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Operative and Nonoperative Management of Esophageal Perforations

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During a 21-year period, 72 patients were treated for esophageal perforations; the diagnosis was made only at postmortem examination in 13 other patients. Fifty-eight of 85 patients (68%) sustained iatrogenic perforations, 11 patients (13%) had "spontaneous" perforation, nine patients (11%) had foreign body related perforation, and seven patients (8%) had perforation caused by external trauma. Eleven cervical perforations, contained between the cervical paravertebral structures, plus eight thoracic perforations, contained in the mediastinum, were treated with antibiotics, intravenous hydration, and nasogastric drainage. The mortality rate after this nonoperative approach was 16% (3/19 patients). Indications for operative treatment in 53 patients were hydropneumothorax with mediastinal emphysema, sepsis, shock and respiratory failure. The operative mortality rate in these instances was 17% (9/53 patients). Six of the nine patients who died had been operated on more than 24 hours after the onset of symptoms. For cervical perforations the best results were obtained by drainage plus repair of the perforation (mortality rate: 0%; 0/10 patients) and for thoracic perforations by suturing supported by a pedicled pleural flap (mortality rate: 11%; 1/9 patients). Simple drainage of thoracic perforation was followed by a mortality rate of 43% (3/7 patients).

DESPITE THE SUPPORT PROVIDED by adjuncts such as mechanical ventilation, hemodynamic monitoring, total parenteral nutrition, and effective antibiotics, esophageal perforations continue to be associated with a mortality rate of more than 20%.[1,2]

In an effort to refine and improve treatment, we asked the following questions while reviewing our experience with esophageal perforation over the past two decades:

1) What criteria should be used to decide which patients would be operated upon?

2) Does the site of perforation along the cervical or thoracic esophagus necessarily dictate treatment:[3] that is, initial nonoperative treatment followed by drainage for cervical perforation and prompt surgical treatment for all thoracic perforations?

3) Are delays before surgical treatment responsible for the high postoperative mortality rate?

4) Does the cause of the perforation influence the therapeutic approach and its result?

5) When the surgical approach is elected for thoracic perforation, is one technique superior to the others?

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Materials and Methods

Patients

Eighty-five perforations of the esophagus were diagnosed in 21 years from January 1, 1958, through December 31, 1978. Esophageal perforations included in the study were related to foreign bodies, external trauma, endoscopic instrumentation, paraesophageal surgical procedures, and those presenting themselves as so-called "spontaneous" rupture of the esophagus. Acquired tracheoesophageal fistulas due to carcinoma and to erosion by endotracheal cuffs were excluded because they represent different diagnostic and therapeutic problems. Cases of anastomotic leakage after elective esophageal surgery were also excluded.

Statistical Techniques

Ordinary parametric techniques were employed to analyze continuous data. When indicated, nonparametric methods for unpaired measurements (Mann-Whitney Test) were used. Comparison of discrete data was done by chi-square or Fischer's exact tests. Survival curves were constructed according to Cutler and Ederer's life table method.[4] Mean values are reported plus or minus the standard error of the mean.

Results

Patients

Thirty-two (38%) cases of esophageal perforation were recorded from 1958 through 1969 and 53

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TABLE 1. *Causes and Locations of Esophageal Perforations*

Causes	Location: Cervical	Location: Thoracic	Location: Abdominal	No. (%)
Iatrogenic perforation				
esophagoscopy	6	2	—	8 (9)
dilatation	2	19	1	22 (26)
Blakemore or Linton tubes	—	9	—	9 (11)
endotracheal tubes	7	—	—	7 (8)
paraesophageal surgery	—	5	5	10 (12)
Levin or Celestin tubes	—	2	—	2 (2)
"Spontaneous" perforation	—	11	—	11 (13)
Foreign body	5	4	—	9 (11)
External trauma	4	3	—	7 (8)
Total	24	55	6	85 (100%)

(62%) cases from 1970 through 1978. Annual fluctuations in the number of cases were random, as assessed by the statistical technique of "runs."

