



Review on Surgical Management of Esophageal Rupture Saudi Arabia, Review Article

**Hashem Bark Awadh Abood ^{a,b*≡}, Fatmah Khalid Aljudaibi ^c,
Zainab Ali Alarayedh ^{d^o}, D. Alazmi, Dalal Ali ^e, Y. Arishi, Dekra Yousef ^f,
A. Alomair, Abdulrahman Mohammed ^g, Zarbah, Jaber Mohammed J. Zarbah ^h,
Suhair Mohammed Alhawkash ⁱ, Nedal Hatem Abada ^j,
Sarah Fahad Alshammari ^j, Aseel Adel Shams ^j, Rahaf Ahmed Alamer ^k,
E. Alotaibi, Hamoud Shaya ^l, Hazem Khairan Althobaiti ^l
and Noor Ameen Al Abbad ^g**

^a Dr. Samir Abbas Hospital, Jeddah, Saudi Arabia.

^b King Fahad Hospital – Al Baha, Saudi Arabia.

^c Batterjee Medical College, Saudi Arabia.

^d Salmanya Medical Complex, Bahrain.

^e Aljouf University, Saudi Arabia.

^f Jazan University, Saudi Arabia.

^g King Faisal University, Saudi Arabia.

^h Ministry of Defense, Saudi Arabia.

ⁱ Najran University, Saudi Arabia.

^j Batterjee Medical College, Saudi Arabia.

^k King Khalid University, Saudi Arabia.

^l Taif University, Saudi Arabia.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JPRI/2021/v33i60B34755

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/81294>

Review Article

**Received 18 October 2021
Accepted 20 December 2021
Published 23 December 2021**

[≡]Consultant General Surgery

^oIntern

*Corresponding author: E-mail: ha-abood@moh.gov.sa;

ABSTRACT

Esophageal rupture presents a significant interprofessional challenge to the entire therapeutic team. The majority of symptoms are non-specific, which can significantly delay the time between perforation and final diagnosis. An esophageal rupture can be caused by a variety of pathophysiological factors. Instruments such as endoscope causes an elevation in the wall tension, particularly iatrogenic interventions, or a massive rise in intraluminal pressure caused by throwing up, chest injury, or abdominal injuries are the main stressors. The choice of the management plan and its outcome depends mainly on the site of the rupture. Although the perforation can occur at any site of the esophagus, there is a tendency to main areas that correspond to natural points of narrowing of the lumen. If esophageal rupture requires surgery, patients should be transported to the operating room as soon as feasible. Minor delays in surgical therapy can lead to higher rates of morbidity and fatality. This review aims to summarize current evidence on etiology, epidemiology, diagnosis, and surgical management of esophageal rupture.

Keywords: Esophageal rupture; esophagus; trauma; perforation; esophageal mucosa.

1. INTRODUCTION

The first occurrence of esophageal rupture in a patient brought to the Dutch Navy Admiral Hospital was described by Hermann Boerhaave in 1723. After multiple instances of vomiting, the patient's oesophagus ruptured spontaneously. The first surgical attempts to repair esophageal perforation, on the other hand, were made in the 1940s. The prevalence of esophageal perforation has risen dramatically since the introduction of diagnostic endoscopy. [1-3] Esophageal rupture is a rare condition with a significant death and morbidity rate. Iatrogenic endoscopic operations are the most common cause of this fatal condition [4-7].

An esophageal rupture can be caused by a variety of pathophysiological factors. Instruments such as endoscopes cause an elevation in the wall tension, particularly iatrogenic interventions, or a massive rise in intraluminal pressure caused by throwing up, chest injury, or abdominal injuries are the main stressors [8,9].

There isn't a lot of agreement on how to handle this life-threatening disease. When therapy is started within 24 hours of rupture, the reported mortality from treated esophageal perforation is 10% to 25%, and when treatment is postponed, the estimated mortality increases from 40% to 60%. [10–14] The choice of the management plan and its outcome depends mainly on the site of the rupture. Although the perforation can occur at any site of the esophagus, there is a tendency to be focal areas that correspond to natural points of narrowing of the lumen [15].

