

Esophageal Gunshot Injuries

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During a 15-year period from August 1964 to August 1979, 48 patients with gunshot wound of the esophagus (24 of the cervical, 17 of the thoracic, and seven of the abdominal) were treated at Grady Memorial Hospital. In the majority of the patients, the initial history, physical findings, and chest roentgenograms were nondiagnostic for esophageal injury. Esophageal perforation was mainly suspected because the bullet tract was in close proximity to the esophagus or the bullet had traversed the mediastinum. The diagnosis of esophageal perforation was made by esophagography (29 patients), at the time of emergency surgical exploration for suspected other organ injuries (17 patients), or by esophagoscopy (one patient). All but one patient were treated surgically. The surgical procedure most commonly used was primary repair of the esophageal wound with wide drainage of the mediastinum. Thirty-eight (79.2%) of the 48 patients survived, 21 (87.5%) of the 24 patients with cervical, 11 (64.7%) of the 17 patients with thoracic, and six (85.7%) of the seven patients with abdominal esophageal wounds. Ten patients died, three with cervical wound, six with thoracic wound, and one with abdominal esophageal wound. Three patients died intraoperatively from major bleeding and the remaining seven died from the esophageal and/or other associated injuries, four to eight days after surgery. None of the seven patients who underwent primary repair with wide drainage and plication of the suture line with pleural flap or other tissue, died or developed leak at the suture line. This study suggests that the physical and roentgenographic findings in patients with esophageal injury are often nondiagnostic and frequently are masked by coincidental injury to other organs. Hence, a high index of suspicion is required for the diagnosis of esophageal injury from gunshot wounds and esophagography should be performed as soon as the patient's condition is stable in all patients who present with a missile wound in close proximity to the esophagus or traversing the mediastinum. All patients with perforation of the esophagus from bullet wounds should be operated upon as soon as possible after the diagnosis is made. Wide drainage of the mediastinum and primary repair of the esophageal wound and plication of the suture line with parietal pleura or gastric fundus provide the best possible results.

GUNSHOT WOUNDS OF THE ESOPHAGUS in most reported series forms a small percentage of esophageal perforations.^{2,3,6} With the current increase of patients with gunshot wound injury and the improve-

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ment of their transportation to medical facilities, the incidence of esophageal gunshot wounds may be expected to increase. The purpose of this communication is to review our last 15 years' experience with gunshot wounds of the esophagus.

Materials and Methods

From August 1964 to August 1979, 48 patients with gunshot esophageal injury were diagnosed and treated at Grady Memorial Hospital. There were 24 cervical, 17 thoracic, and seven abdominal esophageal wounds with the patients' ages ranging from 16 to 67 years. The admission symptoms and clinical findings were nondiagnostic of esophageal injury and included, in addition to the presence of one or more penetrating wounds, bleeding from the mouth in eight patients, dyspnea in five patients, hemoptysis in three patients, stridor in one patient, dysphagia in two patients, hoarseness in two patients, subcutaneous emphysema in ten patients, rigid and tender abdomen in nine patients, shock in 13 patients, mediastinal "crunch" in two patients, decreased breath sounds in six patients, neck hematoma in two patients, hemopericardium in one patient, occult blood in nasogastric tube drainage in two patients and one patient had a cold and clammy right arm. The admission chest roentgenograms were also nondiagnostic of esophageal injury and showed widening of mediastinum in four patients, pneumothorax or hemopneumothorax in 17 patients, subcutaneous emphysema in 11 patients and a foreign body in close proximity to the esophagus in eight patients. The diagnosis of esophageal injury in all patients was mainly suspected because the bullet was in close proximity to the esophagus or had traversed the mediastinum. The diagnosis of esophageal perforation was established by esophagography in 29 patients, at the time of emergency surgical exploration for suspected other internal injuries in 17

Presented at the Annual Meeting of the Southern Surgical Association, December 3-5, 1979, Hot Springs, Virginia.

