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Acute Airway Obstruction Caused by the New Single Use Laryngeal Mask Airway Supreme™

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THE *Laryngeal Mask Airway Supreme*™ (*LMA-S*™; Laryngeal Mask Company Limited, Henley-on-Thames, United Kingdom) is a single-use supraglottic airway device developed as an alternative to the reusable laryngeal mask airway *ProSeal*™ (Laryngeal Mask Company). Featuring an additional drain tube to suction gastric content, the *LMA-S*™ may be used as a backup device in emergency situations. Indeed, its use has been described in difficult emergency intubation[1] and in cardiopulmonary resuscitation.[2] However, even backup devices have their limitations to consider. We report an unforeseen acute airway obstruction directly caused by the *LMA-S*™.

Case Report

A 62-yr-old man with a body mass index of 30.2 kg/m^2 was scheduled for a resection of a malignant melanoma and sentinel lymph node of the left arm under general anesthesia at the Department of Plastic Surgery at the University Hospital Bern. After preoxigenation of more than 5 min, general anesthesia was induced IV (210 mg of propofol and 0.15 mg of fentanyl) and maintained IV with propofol and remifentanil to keep bispectral index between 40 and 60. Face mask ventilation was successful, and a *LMA-S*™ (size 5) was introduced easily. The *LMA-S*™ was cuffed, but ventilation was not possible. This was confirmed by missing end tidal CO_2, no visible thorax movement, and no end expiratory tidal volumes. Fiberoptic bronchoscopy showed that the *LMA-S*™ pushed the epiglottis down, resulting in obstruction of the glottis. Fiberoptic-controlled retraction of the *LMA-S*™ reversed this situation, and a partial view of the glottic opening was noted, corresponding to a grade of 2 according to a fiberscopic rating suggested by Cook[3] and earlier described by Kapila.[4] Nevertheless, ventilation was still insufficient.

Although Spo_2 continued to be stable between 98 and 99% for the entire time, we decided to remove the *LMA-S*™ and ventilate the patient by face mask, which was easily done. We then introduced the *LMA-S*™ a second time. After cuff inflation, only tidal volumes below 300 ml were achieved. Auscultation revealed expiratory and inspiratory stridor over the trachea, and ventilation worsened. Fiberoptic bronchoscopy showed severe narrowing of the laryngeal inlet with barely visible vocal cords, which was interpreted as a supraglottic laryngeal edema.

We removed the *LMA-S*™ again and intubated the patient (100 mg of succinylcholin) easily (Cormack Lehane grade 1). Surprisingly, no laryngeal swelling was revealed by direct laryngoscopy. Ventilation was sufficient, and surgery was performed without further events. The patient was extubated uneventfully 15 minutes postoperatively and some 2 h and 20 min after induction of anesthesia, and he was discharged to the recovery room without any further respiratory sequels.

Discussion

Laryngeal masks are used broadly for elective and emergency airway management and are an essential part of the American and European difficult airway management algorithm.[5,6] Due to their wide use, noticeable complications and side effects have been reported over the last years. The most common side effects are hoarseness and dysphagia. More threatening situations like impossible ventilation with desaturation are much less common. The rare reports of airway obstruction directly triggered by the laryngeal mask are swelling of the pharyngeal soft tissues caused by the leakage of irrigation fluid,[7] herniation of the laryngeal mask airway cuff,[8–10] foreign bodies (Ascaris lumbricoides[11]), and intermittent obstruction related to a vagal nerve stimulator.[12]

Similar to our case, Chin reported a case of increased airway pressure in a *ProSeal*™ laryngeal mask airway[13] and related it to laryngeal edema. However, in a reply by Stix *et al.*, this case was associated with mechanical obstruction of the laryngeal inlet by the cuff and drain tube of the *ProSeal*™.[14]

We primarily attributed the rapidly deteriorating ventilation to soft tissue swelling and edema caused by airway manipulation and the mechanical stimulus of the *LMA-S*™ pushing down the epiglottis. This thesis was not confirmed; direct laryngoscopy after removal of the *LMA-S*™ showed normal laryngeal anatomy without edema. Laryngeal spasm was also excluded as an underlying cause because a propofol bolus did not improve ventilation.