Primary tear repair is reported to be the best option when esophageal rupture is diagnosed early (within 24 hours of rupture), while the best management for the rupture if the diagnosis is delayed for more than 24 hours is still under debate. Different surgical interventions can prevent the inflammatory deterioration caused by esophageal injury from becoming out of control [16–21].

In nearly half of all cases of esophageal rupture, the characteristic Mackler triad of vomiting, chest discomfort, subcutaneous emphysema, and stiffness occurs. In cases of cervical perforation, surgical emphysema is also common [22-27]. The symptoms of thoracic perforation include severe chest discomfort and mediastinitis. These symptoms differ depending on the aetiology and the time of onset. Patients may be gravely unwell and present with sepsis and numerous organ failure syndromes if they present late. [28–35]. This review aims to summarize current evidence on etiology, epidemiology, diagnosis, and surgical management of esophageal rupture.

2. EPIDEMIOLOGY AND CAUSES

In recent population-based research in Iceland, the age-standard incidence of esophageal rupture was 3.1 per 1 000 000 per year. Nonetheless, the real global prevalence of esophageal rupture is unknown. The majority of patients are in their sixties, and males are somewhat more likely than females to suffer from esophageal rupture [36-38].

The most common cause of esophageal ruptures is iatrogenic interventions. Around 70% of esophageal perforations are due to iatrogenic causes, with endoscopic operations accounting for most of the cases. Endoscopic causes of perforation include: endoscopic causes such as diagnostic endoscopy, endoscopic biopsy, endoscopic dilatations, and endoscopic stain placement; infectious causes such as *Candida*, herpes, and syphilis; trauma caused by blunt, penetrating, or sword swallowing; caustic agents such as acid or alkali malignancy of the oesophagus and lung; and ingestion of foreign bodies.

The risk of esophagogastroduodenoscopy used for diagnosis has been reported to be 0.03 percent. When therapeutic management is done during endoscopy, the risk of perforation increases. Perforation rates in esophageal dilation are reported to be 0.5 percent, 1.7 percent in achalasia dilation, 5% in endoscopic laser therapy, 4.6 percent in photodynamic therapy, and 5–25 percent in esophageal stent placement. The cervical oesophagus near the cricopharynx is the most commonly affected site during endoscopy [39–45].

The superficially located cervical oesophagus as well as the thoracic section of the oesophagus can be damaged by penetrating sharp lesions, i.e., external trauma. Although uncommon, bullet wounds can result in tissue injury that is readily overlooked during an examination. As a result, anytime there are penetrating injuries in this area, a high index of suspicion of esophageal perforation is required.[46] Accidental intake of caustic substances is the most common cause of esophageal injury in children. Adults who consume caustic liquids, on the other hand, are more likely to have suicidal thoughts. Cleaners, battery fluid, and solutions used in industrial processes are the most common caustic agents that cause esophageal rupture. While acids, which have a disagreeable taste, generate agglutination in the affected tissue with a limited probability of spreading, alkalis are more acceptable and promote liquefactive tissue necrosis that spreads quickly. The volume, thickness, and intensity of the caustic chemical, along with the time of contact between the agent and the esophageal mucosa, all affect the damage and clinical outcomes of ingestion of caustic compounds [47-49].

Straining and vomiting cause Boerhaave's syndrome. The ability to resist vomiting is

common, but it has also been recorded after weight lifting and childbirth. Ruptures are more common in males and frequently occur in the left posterior part of the lower esophagus. In this situation, a delay in identification and treatment is linked to a lower chance of survival. Trauma to the chest and upper abdomen can cause esophageal ruptures. A gunshot or stab wound can cause a penetrating injury. Esophageal rupture can also be caused by blunt trauma. Blunt esophageal perforations are common in car accidents, with 82 percent of them occurring in the cervical and upper thoracic esophagus, possibly due to their proximity to the esophagus [28-30,50,51]

