Anesthesiology
1996; 84:724–6

Lippincott–Raven Publishers

Univent Tube Provides a New Technique for Jet Ventilation

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HIGH-FREQUENCY jet ventilation (HFJV) is of great advantage during surgical airway resection. When the airway is divided surgically, HFJV can be delivered *via* small catheters across the field to permit ventilation of the distal airways. This technique has been applied during tracheal reconstruction, tracheal stenosis surgery, sleeve resection of a lung, and management of bronchopleural fistulas.[1] We performed HFJV with a Univent tube (Fuji Systems, Tokyo, Japan), a specialized endotracheal tube incorporating a bronchial "blocker" in its design to implement one-lung ventilation (OLV).[2] In our patient, the Univent tube was conventionally used initially to block ventilation to the right lung during surgical resection of a tumor mass. Later, the bronchial blocker was repositioned into the left lung, and HFJV was performed through the lumen of the blocker with the balloon deflated while the carinal area was resected and closed. We are unaware of any reports in which the Univent tube has been used specifically for jet ventilation.

Case Report

The patient is a 44-yr-old woman who presented with a right-sided chest malignancy of unknown etiology. A computed tomography scan revealed a 6 × 7 × 10-cm mass that obliterated the orifices of the middle and upper lobes of the right lung. The tumor extended anteriorly to involve the first three ribs and medially abutted the right mediastinum, bowing the superior vena cava. The mass also extended into the right hilum, where it passed along the anterior and posterior surfaces of the right mainstem bronchus and encroached on the carina. The surgical procedure would involve a carinal resection and possibly necessitate HFJV of the unaffected left lung. The operation also would require conventional OLV of the left side during resection of the bulk of the tumor.

Preoperative vital signs were: heart rate 110 beats/min, blood pressure 120/70 mmHg, respiratory rate 18 breaths/min, and temperature 36.7°C. The laboratory data were as follows: hematocrit 24% with normal leukocyte count, electrolytes, and coagulation studies. A room air blood gas revealed *p*H 7.51, P_{CO_2} 33 mmHg, P_{O_2} 85 mmHg, HCO_3 26.5 mol/l, base excess 4.8, O_2 saturation 97%. Pulmonary function test results were normal.

After insertion of radial artery, pulmonary artery, and peripheral intravenous catheters, anesthesia was induced. After induction of anesthesia, the trachea was intubated with an 8.5-mm Univent tube. The bronchial blocker was positioned into the right mainstem bronchus under direct vision using a fiberoptic bronchoscope. The balloon of the bronchial blocker was inflated, and OLV of the left lung was begun (fig. 1). Ventilation parameters were: F_{IO_2} 1.0, tidal volume 700 ml, and respiratory rate 10 breaths/min. During resection of the tumor, during OLV, the patient remained hemodynamically stable. As the resection began to encroach on the carina, we deflated the bronchial blocker cuff and repositioned the blocker under direct vision 3 cm into the left mainstem bronchus. Moments before the airway was resected, we began ventilating the left lung using HFJV through the bronchial blocker lumen. A Healthdyne impulse ventilator (Anaheim, CA) was used to provide HFJV. The cuff on the blocker remained deflated to permit exhalation from the left lung. Initial ventilatory parameters included: F_{IO_2} 1.0, respiratory rate 99 breaths/min, driving pressure 40 psig, inspiratory time 37%, and airway pressure 5 cmH_2O. The right mainstem bronchus was divided flush with the carina. After arterial blood gas results at 2 min (table 1), driving pressure was decreased to 30 psig and a repeat arterial blood gas measurement was obtained at 7 min. The distal trachea remained open until surgical closure could be completed (fig. 2).

The patient remained hemodynamically stable during the period of HFJV (~11 min), which ended when the bronchus was surgically closed. Conventional OLV with the initial parameters was resumed for the completion of the pneumonectomy. The patient was stable through the remainder of the surgery.

Discussion

Surgery of the lower airway is technically difficult under the best circumstances, particularly when the

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Received from the University of North Carolina at Chapel Hill, Chapel Hill, North Carolina. Submitted for publication August 30, 1995. Accepted for publication November 8, 1995.

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Key words: Tracheal/bronchial resection. Univent tube. Ventilation: jet; one-lung.

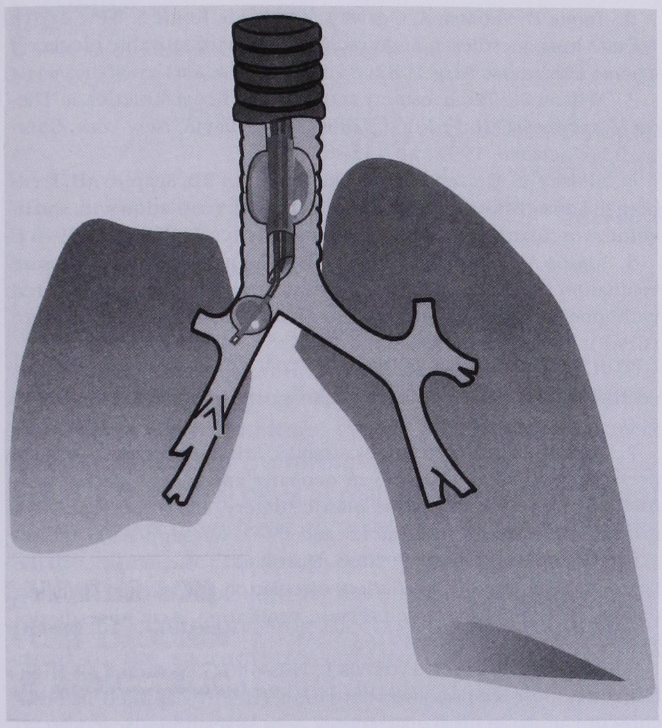

Fig. 1. Ventilation of the left lung with the bronchial blocker positioned in the right mainstem bronchus.

