

Pilot Balloon Malfunction Caused by Endotracheal Tube Bite Blockers

Jacob R. Adams, DO; Justin Hoffman, RRT; Joe Lavelle, RRT; Eduardo Mireles-Cabodevila, MD.

Affiliation of authors: Respiratory Institute, Division of Pulmonary, Allergy and Critical Care Medicine, Cleveland Clinic, Cleveland, OH

Address Correspondence to:

Eduardo Mireles-Cabodevila, MD
Cleveland Clinic Main Campus
Mail Code G62
9500 Euclid Avenue
Cleveland, OH 44195
mirelee@ccf.org

The authors report no conflict of interest in the content of this case report.

Key Words:

Airway extubation, Intratracheal intubation, Laryngeal edema

Introduction

A patient's bite is a frequent cause of endotracheal tube (ETT) obstruction. ETT obstructions affect the volume and pressure delivered by the ventilator. Bite-related ETT occlusions are a frequent cause of ventilator alarm activation, and are known to cause respiratory failure, negative pressure pulmonary edema or ETT tube/pilot tube damage. Clinicians have used objects (syringes, tongue depressors, gauze) or devices intended for other goals (i.e. oropharyngeal airways or intermolar devices) to prevent the patient from biting the ETT. However, these devices are often makeshift, not designed for prolonged use and come with numerous side effects such as, accidental dislodgement, ulcers, aspiration, ischemia and/or injury to the temporomandibular joint. Thus, several commercial bite blocks, which encase and protect the endotracheal tube, are now commonly used. These devices are made of a relatively hard plastic that keeps its form in spite of the body temperature or patient bites. They have a low profile and may double as tube holders. These devices come in single sizes for adults or children. They are easy to use and thus are becoming ubiquitous. The placement of these devices is mainly intuitive, and although instructions and policies may exist, its placement and troubleshooting comes from experience.

Case Summary

A 78 year-old, 152cm tall woman was transferred to our intensive care unit for evaluation of acute respiratory failure. At the outside hospital she was treated for community acquired pneumonia. While admitted, she was noted to have jaw stiffness with limited opening leading to an inability to eat or drink. She developed worsening respiratory failure and hypoxemia and was electively intubated. The intubation was described as very difficult due to limited mouth opening, even with the use of neuromuscular blockers. Intubation was achieved with a 7.0 mm, cuffed ETT (Mallinckrodt™, Mansfield, MA), fixed at 21 cm at the teeth. Her past medical history was significant for hypertension, hyperlipidemia and osteoporosis.

Her physical exam was relevant for the presence of limited mouth opening, less than 2 cm. The neck mobility was limited in all directions. She was awake and interactive. Her lung exam demonstrated scant bilateral basilar crackles. Her heart rate was regular and rhythmic, and there was trace lower extremity edema. The endotracheal tube was easily compressed by the teeth, thus a B&B Universal Bite Block® (B&B Medical Technologies Inc., Orangevale, CA) was placed by the respiratory therapist and secured with an Anchor Fast Oral Endotracheal Tube Fastener (Hollister Inc., Libertyville, IL).

Ear, Nose and Throat and dentistry consultation concluded that the limited mouth opening was due to severe temporomandibular joint disease. The patient was

unable to open her mouth more than 2 finger widths, voluntarily or under paralysis. After four days of therapy, her respiratory status improved. She passed a spontaneous breathing trial, was awake and interactive. Part of our extubation checklist includes the presence of a cuff leak (1,2). She did not have any leak by ventilator volume or auscultation. Due to the absence of a cuff leak and the concern for a difficult re-intubation, the extubation was aborted. Endoscopic exam of the larynx was inconclusive due to partial visualization of the laryngeal structures. The patient was given intravenous steroids (Dexamethasone 8mg IV every 8hrs) for presumed laryngeal edema.

