

Jet Ventilation for Otolaryngologic Procedures - A Mini-Review

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Introduction

Jet ventilation is frequently used in the anesthetic management of otolaryngologic procedures where the presence of an endotracheal tube would interfere with the surgery, as with some vocal cord lesions. (Where an endotracheal tube *can* be used, a narrow-bore microlaryngeal (MLT) tube (Figure 1) is often used; such a tube typically has an inner diameter of 5 mm, compared to a conventional endotracheal tube with an inner diameter between 7 and 8.5 mm).

This mini-review presents the essential issues in using jet ventilation methods for otolaryngologic procedures where an endotracheal tube must be avoided.

Ventilation Techniques

Two main techniques are available for jet ventilation for otolaryngologic procedures: [1] use of a simple hand-held device and [2] use of an automatic jet ventilator system. In both cases the usual gas delivered is 100% oxygen, but because of the Venturi effect resulting in the entrainment of room air, the oxygen concentration of resulting mixture is less than 100%.

Simple Hand-held Jet Ventilation Devices

In the case of the hand-held device such as the unit shown in Figure 2 the operator starts operation with a driving pressure set to about around 20 psi¹ (in adults) and provides manually delivered jets of a little under one second duration delivered approximately 10 to 20 times a minute. In most cases the jet ventilation apparatus is attached to an anterior commissure laryngoscope or other type of otolaryngologic laryngoscope via a screw attachment (Figure 3) to provide supraglottic ventilation. The main means of determining that ventilation is adequate is to watch the chest rise with each delivered jet pulse. For safety reasons the driving pressure should be adjusted down to the minimum needed to achieve adequate chest excursions. Note that obese individuals require higher driving pressures to achieve adequate chest excursions as compared to lean patients.

Automatic Jet Ventilation Systems

In the case of an automatic jet ventilator system, a commercial product such as that provided by the Acutronic company may be used to provide infraglottic ventilation (Figure 4). This is usually achieved in conjunction with a infraglottic ventilation catheter (Figure 5). Table 1 lists a set of ventilation parameters that are commonly used with such a unit. Note that the ventilation rates for infraglottic automatic jet ventilation systems are usually much higher (in the range of 100 per minute and upwards) than for

¹ The term "psi" is short for pounds per square inch. One psi equals 51.7 mmHg or 70.3 cmH₂O

the supraglottic manual jet ventilation systems shown in Figure 2 (which typically operate in the range of 10 to 20 per minute).

Anesthetic Technique

After the induction of general anesthesia with propofol and muscle relaxation achieved with a paralytic such as rocuronium, anesthesia is maintained using a total intravenous (TIVA) technique such as a propofol infusion delivered at an initial rate of 100 mcg/kg/min in conjunction with a remifentanil infusion delivered at an initial rate of 0.1 mcg/kg/min. These infusions are then adjusted based on the factors such as the hemodynamics and the depth of anesthesia as guided by clinical findings and (commonly, but not always) by electroencephalographic (EEG) analysis.

In some centers it is common to add 1 mg of remifentanil to 500 mg (50 ml) of propofol and treat the combination as “superpropofol”, delivering it in a single syringe at an initial rate of 100 mcg/kg/min of propofol. When 100 mcg/kg/min of propofol is delivered in this scheme, the resulting rate of remifentanil infusion is then 0.2 mcg/kg/min. This arrangement has the advantage that only a single syringe pump is needed, but has the disadvantage that the two infusions cannot be independently adjusted.

Complications

Most complications associated with the use of jet ventilation are due to use of a high pressure of the delivered gas source. In particular, barotrauma leading to

pneumothorax, pneumomediastinum, or other problems can result from the high pressures used, which can run as high as 50 psi (= 3500 cm H₂O pressure). This is particularly true if gas trapping due to inadequate expiratory pathway takes place.

Take-home Points

- The two main techniques for jet ventilation for otolaryngologic procedures are the use of a simple hand-held device (Figure 2) and use of an automatic jet ventilator system (Figure 4), the latter which generally employs a much higher breathing frequency.
- Jet ventilation in conjunction with an anterior commissure laryngoscope (Figure 3) is usually supraglottic in nature and usually achieved with manual ventilation using a simple hand-held device such as that shown in Figure 2.
- Jet ventilation via an automatic jet ventilator system (Figure 4) is usually supraglottic in nature and generally achieved using a special jet ventilation catheter such as that shown in Figure 5.
- Anesthesia delivery in this setting is by TIVA (total intravenous anesthesia).
- Complications from jet ventilation (pneumothorax, pneumomediastinum) can occur from the use of high gas pressure.

