Early institutional experience with the use of high-flow nasal oxygen therapy (HFNOT) for pediatric endoscopic airway surgery

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BACKGROUND

• Parallel access for surgical intervention and ventilation represents the major challenge in pediatric endoscopic airway surgery
• Classical techniques to achieve this goal include
  • Intermittent apnea/oxygenation: not suitable for small children
  • Spontaneous breathing: essential for diagnostic procedures but carries an inherent risk of hyperventilation and injury in potentially moving patients
  • Ventilation through a small tube: potentially hinder access to and exposure of the larynx
  • High-frequency jet ventilation: commonly used in adults but not suitable in newborns and small infants
• Use of high-flow oxygen (70 L/min) results in oxygenation and even a ventilatory effect as long as the airway is patent
• Techniques exploiting the phenomenon of ventilatory mass flow or apneic oxygenation have been recently implemented in intensive care settings
• Here we report our early experience with high-flow nasal oxygen therapy (HFNOT) in endoscopic pediatric airway surgery

PATIENTS AND METHODS

Study design
• Prospective observational study (01/2016 – 07/2017)
• Included were pediatric patients undergoing pediatric airway surgery
• Altogether were included 6 patients and 14 procedures

Anesthesia technique
• Induction with sevoflurane; propofol drip (25 mg/kg/h) with remifentanil 0.3 μg/kg/min
• If needed, intubation with a small tube relayed by the Optiflow™ system (Fisher & Paykel)
• HFNOT system was started at a weight-adapted flow of 4 L/kg (children under 5 kg) or 2 L/kg (children above 5 kg)
• Interruption criteria:
  • Rise of transcutaneous CO2 (tcCO2) > 90 mmHg
  • Desaturation (SpO2) < 80%
  • Hemodynamic instability, arrhythmia
• When multiple apneic cycles were needed, patient were endotracheally intubated to correct hypoxemia or hypercapnia

Monitoring
• Pulse oximetry, noninvasive blood pressure, ECG and body temperature
• Transcutaneous CO2
• Monitoring parameters recorded with a patient data management system

RESULTS

Patients’ characteristics

<table>
<thead>
<tr>
<th>Patient (age/gender)</th>
<th>Diagnosis</th>
<th>Procedures</th>
<th>Last follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient 1 (4 mo/male)</td>
<td>Posterior glottic stenosis</td>
<td>Endoscopic debridement Endoscopic cricoid split</td>
<td>Tracheotomy-free</td>
</tr>
<tr>
<td>Patient 2 (3 yr/male)</td>
<td>Thermal injury of larynx</td>
<td>Endoscopic debridement</td>
<td>Full recovery</td>
</tr>
<tr>
<td>Patient 3 (3 mo/fem)</td>
<td>Juvenile recurrent papillomatosis</td>
<td>Debridement and cidofovir injections</td>
<td>Persistent disease</td>
</tr>
<tr>
<td>Patient 4 (1 mo/male)</td>
<td>Subglottic and posterior glottic stenosis</td>
<td>Bouginage Endoscopic posterior glottic expansion</td>
<td>Tracheotomy-free</td>
</tr>
<tr>
<td>Patient 5 (2 mo/fem)</td>
<td>Posterior laryngeal cleft</td>
<td>Cleft repair</td>
<td>Full recovery</td>
</tr>
<tr>
<td>Patient 6 (6yr/male)</td>
<td>Laryngomalacia</td>
<td>Supraglottoplasty and bouginage</td>
<td>Full recovery</td>
</tr>
</tbody>
</table>

Characteristics of included patients, Age at diagnosis ranged 1 day to 3.5 years-old; Age at first surgery was 4 months to 14 years-old; weight range at surgery ranged 3.0-72.0 kg

Effects of respiratory gases

Variations of end-tidal CO2

Effects of HFNOT on respiratory gases. Each patient underwent between 1 and 4 apneic cycles per procedure; no intraoperative or postoperative complications were observed.

Upper panel: variation of eCO2, before and after HFNOT. Maximal eCO2 observed was 86 mmHg after a period of 11 min.

Lower panel: rise-rate of end-tidal CO2

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DISCUSSION AND CONCLUSIONS

• HFNOT is a safe and versatile ventilation technique for tubeless, endoscopic airway surgery in children
• In our early experience we did not observe complications related to the use of HFNOT
• A wide range of conditions were amenable to tubeless endoscopic surgery with the assistance of HFNOT

Applications

A. HFNOT (Optiflow™) system installed in the frame of a microlaryngoscopy (Patient 5); B, preoperative and C, postoperative views of a subglottic stenosis dilated under HFNOT