We therefore attribute this case of airway obstruction to mechanical obstruction of the laryngeal inlet by the cuff as described by Stix.[14] The inflated *LMA-S*™ cuff displaced the cuneiform and corniculate cartilages medially, thereby narrowing the laryngeal inlet as observed during fiberoptic control, obstructing ventilation substantially.

In summary, laryngeal masks are often used as backup devices for the management of possible airway difficulties, and laryngeal masks have been life-saving in daily clinical practice over the years. Supraglottic airway de-

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vices are easy to introduce, and they provide a patent airway in most cases. Nevertheless, even newly developed types of laryngeal masks (as the *LMA-S*™) may be cause for the obstruction of the laryngeal inlet when the mask displaces laryngeal cartilages medially, narrowing the laryngeal inlet. This is the first report of this phenomenon of medialization in a *LMA-S*™.

Because laryngeal masks are important backup devices in the management of difficult airways, this infrequent cause of a laryngeal mask failure must be made known. Strategies to handle laryngeal mask failures might be included in the algorithms for difficult airway management, and backup strategies for the "backup device" laryngeal mask should be considered.

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Technique of Lung Isolation for Whole Lung Lavage in a Child with Pulmonary Alveolar Proteinosis

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PULMONARY alveolar proteinosis is a rare disease in which accumulation of phospholipoproteinaceous material in the alveoli causes pulmonary impairment.[1] A deficiency in granulocyte-macrophage colony-stimulating factor activity results in defective macrophages and reduced clearance of surfactant from the lungs.[1,2] Bronchoalveolar or whole lung lavage is an important part of treatment for this disease and often results in temporary improvement of symptoms and radiographic appearance.

In adolescents and adults, double lumen bronchial tubes are often used to isolate the lungs for lavage; however, such tubes do not currently exist for use in smaller children. Several techniques have been described to isolate the lungs in smaller children to allow for lavage.[3–7] No single method has been shown to be ideal, and each has its risks and limitations. We report a case in which lung isolation and whole lung lavage was performed safely in a small child using two cuffed tracheal tubes without the need for postprocedural ventilation.

Case Report

An 11-kg, 2-yr-old male child with lysinuric protein intolerance and pulmonary alveolar proteinosis presented for left lung lavage. He had a history of recurrent respiratory tract infections and increasing oxygen requirement over a period of 3 months. His metabolic disease was diagnosed 14 months previous, and pulmonary alveolar proteinosis was confirmed by lobar aspirate analysis. Despite having started granulocyte-macrophage colony-stimulating factor therapy 3 months before the current admission, the patient's symptoms continued to deteriorate. His oxygen saturation was 85–93% on 2 l/min oxygen *via* nasal prongs. His respiratory rate was 52 to 70 per minute, and he presented with intercostal indrawing, tracheal tug, and inspiratory and expiratory crackles. A chest radiograph revealed bilateral mixed interstitial and airspace disease, air bronchograms, and subpleural peripheral opacities. He was scheduled to undergo left lung lavage and right lung lavage 2 days later, as tolerated.

The airway assembly consisted of two cuffed tracheal tubes (3.0 and 3.5 mm ID; Sheridan, Temecula, CA) and the angled and Y-connectors from a standard double lumen bronchial tube set (Bronchopart, Rusch, Germany). After anesthetic induction and muscle relaxation, the 3-5 mm ID cuffed tube was inserted in the left mainstem bronchus (bronchial tube), and the 3.0 mm ID cuffed tube was placed in the trachea

