

2. Sasahara AA (editor): Current problems in pulmonary embolism. *Prog Cardiovasc Dis* 17:161, 1974-1975
3. Moser KM: Pulmonary embolism. *Am Rev Resp Dis* 115:829, 1977
4. Parmley LF Jr, North RL, Ott BS: Hemodynamic alterations of acute pulmonary thromboembolism. *Circ Res* 11:450, 1962
5. Glantz SA, Misbach GA, Moores WY, et al: The pericardium substantially affects the left ventricular diastolic pressure-volume relationship in the dog. *Circ Res* 42:433, 1978
6. McIntyre KM, Sasahara AA: The hemodynamic response to pulmonary embolism in patients without prior cardiopulmonary disease. *Am J Cardiol* 28:288, 1971
7. Moser KM, Guisan M, Bartimmo EE, et al: *In vivo* and post-mortem dissolution rates of pulmonary emboli and venous thrombi in the dog. *Circulation* 48:170, 1973
8. Dalen JE, Banas JS, Brooks HL, et al: Resolution rate of acute pulmonary embolism in man. *N Engl J Med* 280:1194, 1969
9. Halmagyi DFJ, Starzecki B, Horner CJ: Humoral transmission of cardiorespiratory changes in experimental lung embolism. *Circ Res* 14:546, 1964
10. Gurewich V, Cohen ML, Thomas DP: Humoral factors in massive pulmonary embolism: An experimental study. *Am Heart J* 76:784, 1968
11. Sasahara AA, Sidd JJ, Tremblay G, et al: Cardiopulmonary consequences of acute pulmonary embolic disease. *Prog Cardiovasc Dis* 9:259, 1967
12. Finely TN, Tooley WH, Swenson EW, et al: Pulmonary surface tension in experimental atelectasis. *Am Rev Resp Dis* 89:372, 1964
13. Fred HL, Axelrod MA, Lewis JM, et al: Rapid resolution of pulmonary thromboemboli in man. *JAMA* 196:1137, 1966

Anesthesiology  
52:175-177, 1980

## Intraoperative Diagnosis of a Gastrobronchial Fistula

ARTHUR L. QUASHA, M.D.,\* AND PETER C. PAIROLERO, M.D.†

Gastrobronchial fistula is a rare condition. Frequently it is a complication of subphrenic abscess.<sup>1,2</sup> Other causes include direct trauma to the chest and abdomen, infiltrating neoplasm, and perforation of the stomach while incarcerated in a diaphragmatic hernia (DH).<sup>3</sup> Despite its rarity, gastrobronchial fistula is suggested by a history of recurrent pulmonary infections resistant to therapy or the coughing up of gastric contents. The diagnosis can usually be established by roentgenographic contrast studies or endoscopy. The following report describes the intraoperative diagnosis and management of a patient with an unsuspected gastrobronchial fistula.

### REPORT OF A CASE

A 53-kg white man was first seen at the Mayo Clinic at the age of 33 years because of persistent gastroesophageal reflux. The patient was a self-described alcoholic who had smoked two packs of cigarettes per day for the preceding 15 years. At 4 years of age, because of bleeding esophageal ulcer, the patient had undergone a distal esophageal and proximal gastric resection with esophagogastronomy reconstruction. At the age of 26 years he had sustained a gunshot wound to the abdomen and undergone small-bowel resection. By the age of 31 years he had noticed regurgitation of gastric contents when he assumed the supine position. He had become progressively dyspneic and orthopneic. Studies of the upper gastrointestinal tract and barium-enema examination had revealed a large amount of stomach and small

and large intestine herniated into the left hemithorax. The patient had undergone repair of the diaphragmatic hernia as well as gastric fundal plication via left thoracotomy.

The patient was admitted to the Mayo Clinic complaining of recurrent gastroesophageal reflux followed by the progressive onset of dyspnea, productive cough, and fever. Physical examination revealed slight respiratory distress. Roentgenogram of the chest demonstrated a diaphragmatic hernia and an interstitial infiltrate in the left lung base with an elevated left hemidiaphragm (fig. 1). *Escherichia coli* were cultured from the sputum. Arterial-blood gas values during breathing of room air were  $P_{aO_2}$  53 torr,  $P_{aCO_2}$  37 torr, and  $pH$  7.41. Pulmonary function studies revealed total lung capacity, forced vital capacity (FVC), first-second forced expired volume ( $FEV_1$ ) and residual volume to be 72, 50, 70, and 45 per cent of predicted values, respectively. The  $FEV_1/FVC$  ratio was 0.74. Flow rates in the mid-lung volume range were 20 per cent of predicted, with no improvement following administration of an aerosolized bronchodilator. These data suggested a combined restrictive and obstructive lesion. Routine laboratory values were all within normal limits. An upper gastrointestinal tract study demonstrated gastroesophageal reflux and a large diaphragmatic hernia with most of the stomach in the left hemithorax. Esophagogastrosomy was performed, with no evidence of esophagitis.

