ANAESTHESIA FOR LARYNGOSCOPY: A TECHNIQUE USING THE NUFFIELD ANAESTHETIC VENTILATOR

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SUMMARY

An inflation catheter technique has been devised for providing general anaesthesia during laryngoscopy using the control module of the Nuffield Anaesthetic Ventilator driven by 50% nitrous oxide in oxygen. The system is simple and reliable in use and ensures adequate pulmonary ventilation.

The principle of jet ventilation through the open airway during laryngoscopy or bronchoscopy is now well established and many modifications of Sanders’ (1967) original technique have been described. One such modification is that of Smith, Babinski and Petruscak (1974) in which ventilation during laryngoscopy is maintained by the intermittent injection of oxygen through a small-bore catheter passed between the vocal cords. It is probable that jet injectors of this type produce little or no air entrainment (Carden and Schwesinger, 1973; Carden et al., 1973), so that useful supplementation of anaesthesia may be expected if nitrous oxide is added to the ventilating gas. For this reason, Poling, Wolfson and Siker (1975) modified Smith’s original method using 57% nitrous oxide in oxygen and demonstrated the adequacy of ventilation of patients undergoing laryngoscopy. Gillick (1976) added a further refinement by controlling the high pressure supply to the injector with an automatic ventilating device (Wolf Injectomat 2025).

The Nuffield Anaesthetic Ventilator (previously known as Pneupac A.P.) (Adams and Henville, 1977) is a compact, gas-powered, pneumatic logic ventilator which incorporates a detachable patient valve. When this valve is removed, the control module may be used to cycle a high-pressure gas source in the manner described by Gillick (1976).

Our experience in ventilating patients through a nasotracheal catheter with a Nuffield Ventilator driven by 50% nitrous oxide in oxygen (“Entonox”) is reported here.

METHOD

Entonox was supplied from cylinders at a reduced pressure of 412 kPa (4 bar) through a reducing valve connected to the driving gas inlet of a Nuffield Anaesthetic Ventilator from which the patient valve had been removed (fig. 1). A length of flexible hosing connected the control module outlet to a 14-f.g. suction catheter which had been marked at a point 7 cm from the distal tip.

Ten patients, who had given informed consent, received premedication with an opiate and either atropine or hyoscine approximately 1 h before operation. Immediately before induction of anaesthesia a specimen of blood was obtained in heparin from the radial artery while the patient was breathing room air. Anaesthesia was induced with a sleep dose of thiopentone followed by either suxamethonium 75–100 mg or pancuronium 5–7 mg (depending upon the anticipated length of the procedure). At the onset of paralysis the cords were sprayed with 10% lignocaine 50–100 mg and the 14-f.g. suction catheter introduced nasally and passed into the trachea so that the 7-cm mark was at the level of the cords. An oral airway was inserted which remained in situ until the surgeon introduced the laryngoscope. Ventilation was commenced with an inspiratory flow rate of 1 litre s⁻¹ (inspiratory time 1.5 s; expiratory time of 3.5 s). A second arterial blood sample was obtained after 10 min. The arterial specimens were stored in ice-cold water and analysed within 30 min of collection for $P_O_2$, $P_C_O_2$ and pH. Further supplements of suxamethonium or pancuronium were given when indicated clinically. No anaesthetic adjuvants were administered.

After operation the patients were questioned about awareness during the procedure.
RESULTS
Details of the patients and durations of anaesthesia are shown in Table I. In all instances $P_{aCO_2}$ during anaesthesia was smaller than the value before surgery. The difference between the mean values was 0.93 kPa ($P < 0.005$ by paired Student's $t$ test). In all patients $P_{aO_2}$ during anaesthesia was greater than the value before operation.

No patient complained of awareness.

DISCUSSION
The advantages of jet ventilation during micro-laryngeal surgery have been discussed by Tobias, Nassar and Richards (1977) and the present study confirmed the findings of those and other authors (Smith, Babinski and Petrusca, 1974; Poling, Wolfson and Siker, 1975).

The ventilator control module will deliver a gas flow of up to 60 litre min$^{-1}$ at a pressure of 250 kPa and it can be driven by most gases or mixtures of gases in clinical use. Although these flow rates and driving pressures are less than those reported in some studies (Poling, Wolfson and Siker, 1975; Tobias, Nassar and Richards, 1977) the ventilating capacity of the system (as assessed by arterial blood-gas analysis) was adequate for all the patients in this study. However, jet ventilation systems behave as pressure generators (Pybus and Adams, 1978) and