The next day a cuff leak test was again performed. No leak was elicited. As part of routine protocol, cuff pressures were measured all averaging 20 cm H₂O. The team was discussing the possibility of a tracheostomy given her difficult airway. The respiratory therapist, recalling similar events, decided to check the pilot balloon line. The bite block had inadvertently kinked the pilot balloon tubing at the junction of the ETT (Figure 1); as a result we saw a completely deflated pilot balloon while the ETT cuff remained inflated (Figure 2). After removal of the bite block, a cuff leak became evident. The patient was extubated over a tube exchanger. She continued to recover and was eventually discharged to the floor without further problems.

Discussion

Our case report highlights the need for specific steps to care for patients that have a bite block in place. We demonstrated that the bite block placement or its migration could kink the pilot balloon tubing, which if not identified, can result in unnecessary interventions.

A kinked pilot tube may cause two scenarios:

- 1) *Persistent under inflation of the cuff.* The pilot balloon is fully inflated, the pressure gauge would be normal, but the ETT cuff is deflated or underinflated. This may lead to persistent air leak, inability to ventilate and aspiration of subglottic secretions. (3,4)
- 2) *Persistent inflation or over inflation of the cuff.* The pilot balloon is deflated or is fully inflated, the pressure gauge would be normal, but the ETT cuff is inflated or overinflated. The result may be an absent cuff leak test, inaccurate cuff pressures or difficulty removing the ETT (5,6).

Although we have experienced both scenarios, there is a paucity of reports referring to this problem. A systematic review of the literature revealed both situations scarcely being reported (Table 1). The stand-alone bite blocks that encase the ETT were the most common device associated with pilot balloon occlusion. (3,4,5). Each of the reported episodes had clinical consequences, which is likely why they reached publication. The reports by Alkire (3) and Brock-Utne (4) describe large air-leaks, desaturations and difficulty ventilating the patients. In both cases, the pilot balloon was completely inflated while the ETT's cuff was deflated. In a case similar to ours,

Gleich (5) et al and Singh et al (6) report unintended kinking of the pilot tubing leading to persistent inflation of the ETT cuff, which resulted in difficulty removing the ETT. Our extubation protocol includes a cuff leak test, where an absence of a leak triggers an alert to the physician to decide whether the tube is removed. Our patient had a difficult airway, thus the decision to provide steroids for 24 hrs (7).

Bite blocks can be grouped into those that serve as individual bite blocks encasing the ETT, and those that are part of an ETT holder. All of these bite blocks come in a variety of sizes ranging from pediatric to adult. The cases reported in the literature all happened with individual bite blocks. Those integrated with the ETT holder may have the advantage that they do not encase the ETT (or pilot balloon) and the bite blocker is not as long as the individual units. Further, as they are attached to the face of the patient, migration is less likely.

When we consider the usual depth of insertion of an ETT, the bite block length may go over the pilot balloon take off. The device we used was the Adult size Universal Bite Block (B&B Medical Technologies Inc.) which measures 4.4cm in length. The pilot balloon take-off occurs at different lengths of the ETT according to its size. In Table 2 we demonstrate patients that may be at risk according to the combinations of pilot balloon take-off, ETT length placements at the lip and an individual bite blocker (Universal Bite Block (adult)[™]). As it can be seen, there is more risk in patients with short ETT insertion, distance to the lips and larger ETT.

Each bite block comes with specific instructions on its placement. In the particular of this case, the bite block may be positioned to avert the pilot balloon kinking, however, this does not allow the respiratory therapist to visualize the length of the tube at the patient's lip. Turning the bite block, to visualize the numbering, will kink the pilot balloon when advancing the bite block (Figure 1). Indeed, the B&B's policies and procedures for insertion (8) indicate that the pilot balloon should be placed between the bite block and the ETT. This may prevent the kinking at the pilot balloon take off. The insert reads: "Should cuff filling problems occur, gently pull the pilot balloon line taut to remove any kinks." However, this would not solve the problem when the kinking is at the pilot line takeoff.

