Temporary Partial Cardiopulmonary Bypass during Emergency Operative Management of Near Total Tracheal Occlusion

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An almost complete tracheal obstruction is obviously a severe emergency. Attempts to insert an endotracheal tube or bronchoscope may cause complete immediate obstruction of the airway. We have found this to be a particular problem in lesions more than 2–3 cm long. Death rapidly will ensue unless some other method of ventilating or oxygenation is rapidly available. If the lesion is in the mid or lower trachea, a tracheostomy can bypass the area of stenosis when performed through the sternum. However, this may not be possible under local anesthesia.

Our management of a patient with near-total occlusion of the mid and upper trachea by an extensive tumor involved the above problems. However, use of partial cardiopulmonary bypass allowed us to treat this patient in a controlled and safe manner.

REPORT OF A CASE

A 47-year-old man was admitted with the chief complaint of a sudden onset of severe shortness of breath. The patient had had increasing hoarseness for several weeks prior to admission. For several days he had also experienced increasing difficulty breathing. This was associated with hemoptysis estimated to be approximately 500 ml in 24 h. The patient’s wife stated that he also had coughed up a 3-inch-long piece of “tissue” just prior to coming to the hospital.

His medical history included a history of heavy smoking (about two packs per day for 30 years). He denied any history of heart disease, hypertension, diabetes mellitus, tuberculosis, or other serious medical problems. He took no medication on a regular basis. He had no known allergies.

Physical examination revealed a man who was in moderate respiratory distress. The neck was supple, with some mild suprasternal retractions. The patient was somewhat diaphoretic and had an audible inspiratory and expiratory stridor. Heavy ronchi were present throughout the lungs. Roentgenographic examination and tomograms revealed a large mass in the mid and upper trachea with almost complete occlusion of the lumen. With oxygen being inhaled via a mask, $P_{H_2}$ was 7.30, $P_{CO_2}$ 38 mmHg, and $P_{O_2}$ 175 mmHg. While the patient was being taken to the operating room, he had increasing respiratory distress. Because the distress seemed to be due entirely to his airway problem and because he was quite cooperative, there was reluctance to use any sedation.

In the preoperative discussions, it was felt that this long stenosis would be difficult to bypass by endotracheal intubation, and the trachea was likely to occlude completely with any such attempts. The lesion was too low to do a tracheostomy, except through the sternum, and this was probably impossible under local anesthesia in this patient. Over the 12 h between admission and surgery, the patient became progressively more dyspneic and diaphoretic. Despite greatly increasing ventilatory efforts and $P_{O_2}$ of 1.0, $P_{H_2}$ was 7.30, $P_{CO_2}$ 52 mmHg, and $P_{O_2}$ 155 mmHg. The arterial blood pressure had increased from 140/80 to 150/90 mmHg.

It was then decided to institute partial cardiopulmonary bypass using femoral artery and femoral vein cannulation, under local anesthesia. Complete heparinization (300 units/kg) was initiated just prior to insertion of the cannulas. As the cannulation was being performed,
the patient denied any pain but he rapidly was developing more severe respiratory distress; pH was 7.24, PaCO₂ 65 mmHg, and PaO₂ 287 mmHg, with a blood pressure of 210/100 mmHg and a heart rate of 135 beats/min.

When cardiopulmonary bypass was started, the patient rapidly relaxed and, despite pump flow of 5–6 l·min⁻¹, the blood pressure fell to 70/40 mmHg. Two doses of Ephedrine® (25 mg iv) and 2,000 ml of lactated Ringer’s solution were given rapidly; arterial blood pressure increased to 100/60 mmHg; pH was 7.51, PaCO₂ 23 mmHg, and PaO₂ 621 mmHg in blood taken from a left radial artery catheter.

Laryngoscopy then was performed. The laryngeal structures were visualized and appeared to be normal. An 8-mm rigid bronchoscope was passed, and the tumor immediately was encountered in the upper trachea. Using a biting forcep, the tumor was resected until a tracheal lumen was developed. Only relatively mild bleeding was encountered, and this was controlled with cautery. A 9-mm endotracheal tube then was inserted beyond the tumor, and the cuff was inflated. Flexible bronchoscopy then was performed through the endotracheal tube to look for bleeding and to determine the location of the end of the endotracheal tube relative to the carina. The end of the endotracheal tube was found to be approximately 1.5 cm above the carina. At this point, cardiopulmonary bypass was discontinued and 300 mg of protamine sulfate (1.5 times the heparin dose) were given to reverse the heparin. Frozen sections obtained during the operative procedure revealed the tracheal tumor to be an undifferentiated neoplasm, suggestive of squamous cell carcinoma.

