How I Do It

Ventilatory Techniques for Central Airway Obstruction

Michele P. Morrison, DO; Steffen Meiler, MD; Gregory N. Postma, MD

INTRODUCTION

Central airway obstruction (CAO) refers to obstruction involving the trachea, mainstem, or lobar bronchi. These lesions can be either benign or malignant. Obstruction of these areas may lead to dyspnea, atelectasis, post-obstructive pneumonia, and death. Treatment options to relieve CAO include airway dilation, laser techniques, cryotherapy, and stenting.1

CAO is becoming more prevalent due to our aging population and increase in life expectancy. Otolaryngologists are increasingly called upon to manage these patients; therefore, it is important to know the various options available to control the airway and ventilate patients with CAO.

Traditionally, CAO is managed either by flexible or rigid bronchoscopy. Flexible bronchoscopy has the advantage of the patient being awake; however, the scope partially occludes the lumen. Rigid bronchoscopy requires general anesthesia, but does not occlude the lumen, which allows for ventilation and easier control of hemorrhage into the airway.2

Jet ventilation is based on delivery of gas under high pressure through an unblocked catheter into the airway, which is open to ambient air. Jet ventilation allows for an unobstructed view of the airway.3 Jet ventilation can be performed supraglottically (above the glottis) or subglottically (below the glottis). High-frequency jet ventilation is the delivery of small tidal volumes at higher than physiological rates followed by passive expiration (Table I).4

MATERIALS AND METHODS

Cases involving central airway obstruction posing challenging operative ventilatory management were reviewed.

In all cases there is a preoperative discussion involving the entire operating room team to discuss the obstructing pathology and airway management plan. The goal of this is to coordinate the technical considerations for a safe and efficient operation with the need for adequate oxygenation and ventilation and to address equipment needs. In a typical, uncomplicated case with supraglottic jet ventilation, general anesthesia is induced with propofol and maintained with intravenous infusions of propofol and remifentanil. Anesthesia depth is monitored continuously by measurement of the bispectral index (Philips, Andover, MA). To induce dense neuromuscular blockade, a prerequisite for suspension microlaryngoscopy, we use a succinylcholine drip with train-of-four monitoring for short cases (<15 minutes), and resort to the non-depolarizing agent rocuronium bromide for its rapid onset and intermediate duration of action for longer procedures. When the anesthesiologist is confident that the patient is in stable stage 3 surgical anesthesia and has a patent mask airway, the operating room table is rotated 90° and the patient is turned over to the surgical team.

Three cases of CAO with various ventilation and treatment techniques are presented here.

CASE 1

A 57-year-old man presented to the pulmonology outpatient service with rapidly progressive shortness of breath with exertion progressing to stridor. Bronchoscopy was performed demonstrating an obstructing lesion in the trachea (Fig. 1). The otolaryngology service was consulted. The patient was taken to the operating room and mask induction was performed in the standard fashion. A ventilating subglottiscope (or standard laryngoscope if desired by the surgeon) was inserted through the glottis. Jet ventilation was then performed in the standard fashion. Great care was taken to allow the return of the chest to its end expiratory position after each and every ventilation. When CO2 build-up occurred, or oxygenation dropped, a 5-0 endotracheal tube was passed through the laryngoscope to ventilate the patient and remove excess CO2 (Fig. 2), and then we returned to jet ventilation. Tracheal bronchoscopy was performed using a rigid Hopkins telescope to delineate the lesion and to make certain there were no distal lesions. At this point the microdebrider (Xomed, Jacksonville, FL) was used to first obtain biopsies and debulk the lesions (Fig. 3). Great care was taken during the performance of this so as not to remove the tumor to...
the very edge of the tracheal wall. This would increase the opportunity to perforate the wall and to cause a pneumothorax or pneumomediastinum.

CASE 2
A 62-year-old woman presented to the otolaryngology clinic with a rapid onset of shortness of breath. Laryngoscopy was entirely normal; therefore, topical lidocaine was sprayed onto the larynx through the working channel of a flexible bronchoscope, and in-office unsublated tracheoscopy was performed that showed multiple implants of apparent metastatic or primary tumor throughout the mid and distal portion of the trachea (technique described by Morris et al. and Rosen et al.5,6). Biopsies were obtained in the clinic and were diagnostic only of carcinoma. This individual was taken to the operating room in a similar fashion; however, rapid sequence induction was done due to larger tumor volume. Due to difficult exposure, a Hunsaker Mon-Jet tube (Xomed, Jacksonville, FL) was inserted for subglottic jet ventilation. The tumor was taken down with the microdebrider, and topical epinephrine and the CO2 laser were used for hemostasis. Due to the larger surface area covered by the tumor, an expandable covered stent was placed to maintain the patency of the airway. Of note, in most cases, stents are reserved for patients with malignant disease.

