

Red flags in paediatric anaesthesia

“Sharing the airways”

ANDREAS MACHOTTA MD DEAA

Department of Anaesthesiology, Sophia Children’s Hospital, Erasmus MC Rotterdam,
Netherlands

Dr. Andreas Machotta DEAA

Department of Anaesthesiology

Sophia Children’s Hospital, Erasmus MC Rotterdam

P.O. Box 2040, Dr. Molewaterplein 60

3000 CA Rotterdam, The Netherlands

Tel: +31 10 7036363

Fax: +31 10 7036804

E-mail: a.machotta@erasmusmc.nl

Introduction

Sharing the paediatric airway with a surgeon for diagnostic procedures or surgical interventions can be a challenging task for the anaesthetist. Establishing a safe airway the anaesthetist has to provide maximum safety for the paediatric patient combined with best conditions for the investigator or surgeon. There are only a few situations where this can be achieved by intubating the child's trachea with an endotracheal tube. In most cases ventilation techniques such as mask ventilation, laryngeal mask, ventilator bronchoscope or high frequency jet ventilation (HFJV) must be used. Furthermore a good personal rapport and effective communication between the anaesthetist and the surgeon or investigator is necessary to obtain the best diagnostic and surgical results.

Clinical situation

Many of the children who are scheduled for these interventions have "airway problems" and can present a difficult or even compromised airway. During the intervention the anaesthetist has limited access to the child's airway, because specific surgical instruments are often introduced into the child's larynx or trachea. Manipulation of the paediatric airways, even during diagnostic interventions always causes airway lesions and these can lead to serious complications.

Indications

Basic ENT-surgery such as adenotonsillectomy or plastic repair of palatoschisis are the most frequent interventions for which one has to share the paediatric airway with a surgeon. In most cases these children do not have comorbidity and show normal airway anatomy, but patients with tonsillitis, peritonsillar, retro- or parapharyngeal abscesses or obstructive sleep apnoea can present with a difficult airway (1-2). Children with palatoschisis may show other craniofacial malformations including a difficult airway. The use of a laryngeal mask (LMA) and/ or endotracheal intubation will provide a safe airway together with good operation conditions in most cases.

Elective tracheostomy, fiberoptic endoscopy of the airway and rigid bronchoscopy for diagnostic purpose and foreign body retrieval are mostly performed in children with a difficult or compromised airway (3-4). These children can present stridor, hypoxemia, upper and lower airway obstruction, bronchial obstruction and pneumonia. Tracheal intubation will not always provide the best operation conditions for the surgeon or the investigator. Therefore the anaesthetist should be trained to use various airway devices to ensure a proper airway and sufficient ventilation.

Serious airway problems such as stridor, supra- and subglottic stenosis are common in children undergoing endoscopic subglottic stenting, endoscopic surgery of the paediatric larynx and trachea and open laryngotracheal reconstruction. Life threatening hypoxia can occur during emergency tracheostomy. During these interventions the attending anaesthetist must be trained to manage children with difficult and compromised airways, and must have enough experience to use a range of paediatric airway devices and ventilation techniques including HFJV. Furthermore one must be familiar with and follow the precautions if LASER technology is used (5).

Choice of anaesthetic technique

Anaesthetic medications

During the intervention, a deeply anaesthetized child is required with good damping of airway reflexes, who is even able to breathe spontaneously when asked by the surgeon. After the intervention the child should breathe spontaneously when fully awake, with good airway reflexes, and excellent expiratory capacity to clear the secretions. To manage these two demands we need short acting, good controllable anaesthetic agents which have a wide range of safety.

Sevoflurane provides excellent airway protection with no cardiac side effects such as arrhythmogenicity or negative inotropy even when used in high dosages (6). Propofol is a short acting drug, well suited for these procedures in children. Furthermore it does not contaminate the environment of the operation theatre when open breathing and ventilatory systems are used (7).

When used in children, the synthetic μ -agonist Remifentanyl has a very short plasma half life, comparable to those in adults. It is short acting, provides good damping of airway reflexes, and

infusion rates up to 1 µg/kg/min do not produce cardiovascular instability in otherwise healthy children (8). The application of lidocaine as topical analgesic of the larynx and the trachea prevents coughing, bucking and laryngospasm. Due to the known side effects if plasma levels become too high, it should be used in the 1% concentration and the maximum dose should not exceed 4 mg/kg body weight (9). The preoperative application of anticholinergic agents such as atropine or glycopyrrolate to dry airway secretions and to prevent reflex-induced bradycardia is controversial. Although supported by some authors (5) it could be demonstrated in adults that the application of anticholinergic drugs prior to bronchoscopy has no positive effect with regard to intraoperative complications (10).

Inhalation induction versus intravenous induction

Most children undergoing diagnostic or interventional airway endoscopy or open surgery for laryngotracheal repair will present a difficult or compromised airway. Recently published surveys demonstrate that an inhalation induction with sevoflurane in those children is the preferred technique among paediatric anaesthetists in Canada (11) and also non specialised anaesthetists in the United Kingdom (12). Malherbe et al. demonstrated that an intravenous induction technique for paediatric airway endoscopy with a loading dose of 1-5 mg kg⁻¹ propofol aiming to maintain spontaneous breathing will be a safe alternative. (13).

