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Case report

Novel tubeless supraglottic ventilation in a difficult paediatric airway

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ABSTRACT

Introduction: Discussion and careful planning are essential between surgeon and anaesthesiologist before upper airway surgery, especially in paediatric patients with upper airway obstruction. Tubeless supraglottic ventilation is an accepted technique worldwide.

Case: A 22-month old boy presented with upper gastrointestinal bleeding and right lung empyema with underlying pneumonia. He was treated for Haemolytic Uremic Syndrome secondary to pneumonia. The boy underwent upper gastroendoscopy under general anaesthesia for arrest of gastrointestinal bleeding and was kept intubated for 21 days. He was subsequently reintubated three days later for emergency video-assisted thoracoscopy, pleural stripping, and pus drainage under general anaesthesia. He was electively extubated on the third post-surgical day. Two weeks later, the patient developed stridor and suffered respiratory distress. A flexible fibreoptic scope revealed left vocal cord palsy. He was subject to emergency direct laryngoscopy and examination under general anaesthesia due to clinical suspicion of airway stenosis. Tubeless supraglottic ventilation was used and balloon dilatation with microlaryngeal surgery was successful.

Conclusion: Tubeless supraglottic ventilation is a novel and useful method in short upper airway surgery.

1. Introduction

Management of the difficult airway in an operative setting requires careful planning to avoid morbidity and mortality. Especially for paediatric patients with expected difficult airway, it is crucial to pay close attention to the details of implementing the chosen approach [1]. In our setting, we routinely conduct fruitful discussion between the anaesthesiologist and the operating airway surgeon on how the airway is to be managed intraoperatively. While jet ventilation provides tubeless ventilation in advantage of the airway surgeon, associated morbidities must be considered, especially in the paediatric patients with severe lung condition. We report a novel method for tubeless supraglottic ventilation in the management of a child with underlying right lobar collapse secondary to severe pneumonia, and upper airway obstruction secondary to tracheal stenosis.

2. Case

A 22-month old-boy presented with six days' history of fever associated with haematemesis and a one-day history of passing maelenic stool. Upon examination, the patient was lethargic, pale and dehydrated. Blood pressure was normo-tensive but tachycardic. Lung examination and chest imaging showed right upper lobe consolidation with reactive pleural effusion. Blood investigation showed anaemia, raised white blood count, raised urea and creatinine, and low platelet count. The boy was resuscitated and non-invasive ventilation was given. He was treated as Haemolytic Uremic Syndrome secondary to pneumonia.

Upper gastrointestinal bleeding was addressed by upper gastroendoscopy under general anaesthesia. He was intubated with a 4.5 mm non-cuffed endotracheal tube in a single attempt. After the procedure, patient was kept intubated and ventilated in the Paediatric Intensive Care Unit. Further investigation showed right lung empyema which was

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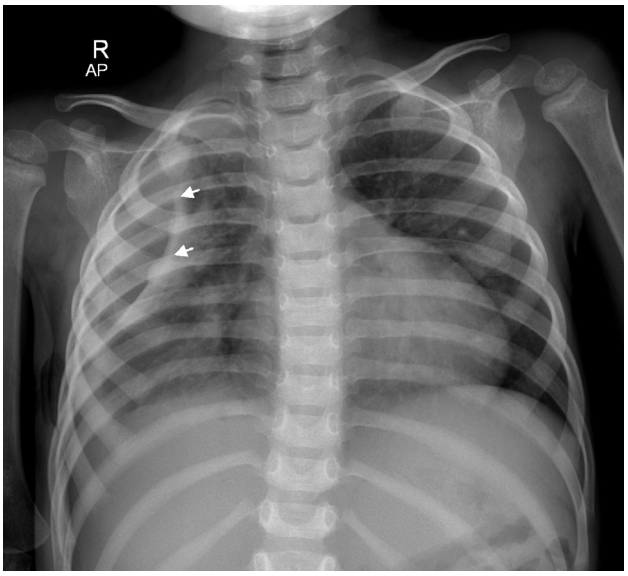

Fig. 1. Chest radiograph of the patient showing right upper lobe collapse (white arrowheads) with residual hydropneumothorax.

not responsive to intravenous cefepime 450 mg (50 mg/kg/dose) every 12 h and amikacin 60 mg every 8 h (20 mg/kg/day). The patient self-extubated on day 21 of intubation. He was then reintubated 3 days later for video-assisted thoracoscopy, pleural stripping, and pus drainage under general anaesthesia. The patient was extubated on the third day post-operation following partial recovery of his lung condition.

