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Management of Difficult Airway in Pediatrics with Laryngomalacia

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Abstract

Introduction: Laryngomalacia is a condition in which the larynx (the base of the throat) does not develop normally, leading to breathing difficulties in children. The condition of laryngomalacia invites intubation to overcome airway obstruction that has the potential to cause laryngeal stenosis. Laryngeal stenosis in children, which can result from various factors including prolonged intubation, repeated intubation procedures, and laryngomalacia, is a major contributor to airway obstruction in children.

Objectives: This case report aims to explain the presence of laryngomalacia in a child, which was later found to have progressed to laryngeal stenosis.

Case: A 1-year and 5-month-old female patient, weighing 8.5 kg and measuring 74 cm in height, was presented as a case. The patient had a prior diagnosis of postoperative stoma status following a limited PSARP procedure and was concurrently affected by an anorectal malformation vestibular fistula. Additionally, the patient exhibited congenital anomalies, including mesocardiac abnormalities, a single right kidney, hypothyroidism, and laryngomalacia. The patient also had the history of prolonged and intubation when she was 3 months old due to pneumonia, and the history of repeated attempts of intubation for the first two surgeries. The preoperative assessment revealed signs of pneumonia, right lung atelectasis, and a history of laryngomalacia. In the preoperative assessment, the patient was found breathing spontaneously, with respiratory rate around 24-28 times per minute, no desaturation was found. The patient has inspiratory stridor, which worsens during feeding and moderate activity. No retraction of the chest or use of respiratory accessory muscles were found. The patient was evaluated for postoperative ICU care during the preoperative consultation as a precaution for chances of laryngeal edema post intubation and unanticipated airway event during anesthesia.

Results: In specific cases, as described in this manuscript, anesthesia procedures become crucial, and specialized equipment such as LMA (Laryngeal Mask Airway) and fiberoptic laryngoscope are used to address difficult airways. However, the use of LMA also has potential pitfalls, such as requiring a large tidal volume and not allowing the use of NGT (Nasogastric Tube) for abdominal decompression. Moreover, a history of repeated intubation attempts can lead to laryngeal edema, which requires management with steroids and adrenaline nebulization. However, the use of steroids and adrenaline does not always yield valid therapeutic effects, and there is a debate regarding the best approach. In specific patient cases, observation for one hour after extubation is necessary before deciding on reintubation.

Conclusions: In the cases described in the manuscript, the patient showed improvement after the use of adrenaline nebulization and intravenous steroids for 24 hours post-extubation. This allowed the patient to be transferred to a lower level of care after five days of treatment.

Keywords: Difficult Airway Management, Pediatrics, Laryngomalacia.

1. Introduction

Airway assessment is crucial for determining the appropriate anesthetic technique. Pediatric airway anatomy differs significantly from that of adults. In neonates and infants, as opposed to older children and adults, several distinctive anatomical features are present. These include a proportionally larger head and tongue, narrower nostrils, a more anterior and cephalad positioning of the larynx, an elongated epiglottis, and a shorter trachea and neck. Unlike adults, where the glottis is typically located at vertebra C6, in the pediatric population, it resides at C4. This anatomical distinction means that neonates and young infants are obligate nasal breathers until around 5 months of age (Dore, 2022; Harless et al., 2014). Notably, the cricoid cartilage represents the narrowest point of the airway in children under 5 years old, while in adults, this narrowest point occurs at the glottis or vocal cords (Dore, 2022). This anatomical divergence underscores the critical role of airway assessment in pediatrics as a vital factor in anesthesia planning.

Laryngomalacia is a common congenital airway anomaly in newborns that results in stridor and airway obstruction, with an incidence ranging from 35% to 75%. Stridor arises due to the inspiratory collapse of the supraglottic structures within the larynx. Approximately 40% of infants with laryngomalacia experience mild symptoms, another 40% have moderate symptoms, and nearly 20% exhibit severe symptoms necessitating surgical intervention (van der Heijden et al., 2015). Laryngomalacia can be suspected through a combination of medical history, physical examination, and often diagnosed within the first four months of life. The most definitive diagnosis is typically achieved through flexible fiberoptic laryngoscopy performed under general anesthesia with spontaneous breathing (Lima et al., 2008). Presently, management strategies include close observation and endoscopic surgical interventions, including supraglottoplasty. In refractory cases, tracheotomy may be required. The primary objective of endoscopic surgery is to establish an airway that does not collapse the supraglottic structures (Lima et al., 2008; van der Heijden et al., 2015).

