

our series, one would anticipate having experienced three dural punctures. Instead, no dural puncture or fetal-scalp injection was encountered, and there has been no rectal injection.

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Tracheoesophageal Fistula Following Prolonged Tracheal Intubation in a Thermally Injured Patient

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Tracheoesophageal fistula formation is an increasingly frequent and often fatal complication of prolonged tracheal intubation. Meticulous care of the tracheostomy tube and assiduous management of the inflatable cuff are essential in minimizing its incidence. We present an unusual example of tracheoesophageal fistula and suggest an alternate mode of management.

REPORT OF A CASE

An 18-year-old youth sustained 56 per cent total body surface burns involving the head, neck, trunk, and upper extremities. Chest escharotomy and nasotracheal intubation performed shortly after injury relieved respiratory distress. The patient was then transferred to the United States Army Institute of Surgical Research. On admission, bilateral wheezes and rales were present and copious quantities of carbonaceous sputum were produced. A lung scan with ¹³³Xenon revealed marked isotope retention bilaterally, indicative of respiratory tract damage and ventilatory impairment, corroborating the diagnosis of inhalation injury. On the fourth postburn day, continued ventilatory support was needed and a tracheostomy was performed. A 12-mm Portex tracheostomy tube with a prestretched cuff was inserted and the audible-leak technique used. Assisted ventilation was maintained with a Bird Mark XIV respirator. The first ten postburn days were complicated by intermittent upper gastrointestinal bleeding. Bilateral pulmonary infiltrates compatible with bronchopneumonia superimposed on

the inhalation injury developed. Blood and sputum cultures yielded *Pseudomonas aeruginosa*.

The patient was supported by nasogastric feedings and supplemental parenteral hyperalimentation. On the fifteenth postburn day, the pulmonary infiltrates partially cleared and he tolerated absence of respiratory assistance for 15 minutes every hour. By the eighteenth postburn day, he tolerated absence of respiratory assistance for 45 minutes of each hour and the roentgenogram of the chest showed further improvement. The upper gastrointestinal bleeding had ceased and the hematocrit was stable at 38 per cent.

Over the next few days, the patient continued to improve, but on the twenty-first postburn day, massive gastrointestinal hemorrhage recurred. Celiac-artery catheterization was performed and epinephrine infused, without diminution in bleeding. A subtotal gastrectomy and vagotomy were performed using ketamine-oxygen-d-tubocurarine anesthesia. Two hours after induction of anesthesia, it was suddenly impossible to obtain a seal of the trachea with the tracheostomy cuff, and it appeared as if the balloon had ruptured. When proper position of the tube and integrity of the balloon had been verified, emergency bronchoscopy was performed; this revealed a large tracheoesophageal fistula, originating 3 cm above the carina and extending 3 cm cephalad. A Carlen's tube was inserted for the remainder of the operation. Although a seal with the tracheal balloon could not be produced, pulmonary aspiration of gastric contents was not apparent. At the conclusion of the operation, 6.5-mm nasotracheal tubes were placed through the tracheostomy stoma into each mainstem bronchus. The balloons were inflated sufficiently to maintain a seal and permit a slight leak on positive-pressure inspiration. The roentgenogram of the chest remained remarkably clear postoperatively. A moderate degree of bleed-

Received from the United States Army Institute of Surgical Research Brooke Army Medical Center, Fort Sam Houston, Texas 78234. Accepted for publication February 8, 1973.

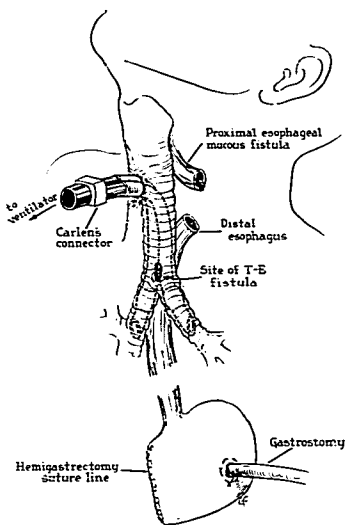


FIG. 1. Diagrammatic presentation of placement of endobronchial tubes and surgical diversion of the esophagus.

ing occurred through the tracheostomy stoma, apparently from the fistula margins; however, no blood entered the lungs. On the twenty-fourth postburn day, purulent secretions increased, but leakage into the bronchi from above the cuffs of the endotracheal tubes was not clinically apparent.