Two weeks after extubation, he developed stridor and a referral was made to the Otorhinolaryngology team. Upon assessment, the child had a breathy voice and biphasic stridor was heard with increased respiratory effort. Oxygen saturation was 97% under ambient conditions and a chest radiograph showed improvement in pleural effusion with residual right upper lobe lung collapse and residual hydropneumothorax (Fig. 1). Bedside flexible laryngoscopy was performed, showing reduced left vocal cord mobility with a significant phonatory gap. The working diagnosis made was left vocal fold paresis with tracheal stenosis. The patient was subsequently counselled for emergency examination under anaesthesia and direct laryngoscopy.

On preoperative assessment, this 22 months old boy weighed 10 kg and had biphasic stridor at rest. He had tracheal tug and subcostal recession with respiratory rate of 30 breaths per minute. Oxygen saturation was 97% under room air and lung auscultation showed reduced air entry on the right upper lobe with no crepitations. His neck movements were not limited, mallampati score was 2 with no receding chin.

During induction, sevoflurane of 8% concentration in 8L/min oxygen flow was given. Intravenous Propofol 8 mg (1mg/kg) and fentanyl 8mcg (1mcg/kg) bolus were administrated twice, on induction and before laryngoscope insertion. Direct laryngoscopy was performed. Topical anaesthesia was given to the airway with Lignocaine 2% (3mg/kg) using a malleable oral atomizer (MADgic® Teleflex, USA). Patient was ventilated with tubeless supraglottic ventilation technique by using an endotracheal tube (ETT) adaptor (ETT ID 3.0, Smiths Medical, USA), which was connected to the jet ventilating port of a Lindholm laryngoscope (Figs. 2a and 2b). A paediatric closed circuit was attached to the ETT adaptor. Bag ventilation was given with respiratory rate 25–30 breaths per minute, I:E ratio 1:2 with Sevoflurane 3–6% in 6L/min oxygen flow. Intravenous Propofol infusion of 100–120 mcg/kg/min was used throughout the procedure. The adequacy of ventilation was monitored by capnography and pulse oximetry. During diagnostic endoscopy, SpO2 was 99 to 100% and ETCO2 was between 35 and 40. Further assessment found Cotton-Myer grade 3 tracheal stenosis 4.2 cm from the vocal cord, with a thickness of 2 mm (Fig. 3). Balloon