Laryngomalacia presents clinical symptoms characterized by inspiratory stridor, which tends to worsen during feeding, crying, supine positioning, and periods of agitation. These symptoms typically manifest at birth or within the first few weeks of life, peak in severity at 6 to 8 months of age, and generally subside by the time the child reaches 12 to 24 months of age (Richter & Thompson, 2008). Diagnosis of laryngomalacia usually occurs within the initial 4 months of life. While inspiratory stridor is the hallmark symptom of laryngomalacia, several other accompanying symptoms have been documented (Landry & Thompson, 2012; Richter & Thompson, 2008).

The etiology of laryngomalacia remains currently unknown, although there are theories suggesting anatomical, cartilaginous, and neurological abnormalities as potential contributing factors. The anatomical abnormality theory posits that the improper positioning of flaccid tissue leads to stridor. In contrast, the neurological theory proposes that laryngomalacia may result from the underdeveloped or aberrant integration of the central nervous system, particularly involving peripheral nerves and brainstem nuclei responsible for regulating breathing and airway patency. With time, laryngomalacia may ameliorate due to the maturation of the central nervous system (Landry & Thompson, 2012).

Laryngomalacia encompasses a spectrum of disease that can be categorized as mild, moderate, or severe, depending on the presence of feeding difficulties and obstructive symptoms. Within the mild category, inspiratory stridor tends to be inconsistent. In the moderate category, symptoms are typically accompanied by feeding difficulties, and in the severe category, surgical intervention such as supraglottoplasty is often necessary. Evaluating the spectrum of symptoms and considering other risk factors can aid in determining the appropriate management approach for the patient (Landry & Thompson, 2012).

It has been reported that approximately 10% of infants diagnosed with laryngomalacia also have congenital heart disease, often presenting with moderate to severe symptomatic manifestations. The combined impact of airway obstruction on an already compromised cardiovascular system exacerbates the infant's condition. In fact, around 34% of infants with both laryngomalacia and congenital heart disease may ultimately require surgical intervention (Landry & Thompson, 2012).

Other congenital and genetic abnormalities are also observed in 8-20% of infants with laryngomalacia. The most common congenital abnormalities include Down syndrome, Pierre Robin sequence, and micrognathia. In cases

where congenital abnormalities coexist with laryngomalacia, tracheostomy may be necessary until the congenital abnormality is addressed (Landry & Thompson, 2012).

In severe cases, surgical management may be considered, with the most significant indication being the presence of stridor accompanied by symptoms of compromised breathing, feeding difficulties, and failure to thrive (Richter & Thompson, 2008). Severe airway obstruction, characterized by significant retraction, pectus excavatum, cor pulmonale, pulmonary hypertension, and hypoxia, constitutes absolute indications for surgical intervention. Relative indications include aspiration leading to recurrent pneumonia, weight loss resulting in true failure to thrive, and feeding difficulties. The decision to proceed with surgery is individualized and depends on a comprehensive assessment of the child's overall health and development. Supraglottoplasty is the primary surgical approach for laryngomalacia. The airway is initially evaluated with rigid endoscopy to rule out secondary lesions in the subglottis and trachea (Landry & Thompson, 2012).

2. Objectives

This case report delves into the medical history of a child, initially diagnosed with laryngomalacia and history of prolonged intubation, and later experiencing the progression to laryngeal stenosis. The objective is to shed light on how these airway conditions are connected and provide valuable insights into their development, anesthetic approaches, and postoperative care in pediatric cases. By examining this specific case, we aim to contribute to the understanding of these complex airway issues in children, ultimately aiding medical professionals in managing similar situations more effectively.

