Clinical paper

Laryngeal tube suction II for difficult airway management in neonates and small infants

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A R T I C L E   I N F O

Article history:
Received 31 December 2008
Received in revised form 28 February 2009
Accepted 3 March 2009

Keywords:
Laryngeal tube
Airway management
Paediatric resuscitation
Neonatal resuscitation

A B S T R A C T

Objective: Difficult paediatric airways, both expected and unexpected, present major challenges to every anaesthesiologist, paediatrician and emergency physician. However, the integration of supraglottic airway devices, such as the laryngeal mask (LM), into the algorithm of difficult airways has improved the handling of difficult airway situations in patients. A recent device for establishing a supraglottic airway is the laryngeal tube, introduced in 1999. We report on the successful use of the laryngeal tube suction II (LTS II) in securing the airway when endotracheal intubation or alternative mask ventilation has failed.

Methods: The use of the LTS II in 10 cases of difficult airway management in neonates and infants <6 months was reviewed.

Results: Use of the LTS II was associated with a high level of success (100%), often rescuing the airway when other techniques had failed. All insertions were successful on first attempt using a modified insertion technique. Placement was classified as “easy” by all users.

Conclusions: The potential advantage of the LTS II is the suction port which allows gastric tube placement and subsequent egression of gastric contents. In emergency situations when direct laryngoscopy fails, or is too time-consuming because of anatomical abnormalities, we recommend the LTS II tube as the first-line device to secure the airway. As with all supraglottic airways, familiarity and clinical experience with the respective device and its insertion technique is essential for safe and successful use, especially in emergencies.

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1. Introduction

Difficult airway management in neonates and small infants still remains a challenge, even for well-trained paediatricians or anaesthesiologists. This holds true particularly when a difficult airway is encountered unexpectedly, e.g. after induction of anaesthesia or in respiratory emergencies. Rapid oxygen desaturation and bradycardia, combined with successively reduced pulmonary compliance due to gastric inflation during – often ineffective – mask ventilation, may create a potentially lethal vicious cycle. Therefore, reliable airway management strategies in neonates and small infants are extremely important. If mask ventilation and/or direct laryngoscopy fails, supraglottic airway devices, i.e. paediatric-sized laryngeal masks (LMA), have been demonstrated to be a reliable rescue device.1–9 A potential disadvantage of the classic LMA, however, is a low airway leak pressure around 20–25 mbar, and the impossibility of draining gastric content. The Proseal-LMA incorporates a channel for a gastric drain tube, but is not available in sizes suitable for neonates and small infants.

The laryngeal tube suction II (LTS II; VBM Medizintechnik GmbH, Sulz am Neckar, Germany) is a reusable, latex-free, supraglottic airway device. The basic version was introduced to the European market in 1999; approval by the FDA followed in 2003. Further research and development led to the construction of the double-lumen LTS II, providing an additional channel for gastric drain tube placement. The LTS II is available in seven different sizes to suit neonates as well as large adults. It is introduced orally and advanced blindly into the oesophagus. Two high volume–low pressure cuffs that are inflated simultaneously seal the oesophagus and hypopharynx. Perforations between the two cuffs face the glottic aperture and allow for ventilation of the trachea.10,11 The distal balloon is intended to seal the oesophagus to serve as protection against regurgitation and gastric inflation (please see Fig. 1).

Quite a number of reports have been published on the use of the laryngeal tube in adult patients,12–17 but experience with the LTS II in paediatric patients is very limited. Most data were obtained...
in children aged 2 years and above.6,18,19 We therefore report on managing expected and unexpected difficult airways with the LTS II tube in neonates and small infants, all aged 6 months or less.