CASE 3
A 30-year-old female with known metastatic ovarian cancer presented with airway obstruction requiring intubation. She was found to have tumor involving the carina and both mainstem bronchi. Biopsy via flexible endoscopy was diagnostic for metastatic ovarian cancer. Even with positive pressure ventilation, the patient was being very poorly ventilated. She had a severe respiratory acidosis due to the distal airway obstruction posing a major concern with the anticipation of inducing anesthesia with paralysis. The patient was taken emergently to the operating room and the cardiothoracic service was consulted for the use of possible cardiopulmonary bypass at the request of our anesthesiologists. The vessels in the lower extremity were isolated, and the patient was placed under anesthesia and paralyzed. Because a computed tomography (CT) scan demonstrated the obstruction was less significant in the right mainstem bronchus, a ventilating laser bronchoscope was used to address this area first. Large amounts of tumor were removed with forceps to quickly open the bronchus, and the laser was used for hemostasis and to improve the airway. A large amount of postobstructive secretions were found and were suctioned free using both rigid suction and flexible catheters. When the right lung was able to be well ventilated, the patient’s metabolic status rapidly improved and it was apparent that we would not be requiring cardiopulmonary bypass. Our attention was then directed to the left side. The tumor was much more extensive in this area, and the combination of both blunt removal with cup forceps and the use of the laser were performed. Controlled radial expansion balloons (Boston Scientific, Natick, MA) were also used to help find the airway lumen and to compress the tumor allowing better

![Fig. 1. Obstructing tracheal lesion. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]](image1)

![Fig. 2. View of a 5-0 endotracheal tube passed through the lumen of a laryngoscope for ventilation. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]](image2)
DISCUSSION

Although a ventilating bronchoscope allows for positive pressure ventilation; we find it much easier to use a laryngoscope in combination with jet ventilation to manage patients with CAO particularly because it allows the use of two hands. When using a rigid bronchoscope to access airway lesions, the scope must be repositioned frequently and can cause hypoventilation if it is moved endobronchially; this problem is removed when using a laryngoscope and jet ventilation. As mentioned previously, it is critical to watch for chest rise and fall during jet ventilation and ensure complete expiration at the end of every jet cycle. We always start with the jet system turned off, and once it is attached to the jet catheter we have the anesthesiologist slowly titrate the amount of pressure needed to obtain adequate chest rise. Some anesthesiologists will keep one hand on the patient’s lower chest to ensure complete expiration. This helps avoid the most feared complication of jet ventilation, which is barotrauma resulting in pneumomediastinum and pneumothorax. If necessary, a 5-0 cuffed endotracheal tube is inserted through the laryngoscope to expel CO₂ and raise O₂ saturations.

High-frequency jet ventilation can also be used, which offers the advantage of less tracheal wall motion (frequency usually around 150 breaths/minute versus 20 breaths/minute with low-frequency jet ventilation). Another jet ventilation option is the percutaneous route. This technique involves insertion of a plastic or metal catheter through the cricothyroid membrane, which is then connected to the jet ventilator. Obviously, the catheter should not be placed through or against the tumor, and if above the tumor one must ensure good chest rise and allow extra time for expiration. Problems with this technique include injury to tissues and bleeding of vessels in neck.

When managing CAO it is critical to maintain good hemostasis. We have used a Foley catheter balloon to tamponade areas of significant hemorrhage on occasion. It is also helpful to use a dilation and curettage (D&C) suction versus a regular suction when bleeding is anticipated. We use this for all tracheal and tracheobronchial tumors. We connect it to a transnasal esophagoscope as well, which is passed through an operating laryngoscope to help with visualization, lesion removal, and suction of blood and tumor. This clearly improves our ability to ventilate our patients.

Radiological studies are usually not obtained unless it will directly impact management. In the second case a CT scan was performed, which did help to determine which side to address first because she had such bulky distal disease.

The utility of the microdebrider system cannot be overestimated; long blades are available up to 45 cm. This allows the surgeon to reach the carina and primary bronchi in the majority of patients. The skills to master this are easily transferred from endoscopic sinus surgery. During jet ventilation, a rigid telescope is placed in one hand, and under direct vision the microdebrider is passed down into the airway. Once again, great care should be taken not to remove tumor down smooth with the edge of the trachea due to the possibility of creating a hole in the trachea. In addition, the suction should not be too strong. It is possible to suck the membranous trachea into the blade of the microdebrider, which could cause a tear leading to pneumomediastinum or pneumothorax.

CONCLUSION

Adequate ventilation is a major concern during surgical management of CAO. Due to the nature of these lesions it is not feasible to use standard ventilation techniques. The use of jet ventilation allows for an unobstructed view of the lesion and decreases the concern of airflow fire with laser use.

BIBLIOGRAPHY