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Submitted for publication: December 7, 1979.

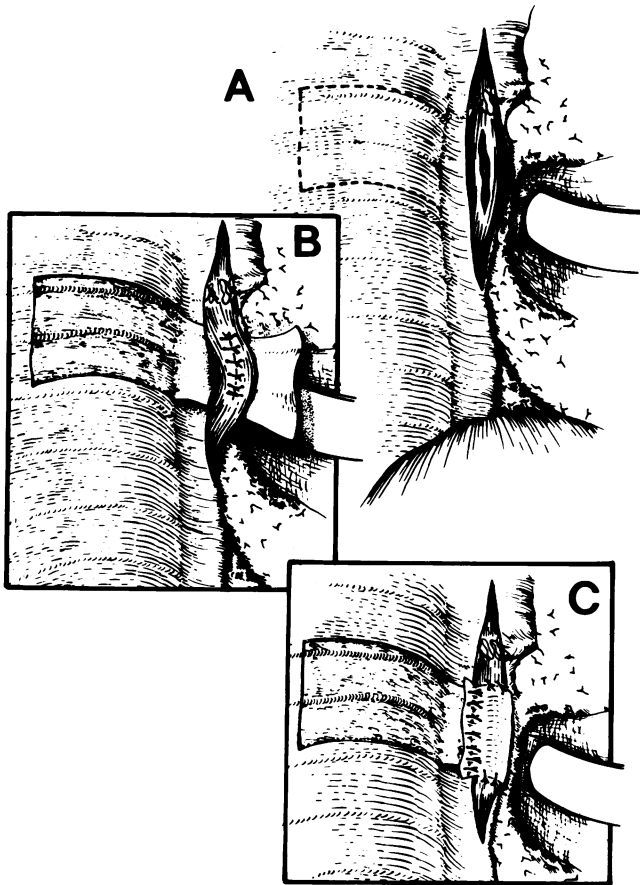


FIG. 1. Diagram of repair of thoracic esophageal wound and plication of the suture line with a parietal pleural flap.

patients, at esophagoscopy in one patient, or the diagnosis was made in one patient after a bullet initially thought to be in the hilum of the left lung traversed the gastrointestinal tract and passed through the rectum. Two patients were reported as having no extravasation of radiopaque material during esophagography. However a later review of the lateral projection of the esophagogram of one patient showed extravasation of small amount of radiopaque material. The initial esophagograms of the second patient could not be located for a review, thus, it is unclear whether the esophagogram was reported as falsely negative. Of the 48 patients with gunshot wounds of the esophagus, nine patients had three or more associated other organ injuries, 14 patients had two and 12 patients had one other organ injured. Eight patients had concomitant tracheal or bronchial injury with tracheoesophageal fistula. Co-existing cardiac or vascular injuries included injuries to the heart in three patients, aorta in three patients, superior vena cava in one patient, superior vena cava and azygos vein in one patient, carotid artery in one patient, subclavian artery in one patient and internal jugular vein in one patient.

All but one patient were treated surgically with a mean delay time between the injury and surgery of 5.2 hours. Delays as long as 14, 16, and 24 hours did occur, most often due to the delay of transporting the patient to a medical facility.

Twenty-two patients with cervical esophageal wounds were treated with wide drainage of the adjacent area and primary repair of the wound. One patient had a primary repair and plication of the suture line with homohyoid muscle flap and in one patient an esophagocutaneous fistula was created with the proximal segment of the injured esophagus, while the distal esophageal segment was suture ligated.

