Two cases of the “cannot ventilate, cannot intubate” scenario in children in view of recent recommendations

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Abstract

We present two cases of a “cannot ventilate, cannot intubate” scenario in children in view of the latest guidelines for the management of unexpectedly difficult paediatric airways.

Case 1 was a 5-year-old boy with Treacher-Collins syndrome who suffered gastric rupture due to gastric distension with oxygen during attempts to maintain oxygenation at the induction of anaesthesia. Difficulties in maintaining this patient’s airways should be attributed to functional rather than anatomical obstruction, because no such problem occurred during subsequent anaesthetic inductions; therefore muscle relaxation would be helpful in this situation.

In case 2, vecuronium was used in a 10-month-old infant scheduled for elective laryngoscopy because of stridor due to vocal cord paralysis. Because of congenital maxillo-facial malformation, the infant could not be intubated, and ventilation via a face mask became difficult. Facing rapid deterioration of oxygenation, neuromuscular block was reversed with the use of sugammadex. The recovery of spontaneous respiration was almost immediate, and normal motor function returned within 90 s.

Functional airway obstruction due to laryngospasm, insufficient depth of anaesthesia, or opioid-induced muscle rigidity with glottic closure can occur in a healthy child, as well as in a child with difficult airways, and requires clear concepts and therapeutic algorithms. Recent paediatric guidelines for the management of unexpectedly difficult airways stress the role of muscle relaxants in overcoming functional airway obstruction. The possibility of reversing neuromuscular block produced by rocuronium or vecuronium with sugammadex to awaken the patient adds to the safety of this algorithm.

Key words: children, difficult airway; muscle relaxants, vecuronium; muscle relaxants, antagonists, sugammadex

The incidence of difficult endotracheal intubation is higher than the incidence of difficult mask ventilation [1–3]. Maintenance of airway patency and gas exchange is particularly important in small children because their hypoxia-tolerance time can be shorter than the time needed to perform difficult intubation. Hypoxia can lead to perioperative cardiac arrest and death or permanent damage to the brain. These complications are more common in children < 3 years of age than they are in older children [4, 5]. Airway obstruction can be either anatomical or functional [6]. In cases with difficult bag and mask ventilation (after insertion of the oropharyngeal or nasopharyngeal airway) in children with a normal airway, functional airway obstruction should be suspected due to laryngospasm, insufficient depth of anaesthesia or opioid-induced muscle rigidity with glottic closure. In such cases, the administration of muscle relaxants is helpful, and this approach has recently been suggested by many authors for children with normal upper airway anatomy [6–10].

None of the management algorithms for difficult airway in adults considers possible functional airway obstruction. However, a recent British guidelines recommend muscle relaxation when surgical access to the airway has to be obtained and waking up the patient is not an option [11].
Here, we report two cases of difficulties in airway maintenance during mask ventilation and endotracheal intubation.

CASE 1

A five-year-old boy with Treacher-Collins syndrome was admitted to our hospital because of gastrointestinal perforation. One day prior to admission, the patient was scheduled for an elective surgical procedure under general anaesthesia in another centre. Although the anaesthesiology team had experience intubating patients with craniofacial deformities, intubation attempts under inhalation anaesthesia with sevoflurane failed. The retrospective analysis revealed that during the induction of anaesthesia, it was impossible to maintain airway patency and provide gas exchange. Thus, to maintain oxygenation, bag and mask ventilation with high-pressure oxygen was required. This resulted in gastric distension and subsequent rupture (Fig. 1).

A laparotomy was necessary and we had to perform endotracheal intubation. Considering the difficulties that the other team faced, we requested the assistance of a laryngologist. If intubation failed, the laryngologist could use a rigid bronchoscope/bronchofibrescope or perform tracheostomy in the child whose lungs were ventilated through the laryngeal mask.

