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Case Report

Manual jet ventilation to rescue a patient with pinhole tracheal stenosis: A case report

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ABSTRACT

Background: Airway management of patients with tracheal stenosis is highly challenging and even establishing a surgical airway may be difficult in these patients.
Case: A 24 year old female developed pinhole tracheal restenosis after undergoing tracheal web resection and reconstruction. After other modes of ventilation had failed, we used the Manual jet ventilator endotracheal tube assembly as a rescue device and performed intermittent low-frequency jet ventilation until a definitive surgical airway could be established.
Conclusion: Central airway obstruction in severe tracheal stenosis can cause life-threatening hypoxia. Jet ventilation through the pin hole opening buys some time for the surgeon to secure the airway.

1. Introduction

Severe iatrogenic tracheal stenosis is a rare but life-threatening condition with an incidence of 4.9 cases per million per year.[1] Typically, the stenosis occurs either at the site of the endotracheal tube cuff (Intrathoracic trachea) or at the level of the tracheostomy stoma due to mucosal ischemia. Airway management of patients with tracheal stenosis is highly challenging and even establishing a surgical airway may be difficult in these patients. We present the emergency airway management of a patient who developed recurrent, severe tracheal stenosis after web resection and reconstruction. After other methods of ventilation had failed, we used a Manual jet (VBM Medizintechnik, Sulz, Germany) endotracheal tube assembly as a rescue device and performed low-frequency manual jet ventilation until a definitive surgical airway could be established. The patient in this case provided informed consent for the publication of this report.

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2. Case Description

A 24-year-old female with a known history of corrosive poisoning developed tracheal stenosis due to prolonged intubation. She was initially managed conservatively with serial tracheal dilatation and steroid injections, and she was discharged with a low tracheostomy. The patient presented to our hospital 3 years later for tracheal web resection with tracheostomy closure. Arterial blood gas analysis indicated mild impairment of oxygenation but normal ventilation (pH = 7.43, Pao^2= 75 mmHg, $Paco^2$=40 mmH). Three-dimensional computed tomography (CT) of the trachea revealed moderate mid tracheal stenosis of 2-3 cm in length. In cross-section, the stenotic lesion was dumble shaped with a minor axis of 1.5 cm and a major axis of 3 cm (Figure 1). Despite the tracheal stenosis, she had no dyspnea during daily activities and was otherwise healthy. All her laboratory investigations were normal, and the airway examination revealed a Mallampati I airway, slightly restricted neck movement, and a tracheostomy in situ. In the operating room, after applying standard

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monitors and obtaining intravenous access with a 16G canula, a loading dose of dexmedetomidine infusion was initiated at 1 μg/kg for 10 min and then reduced to 0.3–0.5 μg/kg/min for maintainance. Fiberoptic bronchoscopy was performed using the spray-as-you-go (SAYGO) technique and a 6 mm flexometallic tube was placed below the vocal cords proximal to the stenosis. The patient was gradually deepened with sevoflurane, oxygen, and air.

Under bronchoscopic guidance, the surgeon was able to resect the thick fibrotic web and the 6.0-mm flexometallic endotracheal tube was passed beyond the stenosis into the trachea. Spontaneous respiration was maintained until the trachea was successfully intubated. Thereafter, general anesthesia was administered with propofol 2μ/kg, fentanyl 2μ/kg, and atracurium 0.5 mg/kg. The tracheostomy wound was refreshed, and the trachea was reconstructed with a supraclavicular muscle flap and costal cartilage. The patient was subsequently transferred to the surgical intensive care unit for elective ventilation and observation.

On the third postoperative day, she was extubated over an airway exchange catheter. She developed subcutaneous emphysema and respiratory distress 4 hours after extubation and required reintubation. Bronchoscopy revealed edematous tracheal mucosa with thick secretions. Two days after being reintubated, a trial extubation was repeated under fiberoptic guidance, which was successful. She was discharged home the next day and was advised to follow-up with the outpatient department.

The patient returned to the hospital 11 days later with severe respiratory distress. The She was nebulized with salbutamol and Budesonide put on non-invasive ventilation (BiPAP) and transferred to the operating room for emergency flexible/rigid bronchoscopy. After applying standard monitors and obtaining adequate intravenous access, humidified oxygen was administered with nasal prongs at 15 L/min in 20 degrees head up position. An emergency flexible bronchoscopy revealed recurrent severe tracheal webs with a pinhole opening (0.5-1 mm) (Figure 2). Bronchoscopic resection of the web was attempted, but the patient's oxygen saturation dropped to 85%. The procedure was abandoned and fiberoptic illumination-guided percutaneous tracheostomy was attempted; however, the tracheostomy tube could not be inserted due to the presence of thick web granulation tissue and the muscle flap. Mask ventilation was also not possible. A 6.0-mm flexometallic tube was quickly railroaded over the bronchoscope and placed over the pinhole opening. Intermittent low-frequency jet ventilation was performed at a rate of 8 to 10 breaths per minute using a Manual jet ventilator endotracheal tube assembly (Figure 3). Initially we started with 20 psi and gradually increased to 40 psi and the I: E ratio was maintained at 1:3 to allow egression of gases from the lung. High-flow oxygen was delivered through the other nostril. The patient's oxygen saturation significantly improved, and a low tracheostomy was subsequently performed under ultrasound guidance. A dexmedetomidine infusion was administered throughout the procedure. Following the tracheostomy procedure, the patient was transferred to the surgical intensive care unit for elective ventilation and observation. She was discharged 2 days later, and her follow-up visits were uneventful.