<table>
<thead>
<tr>
<th>Patient's age (yr)</th>
<th>Patient's weight (kg)</th>
<th>Duration of anaesthesia (min)</th>
<th>$P_{aO_2}$ (kPa) Before operation</th>
<th>$P_{aO_2}$ (kPa) During operation</th>
<th>$P_{aCO_2}$ (kPa) Before operation</th>
<th>$P_{aCO_2}$ (kPa) During operation</th>
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<tr>
<td>25</td>
<td>57.2</td>
<td>15</td>
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<td>5.10</td>
<td>3.90</td>
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<tr>
<td>39</td>
<td>70.0</td>
<td>10</td>
<td>11.0</td>
<td>23.0</td>
<td>5.75</td>
<td>5.21</td>
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<td>78</td>
<td>59.7</td>
<td>25</td>
<td>8.7</td>
<td>29.0</td>
<td>5.42</td>
<td>5.39</td>
</tr>
<tr>
<td>70</td>
<td>63.8</td>
<td>20</td>
<td>10.4</td>
<td>31.9</td>
<td>5.10</td>
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<tr>
<td>23</td>
<td>73.0</td>
<td>30</td>
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<td>37.5</td>
<td>6.18</td>
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<tr>
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<td>9.8</td>
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<td>10.9</td>
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<td>5.48</td>
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<tr>
<td>Mean</td>
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<td>28</td>
<td>10.7</td>
<td>32.0</td>
<td>5.42</td>
<td>4.49</td>
</tr>
</tbody>
</table>
they may not be able to ensure adequate ventilation in patients with unusually low lung compliance.

The frequency of awareness during laryngoscopy when anaesthesia is maintained by i.v. agents alone has been estimated at 4% (Barr and Wong, 1973), and it has been suggested that the addition of nitrous oxide to the ventilating gas will reduce this frequency. It was not possible to measure arterial nitrous oxide tensions or gas entrainment ratios in this study, but examination of the blood-gas measurements obtained suggests that if changes in arterial oxygen tension consequent upon changes in inspired tension follow iso-shunt lines (Benatar, Hewlett and Nunn, 1973), then little air entrainment has occurred. Laboratory studies have confirmed that very low entrainment ratios are found when the lungs are ventilated in this manner (Carden and Schwesinger, 1973) and have demonstrated an inverse relationship between the jet diameter and the entrainment ratio (Pybus and Adams, 1978).

No patients complained of awareness, although the numbers involved are too small to permit statistical evaluation. Fifty per cent nitrous oxide in oxygen failed to abolish awareness in about 25% of patients undergoing Caesarean section, following premedication with atropine alone (Crawford, 1971). However, the use of premedication with an opiate and hyoscine, topical analgesia, and the less stimulating nature of laryngoscopy, may be expected to reduce this frequency considerably. Because it is possible to ensure adequate oxygenation in most patients when a higher Fi \textsubscript{NO} is used (Poling, Wolfson, and Siker 1975; Gillick, 1976), “Entonox” may not be the ideal gas mixture and a nitrous oxide in oxygen mixing device may be preferable to drive the control module so that a higher concentration of nitrous oxide may be administered.

If air entrainment does not occur, it is probable that gas will flow from the trachea to the pharynx throughout the ventilatory cycle, thereby reducing the risk of inhalation of blood or debris from the operating field. In our experience, inhalation has not been a problem.

The use of the control module instead of the handheld trigger allows accurate adjustment of inspiratory and expiratory times and injector flow rates while freeing the hands of the anaesthetist. In theory, it is possible to ventilate the lungs of children by selecting lower inspiratory flow rates, higher ventilatory frequencies and the use of a smaller nasotracheal catheter.

Tobias, Nassar and Richards (1977) stress the importance of waiting until the surgeon has exposed the larynx before commencing jet ventilation, thereby avoiding the hazards associated with continuing high-pressure gas flow in the presence of an occluded upper airway. In practice, insertion of an oral airway before exposure of the larynx seemed a satisfactory alternative.

The system has been found to be simple and reliable in use and gives the surgeon excellent access to the larynx. If bronchoscopy is undertaken subsequently, the control module can be switched easily to provide bronchoscopic ventilation through a Sanders Injector (Pybus and Adams, 1978) while the endotracheal catheter remains in situ.

ACKNOWLEDGEMENTS
We are grateful to Mr W. S. Lund, M.S., F.R.C.S., for permission to study the patients under his care.

REFERENCES
On a mis au point une technique basée sur une sonde d’inflation pour administrer l’anesthésie générale pendant une laryngoscopie, en utilisant un module de contrôle du ventilateur anesthésique de Nuffield, entraîné par un mélange à 50% de protoxyde d’azote et d’oxygène. Le système est simple et fiable et permet d’assurer une ventilation pulmonaire adéquate.

NARKOSE FÜR LARYNGOSKOPIE: EINE METHODE MIT VERWENDUNG DES ANÄSTHETISCHEN NUFFIELD-VENTILATORS

ZUSAMMENFASSUNG