3. ASSESSMENT AND EVALUATION

The diagnosis of esophageal rupture relies mainly on having high suspicion in this case. The history of the patient is the first thing to be asked for, as ingestion of foreign bodies, chemicals, or trauma of any type could help in fast detection and rapid management of the case. Any patient who arrives with discomfort or fever after strong vomiting, esophageal instrumentation, or chest trauma should be assessed thoroughly to exclude esophageal perforation. Early esophageal perforations might have mild clinical symptoms that can be confusing. A lateral neck X-ray may reveal air in the facial planes if cervical esophageal rupture is suspected. Posterior and lateral chest radiographs, as well as an upright abdominal series, should be taken in cases with thoracic or intra-abdominal esophageal perforation. A chest x-ray may reveal subcutaneous emphysema and mediastinal widening [52-54].

Violation of the mediastinal pleura caused pneumothorax in about 77% of the cases. To a lesser extent, to the right (20%), and to a lesser extent, bilaterally (10%).

In individuals with distal third esophageal perforations, hydropneumothorax on the left is common [53]. A contrasting esophagogram must be conducted as soon as the chest X-ray reveals the possibility of esophageal rupture. Because of its intermediate sensitivity (60–70%), the use of a water-soluble contrast agent (Gastrografin) is controversial. A negative scan does not automatically exclude perforation because of the quick passage of the thin contrast medium in the cervical oesophagus. [52,54,55]

If the primary test is negative, contrast esophagography with a water-soluble substance is performed first, followed by a barium examination. It is the most reliable test for determining whether or not a perforation exists and where it is located. The primary location of rupture may be shown by a dilute barium study, which indicates if the perforation is restricted to the mediastinum or connects with the pleural or peritoneal cavities, which has a substantial impact on the future care. A strong inflammatory reaction in tissues, most often mediastinitis, is a cause of worry. A contrast-enhanced CT scan of the chest should be performed if obtaining a contrast esophagogram is difficult, or if a negative study is obtained despite significant clinical examination, or to rule out alternative diagnoses. Mediastinal air, periesophageal fluid collection, or pleural effusions may all be signs of perforation [56,57].

If a perforation is mistakenly thought to occur during an endoscopic process, a careful examination of the oesophagus without air inhalation is recommended before removing the endoscope. However, this is not recommended as a primary diagnostic procedure because inhaled air can end up causing further rupture. MRI is another diagnostic tool that can be utilised to exclude aortic dissection. To exclude pulmonary embolism, a ventilation perfusion (V/Q) scan and a CT scan of the lungs are used. An ECG can rule out myocardial infarction and other cardiac abnormalities [54, 57,58].

4. MANAGEMENT

The treatment option is dictated by the etiology, site of rupture, patient's overall physical state, and the level of contamination as assessed by radiography. Perforation in a normal oesophagus and perforation with a previous intrinsic esophageal illness causing distal blockage require distinct treatments. When esophageal perforation is discovered late, non-operative therapy is appropriate. The cornerstone of treatment is surgery, but there has recently been a movement more toward non-operative treatments. Intravenous fluids, broad spectrum antibiotics, analgesics, parenteral nutrition, and a decision about surgical closure versus non-operative control should all be started as soon as feasible [59-63].

4.1 Non-surgical Management

Cameron et al. first outlined the guidelines for non-operative management in 1979, and Altorjay revised them in 1997. Early or postponed diagnosis with contained leak, perforation not in the abdomen, contained perforation in the mediastinum, composition of the rupture discharging back to the oesophagus, lack of sepsis, existence of a thoracic surgeon, and contrast imaging in the hospital are some of these. The majority of recent iatrogenic perforations or late post-emetic esophageal perforations can be treated without surgery.[64]

In an intensive care situation, non-operative treatment involves good IV access, supplementary oxygen, and cardiovascular and pulmonary observation. A nasogastric tube must be inserted to remove gastric contents and prevent additional contamination; mouth feeding is not allowed in this case. Broad-spectrum antibiotics should be started as soon as feasible and continued for at least 7–10 days. They should be administered using intravenous methods. To reduce pain and distress, enough analgesia, particularly narcotic analgesics, should be supplied, but it should be used with caution in patients with hypotension. Total parenteral nutrition should be considered when the course of treatment is assumed to be long. [65-69]