- Driving pressure (DP) **1.0 bar**
- Pause pressure (PP) **20 mbar**
- Peak inspiratory pressure (PIP) **35 mbar**
- Inspiratory time **50 %**
- Frequency (respiratory rate) **100/min**
- Oxygen concentration (FiO₂) **100 %**

Table 1: Typical settings used with the Acutronic Monsoon III Jet Ventilator

(<https://www.acutronic-medical.ch/products/monsoon-iii.html>)

[1] Insertion of jet ventilator catheters.

<https://www.youtube.com/watch?v=FXP-MADWYs>

[2] Jet oxygenation

<https://www.youtube.com/watch?v=QR7ek7VBNiQ>

[3] Hunsaker Mon-Jet Ventilation catheter for Microlaryngoscopy

<https://www.youtube.com/watch?v=51Y9O-xr7Dg>

Table 2: Helpful Instructional Videos on Jet Ventilation

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Figure 1. A typical microlaryngeal (MLT) endotracheal tube (bottom) with a pediatric endotracheal tube (top) for comparison. Such a tube typically has an inner diameter of 5 mm, compared to a conventional adult endotracheal tube with an inner diameter between 7 and 8.5 mm. While the small diameter of the MLT endotracheal tube allows improved surgical access to the glottic structures, in some cases even narrow bore endotracheal tubes such as the MLT interfere with surgical access to the glottic structures, necessitating the use of a tubeless anesthetic technique such as jet ventilation. **Image credit:** http://www.howequipmentworks.com/wp-content/uploads/2015/01/mlt_paeds.jpg



Figure 2. The Manujet III (VBM Medizintechnik GmbH, Germany) is a portable and easily adjusted medical device that can be used for manual jet ventilation. A color-coded gauge shows the proving pressure in bar and psi units. The gas driving pressure can be adjusted between 0 and 3.5 bar (0 to 50 psi). Note that 50 psi of driving pressure is in the range of 3500 cm H₂O and so can readily produce barotrauma (e.g., a pneumothorax) if not used with caution. Most of the time a driving pressure in the range of 20 psi or less is used. **Image Credit:** <https://www.medizintechnik24.com>



Figure 3. An anterior commissure laryngoscope for use in otolaryngologic procedures. Such laryngoscopes are commonly used in conjunction with a hand-held jet ventilator such as that shown in Figure 2, but in some cases jet ventilation can be avoided by using a narrow bore endotracheal tubes such as the MLT endotracheal tube (Figure 1).

Image Credit: <http://www.teleflexsurgicalcatalog.com/surgical/pilling/products/4007>



Figure 4. The Acutronic Monsoon III automatic jet ventilation system. Such systems are commonly used in conjunction with an infraglottic ventilation catheter (Figure 5). Table 1 lists a set of ventilation parameters that are commonly used with such a unit. Note that the ventilation rates for infraglottic automatic jet ventilation systems are usually much higher (in the range of 100 per minute and upwards) than for the supraglottic manual jet ventilation systems shown in Figure 2 (which typically operate in the range of 8 to 20 per minute). **Image Credit:** www.acutronic-medical.ch

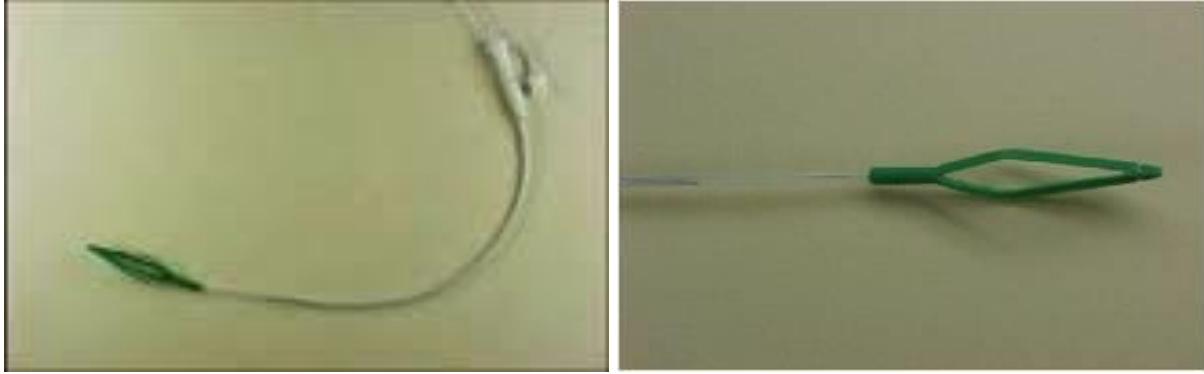


Figure 5. The Hunsaker Mon-Jet intraglottic ventilation catheter. **Image Credit:**

<https://www.aagbi.org>. Note that an instructional video demonstrating the use of the Hunsaker Mon-Jet intraglottic ventilation catheter can be seen online at

<https://www.youtube.com/watch?v=51Y9O-xr7Dg>