The sex distribution was similar: 41 women (48%) and 44 men (52%). The age-by-sex distribution was the same (57 ± 3.8 years for women, 50 ± 3.4 years for men). The average length of hospitalization for the 85 patients was 25 days (range: 3–119 days).

Etiology

Iatrogenic perforation. Fifty-eight patients (68%) had an iatrogenic perforation of the esophagus (Table 1). The 30 cases that occurred during esophagoscopy or esophageal dilatation for stricture correspond to a 0.15% incidence of perforation during elective esophageal instrumentation over the past 20 years (mortality rate: 0.02%). Factors predisposing to perforation in these 30 patients as well as those predisposing to other types of iatrogenic perforations are summarized in Tables 2 and 3.

TABLE 2. *Factors Predisposing to Iatrogenic Perforation during Elective Instrumentation*

Factors Predisposing to Perforation	Instrumentation: Esophagoscopy (Number)	Instrumentation: Dilatation (Number)
Hiatal hernia and stricture	3	13
Postoperative stenosis	1	7*
Esophageal cancer	2	—
Esophageal varices	1	—
Achalasia	—	2
No predisposing factors	1	—
Total	8	22

* Three esophagogastric anastomoses after cancer resection. Two previous repair of tracheoesophageal fistula (Type A). Two postlaryngectomy followed by radiotherapy.

TABLE 3. *Iatrogenic Perforation of the Esophagus Not Related to Elective Esophageal Instrumentation*

Causes	Number	Factors Predisposing to Perforation	Number
Blakemore or Linton tubes	9	Esophageal varices	9
Endotracheal tubes	7	Goiter or cervical arthrosis	1
		Felty's syndrome	1
Paraesophageal surgery			
hiatal hernia repair	3	Hiatal hernia	3
vagotomy	6	Hiatal hernia	1
thoracic aneurysm repair	1	—	
Levin or Celestin tubes	2	Collagen disease of pharynx	1
		Radiotherapy for esophageal cancer	1
Total	28		17

Spontaneous perforation or Boerhaave's syndrome. The adjective "spontaneous" does not imply the absence of predisposing factors or of underlying esophageal disease;[3,5] rather this term means perforation not resulting from iatrogenic trauma, foreign body, or direct external trauma. Eight perforations were due to forceful vomiting; one patient had a hiatal hernia, one had a Schatzki ring, and another had achalasia. One perforation was related to a prolonged episode of emesis after head trauma. Two perforations of the distal esophagus were diagnosed only at postmortem examination in patients with metastases from adenocarcinoma of the lung; no episodes of vomiting were recorded.

Perforation caused by foreign body. Perforation caused by a foreign body occurred in eight adult patients and one two years old child.

External trauma. Two cases of perforation of the cervical esophagus were the result of an open trauma related to a motor vehicle accident. Another patient had a rupture of the distal thoracic esophagus from blunt abdominal trauma clinically mimicking spontaneous rupture. One patient sustained pneumatic rupture of the distal esophagus after having been struck in the face and the upper chest by a blast of nitrogen escaping from a high pressure cylinder. Three other perforations were caused by gunshot and stab wounds.

Symptoms and Signs

Most patients (97%) experienced pain. Acute onset of the pain was the rule in only 30%, however. The