Spontaneous breathing versus controlled ventilation

A variety of anaesthetic techniques have been described for airway endoscopy and airway surgery emphasizing the need for spontaneous breathing or the use of muscle relaxants. Whereas there is no evidence of superiority of a decent technique, the supporters of the spontaneously breathing patient argue that there is a better gas exchange, less chance of pneumothorax and dislodging of foreign bodies and surgical specimen than with positive pressure ventilation. Furthermore, spontaneous breathing can be requested by the investigator for diagnosis of laryngomalacia, vocal cord palsy, tracheomalacia or bronchomalacia. Differently controlled ventilation and the use of a muscle relaxant allows light anaesthesia and prevents

coughing, bucking and movement of the patient. In addition the positive airway pressure impedes atelectasis of the lung and compensates the enhanced airway resistance of the rigid bronchoscope.

Monitoring

Basic paediatric monitoring such as precordial stethoscope, pulse-oximetry, ECG, blood-pressure measurement, body-temperature, inspiratory and expiratory gas measurement, airway pressure and the measurement of tidal volumes are mandatory. During fiberoptic endoscopy the measurement of airway gases and tidal volume can be misleading if the suction channel of the fibrescope is connected with a suction device. During rigid bronchoscopy and HFJV, leaking of airway gases hinders obtaining reliable values of end-tidal CO₂ and tidal volume. Careful observation of thorax movements and listening to breath-sounds with the praecordial stethoscope are essential direct monitoring devices. An arterial line should be inserted during open airway surgery and long-lasting jet ventilation to monitor arterial blood gases.

Complications

Intraoperative complications

During the intervention, hypoxemia and severe hypercarbia can occur as a result of inadequate ventilation. Laryngospasm and bronchospasm can arise during light anaesthesia due to insufficiently damped airway reflexes. Bronchospasm can also occur as a consequence of histamine release if we use a histamine liberator like mivacurium. Tracheal, bronchial and laryngeal lesions, oedema, bleeding or pneumothorax are also possible. During foreign body extraction or endoscopic airway surgery, dislodged excised material or the “dropped foreign body” during its removal are complications that can cause life threatening airway obstruction particularly if the dislodged foreign body or tumour obstructs larynx and trachea. Retrieving the obstacle or pushing it into the left or right main bronchus are the only options to overcome this airway obstruction and to ensure ventilation.

HFJV provides good visualization of the operating field but can cause barotrauma such as pneumothorax, pneumomediastinum, skin emphysema due to the high inflation pressure. Particularly in children with subglottic stenosis care should be taken because high PEEP can develop in the lungs because expiratory gas flow is only driven by the elastic forces of the expanded thorax and lung (14). Dehydration, low body temperature and contamination of the dependent lungs with blood, tissue and infective material are further complications of HFJV. When using LASER-technology for surgery of the airway, no combustible material such as plastic tubes or sponges should be in the operation field. Special designed LASER-tubes are often quite rigid and have thick sidewalls, making them less suitable in children. Oxygen concentration should be reduced to 21% to prevent ignition and combustion (5).

Postoperative complications

Children with compromised airways such as stenosis have a narrow airway. They can develop acute stridor, dyspnoea and hypoxemia after the intervention because even careful manipulation of a narrow airway with rigid instruments can lead to formation of an oedema and postoperative obstruction. The application of intravenous dexamethasone 0.1 – 0.3 mg/kg body weight and the inhalation of vasoconstrictors such as adrenaline can be helpful in this situation.

As anaesthetists, we can not prevent these complications in most cases, but we can anticipate them and be prepared to manage the situation.

Practical considerations

Understanding the procedure

Before starting the anaesthesia, it is vital to have a clear understanding of the pathology, the diagnostic plan and the surgical procedure including the knowledge of possible complications, mishaps and their management. Anticipating what could happen and how one should react can be crucial particularly in children with compromised airway, stridor and stenosis. In case of a complication these patients will immediately become hypoxemic. A preformed plan about what

one should do in this situation and efficient communication between the anaesthetist and the surgeon are keystones to manage such a situation quickly and successfully.

Preparing the anaesthetic workplace

Setting and adequate preparation of the anaesthetic workplace is important. The anaesthetist has to be at the side of the surgeon to enable direct communication and to offer immediate access to the child's airway. All the instruments and medications that could be needed to manage possible complications and to establish a safe airway should be laid out on a table that can be reached easily by the anaesthetist. Because theatre light will be dimmed during endoscopic procedures, a ready light-source should be available for the anaesthetic workplace and the instrumentation table. A dark table cover such as a blue or green towel will make it easier to recognise the instruments on it.

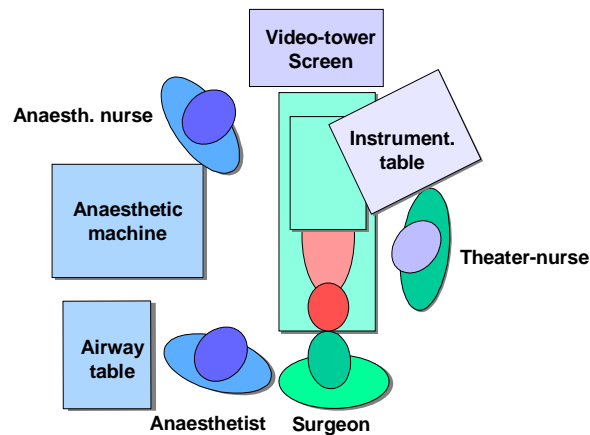


Fig.: Setting of the anaesthetic workplace

Communication-skills

Before starting, all team members should be informed about the procedure, the condition of the patient, the diagnostic or surgical plan, and the equipment needed. During critical situations our communication with the surgeon or investigator should be clear and directed to solve the problem rather than to accuse. We should avoid attributing blame with unhelpful "you messages" such as

“You must stop, or else...” and should rather use direct “I messages” such as “I’ll take over now and ventilate...”. A short “debriefing” after the intervention can help to identify the weak points, to improve communication and to prevent possible mishaps.

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