Ten patients with thoracic esophageal injury were treated with primary repair and wide drainage of the mediastinum and the pleural space(s). Two patients had, in addition, reinforcement of the esophageal suture line with pleural flap (Fig. 1). In two patients, because reconstruction of the esophagus was not considered safe due to the extensive injury of the esophagus or to other organs, the esophageal segment proximal to the injury was exteriorized in the neck and the distal esophageal segment was suture ligated. One patient who had no symptoms or signs or plain roentgenographic evidence of esophageal perforation was treated nonoperatively. The diagnosis in this patient was suspected 48 hours after the injury when the bullet, which appeared on the admission frontal chest portable roentgenogram to be in the hilum of the left lung, was found to have migrated to the abdomen. The diagnosis of esophageal perforation in the patient was established four days later when the migrating bullet passed through the rectum.

Two patients with abdominal esophageal wounds were treated with primary repair alone, and two patients had a primary repair and reinforcement of the suture line with the fundus of the stomach. In two patients, because the injury to the esophagus was too extensive, the esophageal segment proximal to the wound was exteriorized into the neck while the distal esophageal segment was suture ligated.

Thirty-eight of the 48 patients with esophageal perforation survived (21 of the 24 patients with cervical, 11 of the 17 patients with thoracic and six of the seven patients with abdominal esophageal wounds) with an overall survival rate of 79.2%. The survival rate for the cervical esophageal wounds was 87.5%, 64.7% for the thoracic wounds, and 85.7% for the abdominal esophageal wounds (Table 1). Of the ten patients who died, three patients died intraoperatively from bleeding. Two of these three patients had a thoracic esophageal injury, one had an associated wound of the superior vena cava and the azygos vein and the other patient had multiple injuries. The third patient, with an ab-

dominal esophageal wound, had multiple gunshot wounds of the chest and abdomen with injury to the aorta, spleen, liver, kidney, colon and stomach. Four patients had associated severe multiple organ injuries. Two of them with wound of the cervical esophagus had spinal cord transection and the other two, one with a cervical and the other with thoracic esophageal wounds, had extensive tracheal injury and both of them died from cardiorespiratory failure five and six days, respectively, postinjury. The remaining three patients all with thoracic esophageal wounds, who were operated on between 12 and 36 hours after injury and underwent primary repair with mediastinal drainage, developed leakage at the suture line with mediastinal and pleural empyema formation and subsequently died. None of the patients who had plication of the suture line, in addition to the primary repair of the wound and drainage of the adjacent area, died.

Of the 34 patients who had primary repair and drainage of the mediastinum or cervical area, ten developed leak at the suture line. None of the five patients who had plication of the suture line with parietal pleural flap or with other adjacent tissue, in addition to the primary repair, had leakage at the suture line (Table 2). All suture line leakages were managed with dependent drainage and the suture line healed in all surviving patients without stricture formation.

Discussion

The increasing incidence of gunshot wounds in civilian life and the improvement of the transportation and resuscitation of these victims has resulted in an increase in the number of esophageal gunshot wounds treated at medical facilities.¹⁻⁴

Due to the frequent coexistence of other organ injuries, the clinical manifestations of a bullet wound of the esophagus are easily attributed to other more obvious organ injuries. Perforation of the cervical esophagus may be accompanied by pain, local tenderness and subcutaneous emphysema as well as by resistance of the neck to passive motion. Injury of the thoracic esophagus

TABLE 2. Number of Patients Who Developed Esophageal Suture Line Leak

	Cervical	Thoracic	Abdominal	Total
Primary repair	4/22	6/10	0/2	10/34 (29.4%)
Primary repair and plication	0/1	0/2	0/2	0/5
Exteriorization	0/1	0/2	0/2	0/5
Total	4/24	6/14	0/6	10/44* (22.7%)

* Three intraoperative deaths from bleeding and one was not operated on.

may manifest with chest pain, subcutaneous emphysema of the neck, mediastinal "crunch," various degrees of respiratory embarrassment, and shock. Abdominal tenderness and rigidity are the most common clinical manifestations of a gunshot wound of the abdominal esophagus. Widening of the superior mediastinal shadow, subcutaneous emphysema of the neck, and increased prevertebral shadow are the chief roentgenographic signs that are frequently found in cervical esophageal perforation. Widening of the whole mediastinal shadow, mediastinal emphysema and hemothorax, pneumothorax, or hemopneumothorax are the common roentgenographic signs observed in perforation of the thoracic esophagus. All the above clinical and roentgenographic manifestations, for the most part, are nonspecific and, when present, can be due to or attributed to other cervical, thoracic, or abdominal organ injury. Therefore, a high index of suspicion must be exercised when gunshot wounds of the neck, chest or upper abdomen are present in order to make an early diagnosis of esophageal perforation (Fig. 2).