The patient was returned to the operating room 8 days later, and the mediastinum and neck were explored. An unresectable tumor of the trachea was found and a mediastinal tracheostomy performed. Postoperatively ventilation was controlled for 3 days. Radiotherapy was begun as an inpatient and continued on an outpatient basis. The patient did well for approximately 8 months before succumbing to his disease process. No further airway problems developed during that 8 months.

**Discussion**

Near-total tracheal occlusion can be extremely difficult to manage. Small degrees of inspiratory stridor often occur and the extent of the occlusion is not appreciated until the patient has a respiratory or cardiorespiratory arrest. Initially, moist oxygen with maximal humidification should be given to these patients. They obviously must be watched very carefully while necessary roentgenograms or tomograms of the neck and chest are obtained rapidly.

Careful light sedation may help reduce anxiety and thereby decrease the resistance to ventilation caused by rapid frantic breathing. Pain of any kind must be avoided carefully by proper use of local anesthesia. If a low tracheostomy can be performed under local anesthesia, this should be considered. However, doing very low tracheostomies through the sternum under local anesthesia can be very difficult, and any pain greatly may increase the patient’s anxiety and respiratory distress. Furthermore, it may complicate later attempts at curative surgery.

Various methods have been advocated to provide an airway in patients with tracheal obstruction. In 1952, Moerch et al. suggested that a bronchoscope be passed beyond the obstruction and anesthesia then given via the bronchoscope. Unfortunately, if the lesion is more than 2–3 cm long and the initial attempt at intubation is unsuccessful, the tracheal lumen may occlude completely and resist any further attempts at endotracheal intubation. At this point, an emergency tracheostomy may be required. If the lesion is in the middle or lower third of the trachea, the sternum may have to be split in order for one to do a mediastinal tracheostomy.

The use of cardiopulmonary bypass for resection of tracheal tumors is not new. This technique provides a method of maintaining gas exchange even if the trachea becomes completely occluded. It can be done relatively rapidly under local anesthesia using the femoral artery and vein for cannulation. Insertion of an arterial catheter in an upper extremity, preferably the right arm, is important during cardiopulmonary bypass in these patients. Not only does the arterial catheter help to indicate whether or not adequate oxygenation is being provided to the upper body but it also allows continuous monitoring of the blood pressure as the patient’s gas exchange problem is relieved. The sudden decrease in sympathetic nervous stimulation when the patient’s blood gases improve may result in severe hypotension, requiring iv fluid and/or vasopressor administration.

Although many surgical teams perform difficult tracheal resections with the cardiopulmonary bypass team standing by, the risk of intrapulmonary hemorrhage due to heparinization precludes its use in many cases. Even though oxygenated blood is infused in the femoral artery, a flow approximating the normal cardiac output of 5 l·min⁻¹ can provide adequate oxygenation of the entire body including the brain. Consequently, the largest and longest cannula available should be inserted into the inferior vena cava via the femoral vein. In this instance, a 28 French Argyle chest tube was able to provide a flow of 5–6 l·min⁻¹.

Bleeding was no problem in this patient. The surgeon was able to examine the lesion at his leisure and resect enough of the lesion with biopsy forceps to allow a large (9 mm) endotracheal tube to be inserted. This tube with its balloon inflated and drawn up against the tumor helped reduce the bleeding and prevent blood from getting into the lungs postoperatively.

Another approach to airway management during tracheal resection, particularly once the trachea is intubated, even with a small tube, involves use of jet (high frequency) ventilation. With only a small catheter in the field, ventilation can be maintained and the surgeon more easily can perform tracheal resection and anastomosis without concern for possible excess bleeding from heparinization needed for cardiopulmonary bypass. The disadvantages of jet ventilation may include 1) inability to pass the catheter through the stenotic area and still permit adequate egress of gases during exhalation; 2) plugging of the cath-
eter with blood; 3) displacement of the catheter; 4) aspiration of blood; and 5) technical difficulties with high-pressure injectors.

In summary, subtotal tracheal obstruction, especially long lesions due to tumors involving the mid or lower trachea, is an extremely difficult problem. Anesthesiologists and other physicians involved in management of these patients should be reminded of the potential lifesaving value of cardiopulmonary bypass if an adequate airway cannot be obtained readily by other techniques.

REFERENCES


