneumothorax on a subsequent chest X-ray. The perforation was contained within the mediastinum in 14 patients and eight had communication to the pleural cavity. Eleven patients (50%) had damage located in the lower third and 11 (50%) in the mid-esophagus.

Immediately following establishment of the diagnosis a covered SEMS was endoscopically inserted with the aim of covering at least 3 cm of native esophagus oral to the perforation. During the first half of the study period all patients received stents with the same diameter (23 mm proximal and 17 mm shaft). Due to problems with stent migration, patients without anatomical narrowing of the esophagus received a stent with an upper diameter of 28 mm and 23 mm shaft during the second half of the study period. The deployment of the device was performed under flouroscopic and/or endoscopic guidance. A guidewire (Jagwire™ Boston Scientific™) was passed through the area of the damaged organ into the stomach. The endoscope was retrieved and the stent was passed over the guidewire, positioned and released. Finally, a proper placement was confirmed endoscopically. In cases with concomitant pleural effusions a separate 24 Fr pleural drainage tube was inserted.

All patients received broad spectrum antibiotics parenterally and oral intake was allowed as soon as the patency of the stent was confirmed by a CT or esophageal swallowing study with water-soluble contrast medium. Infectious complications such as pleural empyema or mediastinal abscesses was treated with percutaneous ultrasound-guided puncture and drainage, or if this was not successful, an open surgical drainage procedure was performed.

Table 1 Patient characteristics and main outcome

Age (years) Average/median (min-max)	68/70 (35–88)
Gender	
Male	14 (64%)
Female	8 (36%)
Time from perforation to diagnosis	
< 24 h	11 (50%)
< 24 h	11 (50%)
Location of perforation	
Mid third	11 (50%)
Lower third	11 (50%)
Mortality	
Due to perforation	3 (14%)
30 day mortality	5 (23%)
Infectious complications	5 (23%)

Median age was 70 years (35–88) and time from perforation to diagnosis was < 24 hours in 11 cases (50%) and five of these were treated immediately at the time of an instrumental perforation. Eleven cases (50%) were treated > 24 hours after the perforation (Table 1). Fifteen patients (68%) had an ASA score of tree or four.[14]

Thirteen patients had a benign underlying disease including two patients with anastomotic leakage after curative esophageal resection reconstructed with an intrathoracic anastomosis of a gastric tube. Nine patients had a malignant stricture (Table 2).

The perforations were iatrogenic in 14 cases of whom two occurred after retrieval of a foreign body by use of rigid esophagoscopy, one after a transesophageal cardiac ultrasound examination, two anastomotic leakages after surgical resections and nine after dilatation alone. Three patients had spontaneous ruptures and one of those occurred after vomiting (Boerhaave). Five patients perforated after ingestion of foreign bodies (Table 2).

In cases of benign underlying disease the SEMS was removed endoscopically after approximately 3 weeks. The upper edge of the stent was then caught with an endoscopic foreign body grasper, and the stent was subsequently retrieved under flouroscopic guidance. If endoscopic and/or radiological signs of remaining leakage were revealed, another SEMS was inserted. When needed the procedure was repeated until complete healing of the defect had been achieved.

The perforation was defined as sealed if there was no leakage of oral contrast medium outside the esophageal wall on a subsequent CT scan or an

Table 2 Underlying disease and causative factors

	Malignant	Anastomotic leakage	Benign	Total
Iatrogenic	7 (31.8%)	2 (9.1%)	5 (22.7%)	14 (63.6%)
Spontanious	2 (9.1%)	–	1 (4.5%)	3 (13.6%)
Foreign body	–	–	5 (22.7%)	5 (22.7%)
Total	9 (40.9%)	2 (9.1%)	11 (50%)	22

esophageal swallowing study following the stenting procedure. The postoperative course was classified as 'uneventful' if no complications were noted.

RESULTS

A covered stent could be properly placed covering the site of the perforation in all cases. Stent placement could be achieved by an endoscopic procedure alone in all but one case (95%) where a laparotomy and a small gastrotomy had to be carried out and a guidewire passed orally to pass the site of perforation before the stenting procedure could be performed. The perforation was successfully sealed in all but one patient (95%). This 80-year-old patient had a large defect engaging more than half the circumference of the the distal esophagus secondary to a laparoscopic operation for an incarcerated paraesophageal hernia. A covered stent was placed and the leakage decreased but was not completely controlled. A salvage esophagectomy and proximal esophageal diversion was performed 4 weeks later, whereafter the patient succumbed 10 days later due to multiorgan failure.

