Pressure support ventilation during fibreoptic intubation under propofol anaesthesia†

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Goal of the study. To assess the benefit of pressure support ventilation during fibreoptic intubation performed under propofol anaesthesia in patients having an anticipated difficult intubation.

Procedures. Thirty-two patients with ENT cancer, and having at least two criteria for anticipated difficult intubation were prospectively included. All patients received topical lidocaine 2% and propofol by plasma target control infusion (initial target concentration 3 μg ml−1, then adjusted to maintain loss of consciousness without apnoea). They were randomly assigned between two groups: spontaneous breathing (SB) or pressure support ventilation (with a support level set at 10 cm H2O) both using FIO2=1. Conditions for fibreoptic intubation, respiratory parameters (pulse oxymetry, ventilatory frequency, tidal volume and PetCO2 after intubation) and haemodynamic parameters were recorded.

Results. Patient characteristic data and intubation conditions were similar between both groups. All patients had a successful fibreoptic intubation and none needed a rescue procedure because of desaturation. In spite of a longer duration of intubation, PetCO2 after intubation was lower and tidal volume during intubation was higher with pressure support ventilation than in SB patients [38.1 (4.2) vs 42.3 (4.7) mm Hg and 371 (139) vs 165 (98) ml, respectively]. Desaturation episodes were observed in two SB patients conversely to no episode during pressure support ventilation, probably because of the higher minute ventilation.

Conclusion. Pressure support represents a useful method to improve ventilation during fibreoptic intubation under propofol anaesthesia in patients with an anticipated difficult intubation.


Keywords: airway, management; anaesthetics i.v., propofol; intubation, fibreoptic; pressure support

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Pressure support and fibreoptic intubation

Three minutes before induction, patients started breathing spontaneously oxygen (fresh gas flow >6 litre min⁻¹) delivered by the anaesthesia machine (Felix Taema France, Antony, France) in a circle system through a facial mask (Fig. 1) specially designed for fibreoptic intubation (Endoscopy mask, VBM-medical, Sulz, Germany). One of the authors who attempted to maintain a gas tight seal held the mask. In group SB, spontaneous ventilation was maintained until the trachea was intubated (Mallinckrodt safety-flex size 6.5). In the PSV group, PSV was started after loss of consciousness at a pressure level of 10 cm H₂O. Minimal ventilatory frequency was set at 10 bpm: as a result, pressure support ventilation was triggered if spontaneous ventilatory frequency was higher than 10 bpm; otherwise pressure-controlled ventilation was delivered at a rate of 10 cycles per minute. If the tidal volume was lower than 200 ml, airway pressure level was increased by 2 cm H₂O step. Ventilator parameters were standardized: 10 bpm, I:E ratio at 1:2, inspiratory trigger set at the minimal value and maximal inspiratory time at 1.3 s.

Preoperative assessment included patient characteristic parameters (age, height, weight, sex) and predicted difficult intubation criteria: history of difficult intubation, systemic diseases usually associated with difficult intubation, interincisor gap <40 mm, modified Mallampati class including four categories, and neck mobility. Specific criteria related to ENT tumour were added: tongue mobility, cervical radiography, cervical sclerosis and previous cancer ENT surgery.

Intubation conditions assessment included the following parameters: (i) duration of intubation defined as the time elapsed between starting fibrescopy (patient unconscious) and the first respiratory cycle observed on the capnograph after intubation; (ii) the predicted propofol effect-site concentration at the time of intubation; and (iii) clinical upper airway obstruction (partial or complete), hypoxaemia (S₉ₒ₂ < 90%) and subjective difficulties were noted.

After intubation, the first value of end-tidal CO₂ was also recorded. During fibreoptic intubation, the following variables were recorded every 2 min: expired tidal volume, ventilatory frequency, minute ventilation, mean airway pressure, PeCO₂ and SpO₂, as well as non-invasive blood pressure and heart rate.