The diagnosis of gastroesophageal reflux with chronic aspiration pneumonia was made. Intravenous hyperalimentation was initiated and oral feedings were discontinued. Two weeks after admission, the patient was brought to the operating room for diaphragmatic hernia repair and an anti-reflux procedure. Following placement of a precordial stethoscope, blood pressure cuff, six-lead electrocardiogram, and 14- and 18-gauge intravenous catheters, the right radial artery was cannulated with a 20-gauge Teflon® catheter. Following 5 min of preoxygenation, a 50-mg test dose of thiopental and pancuronium, 0.5 mg, were administered, followed in 3 min by 250 mg thiopental and 100 mg succinylcholine. Cricoid pressure was continuously applied. The trachea was easily intubated with a 9-mm endotracheal tube, without evidence of regurgitation or aspiration. The endotracheal tube cuff was ballotted at the suprasternal notch. The patient was ventilated with a mechanical ventilator‡ with a minute volume ( $\dot{V}_E$ ) of 7 l (4 l nitrous oxide and

\* Department of Anesthesiology, Mayo Clinic and Mayo Foundation, Rochester, Minnesota 55901. Current address: Department of Anesthesia, University of California, San Francisco, California 94143.

† Department of Surgery, Mayo Clinic and Mayo Foundation, Rochester, Minnesota 55901.

Accepted for publication August 12, 1979.

Address reprint requests to Dr. Quasha.

‡ Engstrom Ventilator, LKB Medical AB, Stockholm, Sweden.



FIG. 1. Roentgenogram of the chest, showing diaphragmatic hernia and interstitial infiltrate in the left lung base with elevated left hemidiaphragm.

3 l oxygen) at a rate of 12/min (tidal volume [ $V_T$ ] 580 ml). Enflurane, 1.5 per cent, was added without any appreciable alteration in vital signs, and pancuronium, 3 mg, was given iv. Esophageal temperature was recorded at 36 C. The patient was turned to the right lateral decubitus position and the breath sounds remained equal bilaterally. Arterial blood-gas values 20 min after repositioning were  $P_{aO_2}$  68 torr,  $P_{aCO_2}$  79 torr,  $pH_a$  7.18, and base excess  $-1$  mEq/l. A spirometer in the expiratory limb of the anesthesia circuit revealed that only 250 ml gas were expired per breath. The patient was ventilated with 100 per cent oxygen and 2 per cent enflurane, with an increase in  $\dot{V}_E$  to 9 l at a frequency of 12/min ( $V_T = 750$  ml). A left posterolateral thoracotomy incision was already under way and a great deal of bleeding was encountered during entrance into the pleural cavity and mobilization of the herniated stomach and colon. A second arterial blood-gas determination 20 min after ventilation with 100 per cent oxygen was begun revealed  $P_{aO_2}$  78 torr,  $P_{aCO_2}$  88 torr,  $pH_a$  7.12, and base excess  $-5$  mEq/l. The endotracheal tube cuff was again ballotted at the suprasternal notch. No leak could be found in the ventilator, anesthesia circuit, or endotracheal tube. There had been no appreciable change in peak and plateau inspiratory pressures, which remained approximately 34 and 20 cm  $H_2O$ , respectively.

The surgeon noticed increasing gastric distention, which appeared to fluctuate with ventilation. During mobilization of the esophagogastronomy anastomosis from the surrounding tissues, the stomach was entered, and ventilation of the lungs suddenly became impossible as the majority of the tidal volume escaped via the gastrostomy. Manual assistance of ventilation with 100 per cent oxygen and enflurane while the surgeon controlled the air leak with finger pressure on the anastomosis restored what

appeared to be adequate ventilation of the lungs. A tracheo-esophageal fistula was suspected and the esophagus was mobilized and cross-clamped, with no improvement in air leak or sudden egress of air from the pharynx. Fiberoptic bronchoscopy was performed via a sidearm adapter on the endotracheal tube while manually assisted ventilation with 100 per cent oxygen and enflurane continued. A 1.5-cm defect in the right main-stem bronchus 2 cm distal to the carina was visualized. Arterial blood-gas values during bronchoscopy were  $P_{aO_2}$  287 torr,  $P_{aCO_2}$  70 torr,  $pH_a$  7.20, and base excess  $-2$  mEq/l. The opening in the anastomosis was enlarged into the stomach, where further examination revealed a 1-cm fistula located along the lesser curve of the stomach 1.5 cm distal to the esophagogastronomy anastomosis. During bronchoscopy, a probe passed into the gastric fistula entering the right mainstem bronchus was visualized, thereby confirming a gastrobronchial fistula. Finger pressure applied directly to the gastric site of the fistula allowed ventilation to be re-established. The fistula was isolated and divided. The bronchial component was closed while ventilation was intermittently discontinued for 30-sec periods. After closure of the fistula, bronchoscopy was repeated, revealing a patent right mainstem bronchus without evidence of airway obstruction. Continuous airway pressure of 30 cm  $H_2O$  demonstrated no air leak across the repair. Mechanical ventilation was resumed with a  $\dot{V}_E$  of 13 l oxygen and enflurane, 2 per cent, at a frequency of 12/min ( $V_T = 1,085$  ml). The spirometer measured approximately 1,050 ml as the expired  $V_T$ . Peak inspiratory pressure was 45 cm  $H_2O$  and plateau pressure 34 cm  $H_2O$ . Arterial blood-gas values obtained 20 min after bronchial repair were  $P_{aO_2}$  365 torr,  $P_{aCO_2}$  50 torr,  $pH_a$  7.38, and base excess  $+3$  mEq/l.

