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Right Upper Lobe Resection after Left Pneumonectomy

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SURGERY of the airway or lungs remains a challenge to the anesthesiologist because adequate oxygenation and ventilation can be difficult to maintain. We report an unusual case that illustrates the use of low-frequency catheter jet ventilation for improving surgical conditions in thoracoscopic procedures.

Case Report

A 59-yr-old, 90-kg man was admitted for thoracoscopic resection of a right upper lobe mass. He had a 150-pack-yr smoking history and in 1990 had undergone a left pneumonectomy for adenocarcinoma. His medical history also was significant for three myocardial infarctions. Medications were diltiazem and isosorbide dinitrate. His preoperative pulmonary function tests showed a forced vital capacity of 2.37 l and a forced expiratory volume in 1 s of 1.43 l. Preoperative arterial blood gas analysis revealed a *p*H 7.45, a carbon dioxide tension (P_{CO_2}) of 39 mmHg, and an oxygen tension (P_{O_2}) of 84 mmHg at a fraction of inspired oxygen of 0.21.

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A radial artery catheter and a 16-G intravenous catheter were placed before induction. In addition, an epidural catheter was inserted at the T7–T8 interspace in case an open thoracotomy would be needed. After induction of anesthesia with thiopental and vecuronium and initiation of anesthesia with isoflurane in oxygen, bronchoscopy was performed, and the bronchus intermedius was intubated with an 8.0-mm tracheal tube (TT). Fiberoptic bronchoscopy of the TT confirmed that the cuff of the TT was occluding the right upper lobe bifurcation. Because this patient had previously undergone a left pneumonectomy, a right endobronchial intubation was done to attempt deflation of the right upper lobe to improve operating conditions while still maintaining ventilation to the remainder of the lung. Hemoglobin oxygen saturation measured by pulse oximetry remained 100% with an inspired oxygen concentration of 100%, a tidal volume of 420 ml, and a respiratory rate of 10 breaths/min. The peak inspiratory pressure was 20–30 cmH_2O.

After the patient was turned to the left lateral decubitus, thoracoscopy was begun. However, visualization was hampered by inadequate deflation of the right upper lobe and the continued ventilation of the remaining right lung. To decrease the excursions of the lung, we elected to try low-frequency jet ventilation by insufflating 100% oxygen at 50 psi through a small-diameter (2-mm–ID tubing) suction catheter (Rüsch, Duluth, GA) positioned at the distal end of the TT. The technique and apparatus were similar to those described by Salzer *et al.*[1] The oxygen supply of the operating room was connected to a reducing valve with a manometer. Distal to the reducing valve was high-pressure tubing with an interrupter valve with a toggle switch handle; the jet was controlled by intermittently manually activating this valve. The 2-mm–ID tubing of the suction catheter was attached to the outlet of the valve. The proximal end of the TT remained open to the atmosphere.

Because we had no easy way of continuing an inhalational anesthetic, the epidural catheter was injected with 6 ml 1% lidocaine with epinephrine, and an intravenous propofol infusion was begun

at 0.2 $mg \cdot kg^{-1} \cdot min^{-1}$. Ventilation at about 40 breaths/min resulted in minimal movement of the lung and markedly improved operating conditions. Twenty minutes after initiation of jet ventilation, arterial blood gas analysis showed a *p*H of 7.34, a P_{CO_2} of 52 mmHg, and a P_{O_2} of 114 mmHg. The ventilatory rate was then increased to about 60 breaths/min for 20 min, and a second arterial blood gas analysis showed a *p*H of 7.33, a P_{CO_2} of 52 mmHg, and a P_{O_2} of 111 mmHg. Jet ventilation was continued for 45 min. During that time, hemoglobin oxygen saturation remained between 97% and 100%.

After the surgeons had completed a right upper lobe wedge resection and a right lower lobe bullectomy through an expanded "mini-thoracotomy," controlled ventilation *via* the anesthesia machine was resumed at 14 breath/min and with a tidal volume of 300 ml, resulting in a peak inspiratory pressure of 22 cmH_2O. A third arterial blood gas analysis at this time showed a *p*H of 7.38, a P_{CO_2} of 44 mmHg, and a P_{O_2} of 439 mmHg.

The patient was awakened without difficulty, and the trachea was extubated. Postoperative thoracic epidural analgesia was used. Other than a small air leak that persisted for a few days, the patient's postoperative course was uneventful.