2. Methods

The LTS II was used either as a first-line or rescue device in 10 children aged between 4 days and 6 months (mean 46 ± 65 days) with a body weight between 1.6 and 5 kg (mean 3500 ± 1000 g) (please see Table 1). All of these children either had an anticipated or unexpected difficult airway. Since the LTS II is an approved device and was used within its indications, no formal review board approval was required. In every instance, a modified, frontal insertion technique was used (please see Fig. 1): first, the index finger of the left hand was inserted vertically into the oral cavity just behind the tongue using the thumb to help open the mouth. The index finger thereby acted as a placeholder and lifted the lower jaw. This active manoeuvre of lifting the lower jaw allows the creation of retropharyngeal space and results in easier positioning of the LTS II tube.20 The LTS II tube was then advanced along the forefinger without any rotational movement until the black bar of the tube was positioned on the level of the lower/upper alignment. After blocking both cuffs with the appropriate volume of air, the gastric suction tube was advanced via the suction channel. Finally, the correct placement of the LTS II was verified by clinical signs of ventilation and endtidal CO2 measurement. Furthermore, our institutional policy for choosing the appropriate LTS II size differed slightly from the manufacturers’ recommendations as described in Table 2. We used a simple scoring system in order to evaluate the ease of the positioning of the LTS II tube: easy (immediate ventilation satisfactorily possible), difficult (ventilation satisfactorily possible after reinsertion or adjustment), impossible (ventilation not achieved).

Table 1

<table>
<thead>
<tr>
<th>Body weight [kg]</th>
<th>LTS II [size]</th>
<th>Gastric tube [size]</th>
<th>Insertion technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer’s recommendations</td>
<td>0</td>
<td>8</td>
<td>MR(^a)</td>
</tr>
<tr>
<td>5–12</td>
<td>1</td>
<td>10</td>
<td>MR(^b)</td>
</tr>
<tr>
<td>Institutional standard (University Hospital Frankfurt/M., Germany)</td>
<td>0</td>
<td>8 Ch.</td>
<td>FrONTAL(^b)</td>
</tr>
<tr>
<td>4–8</td>
<td>1</td>
<td>10 Ch.</td>
<td>FrONTAL(^b)</td>
</tr>
</tbody>
</table>

The institutional standard of choosing the body weight-related size of the LTS II tube differs slightly from the manufacturer’s recommendations. We use a bigger sized LTS II tube for a lower patient weight range, the cut-off value being 4 kg bodyweight for the change of LTS II tube size 0 to size 1.

\(^a\) Manufacturer’s recommendations.

\(^b\) Insertion technique as described in this manuscript: frontal insertion technique with active lift of the lower jaw without any rotational movement.
3. Results

In 10 neonates and infants <6 months, a difficult airway (expected: \( n = 4 \), unexpected: \( n = 6 \)) was managed using the LTS II. LTS II placement was successful on the first attempt in all cases. Users described insertion and handling as “easy” in all cases. The airway seal was adequate to allow controlled ventilation in all situations encountered (Table 2).

### 3.1. Case 1

A male infant, 4 days old and weighing 2650 g, with Pierre–Robin syndrome hypoplastic aortic arch, patent ductus arteriosus and both atrial and ventricular septum defects, was scheduled for complex cardiac surgery. After failed fibreoptic endotracheal intubation, the boy was initially scheduled to undergo surgical tracheostomy in order to establish a secure airway. Due to insufficient oxygenation in the supine position, the patient arrived in the operating room in a prone position, the transected oxygen saturation being 86%. Within seconds, the patient developed severe respiratory distress, accompanied by oxygen desaturation to <50% and significant bradycardia (HR 20/min). The infant was immediately put into the supine position and cardiopulmonary resuscitation began. Almost simultaneously, atropine 100 \( \mu \)g was administered, and a size 0 LTS II armed with an 8F gastric drain tube was placed without attempting mask ventilation. A frontal insertion technique was used, allowing LTS II placement within seconds. Upon mechanical ventilation with oxygen 100%, unsynchronised to chest compression, the child recovered almost immediately. Surgical tracheostomy was performed uneventfully with the LTS II tube in place. Once the patient’s lungs were ventilated via the tracheal cannula, the LTS II was removed (Fig. 2).