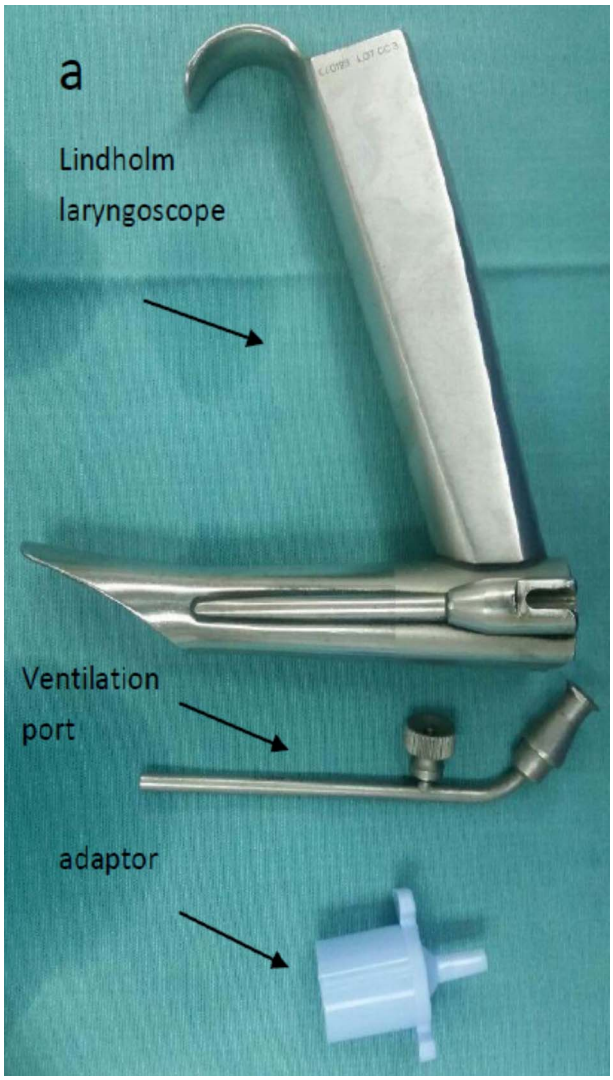

Fig. 2a. Instruments for tubeless supraglottic ventilation (before assembly): Lindholm laryngoscope, ventilation port and ETT adaptor (ETT ID 3.0, Smiths Medical, USA).

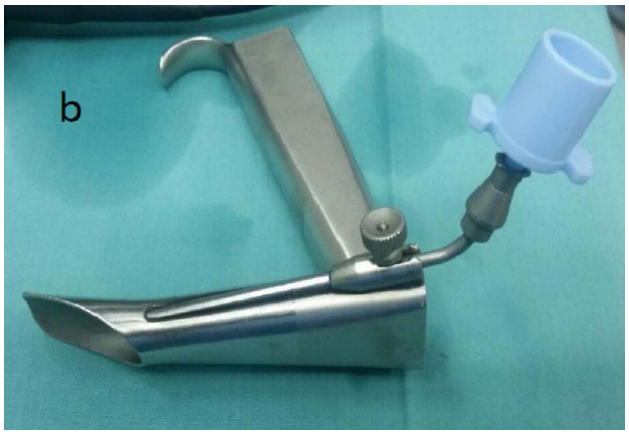

Fig. 2b. Instruments for tubeless supraglottic ventilation (after assembly): Lindholm laryngoscope, ventilation port and ETT adaptor (ETT ID 3.0, Smiths Medical, USA).

dilatation (Inspira Air™ Acclarent®, USA) of the stenotic segment was performed after incising the stenotic segment with cold instrument. Dilatation was performed twice with each lasting two minutes. During period of dilatation, the oxygen supply to the patient was obstructed resulting in mild desaturation up to 96% which picked up following

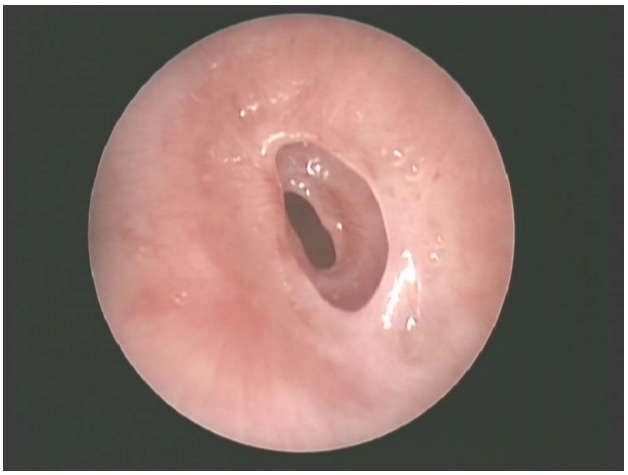

Fig. 3. Endoscopic view of the trachea showing Cotton-Myer Grade 3 tracheal stenosis.

reestablishment of ventilation after ballooning. The ETCO2 was 42 and 44 respectively following the first and second dilatation. Total procedure time on the tubeless supraglottic ventilation was 15 min. At the end of the procedure, he was intubated with a 4 mm endotracheal tube after given intravenous atracurium 5 mg (0.5 mg/kg). There was no unwanted coughing, bucking, movement, laryngospasm nor arrhythmias using the described method of anaesthesia throughout the procedure.

He was successfully extubated on the next day post-surgery in the paediatric intensive care unit. Repeat bedside flexible laryngoscopy and evaluation of swallowing in the ward at postoperative day 2 showed no evidence of penetration to formula milk hence he was allowed oral feeding. Patient was discharged home at day nine post-surgery. Six weeks postoperatively, his voice returned to normal and office flexible laryngoscopy showed complete resolution of left vocal fold paresis. No phonatory gap was present. He was examined under anaesthesia in view of possibility of restenosis. However, complete recovery was observed. Office follow-up at 2 years post procedure showed the patient to be asymptomatic of airway stenosis.