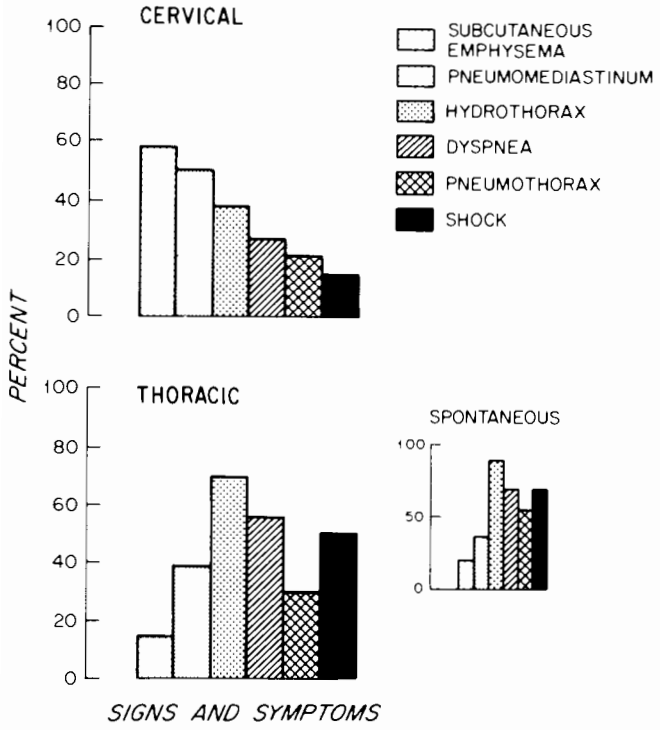

FIG. 1. Distribution of signs and symptoms after perforation of the cervical and thoracic esophagus. Inset: distribution after "spontaneous" thoracic perforation.

distribution of signs and symptoms was different between the groups with cervical perforation and with thoracic perforation (Fig. 1). The subgroup of "spontaneous" perforation of the distal thoracic esophagus is wholly representative of thoracic perforation as it shows the same pattern of distribution of signs and symptoms (Fig. 1 inset). Mackler's[6] triad of vomiting, pain in the lower thorax, and subcutaneous emphysema was recorded in only two of 11 patients with spontaneous rupture of the esophagus.

Fever and leukocytosis with increase in the number of immature polymorphonuclear cells were present in more than 90% of patients.

Routine upright chest roentgenograms revealed that 59% of the patients had pleural effusion, 26% a pneumothorax, and 41% a pneumomediastinum. The presence of subdiaphragmatic air was seen in only one case of intra-abdominal perforation of the distal esophagus following bougienage for benign stricture of the esophagus. Extravasation of contrast material was obvious in 40 (87%) of 46 esophagograms performed. False negative esophagograms occurred in 11% of the thoracic perforations and in 18% of the cervical perforations ($p = 0.37$).

Diagnosis

The diagnosis of esophageal perforation was usually suspected on the basis of presenting signs and symptoms—the suspicion being corroborated by the fact that the signs and symptoms followed clinical events such as esophagogastric instrumentation or insertion of tubes.

Roentgenographic examination of the chest and esophagogram were the most valuable diagnostic studies. A roentgenogram of the cervical spine was helpful in some cases suspected of having perforation of the cervical esophagus. Air was often evident in the prevertebral tissue planes. A widened retropharyngeal space seen on a lateral cervical roentgenogram, due to an abscess, gave a definitive answer in later cases. The disappearance of normal cervical spinal lordosis and appreciable anterior displacement of the esophagus and the upper airways were other useful diagnostic elements.

The diagnosis of esophageal perforation was made in 13 cases (15%) only after death. Causes of perforation, associated conditions, location, and factors predisposing to perforation in these 13 cases are given in Table 4.

Treatment

Nonoperative treatment. This was elected in 19 (26%) of the 72 patients in whom the diagnosis of esophageal perforation was correctly made. This ap-

TABLE 4. *Esophageal Perforation Diagnosed Only at Postmortem Examination*

Causes of Perforation	Location	Number	Associated Conditions	Number
Iatrogenic				
Blakemore or Linton tubes	Thoracic	6	Esophageal varices	6
Endotracheal tubes	Cervical	3	—	—
Paraesophageal surgery	Thoracic	1	Thoracic aneurysm	1
"Spontaneous"	Thoracic	2	Cerebral metastases from lung adenocarcinoma	2
External trauma	Thoracic	1	Multiple thoracic injuries related to gunshot	1
Total		13		10