### 3.2. Case 2

A 14-day-old male neonate (4000 g) with oesophageal stenosis was scheduled for redo oesophageal dilation. Previous dilations had been performed under general anaesthesia with the patient’s trachea being intubated with a 3.5 mm ID endotracheal tube. This time, after anaesthetic induction and muscle relaxation, the first attempt at endotracheal intubation failed despite an optimal laryngoscopic view of the vocal cords, since the endotracheal tube could not be advanced past the vocal cords. A second intubation attempt also failed for the same reason. Mask ventilation became increasingly difficult and when oxygen saturation, as measured by pulse oximetry, dropped to 90%, an airway was immediately established with a size 0 LTS II, using the frontal insertion technique. Despite LTS II placement taking only 15 s, oxygen saturation dropped even further to 78%. Once the LTS II was in place and ventilation initiated, the child recovered immediately despite an audible leak at a cuff pressure of 25 cm H₂O. An 8F bougie catheter was then advanced by a paediatrician through the gastric drain tube lumen of the laryngeal tube to dilate the oesophagus (Fig. 3). After the return of spontaneous breathing the tube’s cuffs were deflated. A flow of oxygen was delivered via the ventilation lumen of the LTS II until the end of excitation. Thereafter, the laryngeal tube was removed. A few minutes after extubation, respiratory distress due to muscular fatigue required reinsertion of the laryngeal tube. A size 1 LTS II was chosen on this occasion. Tube placement was uneventful without an airway leak at a cuff pressure of 30 cm H₂O. The child was transferred to the paediatric intensive care unit, where nasal fibreoptic endotracheal intubation with a small flexible fibrescope armed with a 3.0 mm ID endotracheal tube was performed. When the proximal cuff of the LTS was seen, it was shortly deflated to allow the fibrescope to pass, and inflated again. Once tracheal rings were identified the endotracheal tube was passed over the fibrescope into the trachea, the laryngeal tube’s cuffs being deflated again. The LTS II was then removed. Diagnostic bronchoscopy revealed a tracheo-oesophageal fistula, which most likely caused the respiratory distress.

### 3.3. Case 3

A male infant was scheduled for Hickman line insertion 2 months after premature birth at 29 + 5 weeks of gestation (recent weight 3000 g, weight at birth 685 g). His medical history included an atrial septal defect, tracheal deviation, necrotising enterocolitis, septic shock, and long-term endotracheal intubation. On the day of surgery, the child was breathing spontaneously with supplemental oxygen 2 l/min. After induction of general anaesthesia the child was ventilated via face mask until onset of muscle relaxation. The laryngoscopic view of the vocal cords was excellent; however, a subglottic resistance was met which did not allow a size 3.0 mm ID endotracheal tube to pass. The stenosis was passed with a 2.5 mm ID tube that, however, had significant air leakage at a ventilation pressure of 18 mbar. First, we tried to seal the leakage with a tamponade, but ventilation was still limited. For the next step we tried to change the tube using an Eschmann catheter. Oxygen saturation deteriorated very quickly to a transected oxygen measured SaO₂ of <50% and the patient presented with bradycardia (56 beats per minute).

Cardiopulmonary resuscitation was initiated immediately and the airway was managed with a size 0 LTS II, using the frontal insertion technique. After insertion of the laryngeal tube, ventilation and chest compressions were performed in an unsynchronised manner. The subsequently advanced gastric drain tube immediately evacuated significant amounts of air that had resulted from gastric inflation during mask ventilation. The child recovered immediately, and the further course of anaesthesia was uneventful. Upon ver-

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Table 2

<table>
<thead>
<tr>
<th>Insertion on first attempt</th>
<th>11</th>
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<tbody>
<tr>
<td>Insertion of another airway device necessary after having placed the LTS II</td>
<td>11</td>
</tr>
<tr>
<td>Gastric tube placement</td>
<td>11</td>
</tr>
<tr>
<td>Optimal ventilation during procedure</td>
<td>11</td>
</tr>
</tbody>
</table>

The LTS II could be placed in all patients at first attempt; in no case did another airway device have to be recruited. Gastric tube placement was successful in every patient. In all cases the LTS II allowed optimal ventilation of the lungs; users rated the ease of positioning as “easy” in all cases. Please note that case 2 has been counted twice since we needed to reinsert the LTS II due to respiratory distress after having removed the first LTS II tube. For the second insertion we chose a LTS II one size bigger than the LTS II tube used for the first insertion.