During non-operative therapy, the consultation and involvement of a skilled esophageal surgeon is essential. If these facilities are not accessible at the initial clinic, the patient may need to be transferred to a tertiary care center. In non-operative care, all signs and symptoms of sepsis require rapid surgical treatment. Surgical surgery is also indicated for respiratory problems such as pneumothorax and respiratory failure. Non-operative treatment of esophageal ruptures has a fatality rate ranging from 20% to 38% [61-62].

4.2 Surgical Management

If esophageal rupture requires surgery, patients should be transported to the operating room as soon as feasible. Minor delays in surgical therapy can lead to higher rates of morbidity and fatality. Patients handled within 24 hours of rupture have a mortality rate of less than 10%, compared to 30% after 24 hours. A less invasive surgical approach to repair the esophageal rupture must be considered. Reports are hard to come by; therefore, this method should definitely

be limited to places with highly specialised competence. Good exposure, removal of non-viable cells, application of buttress to support esophageal sutures, and sufficient tube evacuation are the general concepts of esophageal perforation therapy. The surgical procedure should be adapted to the esophageal rupture location [70-72].

4.3 Cervical Esophageal Rupture

Direct repair of the esophageal defect should be undertaken whenever possible for esophageal rupture in the neck. If bilateral cervical exploration is required, the oesophagus is reached through a left neck incision along the anterior edge of the sternocleidomastoid muscle or a collar incision. Esophageal displacement to aid repair, cleaning of the perforated site, tension-free rupture closure, strengthening of the repair with vascularized tissue, and sufficient drainage are all surgical treatments. The use of a feeding tube during surgery allows for early nutritional supplementation and promotes recovery. External drainage is recommended if direct repair is not possible. To reduce contamination of the surrounding regions, a lateral or endoesophageal stoma should be explored [73-75].

4.4 Esophageal Rupture in the Abdomen

For individuals with a free perforation of the abdominal oesophagus, surgical repair is the treatment of choice. A midline laparotomy must be used to treat the abdominal esophageal rupture. After removal of necrotic cells, the wound should be closed using a single-or double-layer closure that is tension-free. Inserting a nasogastric tube, creating a feeding pathway, and executing external drainage [75].

4.5 Thoracic Esophageal Rupture

The primary repair for esophageal rupture with free penetration of the thoracic oesophagus is the primary repair. The treatment of a thoracic esophageal perforation entails stopping mediastinal and pleural infection as soon as possible, excision of the perforation to healthy tissue, tension-free primary repair, and appropriate external evacuation [76].

It's tough to be prescriptive about the actual operative steps in these circumstances because they require an individualised approach. A

thoracotomy will almost always be required, and the degree of apparent wall defect on CT may help to choose which side to make the incision. In order to construct a feeding, a nasogastric tube or a bundle of tubes can be used to allow decompression and feeding. A diversionary cervical esophagostomy (for saliva) is not suggested in most cases. A technique via a midline laparotomy may be employed in select patients with adequate body habitus.

Esophageal exclusion, diversion, or resection should be undertaken if direct repair of thoracic EP is not possible due to hemodynamic instability, delayed surgery, or significant esophageal injury. To generate a regulated esophago-cutaneous fistula and reduce mediastinal and pleural contamination, repair over a large T-tube can be employed. When there is a substantial esophageal disturbance, complete esophageal diversion or thoracic esophageal resection is required. When there is pre-existing esophageal pathology, resection is the best approach. [77,78]