Whenever a pilot balloon is inflated, a clue to obstruction of the tubing is the amount of air needed to fill the ETT cuff. When small volumes are used, or pressure rapidly rises in the pressure manometer while inflating, suspicion should rise for an obstruction of the pilot balloon line. Whenever the balloon is deflated, a clue to an obstruction is low volumes being removed with the syringe.

Teaching Points

- Endotracheal tube bite blocks may cause kinking of pilot balloon tubing.
- Every blocker has its particulars, but patients at risk may be those with larger tubes and short ETT insertion distance to the lips.

- Obstruction of the pilot balloon tubing may cause persistent inflation or under inflation of the cuff.
- The clues that signal kinking of the pilot balloon tubing are small amounts of air (1-2 mL) required to deflate or inflate the cuff.
- Routine assessment of the intubated patient must include evaluation of the pilot balloon and tubing.
- Finally, we suggest that the ETTs should be free of any additional device when performing an extubation.

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Figure 1:

Figure 1 depicts the location at which the bite block typically kinks the pilot balloon tubing.

Figure 2

Figure 2 demonstrates that when the pilot balloon tubing is kinked, as in Figure 1, then deflation of the pilot balloon will result in a completely inflated cuff.

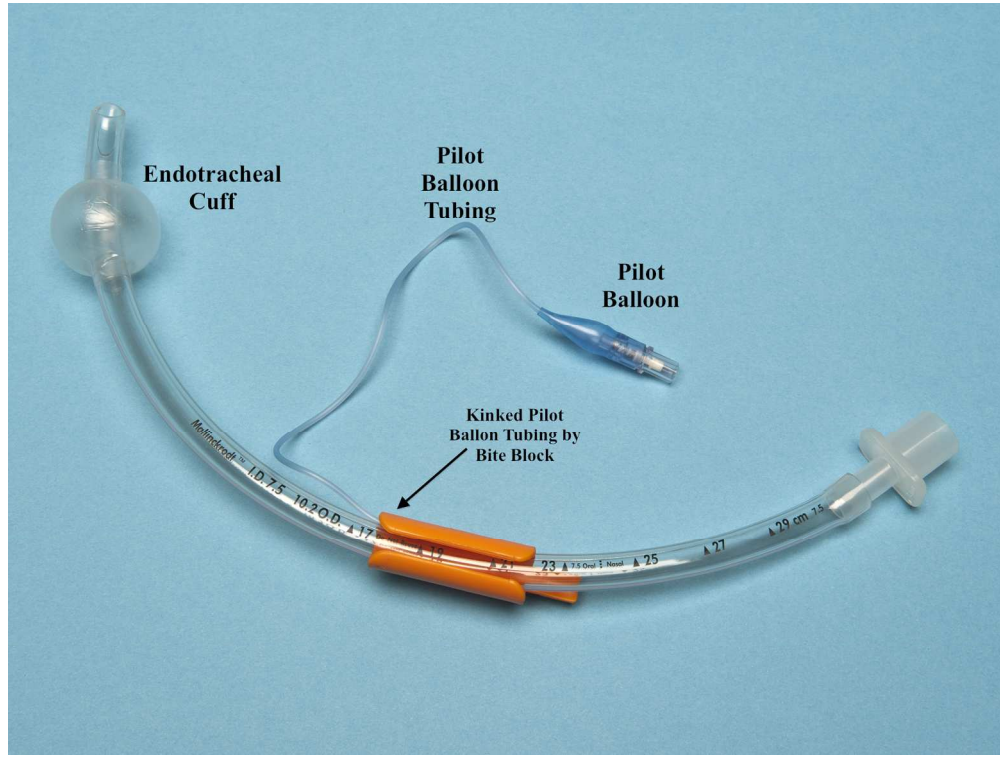
Table 1
Case Reports: Pilot balloon tubing kinking by endotracheal tube bite blocks

