

# Asymmetric Tracheostomy Cuff Inflation Causing Air Leak and Inadequate Tidal Volume Delivery: A Case Report

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## ABSTRACT

We report a rare case of tracheostomy tube malfunction due to asymmetric cuff inflation, a complication scarcely discussed in medical literature and distinct from more commonly reported tracheostomy cuff herniation. This case highlights a less recognized cause of air leak and inadequate ventilation, contributing to the understanding of rare tracheostomy complications.

A 71-year-old male, recovering from Ivor Lewis esophagectomy and requiring surgical tracheostomy for prolonged ventilatory support, presented with a persistent air leak and reduced tidal volume soon after tube placement. This occurred despite an adequate cuff pressure (28 cm H<sub>2</sub>O) and confirmed correct tube positioning. Direct laryngoscopy revealed air escaping through the glottis with each delivered breath, with the tracheostomy cuff visibly intact and no herniation.

The findings led to the diagnosis of asymmetric tracheostomy cuff inflation. The therapeutic intervention involved the replacement of the problematic tracheostomy tube with a new non-fenestrated tube. This intervention immediately and completely resolved the air leak and restored normal ventilation.

This case underscores the importance of prompt recognition and considering asymmetric cuff inflation in the differential diagnosis of tracheostomy tube malfunction. Differentiating between tracheostomy cuff herniation and a merely asymmetric cuff is crucial for healthcare professionals to manage these situations effectively and in an evidence-based manner.

**Keywords:** Airway Management, Critical Care, Tracheostomy.

### Authors' Contribution:

All authors contributed equally to the conception, literature search, manuscript drafting, editing and review

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## Introduction

Tracheostomy is a commonly performed procedure in critically ill patients, crucial for long-term airway management, prolonged ventilatory support, and for preventing complications associated with prolonged translaryngeal intubation.<sup>1</sup> The inflated cuff of a tracheostomy tube helps minimize air leaks

and reduces the risk of aspiration. Tracheostomy tube cuff malfunction can occur due to several reasons, including manufacturing defects, loss of cuff elasticity, and inadvertent over-inflation. One such complication is asymmetric cuff inflation, a rare but potentially life-threatening issue. In this situation, despite seemingly adequate cuff pressure,

the cuff inflates unevenly, causing an incomplete seal and allowing air to escape past the glottis. This results in persistent air leak and inadequate tidal volume delivery, leading to increased morbidity and mortality if not recognized in time.<sup>2</sup> This report aims to highlight this less-discussed form of tracheostomy tube malfunction to enhance clinical awareness and facilitate evidence-based management.

### **Patient Information**

The patient was a 71-year-old male, measuring 175 cm in height and weighing 67 kg. His past medical history included hypertension, type 2 diabetes mellitus, and chronic atrial fibrillation. He initially presented with progressive dysphagia to solids over 2–3 months, accompanied by significant unintentional weight loss of approximately 7–8 kg. Diagnostic workup confirmed adenocarcinoma of the esophagus, specifically involving the gastro-esophageal junction with circumferential wall thickening.

He underwent four cycles of neoadjuvant chemotherapy which led to an improvement in symptoms. Subsequently, he was scheduled for surgical intervention and underwent an uneventful Ivor Lewis esophagectomy. The immediate postoperative period was complicated by bilateral pleural effusions, failure to wean from mechanical ventilation, and prolonged respiratory support. On postoperative day eight, a surgical tracheostomy was planned in the intensive care unit to facilitate continued ventilatory management.

### **Clinical Findings, Diagnostic Assessment, and Therapeutic Intervention**

A bedside surgical tracheostomy was planned in the intensive care unit. Physical examination revealed stable hemodynamic parameters and adequate ventilation. Intravenous sedation, analgesia and muscle relaxation were administered. A pre-procedure tracheostomy tube check did not reveal any abnormal findings. A size 7.6 mm inner diameter, cuffed and fenestrated tube was inserted and its cuff was inflated at a pressure setting of 28 cm H<sub>2</sub>O.<sup>3</sup> The tracheostomy was connected to the