TABLE 5. *Treatment of 72 Cases of Esophageal Perforations*

Type of Treatment	Number of Patients	Mortality Rate	
		Number	Per Cent
Cervical perforations			
nonoperative treatment	11	2	18
drainage	4	—	—
suture repair	6	—	—
Thoracic perforations			
nonoperative treatment	8	1	12.5
drainage	7	3	43
suture repair	10	2	20
suture and pleural flap	9	1	11
esophagectomy	8	1	12.5
exclusion-diversion	3	1	33
Abdominal perforations			
drainage	1	—	0
suture repair	4	1	25
Thal gastroplasty	1	—	0
Total	72	12	16.6

proach included use of antibiotics, intravenous hydration, and nasogastric suction. Two patients were also placed on total parenteral nutrition for 11 and 20 days.

Three patients died. One was a cirrhotic patient who had aspiration pneumonia and bled from esophageal varices; his iatrogenic cervical perforation was caused by esophagoscopy. The second had acute respiratory distress caused by a necrotic epiglottitis requiring emergency tracheal intubation; emergency intubation was the cause of cervical esophageal perforation. The third patient sustained perforation of the distal thoracic esophagus during esophagoscopy. He had refused for years to consider esophageal surgery for treatment of a Zenker's diverticulum and a esophageal stricture related to a Barrett's esophagus.

The sixteen patients (nine with cervical perforation and seven with thoracic perforation) who survived had minimal symptoms at the time of the diagnosis. Furthermore, they did not manifest any signs of clinical sepsis. A Gastrografin swallow performed in 14 of them (87%) demonstrated extravasation of the contrast material in the neck in seven patients (50%), and into the mediastinum in seven other patients. However, the esophageal perforations were contained in the mediastinum or between the cervical paravertebral structures. In no instance did the perforation communicate with the pleural space.

Modes of surgical treatment. Four modes of surgical treatment were used: drainage alone, suture repair of the perforation (supported or not by local tissue flap), early esophagectomy, and esophageal exclusion (Table 5).

Drainage of the neck and the upper mediastinum in four cases of cervical perforation was done by placement of Penrose or Jackson-Pratt drains through an incision anterior to the sternocleidomastoid muscle. Seven thoracic perforations were treated by drainage: closed thoracostomy in four cases, and open drainage through a thoracotomy incision in three other cases. Three patients (43%) with iatrogenic perforations (bougienage, Celestin tube, Levin tube) died after being treated by closed thoracostomy. One patient with intra-abdominal perforation of the distal esophagus during vagotomy survived after surgical drainage of the upper abdomen 72 hours after the initial operation.

Primary suture repair of the perforation (generally in two layers) was done in six cases of cervical perforations. There were no deaths. Ten patients with thoracic perforations were also treated with primary suture repair of the perforations (six iatrogenic perforations, two Boerhaave's syndromes and two after swallowing of a foreign body). Two patients (20%) died who had sustained perforation of the esophagus by a Sengstaken-Blakemore tube. These two patients, as well as two who survived, had a persistent esophageal leak after repair of the perforation.

Four patients with perforations of the abdominal esophagus (three after vagotomy and one after transabdominal hiatal hernia repair) were also treated by primary suture repair. One of these four patients treated more than 24 hours after vagotomy died with persistent esophageal leak.

Repeated leakage occurred in a total of five out of 20 patients (25%) treated by suture-repair of the esophageal perforation.

Primary suture of the perforation followed by turning a flap of pleura onto the sutured perforation or wrapping a flap around the esophagus over the repair[7] was performed in nine patients (three iatrogenic perforations, four Boerhaave's syndromes and two perforations caused by foreign body). Because of delayed diagnosis, six patients were treated more than 24 hours after perforation. Only one patient (with Boerhaave's syndrome) died.