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Fig. 2. Male infant (4 days, 2650 g) with a Pierre–Robin sequence after successful resuscitation and surgical tracheotomy performed during ventilation via the LTS II.
ifying the correct position of the Hickman line by intraoperative fluoroscopy, pneumothorax was diagnosed on the right side, requiring chest tube drainage. Shortly after admission to the intensive care unit the LTS II was removed. Non-invasive nasal CPAP-therapy was administered for another 12 h; the patient was transferred to a general ward the next day.

3.4. Case 4

A premature infant (gestational age: 30 weeks, 1600 g) underwent elective excision of a necrotic fragment of the umbilical cord 5 days after birth. After induction of anaesthesia and muscle relaxation, mask ventilation was uneventful; however, no view of the glottis could be obtained with direct laryngoscopy by two experienced anaesthesiologists. A “blind” intubation attempt resulted in oesophageal tube placement. Therefore, the airway was managed with a size 0 LTS II, the cuffs of which were inflated with air to a cuff pressure of 40 cm H2O. The intraoperative course was uneventful, and the child was extubated immediately after surgery.

3.5. Case 5

A prematurely born infant (premature birth at 31 + 3 weeks of gestation, gestational age: 10 days, 3000 g) presented for elective surgery with a history of long-term ventilation due to enterocolitis necroticans shortly after birth. After induction of anaesthesia, placement of an endotracheal tube failed due to a subglottic stenosis. With ongoing mask ventilation, oxygenation was limited by gastric insufflation and a LTS II size 0 was inserted (cuff pressure 50 cm H2O). After gastric deflation via a gastric drain tube, oxygenation improved and the further intraoperative course was uneventful.

3.6. Case 6

A 5-day-old child (3150 g) with an anticipated difficult airway caused by a huge dorsal cervical tumour was scheduled for a diagnostic MRI. Because sedation was needed a LTSII was successfully used as the primary airway device (LTS 0; cuff pressure 30 cm H2O). During the procedure the child was breathing spontaneously with the LTS II in place.

3.7. Case 7

A 14-day-old boy (4120 g) with a history of failed intubation due to tracheal stenosis was scheduled for elective dilation of a stenosis of the oesophagus. Because tracheal intubation had previously been described as difficult, caused by known tracheal stenosis, the procedure was uneventfully performed with the LTS II as a first-line airway device using the suctioning channel for insertion of the bougie catheter.

3.8. Case 8

A 21-day-old boy (4200 g) presented with a non-responsible inguinal hernia for surgical repair. After induction of anaesthesia, several attempts to place an endotracheal tube failed. Laryngoscopy was difficult and the vocal cords could not be visualised. Insertion of a LTS II size 1 was quick, and subsequent mechanical ventilation was uneventful.

3.9. Case 9

In another male infant (aged 5 months, weighing 4300 g) undergoing Hickman line exchange, the airway was initially managed with a size 1 laryngeal mask. Steadily increasing inspiratory pressure, of unknown reason, led to gastric inflation and gastric distension. The laryngeal mask was exchanged for a size 1 LTS II. Once the gastric air was released via the gastric drain tube, respirator settings could be reset to physiologic values. The further course of the procedure was uneventful.

3.10. Case 10

A 28-day-old male infant (weight: 3600 g) presented after induction of anaesthesia with a CL grade 3. Several attempts to place an endotracheal tube failed and a laryngeal mask was inserted. Even with the laryngeal mask in place oxygenation was still limited due to gastric inflation, so we changed the laryngeal mask to a LTS II size 0, which allowed release of the gastric air via a gastric tube. After release of the gastric air, oxygenation improved and ventilator setting could be set to more normal values.
4. Discussion

We have demonstrated that, in cases of both expected and unexpected difficult airways in neonates and small infants, the LTS II has proven feasible as a rescue airway device. LTS II placement was successful at first attempt in every case, and a controlled airway could be established within seconds, even in cases of difficult airway anatomy.

Specifically, we did not observe any problems with oxygenation or ventilation after the insertion of the laryngeal tube. We used a modified insertion technique (Fig. 2). The main difference of this technique, compared to the manufacturer’s instructions for use, is that a forced chin lift manoeuvre (“Emshar grip”) was performed to create sufficient retropharyngeal space, thereby allowing the LTS II easier passage through the pharynx, resulting in a significantly higher rate of successful and fast placement attempts. This modified technique can be performed with both rescuer and patient being in almost any position. In all of our cases, the rescuer stood in front of the child, i.e. they positioned the LTS II “face-to-face” (frontal insertion).