Statistical analysis

The number of patients to include has been determined as follows: in our experience, propofol light anaesthesia, titrated as described, usually depresses minute ventilation by 50% (2.5 litre min⁻¹ instead of 5 litre min⁻¹) with a variability of 50–60%. Assuming that PSV would restore normal minute ventilation, a sample size of 15 patients in each group would have 95% power to detect a difference in means of -2.5 litre min⁻¹ with a common standard deviation of 2 litre min⁻¹, using a two group t-test with a 0.05 one-sided significance level.
In both groups, decreasing the propofol target concentration did not affect the incidence of apnoea or upper airway obstruction (Table 1). The number of patients who had ventilatory frequency<10 bpm was similar in both groups. Twenty-seven patients in each group had been previously treated for a head and neck cancer either by surgery or by radiotherapy or both.

**Results**

A total of 32 patients [age: 59 (11) yr, height 164 (8) cm, weight 57 (10) kg] were included, 16 in each group. Preoperative variables were similar in both groups. Twenty-seven patients had been previously treated for a head and neck cancer either by surgery or by radiotherapy or both. Most of the patients were classified as class 4 Mallampati (n=28) and presented a severe reduction of inter-incisor gap (15[6] mm).

Predicted propofol effect-site concentration at tracheal intubation was similar between groups, with a large interindividual variability (Table 1).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Pressure support (n=16)</th>
<th>Spontaneous breathing (n=16)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral/nasal intubation</td>
<td>5/11</td>
<td>5/11</td>
<td>NS</td>
</tr>
<tr>
<td>Intubation duration (min)</td>
<td>12.6 (7.2) [2–29]</td>
<td>8.8 (3.6) [3–15]</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Predicted propofol effect-site concentration at intubation (μg ml⁻¹)</td>
<td>3.7 (1.5) [1.7–7.0]</td>
<td>3.5 (1.1) [1.1–6.7]</td>
<td>NS</td>
</tr>
<tr>
<td>Number of patients who had ventilatory frequency&lt;10 bpm</td>
<td>3</td>
<td>2</td>
<td>NS</td>
</tr>
<tr>
<td>Number of patients with upper airway obstruction</td>
<td>3</td>
<td>2</td>
<td>NS</td>
</tr>
<tr>
<td>Number of patients with minimal SpO₂&lt;90 %</td>
<td>0</td>
<td>2</td>
<td>NS</td>
</tr>
<tr>
<td>Oesophageal intubation/Difficult fibreoptic intubation</td>
<td>2/3</td>
<td>0</td>
<td>NS</td>
</tr>
<tr>
<td>Post intubation ECO₂(mm Hg)</td>
<td>38 (4)</td>
<td>42 (5)</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

Results are presented as mean (SD) or number of patients. Student’s t-test was used to compare continuous variables. For others, exact Fisher’s test was used. A value of P<0.05 was considered as a significant threshold.

The number of patients having at least one episode of apnoea or upper airway obstruction was similar (Table 1). In both groups, decreasing the propofol target concentration by 0.5 μg ml⁻¹ steps treated apnoea. In the PSV group, the anaesthesia machine easily ventilated all apnoeic patients whereas in two SB patients, fibreoptic intubation had to be stopped for face mask ventilation. In the SB group, upper airway obstruction (n=2) was partially controlled by adjusting the head position and by jaws thrust. In the PSV group, increasing the level of pressure support above 15 cm H₂O was necessary in two patients (18 and 20 cm H₂O).

The duration of the procedure was statistically longer in the PSV group of patients had a significantly higher tidal volume and minute ventilation and a lower PEEP after intubation than the SB group (Table 2). PEEP during fibrescopy was greater, probably because the tidal volumes were sufficient to register a greater end-tidal value during mask breathing.

Conversely, the ventilatory frequency and mean SpO₂ were similar in both groups as well as blood pressure and heart rate.