proximal airways are involved with tumor. The surgery is complicated by the need to provide adequate oxygenation and ventilation by techniques not routinely employed. Airway management frequently may involve placement of endotracheal tubes and jet ventilation devices orally as well as directly into a mainstem bronchus from the surgical field. Repositioning of endotracheal or endobronchial tubes may be required, especially when the carina is involved. These techniques are described elsewhere in more detail.[3]

Table 1. Blood Gases during High-frequency Jet Ventilation (HFJV)

Time	pH	P_{CO_2} (mmHg)	P_{O_2} (mmHg)	HCO_3 (mEq/L)	Base Excess (mEq/L)
Preoperative	7.51	33	85*	26.5	4.8
Before HFJV (OLV)	7.49	29	568†	22.3	0.4
HFJV at 2 min	7.51	27	480†	21.5	0.1
HFJV at 78 min	7.50	28	471†	22.3	0.6
After HFJV (OLV)	7.46	32	528†	23.2	0.6

OLV = one-lung ventilation.

* $F_{I_{O_2}}$ = 0.21.

† $F_{I_{O_2}}$ = 1.0.

A variety of approaches have been described to ensure oxygenation and ventilation during airway resection. These include positive pressure ventilation with or without periods of spontaneous ventilation, apneic oxygenation for brief periods of time, and high-frequency ventilation (HFV). Disadvantages of apneic oxygenation include hypercarbia with cardiac dysrhythmias or hemodynamic instability that may ensue. Physiologically, HFV results in a lower pleural pressure, allowing a greater venous return and a better maintained cardiac output. Also, HFV potentially decreases the incidence of airway barotrauma. Under some circumstances, HFV may decrease shunt fraction and alveolar-arterial P_{O_2} gradients, resulting in improved pulmonary oxygenating ability and enhanced oxygen transport when compared to conventional positive pressure ventilation. These potential advantages of HFV are well documented.[1,4–12]

For our patient, attention was directed preoperatively to optimally manage the airway, particularly during the period when the carina would be open. It was antici-

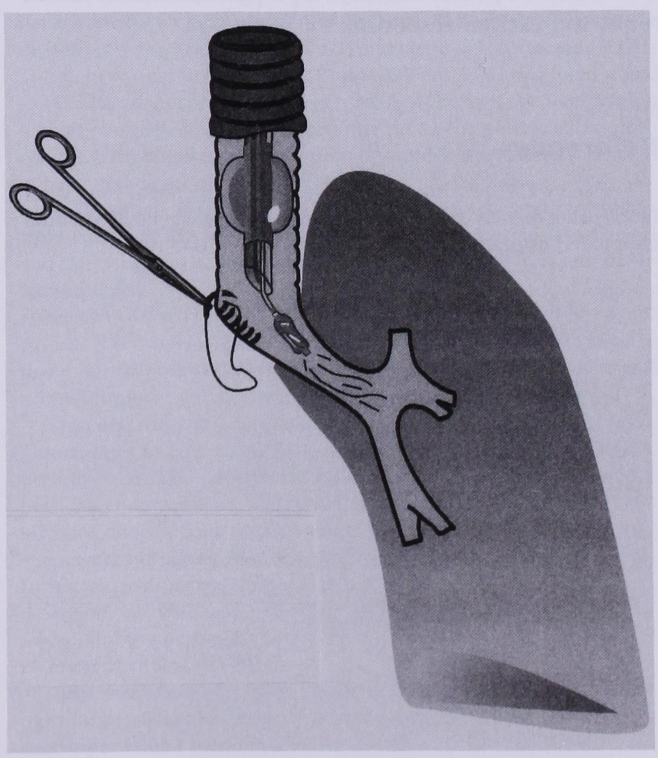

Fig. 2. HFJV of the left lung with the bronchial blocker positioned in the left mainstem bronchus. The bronchial blocker cuff is deflated.

pated by the surgeon that the airway may not be surgically closed easily if either a double-lumen tube or an endobronchial tube crossed from the surgical field. Anatomically this was anticipated because of the encroachment of the tumor on the carina and adjacent mainstem bronchus. A small endobronchial catheter and HFJV was anticipated to solve the anatomic problem and provide adequate ventilation during surgical repair. Consideration was given to apneic oxygenation. However, the period of apnea could not be guaranteed to be short. HFJV was considered to be the technique of choice in this patient.

Preoperatively, the mode for delivery of HFV was discussed. Several options existed. These included placement of a ventilation catheter down a standard oral endotracheal tube into the left mainstem bronchus or placement of a sterile ventilation catheter into the left mainstem bronchus *via* the surgical field. The Univent tube incorporated desirable characteristics of all of these options and allowed for expeditious tumor resection and closure of the patient's lower airway without cardiorespiratory compromise.

In summary, we reported the use of a Univent tube as a means of providing HFJV in a patient with a tumor requiring carinal resection.

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