3. Case

A girl aged 1 year and 5 months with a weight of 8.5 kg and a height of 74 cm, was presented as a case. The patient had been previously diagnosed with postoperative stoma status following a limited PSARP procedure and had a concomitant anorectal malformation vestibular fistula, along with additional congenital abnormalities, including mesocardiac anomalies, a single right kidney, hypothyroidism, laryngomalacia, and history of prolonged and repeated intubation. During the preoperative evaluation, the patient displayed signs of pneumonia, atelectasis in the right lung, and a history of laryngomalacia. In the preoperative assessment, the patient was found breathing spontaneously, with respiratory rate around 24-28 times per minute, no desaturation was found. The patient has inspiratory stridor, which worsens during feeding and moderate activity. No retraction of the chest or use of respiratory accessory muscles were found. At the preoperative consultation, the patient was assessed for postoperative care in the ICU to during the preoperative consultation as a precaution for chances of laryngeal edema post intubation and unanticipated airway event during anaesthesia.

4. Results

During Surgery Condition

The patient was reevaluated in the premedication room before surgery and was given premedication consisting of dexamethasone 2.5 mg, midazolam 0.5 mg, and atropine sulphate 0.15 mg to prevent post-induction airway edema, reduce anxiety, and prevent post-induction spasms.

The patient was induced with fentanyl 10 mcg, propofol 10 mg, and sevoflurane with a concentration of 2-2.5 vol%. After the patient was asleep, ventilation was initiated, and rocuronium 5 mg was administered. After 3 minutes, direct laryngoscopy was performed, revealing Cormack-Lehane grade 2, followed by intubation using a Macintosh blade size 1, but there was difficulty inserting a size 4.0 ETT with a cuff. The ETT could not pass through the vocal cords. The patient was ventilated again, and intubation was attempted once more using a size 4.0 non-cuffed ETT, but it could not pass. The patient was ventilated again. Subsequent intubation attempts were made using ETT sizes 3.5, 3.0, and 2.5, but they still could not pass through the vocal cords. Finally, a size 1.5 LMA was inserted, confirmed to have entered with end-tidal CO2 reading, and the LMA was secured. Anaesthesia was maintained with sevoflurane at 2.5 vol%. On respiratory evaluation, wheezing was heard throughout the lung fields, and ETCO2 was reading 70. Anaesthesia was deepened by increasing sevoflurane concentration to 3 vol% and injecting propofol 10 mg. Additionally, a dexamethasone injection of 2.5 mg was administered. The patient

was then placed on a ventilator machine using PCV mode, with TV 90 ml, PEEP 4, rate 24, I:E 1.2, FiO2 60%. However, the tidal volume could not be read adequately. It was decided to continue manual ventilation during the surgery, without using the ventilator machine. During surgery, the patient required high tidal volume and respiratory frequency, with a tidal volume of around 90-100 ml and a respiratory rate of 30-35 breaths per minute. Peak pressure reached 33-35, and ETCO2 ranged between 60-65. Throughout the surgery, ETCO2 never reached normal levels.

Hemodynamic conditions during the surgery showed a pulse rate ranging from 138-160 beats per minute, systolic blood pressure ranging from 70-100 mmHg, and diastolic pressure ranging from 38-60 mmHg. The problem encountered during surgery was the need for a significant tidal volume, causing abdominal distension and making the operation difficult for the operator. Analgesics given during surgery included 100 mg of paracetamol and 100 mg of ibuprofen. After the surgery, the LMA was removed while sevoflurane was still running. After the removal of the LMA, the patient experienced stridor and shortness of breath. Nebulized adrenaline and chest clapping were administered, and the patient was placed in a tilted position. After nebulization and positioning, the patient's condition improved, breathing became adequate, and there was no more shortness of breath. The patient was then transferred to the ICU for postoperative airway evaluation with minimal stridor. The patient was scheduled for consultation with an ENT specialist to evaluate the suspicion of laryngeal stenosis. Subsequently, the patient was moved from the ICU to a low-care inpatient room in a stable condition, without stridor or shortness of breath. Nebulized β2 agonist therapy continued until the patient was discharged from the hospital on the 5th day post-surgery.

5. Discussion

Laryngeal stenosis is one of the most common causes of airway obstruction in pediatrics. The etiology of laryngeal stenosis can be categorized into two main types: congenital and acquired. One of the etiologies of laryngeal stenosis is prolonged intubation, which often occurs in infants or neonates who require extended care in the NICU. Prolonged intubation can lead to scar tissue formation in the area surrounding the larynx and trachea due to the extended use of endotracheal tubes. This, in turn, results in subglottic stenosis, ultimately leading to laryngeal stenosis (Smith & Cotton, 2018).

