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Tracheomalacia with Hyperdynamic Airway Collapse Diagnosed and Treated in the Emergency Department

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ABSTRACT

Tracheomalacia poses a significant challenge in diagnosis due to its rarity and the absence of distinctive diagnostic features. This case study presents a female patient with a history of anoxic brain injury following cardiac arrest who underwent tracheostomy and mechanical ventilation. The patient's caregiver sought medical attention in the emergency department due to elevated Peake pressure and a clinical presentation resembling obstructive airway disease. Nonetheless, the patient did not exhibit improvement with initial therapy and began to deteriorate. Subsequent assessment using a bronchoscope unveiled tracheomalacia alongside hyperdynamic airway collapse, effectively addressed through the advancement of the tracheostomy tube. Following treatment, the patient was safely discharged home. In conclusion, healthcare providers must consider tracheomalacia as a potential etiology of airway obstruction in tracheostomized patients.

Keywords

Tracheomalacia, Hyperdynamic airway collapse, Emergency department.

Case Presentation

A 56-year-old female patient, who had experienced anoxic brain injury as a consequence of cardiac arrest while on a Tracoe Vario cuffed size 8 tracheostomy tube and mechanical ventilation, was brought to the emergency department by her caregiver due to an alarm from her ventilator indicating high peak pressure reaching 60 cmH2O.

Despite maintaining normal saturation at home, upon evaluation in the resuscitation room, the patient exhibited bilateral wheezes upon chest auscultation. Her hemodynamics remained stable, with no signs of fever or tachycardia. Connected to the resuscitation ventilator, the patient's peak pressure was noted at 50 cm H_2O, and the end-tidal CO_2 tracing displayed a sharkfin shape, leading to the initial impression of airway obstruction such as asthma or a mucus plug. The primary management interventions focused on suctioning and nebulization; however, challenges arose during the suctioning process using the tracheostomy suction tube, as advancement of the tube was hindered.

A comprehensive septic workup was conducted for the patient, yielding unremarkable results. Additionally, a chest X-ray revealed that the tracheostomy tube had shifted upwards by approximately 2 cm compared to the previous imaging (Figure 1). Despite initial treatments involving suctioning and nebulization, there was no notable improvement.

Subsequently, when the patient reached the peak pressure limit, the ventilator stopped providing enough tidal volume to overcome the high peak pressure. The patient experienced a sudden desaturation from inadequate tidal volume delivery from the ventilator, prompting immediate manual ventilation with an Ambu bag.

Our emergency senior consultant opted to perform a bronchoscopy to investigate potential causes of airway obstruction. The examination revealed tracheomalacia with hyperdynamic airway collapse, as depicted in Figure 2. Consequently, the tracheostomy

tube was advanced further by about 3 cm. Interestingly, following this adjustment, the patient's ventilation parameters improved significantly. The peak pressure decreased to below 40 cmH2O, adequate tidal volume was achieved, and the sharkfin appearance in the end-tidal CO2 waveform transformed into a normal square shape. Furthermore, the wheezing sounds disappeared.

After two hours of observation, during which the patient remained connected to her home ventilator at baseline settings, she was safely discharged home.

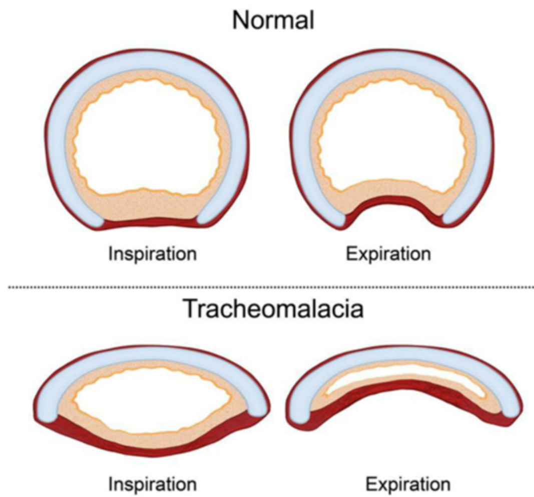


Figure 2: Illustration of tracheomalacia with the hyperdynamic airway collapse during expiration [1].