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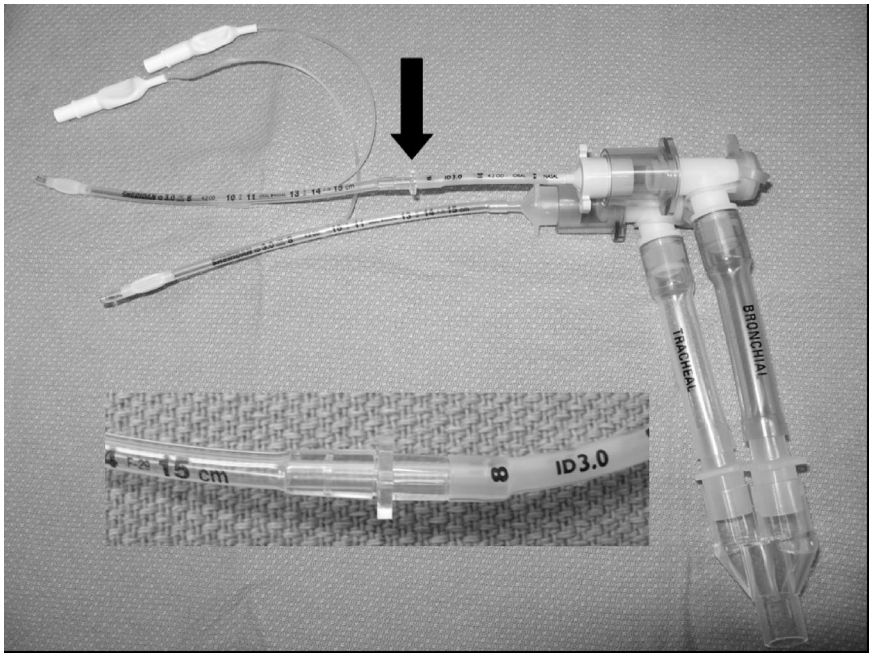

Fig. 1. Pediatric lung lavage airway assembly consisting of two cuffed tracheal tubes (3.0 mm ID) connected to the angled and Y-connectors from a standard double lumen bronchial tube set. An endotracheal tube connector (arrow, inset) was used to splice two 3.0-mm ID tubes together to lengthen the endobronchial tube. The other cuffed tube was inserted in the trachea.

(endotracheal tube) Both tubes passed easily and without resistance, and the cuffs were inflated with just enough air to ensure proper lung isolation and adequate ventilation without a leak. Proper tube positioning was verified with a 2.2-mm OD flexible fiberoptic bronchoscope (Olympus, Center Valley, PA). Lung isolation was also verified clinically by clamping each of the angled connectors while auscultating for breath sounds. Intermittent positive-pressure ventilation was instituted using pressure-control (25/5 cm H_2O, FiO_2 1.0). The patient was kept in the supine position during the procedure. Anesthesia was maintained with propofol and remifentanil infusions titrated to effect. A test lavage was performed with 10 ml of normal saline administered *via* the bronchial tube under fiberoptic visualization through the endotracheal tube to ensure there was no fluid leak. Left lung lavage then proceeded with aliquots of 60–120 ml of warmed saline. Chest clapping was performed during the procedure, and lavage returns were collected by gravity after each aliquot. The first samples were thick and milky but gradually cleared during the procedure. A total of 2100 ml of saline was injected, and 2000 ml was collected as lavage return. Dexamethasone 0.2 mg/kg IV was given intraoperatively to minimize vocal cord edema.

The patient's oxygen saturation fell briefly to 85% with each aliquot but recovered quickly with drainage of lavage fluid. End-tidal carbon dioxide was maintained at or below 60 mmHg. The entire procedure, including lung isolation and emergence, was completed in 3 h. The airway assembly was removed with the patient awake and breathing spontaneously upon completion of the procedure. The patient's oxygen requirements returned to baseline soon after admission to the postanesthetic care unit, and the repeat chest radiograph revealed significant improvement in the left lung. In retrospect, it would have been more convenient if the endobronchial tube had been made longer than the endotracheal tube. This would have improved the stability of the proximal end of the airway assembly at the Rusch Y connector.