After premedication with i.v. atropine 0.01 mg kg⁻¹, the patient underwent a volatile induction of anaesthesia with 100% oxygen and sevoflurane. The concentration of sevoflurane was increased incrementally every few breaths from 0.5% to 7% in the inspired gases. The initial difficulties in providing gas exchange were overcome by changing the round face mask into the profiled mask (Rendell-Baker type, without a cuff). The insertion of an oropharyngeal airway was not helpful in this case. The patient was intubated once the masseter muscle tone and reaction to pain (caused by masseter angle compression) were lost. Although the glottis was not visible after the introduction of a laryngoscope (Cormack-Lehane grade 4), we inserted a 5.0 endotracheal tube without a cuff on the first attempt. The same technique and devices were used during subsequent anaesthesias. One attempt was needed to insert the tube during the second surgical procedure, and two attempts were required during the third procedure. In all cases, extubation was uneventful.

During the first laparotomy, the site of perforation was not detected within the lower oesophagus or stomach, and the gastric tube and peritoneal drainage catheter were kept in place. On day 2, a gastrointestinal haemorrhage developed. An abdominal ultrasound showed that the stomach was filled with thrombi. A conservative treatment was initiated, but on hospitalisation day 5, haemorrhage from the upper digestive tract increased (Fig. 2). On day 9, gastros-
copy was performed, but no oesophageal haemorrhage was observed. The stomach was found to be filled with blood clots. During the second laparotomy, the anterior gastric wall was opened, and the clots were removed. Three linear sites of bleeding were visualised on the posterior wall, and these sites were secured. On the following day, haemorrhage leading to severe anaemia reappeared. On day 12, the laparotomy was repeated, and after opening the stomach, two additional sites of haemorrhage were found and surgically secured. The postoperative period was uneventful; on treatment day 27, the boy was discharged from hospital in good general condition.

**CASE 2**

A nine-month-old infant weighing 5900 g was admitted for diagnostic procedures for laryngeal stridor. The girl was born at gestational week 40 in good condition. However, respiratory failure occurred on the first day due to congenital pneumonia. At that time the trachea was intubated without difficulties, despite face dysmophia. After extubation, laryngeal stridor was diagnosed, and the girl was discharged. Upon admission to our hospital, severe laryngeal stridor, retraction of the jugular notch and use of additional respiratory muscles were observed. There were visible abnormalities of craniofacial and neck structures including the following: micrognathia, the large tongue moved backwards, low-located ears, shallow-placed eyeballs, a decreased anterior-posterior dimension of the pharynx and a short and flipper-like neck. Ultrasound of the larynx revealed immobile vocal cords, which was considered the cause of stridor. The child was scheduled for an endoscopic examination of the larynx under general anaesthesia. The intubation conditions according to the Mallampati scale were assessed as class 3. Based on the data (intubation during the neonatal period without difficulties) and the diagnosed cause of stridor (paralysis of vocal cords), intravenous induction of anaesthesia and administration of muscle relaxants were selected. After initial oxygenation, 3 mg kg⁻¹ propofol and 2 µg kg⁻¹ fentanyl were administered. Once no difficulties in bag and mask ventilation were encountered, 0.1 mg kg⁻¹ vecuronium was given. The anaesthesia was continued with 3% sevoflurane in 100% oxygen. The lungs were ventilated through the face mask using the Jackson-Rees system. The attempts to visualise the larynx using a Macintosh laryngoscope blade 1 and a straight blade failed. There were difficulties maintaining ventilation and proper arterial blood oxygen saturation (a decrease in SaO₂ to 75%). The stomach filled with oxygen, and we decided to abandon the procedure. Sevoflurane was discontinued, and 8 mg kg⁻¹ of sugammadex was administered. Spontaneous efficient breathing returned 25 s after the drug administration. Ninety seconds later, the child regained consciousness. The skeletal muscle tone was normal, and respiration was efficient but hindered by severe stridor. Oxygen saturation (SaO₂) was normal (99–100%) at passive oxygen therapy (FiO₂ approximately 0.4). The time from the administration of vecuronium to the administration of sugammadex did not exceed 6 minutes.