Twelve patients experienced an uneventful postprocedural course without complications and oral intake was resumed within a few days and the patients were discharged without further procedures with a median hospital stay of 10.5 days (4–25). Two of these patients were submitted to later resection of an underlying malignant disease. In eight of the 12 cases the diagnosis was established within 24 hours and four of them were stented immediately at the time of instrumental perforation. Among the 11 patients with a history of < 24 hours between perforation and diagnosis we experienced three infectious complications but no fatal outcome (Table 3).

Five patients recovered from the perforation but required additional procedures due to infectious complications and had their subsequent courses complicated by mediastinal abscesses and/or pleural empyema not responding to antibiotics. The median hospital stay in these five patients were 35 days (21–97). Three of them were treated with percutaneous drainage and one with open drainage of the pleural cavity through a small thoracotomy. Three weeks after successful sealing of a mid-esophageal perforation one patient developed a mediastinal abscess which was drained through a right-sided thoracotomy.

Two of these five patients with infectious complications had a diagnostic delay extending more than 24 hours and one was diagnosed and treated immediately within the same procedure as the perforation occurred.

Five patients (23%) died within 30 days after the procedure or during the same hospital stay as the initial stent placement. Two of these deaths were judged not to be procedure-related. One was a 35-year-old woman with a spinocellar esophageal carcinoma, with pulmonary and bone metastasis and a spontaneous tumor perforation, who had recovered well by stent insertion but died during induction of chemotherapy three weeks after the stenting procedure. A CT scan prior to chemotherapy revealed no signs of leakage or infectious complication. The other patient was a 40-year-old woman with Marfan's syndrome with an infected vascular graft in the ascending aorta, whose esophagus was severely damaged during a transesophageal echocardiography examination. The perforation was successfully covered but the patient died 3 weeks later due to bleeding from the vascular graft.

Three patients (14%) succumbed due to causes probably related to the perforation. In addition to the case where the perforation was not sealed, an 85-year-old patient died from multiorgan failure after leakage from an esophagogastric anastomosis which was successfully sealed by a covered SEMS. The third lethal case was a 76-year-old woman with congestive heart failure and medication with corticosteroid due to reumatological arthritis, who had a spontaneous rupture of her esophagus. She did not recover and died 25 days after stent placement although no leakage or infectious complication could

Table 3 Relation between complication rates and disease and therapy specific factors

	Uneventful recovery $n = 12$	Infectious complications $n = 5$	Dead within 30 days $n = 5$
Time perforation-diagnosis			
< 24 h	8	3	0
> 24 h	4	2	5
Reason of perforation			
Iatrogenic	8	3	3
Spontanious	1	0	2
Foreign body	3	2	0
Underlying esophageal disorder			
Benign	5	3	3
Malignant	6	2	1
Anastomotic leakage	1	0	1

be found. None of these patients were judged to be fit for thoracotomy. The relation between outcome and disease and therapy specific factors are given in Table 3.

Stent dislocation was noted in three patients without an anatomical narrowing of the esophageal lumen and who received stents with a proximal diameter of 23 mm. The index stent was removed and replaced with a stent with a wider proximal diameter (28 mm). No dislocation was noted when stents with an upper diameter of 28 mm were used. Nine patients with benign disease were treated with temporary stents. The stents were successfully removed and when needed a new temporary stent was inserted. In total 17 stents, including the dislocated stents, were successfully retrieved.

DISCUSSION

Covered SEMS have proven their pivotal role in the management of fistulas between the esophagus and the respiratory tree.[11,15] Moreover the efficacy by which these devices can seal defects in the esophageal wall has also been documented through an expanding number of studies reflecting selected experiences from single institutions.[9,10] However, a key issue remains to be addressed and that is to define the limitations of a SEMS-based strategy in the management of significant damage to the esophagus. In this context the impact of factors such as time to diagnosis, comorbidity, underlying disease, the size of the defect and the cause of damage have to be elucidated during the subsequent clinical course. This is a very challenging task depending on the severity of the condition. We considered it ethically and professionally justified to apply this minimal invasive strategy, where perforation-rupture of the intrathoracic esophagus is treated with a covered SEMS, on all index cases as the initial treatment step. This therapeutic concept was maintained as long as it was considered justified on purely clinical grounds. Consequently we thereby approached all secondary infectious manifestations primarily through a conservative percutaneuos drainage-based management strategy.