Fig. 1: Initial presentation of the patient (grade 1 stenosis)

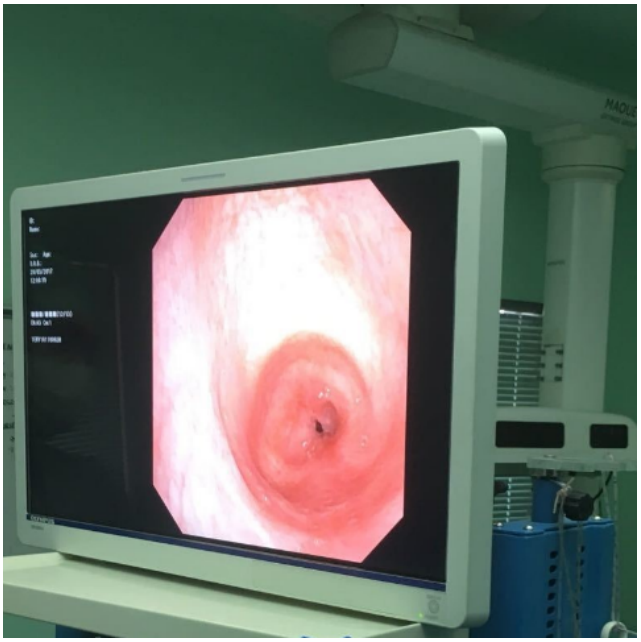

Fig. 2: Pin hole tracheal stenosis

3. Discussion

The incidence of iatrogenic tracheal stenosis following endotracheal intubation or tracheostomy has decreased over time due to the advent of low-pressure, large-volume endotracheal cuffs.[1] Despite the use of low-pressure cuffs, tracheal stenosis can still occur following prolonged intubation and managing patients with recurrent stenosis can be very challenging for both the surgeon and

Fig. 3: Manual jet ventilator with endotracheal tube

the anesthesiologist. These patients typically present with inspiratory stridor or severe respiratory distress, depending on the degree of tracheal narrowing. The degree of tracheal narrowing can be graded based on the percentage of obstruction using the Myer–Cotton scale: grade I is from normal to up to 50% obstruction; grade II is from 51% to 70% obstruction; grade III from 71% to 99% obstruction; grade IV is for no detectable lumen.[2]

Our patient initially had grade I tracheal stenosis; however, she developed grade III stenosis after the web resection and reconstruction. In addition to a history of prolonged intubation, the patient had also failed recurrent serial dilatation, which demonstrated the aggressive nature of the granulation tissue and tracheal web. Various authors have suggested supraglottic airway devices and the Aintree intubation catheter as rescue devices in cases of severe tracheal stenosis.[3,4] In our patient, spontaneous respiration was maintained during her initial surgery before her trachea could be intubated. High-flow nasal oxygen insufflation was administered during the bronchoscopy. A Manual jet should also be available in these cases as an emergency rescue device in the event of airway loss and hypoxia.

During the patient's second presentation, she was in respiratory distress and placement of the tracheostomy tube was difficult due to the previous reconstruction and thick web formation. Her oxygen saturation dropped during repeated attempts at bronchoscopy-guided web resection and tracheostomy, and the Manual Jet ventilation through an endotracheal tube placed above the pin hole tracheal opening proved to be a saviour while definitive airway access could be established. Unlike other injectors, the Manual jet ventilator utilizes the minimum driving pressure necessary to ventilate the lungs by entraining the surrounding gases, thereby reducing the risk and extent of any barotrauma.[5] The low frequency and I: E ratio of 1:3 also allows for the egression of inspired gases.

The surgical management of patients with tracheal stenosis remains a controversial subject. Most authors prefer tracheal resection with end-to-end anastomosis when feasible. However severe restenosis after surgery increases the difficulty quotient by many folds. Central airway obstruction coupled with difficult surgical airway can lead to chaotic situations and life-threatening hypoxia. Jet ventilation through the pin hole opening buys some time for the surgeon to secure the airway.

4. Source of Funding

None.

5. Conflict of Interest

None.

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