On the twenty-fifth postburn day, bilateral pulmonary infiltrates developed. Endobronchial and tracheal secretions markedly increased and a proximal diverting cervical esophagostomy was performed under halothane anesthesia. The proximal esophagus was developed into a mucous fistula and the distal esophagus was drained (fig. 1).

On the twenty-ninth postburn day, the patient developed renal insufficiency. Pulmonary edema ensued and hemodialysis was performed, with a 3-kg weight loss and minimal clearing of the lungs. The trachea continued to be bathed with secretions from the tracheoesophageal fistula despite the diverting esophagostomy. Under fluoroscopy, inadequate emptying of the distal esophagus and reflux through the tracheoesophageal fistula were seen (fig. 2). A sump tube was placed in the distal esophageal segment to remove secretions. On the thirtieth postburn day, nine days after the development of the tracheoesophageal fistula, an adequate seal of the trachea was obtained with an anode tube transected just below the balloon,

placed proximal to the carina. One day later, the patient developed status epilepticus, became hypotensive, and, after several cardiac arrests, died. Proximate cause of death was electrolyte imbalance complicating a 56 per cent total body surface burn with severe inhalation injury, bronchopneumonia, and associated renal failure.

DISCUSSION

Tracheoesophageal fistulas, occurring as a complication of tracheal intubation, have been described with increasing frequency in recent years. All cases to date have been discovered while the patients were being ventilated in some type of respiratory care facility, and have involved the anesthesiologists only in his capacity as a respiratory consultant. This case illustrates the development of an iatrogenic tracheoesophageal fistula as a potential catastrophic intraoperative complication.

Rapid loss of pressure in an anesthetic system is most often due to a disconnection within the gas delivery system. Less common causes of this phenomenon are gas supply failure, improperly functioning pop-off valves, rupture of the endotracheal tube cuff, and improper positioning of the tube.

In the case presented, it was immediately apparent that the problem lay not in the gas delivery system but with the tracheostomy tube, since gas suddenly leaked from the patient's mouth and nose as pressure was lost.



FIG. 2. Contrast medium above the anode tube cuff following injection of barium into the distal esophagus.

When proper position of the tube and integrity of the balloon had been verified, subsequent bronchoscopy revealed the fistula. An awareness of the conditions predisposing to the formation of tracheoesophageal fistula which existed in this case prompted immediate bronchoscopy and rapid identification of the problem. These conditions were: prolonged tracheal intubation with a cuffed tube,^{1,2} simultaneous use of a nasogastric tube,² tracheobronchial inhalation injury with superimposed infection, systemic sepsis,⁴ and intermittent episodes of moderately severe hypotension secondary to gastrointestinal hemorrhage.⁴

The use of endobronchial tubes in the management of a comparable problem has been described by Butlin, *et al.*⁵ This technique permits adequate ventilation if care is taken to prevent obstruction of the right upper lobe bronchus and protects against soilage of the lower airway. Because mediastinitis, a complication of tracheoesophageal fistula formation, invariably occurs, normal esophageal function is impaired. Therefore, esophageal diversion and gastrostomy may be useful in

protecting the airway if adequate drainage can be achieved. The combined usage of endobronchial tubes for airway maintenance and protection and esophageal diversion for drainage may be helpful for management of problems such as that described here until the patient's condition will permit corrective surgery.

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Circulatory Changes Following Implantation of Methylmethacrylate Bone Cement

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Methylmethacrylate has been extensively used as a dental prosthetic and as a cranial-

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Received from the Department of Anesthesiology Buffalo General Hospital. SUNY at Buffalo, 100 High Street, Buffalo, New York 14203. Accepted for publication February 20, 1973. A preliminary abstract was presented at the Fifth International Congress on Pharmacology, San Francisco, 1972.

bone substitute for over two decades. In the early 1960's, Charnley introduced methylmethacrylate into hip-joint replacement surgery for fixation of prostheses.¹ Recently the Food and Drug Administration approved its use in the United States for that purpose. However, episodes of acute hypotension and cases of cardiovascular collapse at the time of intraosseus implantation of the cement have been reported.^{2,3}

The present investigation was undertaken to determine the frequency and magnitude of circulatory changes following methylmethacrylate implantation.

MATERIALS AND METHOD

Studies were made in 52 patients undergoing total hip replacement (Mueller-Charnley

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