The remainder of the operation was uneventful. The postoperative course was complicated by respiratory failure with bilateral pneumothoraces, necessitating bilateral tube thoracostomies. A tracheostomy was performed with local anesthesia on the twelfth postoperative day. Fiberoptic bronchoscopy repeated on postoperative day number 13 confirmed that the bronchial repair was healing satisfactorily without obvious airway obstruction. An upper gastrointestinal tract study demonstrated that the gastroesophageal anastomosis was intact, without evidence of gastroesophageal reflux or fistula. Both thoracostomy tubes had been removed by postoperative day 20, while the tracheostomy tube was removed 18 days later. The patient was discharged to his home six weeks after operation.

Microscopic examination of the surgical specimen revealed chronic inflammation surrounding the fistulous tract, without evidence of malignancy. A gastric perforation was found in the resected portion of the stomach. The probable etiology of the gastrobronchial fistula was erosion of a gastric ulcer into the mediastinum and the adjacent right main-stem bronchus.

## DISCUSSION

The sudden occurrence of a life-threatening loss of tidal volume in a paralyzed mechanically ventilated patient is obviously a true anesthetic emergency, which requires immediate diagnosis and treatment. Other than failure of the mechanical ventilator or a large leak in the anesthesia circuit or endotracheal tube, the sudden loss of tidal volume can be accounted for only by a fistula in the tracheobronchial tree. The present case report concerns the intraoperative diagnosis and management of a previously unsus-

pected gastrobronchial fistula in a patient under exactly those circumstances.

The survival of this patient was contingent upon the surgeon's ability to control the bronchial air leak manually while the anesthesiologist hand-ventilated the patient with 100 per cent oxygen. The availability of an experienced bronchoscopist allowed us to localize the lesion and make an immediate diagnosis, resulting in only minimal delay until institution of appropriate surgical therapy. Had bronchoscopy been unavailable, our contingency plan was transiently to cross-clamp each main-stem bronchus in turn, in an attempt to restore ventilation to one lung as an emergency measure and isolate the lesion to the contralateral bronchial tree. The presence of an arterial cannula placed prior to the induction of anesthesia provided ready access to arterial blood for analysis of oxygen and carbon dioxide content, as well as acid-base balance. These determinations confirmed the fact that the patient was being inadequately ventilated, although the discrepancy between the delivered tidal volume and that which was measured by the spirometer was the earliest clue to an air leak. Moreover, an increase in minute ventilation with 100 per cent oxygen failed to improve oxygenation or alveolar ventilation. The surgical procedure was not terminated at this point because the operation had already progressed to mobilization of the stomach and esophagus.

Although gastrobronchial fistula is an exceedingly rare condition, occurring most commonly as a complication of infection or trauma, it should be considered in all cases of patients who have undergone previous esophagogastrrectomy with esophagogastrtomy and subsequently present with esophageal reflux. In addition to esophagogastrtomy and barium swallow, evaluation of these patients should

include bronchoscopy and bronchography. Once the diagnosis has been established, surgical repair is the treatment of choice.

Prior to operation oral feedings should be discontinued and intravenous hyperalimentation instituted. Nasogastric decompression with a sump tube is also recommended. A preoperative regimen of cimetidine, iv, would probably reduce both the volume and the acidity of gastric contents,<sup>§</sup> thereby ameliorating the chronic pneumonitis. A rapid intravenous anesthetic induction sequence with a double-lumen endotracheal tube is indicated, to provide protection and selective ventilation of the uninvolved decubital lung.

Gastrobronchial fistula is a rare condition, occurring most commonly as a complication of infection or trauma. Most patients with gastrobronchial fistulas are chronically ill, and the diagnosis is generally made preoperatively. We have reported a case in which the diagnosis was made intraoperatively only after the fistula was surgically decompressed, leading to a sudden loss of tidal volume. Methods of preoperative and intraoperative management of gastrobronchial fistula are discussed.

#### REFERENCES

1. Missen AJG, Pemberton J, Boon A: Gastro-bronchial fistula. *Postgrad Med J* 50:504-507, 1974
2. Hathirat S, Renzetti AD Jr: Gastrobronchial fistula complicating subphrenic abscess. A case report. *Am Rev Resp Dis* 99:581-584, 1969
3. Milne RM, Thomson JWW: A case of gastrobronchial fistula. *Br J Surg* 57:632-635, 1970

---

<sup>§</sup> Coombs DW, Hooper D: Gastric pH in anesthetized patients premedicated with intravenous cimetidine. *Abstracts of Scientific Papers, annual meeting of the American Society of Anesthesiologists, October 1978*, pp 653-654.