Early esophagectomy was performed in eight patients with instrumental perforations. Re-establishment of gastrointestinal continuity was performed by a left colon bypass in three cases, esophagogastrostomy in four cases and esophageal end-to-end anastomosis in one pediatric patient, operated on previously for correction of a congenital tracheoesophageal fistual (Type A). In these eight patients, the presence of a badly diseased esophagus (caustic burn with stricture, severe stricture related to hiatal hernia with reflux, adenocarcinoma of the lower esophagus, previous repair of a congenital tracheoesophageal fistula) made more conservative techniques of treatment seem un-

wise.[8] One patient (12.5%), with adenocarcinoma of the esophagus and metastases in the liver, died postoperatively.

Exclusion-diversion of the thoracic esophagus was performed in one patient with Boerhaave's syndrome, one with perforation related to a Sengstaken-Blakemore tube, and one with perforation caused by a nitrogen blast escaping from a high pressure cylinder. At the initial thoracotomy, performed, respectively, more than 24, 72 and 24 hours after the accident, the esophageal perforation was sutured, and mediastinal and pleural drainage was instituted. A ligature was also placed on the esophagus above the cardia and diversion of the esophagus was accomplished by cervical esophagostomy.[9,10] Staged repair was required later for reestablishment of gastrointestinal continuity (by colon bypass in two cases and esophagogastrostomy in one other case). One patient (33%) with Boerhaave's syndrome died.

A Thal[11] gastroplasty was performed in one patient with perforation of the abdominal portion of the distal esophagus during transabdominal vagotomy.

Factors Correlated with Mortality rate

The overall mortality rate in this group of 85 esophageal perforations was 29% (25 patients). Thirteen (52%) of these 25 patients had the diagnosis of esophageal perforation made after death. Twelve (16.6%) of the 72 patients correctly diagnosed as esophageal perforation died during their hospital stay. This is, hence, the true mortality rate figure for treatment of esophageal perforation in this collection of cases.

The mortality rate related to nonoperative treatment was 16% (3/19 patients) versus 17% (9/53 patients) for surgical treatment. However, the mortality rate related to operative treatment fluctuated from 0 to 43% according to the type of approach and the location of the perforation (Table 5). Furthermore, the cause of perforation divided the results of treatment between iatrogenic perforation (21%; 10/48 patients) and spontaneous perforations (22%; 2/9 patients) versus perforation related to foreign body or external trauma (0%; 0/15 patients) ($p = 0.05$).

The presence of underlying esophageal disease also affected the outcome after treatment. Eleven (23%) of the 48 patients who had underlying esophageal diseases died, versus one (4%) of the 24 patients who had no esophageal disease before the accidental perforation occurred ($p = 0.04$).

Another potential factor that could have influenced the outcome of treatment was delay before operation. The length of delay was discernible in 49 (92%) of the 53 patients operated on. Six (28.6%) out of 21 patients operated on more than 24 hours after perforation died, but only three (11%) out of 28 patients operated on less than 24 hours after perforation ($p = 0.09$). To disclose a specific relation between delay before surgery and mortality rate, the cases were divided in subgroups according to the location of the perforation, the cause of the perforation, and the type of surgical treatment. Comparison of the mean lengths of delay before surgery in each subgroup was of limited value because the 95% confidence limits were wide. The only difference that reached a statistical level of significance was between the mean length of delay before surgery for thoracic iatrogenic perforation (22 hours) and for thoracic spontaneous perforation (44 hours) ($p < 0.05$, Mann-Whitney test). However, mortality rates were identical in both groups (6/28 patients, 21% versus 2/9 patients, 22%).

Since multiple factors are involved, the superiority of any form of surgical approach cannot be determined. Primary suture repair of the esophageal perforation plus pleural flap gave the best results in thoracic perforations requiring surgery. This technique was used in nine cases with only one death (11%) even though six (67%) of these nine patients had underlying esophageal diseases, and four of them (44%) with forceful postemetic perforations of the distal esophagus had massive suppurative mediastinitis and pleural soilage. Furthermore the average delay before surgery was long (mean: 30 hours; range: 5–72 hours; median: 24 hours).