5. CONCLUSION

Esophageal rupture is a serious condition with high mortality and morbidity rates. Rapid diagnosis and management is critically important as the efficacy of the treatment decreases after 24 hours of the onset of the rupture. Causes are different but could be classified into four main categories, which are: endoscopy, foreign bodies, caustic agents, and trauma. The first diagnostic approaches are history and clinical presentation, followed by X-ray and contrasting imaging. The management could be done either by non-surgical methods, which are done mainly within the first 24 hours in mild cases, or by surgical intervention in the case of severe cases, where the management depends mainly on the site of rupture.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Derbes VJ and Mitchell RE Jr. Hermann Boerhaave's Atrocis, nec descripti prius, morbi historia, the first translation of the classic case report of rupture of the esophagus, with annotations. *Bull Med Libr Assoc* 1955;43: 217–240.
2. Barrett NR and Franklin RH. Concerning the unfavourable late results of certain operations performed in the treatment of cardiospasm. *Br J Surg* 1949; 37: 194–202.
3. Olsen AM and Clagett OT. Spontaneous rupture of the esophagus; report of a case with immediate diagnosis and successful surgical repair. *Postgrad Med* 1947;2: 417–419.
4. K. K. Sng, A. J. H. Koh, N. C. Tan, S. M. Tan, and K. H. Tay, "An eastern perspective on oesophageal perforation: a high incidence of ingested bones," *ANZ Journal of Surgery*, vol. 78, no. 7, pp. 573–578, 2008.
5. M. Huber-Lang, D. Henne-Bruns, B. Schmitz, and P. Wuerl, "Esophageal perforation: principles of diagnosis and surgical management," *Surgery Today*, vol. 36, no. 4, pp. 332–340, 2006.
6. L. Michel, H. C. Grillo, and R. A. Malt, "Operative and nonoperative management of esophageal perforations," *Annals of Surgery*, vol. 194, no. 1, pp. 57–63, 1981.
7. O'kten, A. K. Cangir, N. O'zdemir, S. Kavukcu, H. Akay, and S. Yavuzer, "Management of esophageal perforation," *Surgery Today*, vol. 31, no. 1, pp. 36–39, 2001.
8. Jones WG, 2nd, Ginsberg RJ. Esophageal perforation: a continuing challenge. *Ann Thorac Surg* 1992;53(3):534-543.
9. Skinner DB, Little AG, DeMeester TR. Management of esophageal perforation. *Am J Surg* 1980;139(6):760-764.
10. Sarr MG, Pemberton JH, Payne WS. Management of instrumental perforations of the esophagus. *J Thorac Cardiovasc Surg* 1982;84(2):211-218.
11. Michel L, Grillo HC, Malt RA. Operative and nonoperative management of esophageal perforations. *Ann Surg* 1981;194(1):57-63.
12. Brewer LA, 3rd, Carter R, Mulder GA, Stiles QR. Options in the management of perforations of the esophagus. *Am J Surg* 1986;152(1):62-69.
13. Bladergroen MR, Lowe JE, Postlethwait RW. Diagnosis and recommended management of esophageal perforation and rupture. *Ann Thorac Surg* 1986;42(3):235-239.
14. Altorjay A, Kiss J, Voros A, Sziranyi E. The role of esophagectomy in the management of esophageal perforations. *Ann Thorac Surg* 1998;65(5):1433-1436.
15. Wichern WA. Perforation of the esophagus. *Am J Surg* 1970;119:534–6.
16. Ohri SK, Liakakos TA, Pathi V, Townsend ER, Fountain SW. Primary repair of iatrogenic thoracic esophageal perforation and Boerhaave's syndrome. *Ann Thorac Surg* 1993;55:603–6.
17. Whyte RI, Iannettoni MD, Orringer MB. Intrathoracic esophageal perforation: the merit of primary repair. *J Thorac Cardiovasc Surg* 1995;109:140–6.
18. Lawrence DR, Ohri SK, Moxo RE, Townsend ER, Fountain SW. Primary esophageal repair for Boerhaave's syndrome. *Ann Thorac Surg* 1999;67:818–20.
19. Attar S, Hankins JR, Suter CM, Coughlin TR, Sequeira A, McLaughlin JS. Esophageal perforation: a therapeutic challenge. *Ann Thorac Surg* 1990;50:45–51.
20. Lundell L, Liedman B, Hyltander A. Emergency oesophagectomy and proximal deviating oesophagostomy for fulminant mediastinal sepsis. *Eur J Surg* 2001;167:675–8.
21. Sung SW, Park J-J, Kim YT, Kim JH. Surgery in thoracic esophageal perforation: primary repair is feasible. *Dis Esophag* 2002;15:204–9.
22. Ayed AK, Al-Din HJ, Asfar SK. Reinforced primary repair of early distal esophageal perforation. *Eur J Surg* 2000;166:938–41.
23. Hueting WE, Van Laarhoven CJHM, Gooszen EHG. Chirurgische behandeling van distale oesofagusperforatie die niet berust op een maligniteit: ervaringen bij 11 patienten, universitair medisch centrum Utrecht, 1994–1998. *Ned Tijdschr Geneesk* 2000;144:1276–9.
24. Zumbro GL, Anstadt MP, Mawulawde K, Bhimji S, Paliotta MA, Pai G. Surgical management of esophageal perforation: role of esophageal conservation in delayed perforation. *Am Surg* 2002;68:36–40.
25. Avanoğlu A, Ergün O, Mutaf O. Management of instrumental perforations