Esophagography has been of great value in diagnosing esophageal perforation in patients with a bullet wound in close proximity to the esophagus and in those patients in whom the bullet has traversed the mediastinum (Fig. 2). An esophagogram should be performed in all patients with such an injury as soon as the patient's condition is stable. Both frontal and lateral projections should be obtained both during and after the radiopaque material has been swallowed. If, however, the patient's condition does not allow the performance of esophagography and if immediate surgical intervention is necessitated because of bleeding or other suspected injury, the possibility of esophageal perforation should be excluded before the termination of the operative procedure by exploring the esophageal segment that may have been injured or by esophagoscopy.

Although the management of esophageal perforation from other causes has been somewhat controversial, it is our feeling that all patients with suspected perforation of the esophagus from a bullet, should have a nasogastric tube inserted and low suction applied, oral

TABLE 1. Number of Patients with Esophageal Wound Who Recovered from Their Injuries

	Cervical	Thoracic	Abdominal	Total
Primary repair	19/22	7/10	2/2	28/34
Primary repair and plication	1/1	2/2	2/2	5/5
Exteriorization	1/1	1/2	2/2	4/5
Exploratory surgery		0/2	0/1	0/3
No surgical therapy		1/1		1/1
Total	21/24 (87.5%)	11/17 (64.7%)	6/7 (85.7%)	38/48 (79.2%)

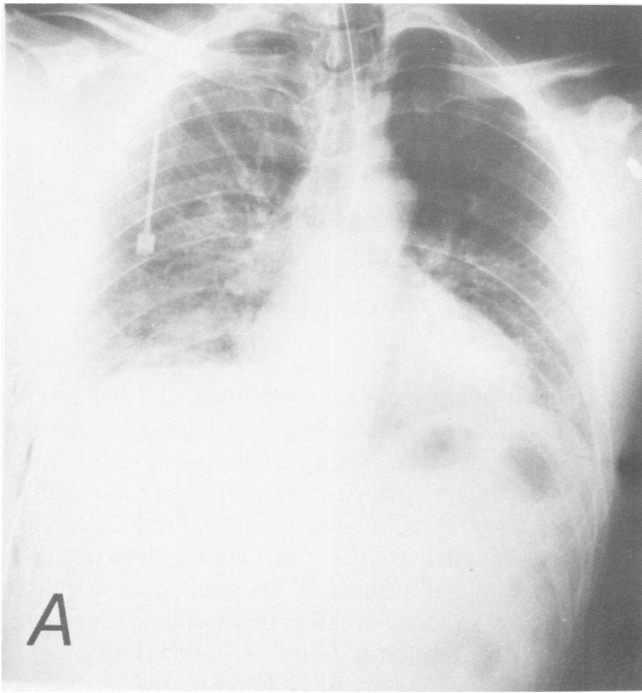


FIG. 2A. Admission chest roentgenogram in a patient with bullet wound of the right chest and the bullet imbedded in the left axilla. No evidence of mediastinal widening or pneumomediastinum is noted.

alimentation suspended, and intravenous fluids and broad spectrum antibiotics administered as soon as the diagnosis is suspected. After the diagnosis is established, the patient should be operated on as soon as