3. Discussion

Issues concerning ventilation and oxygenation for surgery for laryngotracheal stenosis are always challenging. Conventional methods of endotracheal intubation may not be ideal due to obstructed surgical field and some procedures such as dilatation requires unrestricted access to the larynx. Therefore, various tubeless methods have been reported throughout the years. These methods involve either tubeless spontaneous respiration technique or tubeless jet ventilation.

Xu et al. described a spontaneous respiration technique in which anaesthetic gas insufflations was used and maintained by continuous anaesthetic gas delivery via an endotracheal tube placed above the glottis [2]. Other methods of delivering volatile gas anaesthesia during airway procedure include attaching breathing circuit to nasopharyngeal tube. Richards et al. reported 45 laser procedures performed using this technique in paediatric patients. Only one patient developed laryngospasm, and the technique was able to provide unrivalled view of the larynx [3]. Anaesthesia for spontaneous respiration technique can also administered using total intravenous anaesthesia (TIVA) with combination of Propofol and remifentanil. A study of 52 airway endoscopy procedures in children (mean age 6.9 years) using TIVA showed that three patients (6%) developed desaturations which required temporary assisted ventilation or bronchodilators. No serious adverse events were reported [4].

Supraglottic or infraglottic tubeless jet ventilation are both good options. Anaesthesia is provided using TIVA. Mausser et al. reported the success supraglottic superimposed high-frequency jet ventilation in 139 cases (mean age 58.93 months) of laryngotracheal stenosis surgery. The authors reported no complication post operatively by using this technique and also less risk of barotrauma in comparison with infraglottic ventilation [5]. Ihraet al. described the success of supralaryngeal high-frequency jet ventilationin ten children (mean age 4.6 years), with four out of ten diagnosed with subglottic or tracheal stenosis [6]. This technique has been safely used in an ex-premature baby [7]. High-frequency jet ventilation may not be available in certain operating theatres. Most otolaryngology and anaesthetic practices use low-frequency jet ventilation in airway surgery. The latter device is robust, less expensive, and easy to operate, but carries a higher risk of barotrauma [1].

This case posed difficulties in airway management for several reasons. In cases of tracheal stenosis, the otolaryngologist must assume a relatively immobile surgical field; hence, spontaneous respiration techniques without muscle relaxant are not recommended. The presence of lung empyema and collapse in this case makes supraglottic jet ventilation not suitable. Inadequate gas exchange and intraoperative hypoxemia as well as hypercapnia are very likely to occur when jet ventilating patients with severe lung pathology. Tubeless supraglottic ventilation via laryngoscope was applied in this case with good outcome. Ventilation through the jet ventilating port was successful throughout surgery without any complications. Both inhalation and intravenous anaesthesia agents were used. The advantages of this novel technique include the ability to maintain depth of anaesthesia using inhalational agents, the ability to provide good surgical field to the otolaryngologists, and a lack of jet ventilation use. This ventilation technique has significant lower risk of barotrauma. To the best of the authors' knowledge, no similar technique has been reported in the English literature to date.

The laryngeal mask airway (LMA) has emerged as a novel airway management technique in airway surgery. Vorasubin et al. described this technique in treating 21 adult patients with laryngotracheal stenosis. The LMA was inserted after induction of general anaesthesia. A flexible video-bronchoscope was inserted through a bronchoscope adaptor on the laryngeal mask airway. A fibre-based Carbon Dioxide (CO2) laser was passed through the working channel of the bronchoscope to perform laryngotracheal laser surgery [8]. While this is a good technique for treating upper airway stenosis, the availability of the equipment must be considered.

4. Conclusion

Tubeless supraglottic ventilation using an ETT adaptor provides adequate ventilation for a short airway procedure such as dilatation. The novel technique requires an ETT adaptor (ETT ID 3.0, Smiths Medical, USA) which was connected to the jet ventilating port of a rigid laryngoscope. The equipment required is widely available in any standard operative setting.

Conflict of interest

The authors declared that there is no conflict of interest.

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