The procedure was re-attempted on the following day. After premedication with atropine 0.01 mg kg⁻¹, the patient underwent volatile induction with halothane in 100% oxygen. The concentration of the anaesthetic in inspiratory gases was gradually increased from 0.5% until provision of deep anaesthesia enabling intubation. The larynx was visualised using a straight blade modified according to Miller (the tip bent at the angle of approximately 60°). The “bougie” wire was inserted to introduce a 4.0 mm endotracheal tube. The laryngoscopy demonstrated the patient had a low larynx location, and it was not possible to inspect it thoroughly using a rigid directoscope or bronchoscope due to the retracted mandible, large tongue and decreased anterior-posterior dimension of the pharynx. The epiglottis was wide, flat, slightly rotated to the left and flaccid. The arytenoids were symmetrical, and the interarytenoid notch was widened. The vocal cords were adducted, and the subglottic region was wide. Once bilateral paralysis of vocal cords and laryngomalacia were diagnosed, a tracheotomy was performed without complications. The further treatment was uneventful, and the child was discharged.

**DISCUSSION**

In the first case, the team of experienced anaesthesiologists followed the guidelines indicating that muscle relaxants should not administered to a child whose airway is difficult to maintain during bag and mask ventilation [12]. In this case, the patency of upper airways was not maintained during the induction of anaesthesia when the anaesthesia was not deep enough to attempt intubation. The administration of high-pressure oxygen through the face mask led to life-threatening complications. Relative ease of volatile induction in our centre, where the boy was transferred to for the treatment of the complications may suggest that the problems with ventilation resulted from the functional obstruction of the airways (laryngospasm, insufficient depth of anaesthesia and/or gastric distention). If the cause had been anatomical, the second team of anaesthesiologists would have faced similar difficulties as the first team in maintaining patent airways. In accordance with the algorithm suggested by Weiss and Engelhardt [6, 7], the administration of muscle relaxants could be helpful in this case.

The administration of muscle relaxants and eliminating the patient’s spontaneous breathing in the situation where the maintenance of airway patency is considered dangerous. However, it is worth emphasising that a neuromuscular block caused by rocuronium or vecuronium can be
quickly and almost immediately reversed with sugammadex. Thus, in situations where lung ventilation after administration of a muscle relaxant remains difficult, spontaneous breathing can be quickly restored (or to provide surgical access to airways) performing tracheostomy of the paralysed child, as recommended in adults if the patient can be awakened [11].

In the management algorithm suggested by Weiss and Engelhardt in 2010 [6, 7], the administration of muscle relaxants in cases of unexpected difficulties in ventilation and intubation of a healthy child with normal craniofacial and airway anatomy is appropriate. In our patient with Treacher-Collins patent syndrome, unanticipated difficulties in maintaining upper airways occurred, and the difficulties were more serious than those anticipated by the experienced team of anaesthesiologists. Analysing the entire treatment strategy, one can speculate that in this particular situation, the use of muscle relaxants, although beyond the standard management guidelines, would most likely have prevented the severe life-threatening complication. According to the latest British recommendations [11], the panel of experts advocates the use of muscle relaxants in such situations. The above recommendations concern adults; the British recommendations for children are still being prepared (APAGPI 2012).

The observations resulting from the second case indicate that the return of spontaneous breathing after administration of the “rescue” dose of sugammadex is almost immediate. The problem is that this dose of sugammadex has not been approved for children [13]. However, because neostigmine would be definitely ineffective [14], the off-label use of sugammadex should be considered for the patient’s safety.

CONCLUSIONS

Situations in which a skilled anaesthesiologist cannot provide effective gas exchange in a child are so rare that even experienced teams sometimes fail to handle it efficiently. Therefore, continuous training is essential. A training programme complying with the algorithm proposed by Heard et al. [15] and modified for paediatric patients may be an option, but it needs to be taken into account that the puncture of the crico-thyroid membrane in children below 8 years of age is difficult and associated with a high failure rate and complications.

In the case of unanticipated difficult intubation and an inability to provide gas exchange in healthy children, as well in those with difficult airway, the administration of rocuronium or vecuronium to eliminate the cause of airway obstruction related to laryngospasm, insufficient depth of anaesthesia or opioid-induced muscle rigidity resulting in glottic closure, and the “rescue” dose of off-label sugammadex should be considered.

CONFLICT OF INTEREST

Bogumiła Wołoszczuk-Gębicka is a member of the European Advisory Board of MSD.

References:


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