Discussion

In the jet ventilation technique, a small stream of quickly flowing gas entrains a surrounding gas by the Venturi effect. High-frequency jet ventilation (HFJV) is defined as jet ventilation at a rate greater than 60 ventilations/min. The technique has been used successfully for procedures involving the trachea, larynx, bronchi, and lungs when low peak pressures are needed or when operating conditions must be improved.[2-4] Most authors have used commercially available jet ventilators that can supply pulses of gas flow at variable pressures and at rates as great as 250 cycles/min.[6,9]

This case report describes one method of managing a potentially difficult situation—thoracoscopic lung surgery in a patient who previously had undergone pneumonectomy. Although we did not intend at the outset of the case to perform jet ventilation, a change in anesthetic plan was easily and quickly accomplished when visibility through the thoracoscope was found to be poor. The technique used was very similar to that described by Salzer *et al.*[1] in that oxygen was delivered distal to the end of the TT through a 2-mm–ID catheter by rhythmic manual pressing of an interrupter valve. Those authors[1] found that a rate of 60–90 jet ventilations/min into the left bronchial tree was able to keep arterial P_{O_2} at 90 mmHg or greater and arterial P_{CO_2} at less than 70 mmHg during tracheal or right-lung surgery lasting 36–105 min.

The use of one-lung HFJV during repair of bronchial stump fistulas after pneumonectomy was reported by Mallios *et al.*[5] They found that with this technique they could maintain adequate ventilation and oxygenation. Lain *et al.*[3] used HFJV successfully from the 3rd to 6th postoperative days in a patient who had undergone a right pneumonectomy for pulmonary sporotrichosis and who had increasing peak inspiratory pressure. Other authors[4,6,7] have described the use of HFJV during pneumonectomy, usually with commercially available HFJV machines. Kan and Oh[8] used a technique similar to ours to reduce inspiratory pressures in patients undergoing bullectomy.

Although this technique maintained oxygenation well, it did produce mild hypercapnia. Although the frequency was increased from 40 to 60 ventilations/min, the P_{CO_2} remained at 52 mmHg during low-frequency jet ventilation. Hypercapnia can produce a variety of cardiovascular effects, including hypertension, tachycardia, and ventricular arrhythmias. In a patient with significant coronary artery disease and decreased cardiac function like ours, hypoventilation and the effects of hypercapnia are of concern. Our patient, however, did not experience any of these effects from his mild hypercapnia.

To our knowledge, the use of jet ventilation to improve surgical conditions during thoracoscopic surgery has not been described previously. The technique as we performed it required little equipment and was set up in a matter of minutes. Although HFJV has been shown to increase shunt,[9] this was not a concern in our postpneumonectomy case.

In conclusion, jet ventilation maintained ventilation and oxygenation during thoracoscopic surgery and improved the surgeon's operating conditions.

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Radiographic Documentation of Increased Visibility of the Larynx with a Belscope Laryngoscope Blade

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AN angulated laryngoscope, the Belscope, for use in patients in whom tracheal intubation was difficult, was developed and introduced by Bellhouse.[1] Mayall[2] was able to convert all of 12 cases of Cormack and Lehane[3] grade 3 to grade 2 or better by using the Belscope. Benumof,[4] in contrast, does not consider the Belscope blade superior to the Macintosh or other currently used blades; he asserts that special skill or a prism may be required for difficult cases and furthermore that evaluation of these aspects of its use has not been complete.

Recently, we treated patient in whom intubation was difficult. We performed comparative analysis by means of a lateral radiograph of the line of vision with each blade.

Case Report

A 60-yr-old, 55-kg, 165-cm man was scheduled for nephrectomy during general anesthesia. In the preanesthetic interview we noted that the maxilla was slightly protruding and that the tongue was moderately enlarged (class 2 of classification by Mallampati *et al.*), suggesting the possibility of difficult intubation.[5] After induction of anesthesia with thiopental and vecuronium administered intravenously, we inserted a number 3 Macintosh blade into the right side of the mouth. Drawing the handle anterocaudally with the tip anterior to the epiglottis displaced the tongue to the left. Despite the more than 10-cm elevation of the head, the full sniff-positioning of the chin and face for full extension of the head on neck, and the application of external laryngeal pressure,[6,7] only the epiglottis could be visualized (Cormack and Lehane[3] grade 3). Therefore, it was decided that a Belscope blade should be used.

A medium Belscope blade was inserted on the midline in the same position as the Macintosh, and the tip of the blade was rotated anteriorly. This procedure was repeated until the tip reached the esophagus, and then the blade was withdrawn and the epiglottis was held forward, when the posterior end of the laryngeal aperture was partly exposed, without additional maneuvers such as external laryngeal pressure (Cormack and Lehane[3] grade 2).

Lateral radiographs were taken with each blade in place (fig. 1). Tracheal intubation was then successfully performed. All laryngoscopic procedures and intubations were performed by an anesthesiologist with 23 yr of experience (S.W.). The patient and his family were informed of this event after he was awake, and it was described in his medical record.

Discussion

Recently published, the "Practice Guidelines for Management of the Difficult Airway" states that the "difficult airway" has not yet been defined in the literature and emphasizes the importance of objective reporting for the sake of physicians and their patients.[8] However, it is difficult to photograph the different views of the glottis obtained with various rigid laryngoscope blades.

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