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A Simple Device to Enable Capnography during Jet Ventilation for Laryngoscopy

To the Editor:—Jet ventilation as described by Sanders[1] for bronchoscopy and modified by Oulton and Donald for use during laryngoscopy[2] can facilitate surgical access to the larynx and is often recommended for use during laser surgery of the airway to eliminate the presence of a flammable endotracheal tube.[3] A disadvantage of this technique is the lack of end-tidal carbon dioxide monitoring. An experimental dog model of translaryngeal jet ventilation demonstrated the correlation of end-tidal carbon dioxide, sampled at the tip of the injector, and arterial carbon dioxide when the respiratory rate was 15 breaths/min, even during obstruction of up to 80% of the cross-sectional area of the upper airway.[4] The authors of this experimental study suggest monitoring end-tidal carbon dioxide during translaryngeal jet ventilation by the use of side-stream sampling through a nasal canula or a low deadspace face mask. To enable side-stream sampling when jet ventilation is used during laryngoscopy, we produced the double lumen injector shown in figure 1. This consists of a 13-Ga metal injector attached to a thumbscrew to which an 18-G 9-cm needle was welded. The entire device was then sand-blasted to decrease specular reflectance. As can be seen in figure 1, the addition of the sampling lumen does not appreciably increase the size of the injector or the potential for the device to interfere with surgery. The injector is clamped to the base of the laryngoscope and attached to a high-pressure gas source and a side-stream sampling device.

The capnographic tracings in figure 2 illustrate the results obtained while sampling from the modified injector of figure 1 during suspension laryngoscopy. These tracings were obtained with an infrared analyzer (OR SARACAP, PPG Industries, Lenexa, KS) while sampling at 110 ml/min through a 10-foot catheter. A muscular 49-yr-old man weighing 100 kg presented for biopsy of the vocal cords. His history is notable for moderate chronic obstructive pulmonary disease and former intravenous use of heroin and amphetamine. The airway was unremarkable. General anesthesia was induced and maintained with fentanyl, propofol, succinylcholine, and vecuronium. A 7-mm oro-

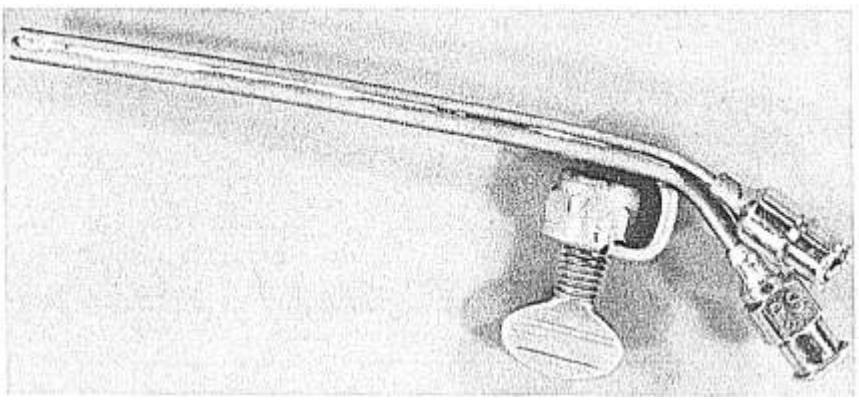

Fig. 1. Addition of a second lumen to the injector to permit side-stream sampling.

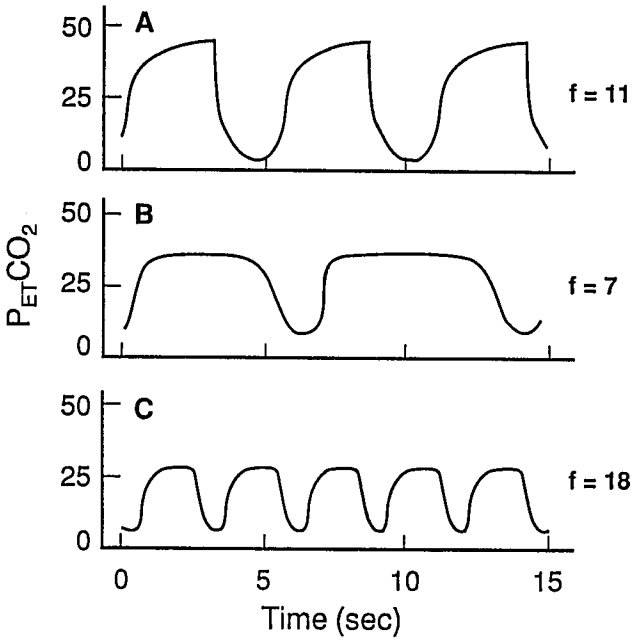

Fig. 2. Waveforms from carbon dioxide analyzer output during controlled ventilation with an endotracheal tube (*A*) and during jet ventilation at two respiratory frequencies (*B* and *C*).

tracheal tube was inserted in the trachea, and the capnographic tracing shown in figure 2A was recorded during controlled ventilation with 100% O_2 at f = 11 breaths/min, V_T = 800 ml, and PIP = 21 mmHg. Five minutes later, the end-tidal P_{CO_2} was 32 mmHg while arterial blood analysis revealed pH = 7.37, Pa_{CO_2} = 42 mmHg, and Pa_{O_2} = 270 mmHg. The surgeon inserted the suspension laryngoscope with the injector of figure 1 attached to its base, the endotracheal tube was removed, and the patient's lungs were ventilated with intermittent jets of 100% O_2 using a hand-controlled apparatus (Anesthesia Associates, Philadelphia, PA) at a supply pressure of 20 psi. After 15 min of jet ventilation with f = 7 breaths/min, the capnographic tracing in figure 2B was obtained, the $P_{ET}CO_2$ was 33 mmHg, and arterial blood analysis revealed *p*H = 7.33, Pa_{CO_2} = 46 mmHg, and Pa_{O_2} = 102 mmHg. The rate and depth of ventilation was varied. Seven minutes later with f = 18 breaths/min, $P_{ET}CO_2$ was 32 mmHg, and the capnographic trace of figure 2C was obtained along with an arterial blood gas analysis, which revealed pH = 7.35, Pa_{CO_2} = 43 mmHg, and Pa_{O_2} = 108 mmHg.

The data of figure 2 indicate that capnographic tracings with well defined plateaus can be obtained using side-stream sampling during jet ventilation for laryngoscopy. The end-tidal to arterial P_{CO_2} differences during controlled ventilation through an endotracheal tube and during jet ventilation are comparable. Therefore, we conclude that reliable capnographic data can be obtained readily with side-stream sampling when jet ventilation is used during laryngoscopy.

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Epidural *Versus* Intravenous Fentanyl Following Thoracotomy

To the Editor:—Although the evidence continues to mount against the clinical application of fentanyl for postoperative epidural analgesia, I still find myself reluctant to abandon fentanyl in favor of morphine. Based on theory and my clinical experience, I had hoped that by delivering fentanyl into the thoracic epidural space, closer to the proposed site of action in the spinal cord, it would provide a more selective spinal analgesic effect and avoid the systemic levels produced with lumbar epidural fentanyl analgesia. Unfortunately, Guinard and his associates, in a carefully designed and well executed study, have effectively proved that even thoracic epidural fentanyl infusions do not appear to offer a substantial reduction in fentanyl requirement and systemic exposure.[1] Although they did offer a glim-