Study	Type of ETT	Size of ETT	Bite Block Used	Main problem	Complication
Alkire, M. T. (1998) ³	Unknown	Unknown	Bite proof bite block <u>B&B Medical Technologies</u>	Tubing kinked by bite block	-Large air leak -Difficulty oxygenation & ventilation
Brock-Utne, A. J. (2006) ⁴	Unknown	#8	Universal Bite block <u>B&B Medical Technologies</u>	Tubing kinked by bite block	-Air leak -Desaturation
Gleich, S. J., et al. (2008) ⁵	Hudson Respiratory Care	#9	<u>B&B Medical Technologies</u>	Tubing kinked by bite block	-Difficulty removing ETT
Singh, M., et al. (2009) ⁶	The Laryngeal Tube® (VBM Medizintechnik, Sulz, Germany)	Unknown	Unknown	Tubing kinked by bite block	-Difficulty removing ETT

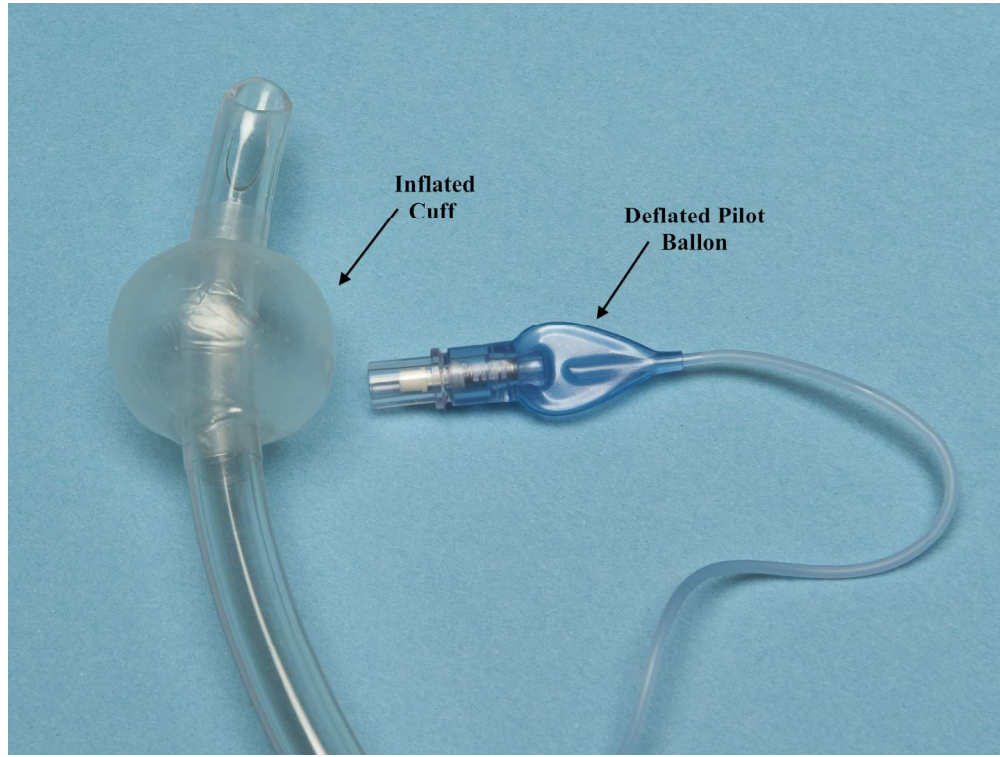
Table 2
Endotracheal Tube Sizes at Risk For Pilot Balloon Kinking by a bite blocker

ETT Size	Pilot Balloon Take-off (cm)	Male* (23cm lip)	Female* (21cm lip)
6.0	15	Low risk	Low risk
6.5	16.5	Low risk	Low risk
7.0	18.0	Low risk	Risk
7.5	19.2	Risk	High Risk
8.0	20.2	High Risk	Highest Risk
8.5	21.2	Highest Risk	Highest Risk
9.0	22.2	Highest Risk	Highest Risk

*ETT based on Mallinckrodt Lo-Pro Oral/Nasal Tracheal Tube cuffed and a bite blocker by Universal Bite Block (adult)[™]



254x190mm (200 x 200 DPI)



254x190mm (200 x 200 DPI)