- of the esophagus occurring during treatment of corrosive strictures. *J Pediatr Surg* 1998;33:1393–5.
26. Jougon J, Delcambre F, MacBride T, Minniti A, Velly JF. La mortalité des perforations instrumentales de l'oesophage est élevée: expérience de 54 cas traités. *Ann Chir* 2002;127:26–31.
 27. Altorjay A, Kiss J, Vörös A, Sziranyi E. The role of esophagectomy in the management of esophageal perforations. *Ann Thorac Surg* 1998;65:1433–6.
 28. Attar S, Hankins JR, Suter CM, Coughlin TR, Sequeira A, McLaughlin JS. Esophageal perforation: a therapeutic challenge. *Ann Thorac Surg* 1990;50(1):45-49; discussion 50-41.
 29. Vial CM, Whyte RI. Boerhaave's syndrome: diagnosis and treatment. *Surg Clin North Am* 2005;85(3):515-524, ix.
 30. Ochiai T, Hiranuma S, Takiguchi N, Ito K, Maruyama M, Nagahama T, Kawano T, et al. Treatment strategy for Boerhaave's syndrome. *Dis Esophagus* 2004;17(1): 98-103.
 31. Nehra D, Beynon J, Pye JK. Spontaneous rupture of the oesophagus (Boerhaave's syndrome). *Postgrad Med J* 1993;69(809):214-216.
 32. Goldstein LA, Thompson WR. Esophageal perforations: a 15 year experience. *Am J Surg* 1982;143(4):495-503.
 33. Bhatia P, Fortin D, Inculet RI, Malthaner RA: Current concepts in the management of esophageal perforations: a twenty-seven year Canadian experience. *Ann Thorac Surg* 2011, 92:209-215.
 34. Bobo WO, Billups WA, Hardy JD. Boerhaave's syndrome: a review of six cases of spontaneous rupture of the esophagus secondary to vomiting. *Ann Thorac Surg* 1969; 172:1034-38.
 35. Henderson JA, Peloquin AJ. Boerhaave revisited: spontaneous esophageal perforation as a diagnostic masquerader. *Am J Med* 1989;86(5):559-567.
 36. Vidarsdottir H, Blondal S, Alfredsson H, Geirsson A, Gudbjartsson T: Oesophageal perforations in Iceland: a whole population study on incidence, aetiology and surgical outcome. *Thorac Cardiovasc Surg* 2010,58:476-480.
 37. Byard RW: Esophageal causes of sudden and unexpected death. *J Forensic Sci* 2006, 51:390-395.
 38. Jones WG, 2nd, Ginsberg RJ. Esophageal perforation: a continuing challenge. *Ann Thorac Surg* 1992;53(3):534- 543.
 39. Skinner DB, Little AG, DeMeester TR. Management of esophageal perforation. *Am J Surg* 1980;139(6):760- 764.
 40. Sarr MG, Pemberton JH, Payne WS. Management of instrumental perforations of the esophagus. *J Thorac Cardiovasc Surg* 1982;84(2): 211-218.
 41. Michel L, Grillo HC, Malt RA. Operative and nonoperative management of esophageal perforations. *Ann Surg* 1981;194(1):57-63.
 42. Brewer LA, 3rd, Carter R, Mulder GA, Stiles QR. Options in the management of perforations of the esophagus. *Am J Surg* 1986;152(1):62-69.
 43. Bladergroen MR, Lowe JE, Postlethwait RW. Diagnosis and recommended management of esophageal perforation and rupture. *Ann Thorac Surg* 1986;42(3):235-239.
 44. Altorjay A, Kiss J, Voros A, Sziranyi E. The role of esophagectomy in the management of esophageal perforations. *Ann Thorac Surg* 1998;65(5):1433-1436.
 45. Gupta NM, Kaman L. Personal management of 57 consecutive patients with esophageal perforation. *Am J Surg* 2004;187(1):58-63.
 46. Enguidanos L, Pflleiderer A, Smith W, Ramkumar S: Pneumomediastinum secondary to an apparently trivial stab wound to the neck: the value of the Hamman's sign and thorough radiological investigation. *Emerg Med J* 2005;22: 230-231.
 47. Riffat F, Cheng A: Pediatric caustic ingestion: 50 consecutive cases and a review of the literature. *Dis Esophagus* 2009, 22:89-94.
 48. Cheng HT, Cheng CL, Lin CH, Tang JH, Chu YY, Liu NJ, Chen PC: Caustic ingestion in adults: the role of endoscopic classification in predicting outcome. *BMC Gastroenterol* 2008, 8:31.
 49. Rauber-Luthy C, Kupferschmidt H: Household chemicals: management of intoxication and antidotes. *EXS* 2010, 100:339-363.
 50. English GM, Hsu SF, Edgar R, Gibson-Eccles M. Oesophageal trauma in patients with spinal cord injury Paraplegia 1992;30(12):903-912.