Furthermore, repeated intubation procedures can also contribute to the development of laryngeal stenosis. Traumatic intubation or repeated intubations can cause a cascade of inflammation, leading to scar tissue formation. The use of excessively large endotracheal tubes can reduce blood flow to the airway mucosa and result in airway ulceration, which can trigger the development of stenosis. In pediatric airways, the subglottic region is the most common site for stenosis to occur since it represents the narrowest part of the pediatric airway (Smith & Cotton, 2018).

Laryngomalacia in this case also played a role in the development of laryngeal stenosis in pediatrics. However, laryngomalacia typically leads to supraglottic stenosis rather than subglottic. A comprehensive evaluation of the airway in patients with comorbid difficult airways is crucial for anaesthesia management and to map out the risks and complications that may occur during anaesthesia.

In this case, anticipation of a difficult airway in the patient was made beforehand. Various difficult airway equipment was prepared, including a small pediatric LMA, a small pediatric fiberoptic laryngoscope (FOL), and pediatric cricothyrotomy equipment. During induction, it was observed that the patient could be ventilated effectively. Therefore, the decision was made to use a muscle relaxant to facilitate ventilation and reduce spasms during intubation. However, intubation failed, and repeated attempts were unsuccessful, leading to the use of an LMA in the patient.

One of the pitfalls of using an LMA is the need for a sufficiently large tidal volume to expand the chest and achieve adequate minute ventilation in this case. This tendency for abdominal enlargement and distension persisted throughout the procedure, partly due to the use of the classic version of the supraglottic airway (LMA). Additionally, an NGT (nasogastric tube) could not be inserted for abdominal decompression.

Another pitfall is the history of repeated intubation attempts, which made the child highly susceptible to laryngeal edema following intubation attempts. This was indicated by the presence of post-extubation stridor and was

managed by the early use of steroids as prophylaxis to prevent laryngeal edema in this patient with comorbid laryngomalacia and a history of difficult intubation, even though some studies suggest that continuous steroid administration for laryngeal edema cases has not provided valid therapeutic effects. Administration of nebulized adrenaline in adults lacks valid evidence for reducing edema, but in the pediatric population, nebulized adrenaline is given to reduce upper airway edema in severe croup. One study stated that the combination of intravenous steroids and nebulized adrenaline did not prove effective in preventing the progression of airway obstruction due to laryngeal edema. A recent study compared intravenous dexamethasone and nebulized budesonide, concluding that nebulized budesonide can replace the role of intravenous dexamethasone in helping to reduce edema (Ak AK, 2020).

For patients with symptomatic post-extubation laryngeal edema that does not improve with anti-edema agents (intravenous steroids/nebulized adrenaline), monitoring can be done for 1 hour before deciding on reintubation. If the patient has symptomatic post-extubation symptoms but starts improving during this 1-hour period, intravenous steroids and nebulized adrenaline can be continued for the next 24-48 hours. In patients requiring reintubation, intravenous steroids and nebulized adrenaline should be continued for the first 24-48 hours before considering extubation or tracheostomy. Elevating the head and neck can also be performed to reduce venous congestion, which can worsen edema (Ak AK, 2020).

In this case, nebulized adrenaline and intravenous steroids were administered for 24 hours post-extubation, and the patient clinically improved. The patient was then transferred to the low-care unit after 5 days of treatment.

6. Conclusion

In this case, suspicion of laryngeal stenosis necessitates an evaluation of its causes. The patient is currently awaiting a queue for a 3D airway reconstruction CT scan to determine the underlying cause of the airway narrowing. The history of prolonged intubation at 3 months of age, repeated intubations during the initial surgery, and the diagnosis of laryngomalacia in the patient are multiple interrelated factors contributing to the occurrence of laryngeal stenosis. However, it is essential to remember that when a patient with a difficult airway is scheduled for surgery, it is crucial to educate the family about the condition, anaesthesia plan, and the risks and complications involved. A comprehensive evaluation of the airway, complete preparation of difficult airway equipment, and strategies to address worst-case scenarios in patients should also be implemented.

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