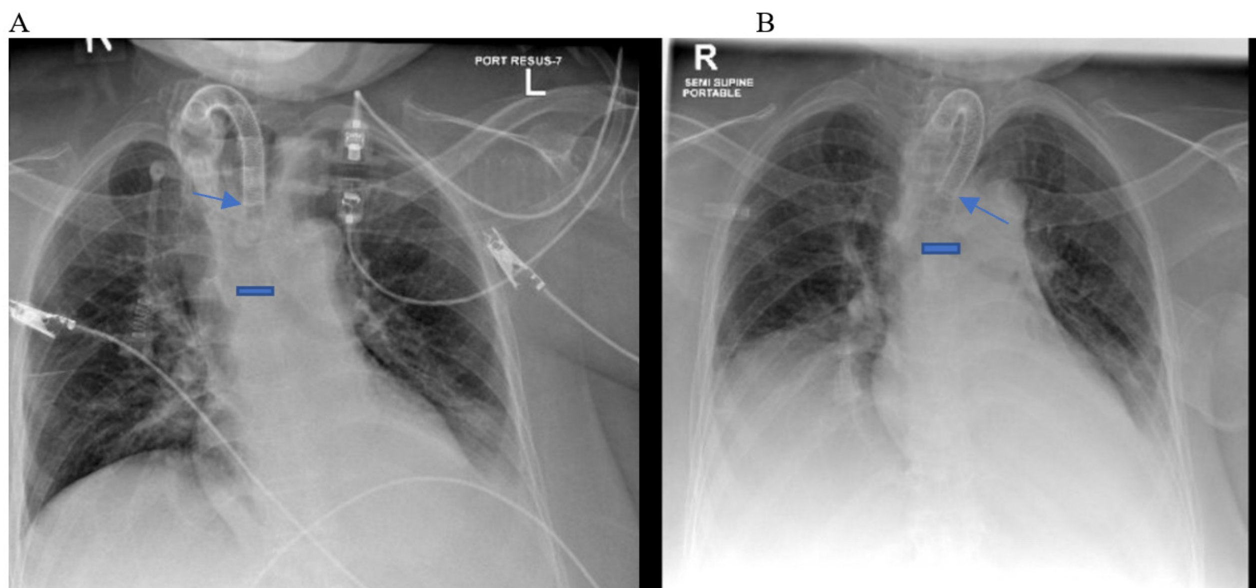
Introduction

Tracheomalacia (TM) and hyperdynamic airway collapse (HDAC) are commonly found to coexist in patients. Tracheomalacia is characterized by the weakening and softening of the cartilaginous structure of the trachea, leading to a reduction in its structural integrity. On the other hand, hyperdynamic airway collapse (HDAC) is defined as the excessive narrowing of the airway during forceful expiration. In individuals without any respiratory disorders, the collapse of the airway is typically around 35%, but in cases of HDAC, this percentage can exceed 50%, indicating a more pronounced and severe collapse during exhalation [2].

In this detailed case report, we will delve deeply into the complex topic of TM and explore the intricate ways in which it embodies and presents diagnostic obstacles.

Discussion

The prevalence of tracheomalacia (TM) within the general adult population remains uncertain, primarily due to the fact that most studies have focused on specific patient groups rather than the overall adult population. Furthermore, the process of diagnosing tracheomalacia poses a significant challenge, largely stemming from the infrequent encounters physicians have with this rare condition. What complicates matters further is the lack of distinct or defining characteristics associated with tracheomalacia. Patients typically present with a history of symptoms such as cough, dyspnea, wheezes, stridor, or hemoptysis, which can easily lead to misdiagnosis. In many cases, tracheomalacia is mistaken for asthma or chronic obstructive pulmonary disease (COPD). Interestingly, individuals with COPD are also susceptible to developing tracheomalacia, which can manifest similarly to a COPD exacerbation. This similarity in presentation between the



The blue Arrows shows the end to the tracheostomy tube.
The blue line shows the level of the carina.

Figure 1A: Shows the migration of the tracheostomy tube B: shows the original place of the tracheostomy tube.

two conditions often makes it challenging for healthcare providers to differentiate between them [3,4].

Causes of TM in adults can be classified as either primary, which is typically congenital and present since birth if the patient survives into adulthood, or secondary. Secondary causes of TM often stem from post-intubation, which stands as the most prevalent trigger, as observed in the presented case, where the endotracheal or tracheostomy tube damages the supportive cartilaginous wall of the trachea, leading to a weakening of the tracheal structure. Additional secondary causes of Tracheomalacia include smoking or recurrent infections linked to chronic respiratory diseases [5].

In the process of diagnosing TM subsequent to careful evaluation of the presenting symptoms, it is common practice to conduct pulmonary function tests, such as spirometry and flow-volume loop assessments. However, the preferred method regarded as the gold standard and definitive diagnostic tool for TM is the utilization of bronchoscopic examination. Additionally, an alternative modality employed in the diagnostic process is the application of dynamic expiratory computed tomography (CT), which has shown to possess a notable level of sensitivity in the identification of tracheomalacia [6,7].

The intervention implemented for our patient involved advancing the tracheostomy tube further into the respiratory system. This strategic placement aims to circumvent the region affected by malacia, allowing the tracheostomy tube to serve as a supportive splint and aid in maintaining a patent airway [5].

In patients who are not intubated or tracheostomized and are experiencing severe symptoms of tracheobronchomalacia (TM), the surgical approach involves the utilization of silicone stents in the trachea with or without the main bronchus. An alternative surgical option that has been explored is tracheobronchoplasty, which entails surgical plication and the use of mesh to stabilize the trachea. However, it is important to note that this particular surgical intervention is reserved for a specific subgroup of patients and necessitates a high degree of surgical proficiency [8,9].

Conclusion

In conclusion, it is of utmost importance to recognize that tracheomalacia (TM) has the potential to evade detection due to its resemblance to other prevalent obstructive pulmonary diseases. However, the displacement of the tracheostomy tube, even if it is minimal, in conjunction with symptoms of airway obstructions and alarms indicating high peak airway pressure on the ventilator, may serve as an indicator hinting at the presence of tracheomalacia with hyperdynamic collapse of the airway. To substantiate this suspicion, it will be imperative to conduct a thorough bronchoscopic examination. Moreover, the management of this condition within the confines of the emergency department will simply necessitate the repositioning of the tracheostomy tube to its original placement.

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