51. Pass LJ, LeNarz LA, Schreiber JT, Estrera AS. Management of esophageal gunshot wounds. *Ann Thorac Surg* 1987;44(3):253-256.
52. Okten I, Cangir AK, Ozdemir N, Kavukcu S, Akay H, Yavuzer S. Management of esophageal perforation. *Surg Today* 2001;31(1):36-39.
53. Han SY, McElvein RB, Aldrete JS, Tishler JM. Perforation of the esophagus: correlation of site and cause with plain film findings. *AJR Am J Roentgenol* 1985;145(3):537-540.
54. Rubesin SE, Levine MS. Radiologic diagnosis of gastrointestinal perforation. *Radiol Clin North Am* 2003;41(6):1095-1115, v.
55. Naclerio EA. The V sign in the diagnosis of spontaneous rupture of the esophagus (an early roentgen clue). *Am J Surg* 1957;93(2):291-298.
56. Maniatis V, Chryssikopoulos H, Roussakis A, Kalamara C, Kavadias S, Papadopoulos A, Andreou J, et al. Perforation of the alimentary tract: evaluation with computed tomography. *Abdom Imaging* 2000;25(4):373-379.
57. Backer CL, LoCicero J, 3rd, Hartz RS, Donaldson JS, Shields T. Computed tomography in patients with esophageal perforation. *Chest* 1990;98(5):1078-1080.
58. Pace F, Antinori S, Repici A. What is new in esophageal injury (infection, drug-induced, caustic, stricture, perforation)? *Curr Opin Gastroenterol* 2009;25(4):372-379.
59. Bhatia NL, Collins JM, Nguyen CC, Jaroszewski DE, Vikram HR, Charles JC. Esophageal perforation as a complication of esophagogastroduodenoscopy. *J Hosp Med* 2008;3(3):256-262.
60. McMahon MA, O'Kelly F, Lim KT, Ravi N, Reynolds JV. Endoscopic T-tube placement in the management of lye-induced esophageal perforation: Case report of a safe treatment strategy. *Patient Saf Surg* 2009;3(1):19.
61. Cameron JL, Kieffer RF, Hendrix TR, Mehigan DG, Baker RR. Selective nonoperative management of contained intrathoracic esophageal disruptions. *Ann Thorac Surg* 1979;27(5):404-408.
62. Altorjay A, Kiss J, Voros A, Bohak A. Nonoperative management of esophageal perforations. Is it justified? *Ann Surg* 1997;225(4):415-421.
63. Abbas G, Schuchert MJ, Pettiford BL, Pennathur A, Landreneau J, Luketich JD, Landreneau RJ. Contemporaneous management of esophageal perforation. *Surgery* 2009;146(4):749-755; discussion 755-746.
64. Griffin SM, Lamb PJ, Shenfine J, Richardson DL, Karat D, Hayes N. Spontaneous rupture of the oesophagus. *Br J Surg* 2008;95(9):1115-1120.