The patient returned to the operating room for right lung lavage 2 days after the first procedure. At that time, the patient had an oxygen saturation of 91–97% on 0.5 l of oxygen *via* nasal prongs, and his respiratory rate was between 44 and 52. Because of residual hoarseness after the first procedure, dexamethasone 0.2 mg/kg IV was given preoperatively, and the airway assembly was downsized to two 3.0-mm ID cuffed tubes. To lengthen the bronchial tube without having to use a larger one, a endotracheal tube connector (Trudell Medical, London, Canada) was used to splice two 3.0-mm ID cuffed tubes together (fig. 1). The anesthetic and lavage management proceeded in the same manner as the first procedure. A total of 1600 ml of warmed saline was injected into the right lung, and lavage returns totaled 1300 ml. The patient was discharged to the ward after an uneventful 3-h stay in the postanesthetic care unit.

Discussion

We present a simple and reliable airway assembly that can be used to provide lung isolation for lung lavage or other such procedures in small children. Essentially, two tracheal tubes are passed through the glottis, one seated endobronchially to isolate the lung to be lavaged and the second seated in the trachea. This assembly mimics commercially available double lumen bronchial tubes, considered by many to be the airway device of choice for lung isolation. The obvious advantages of this technique include effective lung isolation, the ability to collect lavage returns by gravity instead of suction, and the option of differential lung ventilation after lavage. In addition, the patient can be kept in the supine position, and fiberoptic bronchoscopy can be used to periodically ensure continued lung isolation throughout the procedure.

A possible disadvantage of this technique is the potential for vocal cord edema, stridor, or mucosal damage due to the fact that two tracheal tubes are being inserted through the glottis. To minimize this risk, the smallest sized tubes that allowed adequate ventilation and lavage were used. The tubes were inserted along the long axis of the glottic opening to minimize lateral stretch of the vocal cords. The patient developed hoarseness after the first procedure, so we downsized the airway assembly to

two 3.0-mm ID tubes for the second lavage. In addition, dexamethasone was administered before the procedure. As a result of these modifications, hoarseness and stridor were not an issue after the second lavage procedure. Downsizing the endobronchial tube to a 3.0-mm ID in a 2-yr-old resulted in a short bronchial tube. We elected to use a connector to lengthen the tube; however, telescoping a 2.5-mm ID or another 3.0-mm ID into the wide proximal end of the tube would also have been a reasonable option. Although using a 2.5-mm ID tube telescoped into the 3.0-mm ID bronchial tube would have been simple to assemble, lavage may not have been as successful due to the extremely small lumen size. It must be emphasized that any "home-made" or modified device, particularly if being inserted into the airway, must be used with caution. We ensured the tube connector was fastened securely before clinical use to minimize the risk of disconnect.

Cuffed tubes were used not only to ensure lung isolation but also to minimize the risk of tracheal and bronchial tube movement and dislodgement during lavage. The minimum amount of air was inserted into each cuff to allow lung isolation and ventilation without a leak. Although the use of cuffed tubes may contribute to mucosal edema and trauma, we felt the benefit of superior lung isolation justified this risk. A major advantage of this approach to lung lavage in small children seems to be higher lavage returns as compared to other techniques.[1] This allowed us to extubate the patient's trachea at the end of the procedure, which is often impossible if multiple lobar lavages are performed using fiberoptic bronchoscopy.[1] The nature of the procedure and the airway assembly makes total intravenous anesthesia preferable if this technique is to be used.

Although our airway assembly had a Murphy eye, it might be advisable to use a left-sided bronchial tube to avoid obstructing the right upper lobe bronchus. This method may not be suitable for every child, but it is an option when strict lung isolation is required in the child too small to accept commercially available double lumen bronchial tubes.

In conclusion, we report the successful use of two cuffed tubes (one bronchial and one tracheal) in a small child to perform whole lung lavage without the need for postprocedural ventilation.

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