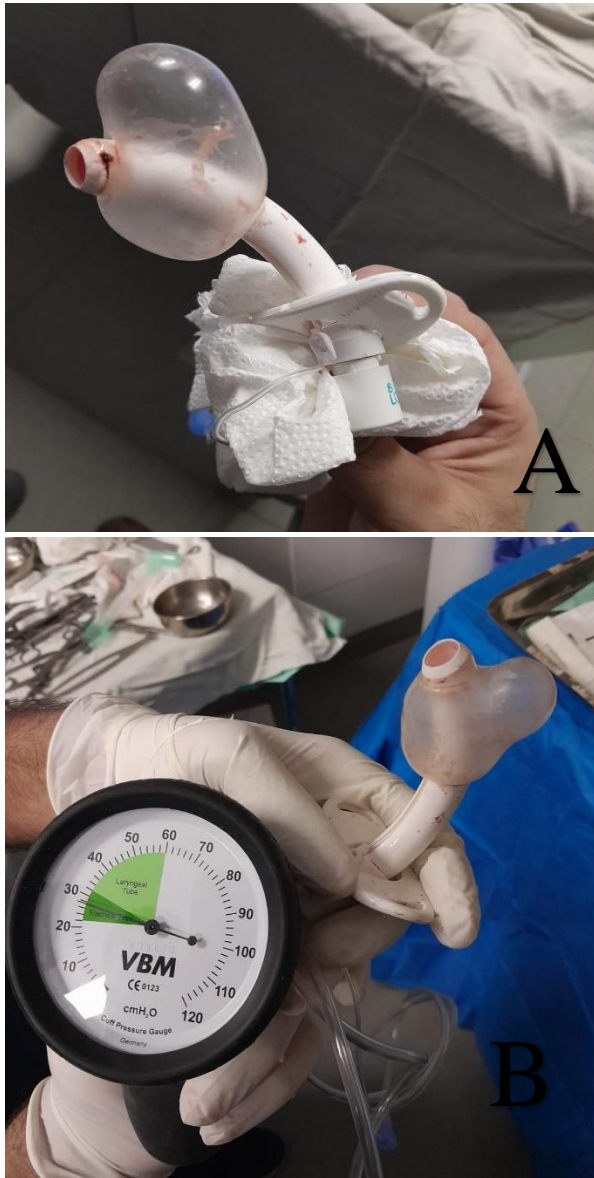
ventilator and a normal capnograph trace confirmed the correct placement.<sup>4</sup> The already placed endotracheal tube was accordingly removed. Bilateral air entry was confirmed on chest auscultation. Volume-controlled ventilation was resumed with setting of 480 ml Tidal Volume, Respiratory rate 16 breathes per minute, 5 cm H<sub>2</sub>O Positive end-expiratory pressure, 100% FiO<sub>2</sub>). At that point, an air leak was heard over the mouth.

While assessing the ventilator graphics, the respiratory therapist noticed a low tidal volume alarm with a difference of 100 ml in the set tidal volume (480 ml) and delivered tidal volume (380 ml). Notably, the peak airway pressures remained within normal limits. Repeat measurement of the cuff pressure revealed a constant value of 28 cm H<sub>2</sub>O. The addition of extra volume to the cuff failed to resolve the air leak. Also, a suction catheter was passed easily through the tracheostomy tube into the trachea without resistance. Our findings till that point of time directed us away from the possibilities of either a cuff rupture or a blocked tracheostomy tube.

As bronchoscopy was not available in the unit, a decision was made to do a direct laryngoscopy. Upon direct laryngoscopy, a Cormack-Lehane grade I view was obtained. In addition, the tracheostomy tube cuff could be visualized within the trachea, with its cuff intact. There was no herniation of the tracheostomy cuff proximally through the vocal cords. Importantly, air bubbles were observed escaping through the glottis with each delivered breath.

In light of the above, a suspicion arose regarding the integrity of the tracheostomy tube. After a thorough discussion, a decision was made to replace the tracheostomy tube with a new one. Insertion of a new tracheostomy tube (non-fenestrated 7.5 mm inner diameter) completely resolved the air leak. Examination of the initial tracheostomy tube revealed asymmetric cuff inflation (Figure 1A-B). The patient tolerated the new tracheostomy tube well, and tidal volume delivery normalized. Ventilator

parameters remained stable over the following 48 hours, and no further airway complications were observed during the intensive care unit stay.



**Figure 1.** View of the initial tracheostomy tube showing asymmetric cuff inflation (A) at Cuff Pressure setting of 28 cm H<sub>2</sub>O (B)

## Discussion

In our case, the primary findings were air leak and inadequate tidal volume delivery. This is in contrast to the majority of cases of tracheostomy cuff malfunction present in the literature, in which the predominant feature of a tracheostomy cuff

malfunction has been noted to be airway obstruction and blockage of distal lumen secondary to tracheostomy cuff herniation.<sup>5</sup> Asymmetric cuff inflation and cuff herniation need to be seen from a separate viewpoint as resultant findings can be quite different.

Asymmetrical cuff inflation can be attributed to loss of cuff elasticity, of which the two most common causes are tube cuff manufacturing defect and inadvertent over-inflation of the cuff.<sup>6</sup> Other causes of tracheostomy or endotracheal tube malfunction include physical malpositioning and surgical manipulation. In addition, in surgical cases with prolonged duration of nitrous oxide administration, the cuff can be over-inflated over time, leading to loss of its integrity and function.

Differential diagnosis for an air leak, immediately following tracheal intubation/tracheostomy, includes cephalad displacement of the cuff above the vocal cords, leading to loss of delivered tidal volume. In addition, there could be a cuff leak (leak around an intact cuff) leading to similar clinical findings. On the other hand, differential diagnosis of airway obstruction following a tracheostomy includes cuff herniation leading to partial or complete obstruction of the trachea, main bronchus, or distal lumen of the tube.

Tracheostomy cuff herniation should always be considered as a potential cause of impaired airflow following tracheostomy procedures. The most frequent cause of endotracheal tube (ETT) cuff herniation is overinflation of the cuff. Therefore, it is recommended to inflate the cuff gradually, using the minimal amount of air necessary to achieve an effective seal.<sup>7</sup> If there is any uncertainty regarding the situation, removal of the tube should be promptly considered.<sup>8</sup>

### Patient Perspective

Due to the patient's ongoing clinical condition and prolonged mechanical ventilation in the intensive care setting, a direct patient perspective on the

treatment received was not available for inclusion in this report. The patient's family was informed about the complication and treatment.

### Informed Consent

Written informed consent for the publication of this case report was obtained from the patient's son.

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