Morbidity Rate

Thirty-nine (65%) of the 60 patients who left the hospital alive were followed for more than one year. The mean length of follow-up was 48 months (range: 13–156 months). Ten (26%) of the 39 patients required further treatment: repair of hiatal hernia, repeated esophageal dilatation of a stricture, or presented various disorders of esophageal motility. Nine (90%) of these ten patients had underlying esophageal disease before the acute accident of esophageal perforation.

Impact of New Therapeutic Techniques of the Management of Esophageal Perforation

Since 1970, total parenteral nutrition (TPN) has been used increasingly in the treatment of fistula of the gastrointestinal tract, including leaking esophageal anastomoses.[1,12,13] During the last decade, 19 patients received TPN as part of their medical or surgical management (42%; 19/45 patients). The average length of TPN course was 23 ± 3 days. Thirteen (68%) of

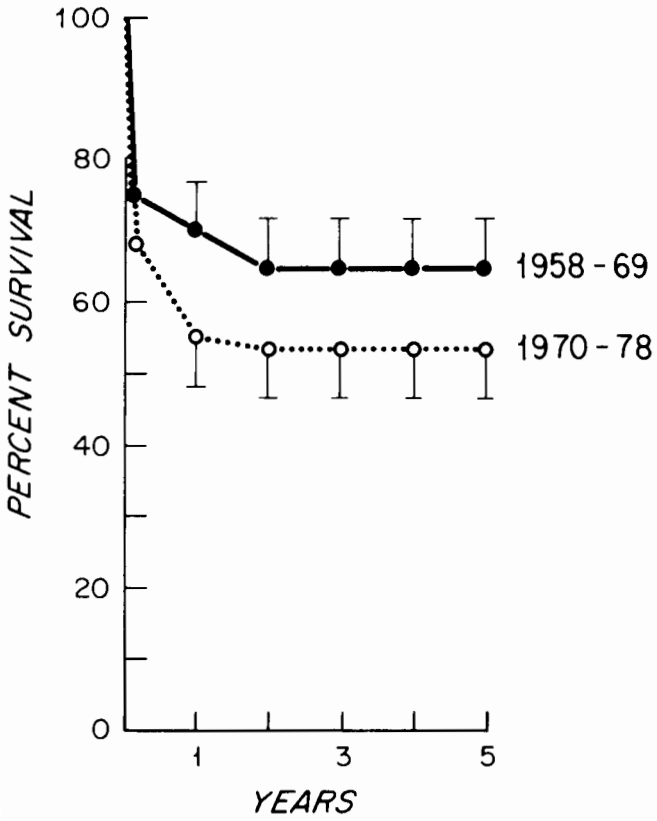

FIG. 2. Comparison of survival rates after esophageal perforation between the period 1958–1969 and the period 1970–1978. There is no difference between the curves.

these 19 patients also required mechanical ventilation with positive end-expiratory pressure for more than a week: six required a tracheostomy and two required hemodynamic monitoring with pulmonary artery catheter.

Comparison of mortality rates between the first decade (1958–1969) and the second decade (1970–1978) was made possible as both groups were matched for age, sex, delays before treatment, incidence of nonoperative and operative treatment, and incidence of thoracic perforations and postmortem diagnoses. The hospital mortality rate was 11% (3/27 patients) during the first decade and 20% (9/45 patients) ($p = 0.17$) during the second decade. The overall five year survival rates were similar (Fig. 2). The mortality rate was the same in the subgroup of 19 patients placed on TPN and in the subgroup of 26 patients treated during the second decade without TPN (26% and 15%) ($p > 0.1$).