**Discussion**

Fibreoptic tracheal intubation is strongly recommended to manage predicted difficult airway. Historically, light sedation was first ensured by diazepam or midazolam. Patients were drowsy but still conscious and responsive. The rate of success was high, nevertheless 45–50% of the patients recalled the procedure and failure may be observed in restless patients or hyper-reactive upper airways. Hypoventilation was rare except when an opioid was given and desaturation could be prevented by preoxygenation and the use of pharyngeal oxygen supply. However, in patients having preoperative upper airway obstruction, complete loss of airway may occur at very light sedation level or even without any sedation. For this reason, those patients were excluded from our study, and had fully awake intubation or tracheotomy, as recommended by academic societies.

General anaesthesia (defined by a loss of consciousness) with SB has then been proposed to improve the patient comfort (analgesia, anxiolysis and amnesia), to facilitate the procedure and to attenuate the response (respiratory or haemodynamic) to the tracheal tube insertion. It should be carefully titrated because an insufficient level of sedation...
may induce severe laryngospasm, whereas excessive sedation may impair airway patency or induce respiratory depression.

However, in some cases, anatomical or technical reasons prolong the duration of difficult fibroptic intubation (up to 28 min in the literature as in our results) and make desirable to maintain both stable spontaneous ventilation and sedation. Performing fibroptic intubation in apnoeic patients requires a fast procedure, in order not to exceed the oxygen storages consumption (2–6 min).

As midazolam may be difficult to titrate to achieve deep sedation without hypoxaemia, general anaesthesia using sevoflurane or propofol has then been proposed. Sevoflurane anaesthesia has been successfully used in patients with predicted difficult intubation in several studies using various intubation techniques (gum elastic bougie, intubating laryngeal mask airway or rigid bronchoscope) without critical incident. It allowed satisfactory spontaneous ventilation in patients without difficult airways with only 16% of apnoea except when sufentanil was added (up to 28%). However, it requires a specially designed face mask and leaks make it difficult to maintain a stable end-tidal sevoflurane concentration and therefore a stable level of sedation.

Propofol is attractive because its i.v. delivery is independent from airway management. It provides unconsciousness, amnesia, good pharyngeal muscles and vocal cord relaxation. However, this relaxation may induce unconsciousness, amnesia, good pharyngeal muscles and vocal cord relaxation. However, this relaxation may induce severe laryngospasm, whereas excessive sedation may impair airway patency or induce respiratory depression.

During anaesthesia, similar benefits may be expected by PSV: it was observed during sevoflurane induction in patients without expected difficult intubation, during iso-flurane anaesthesia (increased tidal volume from 212 to 509 ml) and during anaesthesia using a laryngeal mask airway. In all these situations, clinical benefits were attributed to an increase in minute ventilation and a decrease in work of breathing.

The benefit of PSV during propofol anaesthesia and difficult airway management remained to be studied in other medical context as obesity or sleep apnoea syndrome.

Oxygen supply and a low number of patients included in this study do not allow us to make a conclusion about the preventive effect of PSV on hypoxaemic episodes. In SB patients, desaturation may be related either to upper airway obstruction or to more air mixture through any face mask leaks.

The level of inspiratory pressure necessary to achieve satisfactory tidal volume was low (always <20 cm H₂O), and was unlikely to induce gastric gas insufflation although we did not evaluate this occurrence. Devitt and colleagues measured gastric insufflation at peak airway pressure of 15–30 cm H₂O and found that gastric insufflation incidence rose from 2 to 35%.

A reduction of the respiratory rate (RR) during PSV has been reported in intubated critically ill patients in anaesthetized patients using isoflurane and in awake healthy subjects. We found no reduction in RR with PS; this may be related to the relatively low level of airway pressure which was required to maintain a satisfactory tidal volume in our patients or to the specific respiratory depressant effect of propofol.

No difference in haemodynamic stability was observed between PSV and SB. This is not surprising because average intra-thoracic pressure differences were small and would not have induced detectable haemodynamic change as previously demonstrated when comparing positive pressure ventilation with SB during laryngeal mask anaesthesia.

In conclusion, this study shows that PSV provides more effective ventilation than does SB during fibroptic intubation in patients anaesthetized using a continuous propofol infusion.

Acknowledgement

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