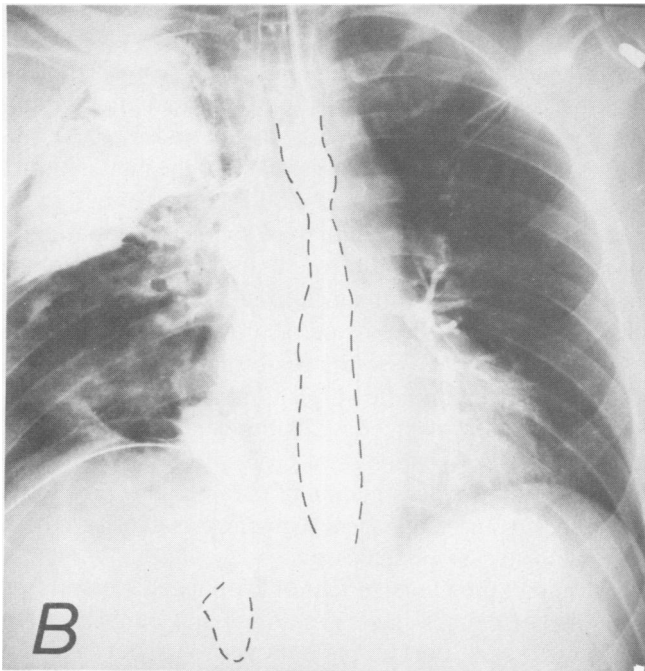


FIG. 2B. Esophagogram shortly after admission showing tracheo-esophageal and esophagopleural communications.

possible. The wound should be repaired, if possible, and the adjacent area widely drained. The suture line of abdominal and thoracic esophageal wounds, as well as cervical esophageal wounds with coexisting injury of a neighboring large artery or of the trachea, should be plicated with a well vascularized flap. In thoracic esophageal wounds, a parietal pleural flap is constructed and placed over the wound and around the esophagus (Fig. 1). When there is a coexisting tracheal injury, an additional pleural flap may be constructed and placed over the tracheal wound. A wound of the abdominal esophagus can be protected by plication with gastric fundus, whereas in cervical wounds, a muscle flap from the sternocleidomastoid or homohyoid can be used.

Previous study of tissue debrided from edges of the gunshot wound of the esophagus demonstrated diffuse hemorrhage involving all layers of the esophageal wall, acute coagulation necrosis of the muscle fibers and acute inflammatory reaction.⁵ Debridement of the edges of the wound of the esophagus before its repair, in a small number of patients, did not appear to favorably influence the healing of the wound.⁵ Since then, the repair of the esophageal wound has been done without debridement of its edges and lately plication of the suture line has been used with gratifying results.

For perforations of the esophagus located below the aortic arch, concomitant gastrostomy and feeding jejunostomy is of great value. In a case where there

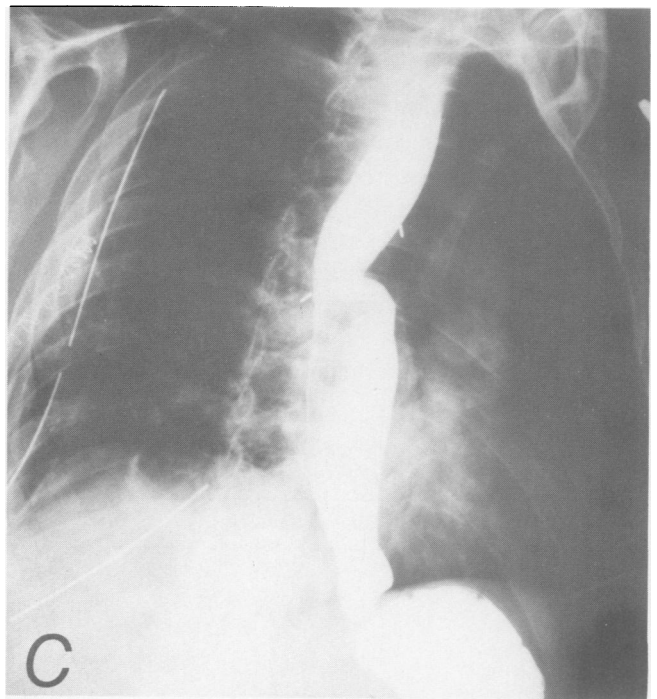


FIG. 2C. Esophagogram seven days after primary repair of both tracheal and esophageal wound and plication of both suture lines with two different pleural flaps.