Discussion

Often in analyses of the treatment of esophageal perforation, cases diagnosed postmortem have been excluded or deliberately ignored. The actual incidence rate and the true mortality rate were, therefore, underestimated. Better than any other consideration, the incidence of 15% of postmortem diagnoses in our patients emphasizes the fact that many errors are still being made in diagnosis of esophageal perforation.

What criteria Should be Used to Decide Which Patients Should be Operated on?

Indications for immediate operative treatment are presence of pneumothorax, mediastinal emphysema with pleural effusion, systemic sepsis, respiratory failure, and shock. One or several of those signs are frequently present after perforation of the thoracic portion of the esophagus, but are not rare after perforation of the cervical portion (Fig. 1).

Criteria for considering nonoperative management of esophageal perforation have been proposed[14]: a) the cavity around the "contained" perforation should be "well drained back into" the esophagus, b) minimal symptoms should be present, and c) there should be minimal evidence of clinical sepsis. However, in the early stage after perforation of the esophagus confirmed by extravasation of contrast material, it can be very difficult to determine whether the perforation will remain "contained" or will lead to mediastinitis and pleural contamination, with subsequent respiratory failure and septic shock.

Does the Site of Perforation Along the Cervical or Thoracic Esophagus Necessarily Dictate Treatment?

In perforation of cervical esophagus drainage and suture-repair were uniformly effective. The same treatment for thoracic perforations, however, was followed by 24% incidence of persistent esophageal leak and 30% death rate. More aggressive surgical approaches (suture plus pleural flap, esophagectomy, exclusion-diversion) for thoracic perforations were followed by no leak and 15% mortality rate ($p = 0.18$).

Are Delays Before Surgical Treatment Responsible for the High Postoperative Mortality Rate?

When diagnosis is made and surgical treatment indicated, the operation should be performed as soon as necessary resuscitation measures have been carried out. Our experience indicates that operations not performed until more that 24 hours after the onset of symptoms were followed by a mortality rate more than twice the mortality rate of operations performed less than 24 hours after perforation.

Does the Cause of the Perforation Influence the Therapeutic Approach and its Result?

Surgery is probably indicated in all cases of "spontaneous" forceful postemetic perforation because this type of perforation is associated with a very high incidence of respiratory failure and septic shock. It is risky to try controlling such an acute intrathroacic insult only by antibiotic therapy, fluid replacement, and nasogastric drainage. In this series, all cases of "spontaneous" perforations correctly diagnosed were operated on. A more lenient attitude was adopted for treatment of perforations related to other causes. One-third of these were treated nonoperatively and two-thirds operatively. Overall results were the same as in the group of "spontaneous" perforations.

When the Surgical Approach is Elected for Thoracic Perforation, is one Technique Superior to the Others?

Since leakage after suture repair is a frequent occurrence, the closure should be supported by a local tissue flap. Many types of flaps have been described, using pericardium,[15] diaphragm,[16] intercostal muscle[17,18] and stomach wall.[11] In this series the use of pleural flap was followed by a mortality rate of only 11% even though the technique was used in severe cases often delayed in diagnosis.

The presence of an obstructing lesion of the esophagus (*e.g.*, cancer, hiatal hernia with stricture, postoperative stenosis) requires relief of the obstruction for successful treatment of the perforation. In those situations, immediate esophagectomy resecting both the perforation and the original obstructing lesion is better than relying on drainage or repair alone.[8]

Exclusion-diversion of the esophagus,[9,10] when the diagnosis has been delayed or the primary treatment has failed, is sometimes the only way to control persistent mediastinal and pleural infection. Since such a radical approach, requiring multiple operations and prolonged period of hospitalization, was necessary in less than 5% of our patients, we can not comment on its relative efficacy.

Nutritional support provided since 1970 with total parenteral nutrition has not changed the prognosis of esophageal perforation. In fact, nutritional support via a feeding jejunostomy combined with use of drainage gastrostomy were already considered to be of major importance in one-third of the patients before the era of parenteral nutrition techniques. An enterostomy for feeding should be used for long-term support of these patients whenever possible.

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