We deliberately choose the intrathoracic esophagus as the target area since penetrating damage to this part of the organ exposes the patient to the most paramount risks of severe complications and even lethal outcome.[16,17] Furthermore, no single first-line treatment has been defined for patients with intrathoracic esophageal perforations.[1,18] This is in contrast to abdominal or cervical perforations where suturing of the defect and subsequently creating a fundoplication and conservative treatment, respectively, have been recommended as first-line treatment.[17,19,20] Therefore, we only included patients who presented with signs of perforation-rupture of the intrathoracic portion of the esophagus.

The present series compares well with what has been reported in the literature concerning pathogenesis behind the damage and treatment delay.[16,21] Interestingly enough the recorded overall mortality was at the expected level, but probably compares well, taking in to account the age and concomitant diseases of the patients and the fact that this is a consecutive series. However, a unique finding of our series is the markedly short hospital stay that we encountered in those with an uneventful recovery. This observation is in accordance with other recent selected reports where expandable stents have been used[9] and it is highly unlikely that a strictly conservative treatment strategy could offer a similar benign course.[18]

Another very important finding of our study was that essentially all defects could be effectively sealed by the stent irrespective of the cause of the damage and underlying esophageal disorder. The subsequent therapeutic interventions should be mandated by the clinical response to this minimal invasive strategy to control leakage. Additional measures such as pleural drainage have to be taken, in order to control contamination and pus accumulation. Sometimes a limited thoracotomy may be indicated to control the empyema.

Time from perforation to diagnosis has been considered to be of crucial importance for the outcome after esophageal perforation – ruptures.[1,16] In this study we noted no fatal outcome among the patients diagnosed within 24 hours and only one infectious complication among the patients where the perforation was diagnosed and treated immediately within the same endoscopical procedure. It is our opinion that patients diagnosed with perforation-ruptures of the esophagus should receive a covered SEMS as soon as possible, irrespective of the hour of the day.

Other factors that have been associated with poor outcome after oesophageal perforations is malignant disease and comorbidity.[1,16] In this study we noted no increased mortality or complication rate among patients with a malignant disease compared to those with benign disease. All patients that died in this study were old and/or had concomitant diseases and most surgeons probably would have hesitated to perform open surgery including thoracotomy on these cases. On the other hand this SEMS-based treatment strategy offered survival to several other old patients and patients with concomitant diseases similar to the comorbidity of those who died.

In this study we have not been able to measure the size of the perforation. One perforation though, was strikingly larger than the other and engaged half of the circumference of the esophageal wall. This perforation could not be sealed by the stent. It is hard to draw conclusions from this single case

but it seem reasonable to assume that such large defects are not suitable for this strategy and that a more aggressive surgical approach should be preferred in these situations.

With growing experience of the use of SEMS other aspects of clinical practical value have emerged. One is that in case of benign underlying cause it is common that a concomitant lumen-narrowing is lacking. In those instances a stent with a proximal diameter of 28 mm should be preferred to prevent stent migration. In cases with a benign underlying cause of perforation, many clinicians have been reluctant to use SEMS due to late adverse effects of the stent and subsequent failure to remove the device.[22–24] However it has become clear that currently inserted stents can be removed and replaced to effectively support the healing process of the lesion of the esophageal defect. We have found that a 3-week period represented a practical time limit whereafter the stents which we used (Ultraflex™) could be difficult to expel. It is possible that a different treatment schedule should be applied when using other stent designs.[25,26] An interesting area for future exploration in this setting is the use of expandable stents made of absorbable materials.

In conclusion, there are two key findings of the present study. The first is that all patients with rupture of the intrathoracic esophagus can be offered an effective treatment of the perforation with covered SEMS, this regardless of age, general condition, concomitant diseases, diagnostic delay and cause of perforation or rupture. In patients with large defects of the esophageal wall however, other surgical strategies might be considered. Secondary infectious complications will occur with the stent strategy and these must be treated according to normal surgical principles by percutanious, or even sometimes by open, surgical drainage. The second key finding is that when lifelong treatment with SEMS is not desired these devices can be retrieved and if needed replaced within 3 weeks after insertion.

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