Clinical experience with neonate-sized supraglottic airway devices is fairly limited, thus only few data exist, most of which has been obtained using the classic LMA, which proved particularly helpful in children with cranio-facial dysplasia. Other supraglottic airways, e.g. Proseal-LMA, oesophageal-tracheal combitube, cuffed oropharyngeal airway (COPA) and ETT tube, are not available in sizes small enough to suit neonates or infants. With the LTS II another supraglottic airway device has become available, even in the smallest sizes. However, the currently available data with respect to paediatric-size laryngeal tubes were mainly gathered in children aged 2 years and above.

Richebé and colleagues used the classic laryngeal tube – without the separate gastric drain tube channel – for airway management during general anaesthesia for elective surgery or magnetic resonance imaging in 70 children aged from 1 month to 15 years. The authors concluded that the LT™ cannot be recommended for routine use in children with a weight below 10 kg because of a high rate of global failures (80%) including failure of insertion of the laryngeal tube and inability to obtain satisfying assisted or spontaneous ventilation after insertion. This poor placement success was attributed to anatomical differences in small children compared to older children, and to an inadequate design of the classic laryngeal tube, which was said to not match small children’s airway anatomy. The authors further conclude that the observed high failure rate in infants was likely attributable to the small number of children in that age group and relatively inexperienced personnel regarding use of the size 0 laryngeal tube.

The LTS II has become the first-line airway device in our institution during paediatric surgery under general anaesthesia whenever endotracheal intubation is not required. We have used the LTS II in 1500+ patients, including 200+ neonates and infants aged below 2 months. In our experience the LTS II tube is easy and quick to insert with a very low rate of insertion failure, even in neonates and small infants with a fairly difficult airway anatomy and in emergencies. We therefore recommend the LTS II as a first-line airway device in difficult airway situations and during neonatal resuscitation.

With increasing clinical routine use of the LTS II we have also modified the recommended insertion technique as described above, and further established an alternative protocol to choose the weight-related size of the LTS II, which is shown in Table 1. This modified approach for choosing the size of the LTS II results in improved fit of the tubes and less leakage during controlled ventilation. In life-threatening situations when immediate oxygenation of the patient is of vital importance, we rely on the frontal insertion technique, which is illustrated in Fig. 1. In adults we were able to demonstrate that the frontal insertion technique results in faster placement and very high placement success at the first attempt [interim analysis of an ongoing clinical trial comparing two insertion techniques of the LTS II in simulated difficult airway situations by Schalk et al.]. However, although the superiority of the modified insertion technique in small infants needs to be confirmed in a randomized clinical trial, we did not observe any placement failure in our small cohort.

In two infants the LTS II was successfully used to manage the airway during cardiopulmonary resuscitation. One of these infants had a known difficult airway due to Pierre–Robin syndrome. Both infants could be oxygenated very quickly and recovered from hypoxic cardiac arrest in less than 1 min after LTS II placement. The LMA has been reported to be an effective airway device during cardiopulmonary resuscitation, and the guidelines for neonatal resuscitation recommend its use whenever bag-valve-mask ventilation is ineffective and endotracheal intubation fails. However, the routine use of the laryngeal mask instead of endotracheal intubation is not recommended. Ethical reasons do not allow a randomized comparison of the LMA and the LTS II during cardiopulmonary resuscitation in neonates and infants, and there is not enough data available at this time to generally support LTS II use in emergency situations. In the two cases described, resuscitation was short, and we do not have any experience with the LTS II in small patients that need to be resuscitated for a longer period of time.

5. Conclusions

In emergency situations when direct laryngoscopy fails or is too time-consuming because of anatomical abnormalities, we recommend the LTS II tube as a first-line device to secure the airway. As for all supraglottic airways, familiarity and clinical experience with the respective device and its insertion technique is essential for safe and successful use in emergencies.

Conflict of interest

All authors declare that there are no conflicts of interest.

References