65. Tuebergen D, Rijcken E, Mennigen R, Hopkins AM, Senninger N, Bruewer M. Treatment of thoracic esophageal anastomotic leaks and esophageal perforations with endoluminal stents: efficacy and current limitations. *J Gastrointest Surg* 2008;12(7):1168-1176.
66. Freeman RK, Van Woerkom JM, Ascoti AJ. Esophageal stent placement for the treatment of iatrogenic intrathoracic esophageal perforation. *Ann Thorac Surg* 2007;83(6):2003-2007. Discussion 2007-2008.
67. White RE, Mungatana C, Topazian M. Expandable stents for iatrogenic perforation of esophageal malignancies. *J Gastrointest Surg* 2003;7(6):715-719; discussion 719-720.
68. Sarper A, Oz N, Cihangir C, Demircan A, Isin E. The efficacy of self-expanding metal stents for palliation of malignant esophageal strictures and fistulas. *Eur J Cardiothorac Surg* 2003;23(5):794-798.
69. Blocksom JM, Sugawa C, Tokioka S, Williams M. The Hemoclip: a novel approach to endoscopic therapy for esophageal perforation. *Dig Dis Sci* 2004;49(7-8):1136-1138.
70. Abbas G, Schuchert MJ, Pettiford BL, et al. Contemporaneous management of esophageal perforation. *Surgery*. 2009;146(4):749-55 discussion 755-6.
71. Nakano T, Onodera K, Ichikawa H, et al. Thoracoscopic primary repair with mediastinal drainage is a viable option for patients with Boerhaave's syndrome. *J Thorac Dis*. 2018;10(2):784-9.
72. Cho JS, Kim YD, Kim JW, et al. Thoracoscopic primary esophageal repair in patients with Boerhaave's syndrome. *Ann Thorac Surg*. 2011;91(5):1552-5.
73. Chirica M, Champault A, Dray X, et al. Esophageal perforations. *J Visc Surg*. 2010;147(3):e117-28.

74. Brinster CJ, Singhal S, Lee L, et al. Evolving options in the management of esophageal perforation. *Ann Thorac Surg.* 2004;77(4):1475–83.
75. Ivatury RR, Moore FA, Biffi W, et al. Oesophageal injuries: position paper, WSES, 2013. *World J Emerg Surg.* 2014;9(1):9.
76. Vallbohmer D, Holscher AH, Holscher M, et al. Options in the management of esophageal perforation: analysis over a 12-year period. *Dis Esophagus.* 2010; 23(3):185–90.
77. Linden PA, Bueno R, Mentzer SJ, et al. Modified T-tube repair of delayed esophageal perforation results in a low mortality rate similar to that seen with acute perforations. *Ann Thorac Surg.* 2007;83(3):1129–33.
78. Okonta KE, Kesieme EB. Is oesophagectomy or conservative treatment for delayed benign oesophageal perforation the better option? *Interact Cardiovasc Thorac Surg.* 2012;15(3): 509–11.

© 2021 Abood et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/81294>