is a significant loss of esophageal wall, which renders the safe repair of the esophageal wound impossible, the procedure of choice, in addition to wide drainage of the mediastinum, is the exteriorization of the esophageal segment proximal to the injury. The distal segment is then closed and a pyloroplasty and gastrostomy are performed. The esophageal continuity in these patients is established at a later date, after all other wounds have healed. Following the repair of the esophageal wound, the nasogastric or gastrostomy tube is connected to low constant suction, which is continued until the seventh postoperative day when esophagography is performed. During this period, depending on the patient's postoperative nutritional status, he is either maintained with intravenous fluid administration or preferably with hyperalimentation, either administered parenterally or through a long fine tube passed transnasally or through a previously placed jejunostomy. If the patient's clinical picture, however, is not satisfactory and/or there is suspicion of leakage of the esophageal suture line from the chest roentgenographic pictures, esophagography should be performed immediately. This will demonstrate a suture line leak, if such is present,

and will show where a loculated empyema is located and whether there is sufficient drainage through the thoracostomy tube or if additional drainage should be provided. In a case where there is leakage of the esophageal suture line, wide and dependent drainage of the area should be secured and hyperalimentation continued until the wound is healed. With these measures and the administration of the appropriate antibiotics, the esophageal wound usually heals without any luminal impairment.

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DISCUSSION

DR. EDWARD F. PARKER (Charleston, South Carolina): I want to mention a diagnostic technique which we have found exceedingly important: and that is the superiority of esophagography over endoscopy, as he showed in his slides. During esophagography we have found that the patient's swallowing a contrast medium is not adequate, especially if the perforation is in the neck, which is not subject to the negative intrathoracic pressure. So that in addition to any swallow—and frequently the patient is unconscious, and unable to swallow—we use an endoesophageal catheter and inject the contrast medium under pressure, and that has shown perforations that were not detected otherwise.

On the same basis, during operation, when perforation is known to be present, or when it is suspected and was not demonstrated by esophagography and the entire thoracic esophagus is exposed, we have found also that injection through a catheter, under pressure, will disclose a perforation that might otherwise not be detectable because of its small size.

I do feel that those additional tactical factors have been of great help to us.

DR. PANAGIOTIS N. SYMBAS (Closing discussion): The point that Dr. Parker raised is an excellent one. Certainly with the intra-

esophageal injection of methylene blue, the hole in the esophagus will be demonstrated if it is in the operative field and it is not sealed. An even better way, perhaps, in identifying the esophageal injury is, after having poured saline in the chest, a vigorous injection of air in the esophagus through an oroesophageal tube will be followed with air bubbling through the hole of the esophagus if esophageal injury is present.

In order, however, either of these two modalities, to be diagnostic the injured esophageal segment has to be dissected off the mediastinal structure so that the exit of the injected dye or air through the hole will not be impaired by adjacent tissue. Because of the limitation of these diagnostics modalities, whenever there is a question of a possible esophageal injury, esophagoscopy should be performed before the termination of the procedure, if esophagography was not feasible to be done before surgery. The patient with an aortic injury that I cited in my presentation at the time of the repair of the aorta and the partial exploration of the esophagus, both air and methylene blue were injected in the esophagus but neither one was seen in the operative field because the injured segment of the esophagus had not been dissected off the mediastinal structures. The esophagoscopy, however, before the termination of the operative procedure disclosed the strongly suspected esophageal injury which was then successfully repaired.