Original Article

Pilot tubing repair: a technical note

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Contributions: (I) Conception and design: All authors; (II) Administrative support: None; (III) Provision of study materials or patients: All authors; (IV) Collection and assembly of data: None; (V) Data analysis and interpretation: None; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

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Background: Endotracheal tubes are designed with multiple features to enhance patient safety during the delivery of anesthesia. Some of these features include the cuff, cuff line, and spring-loaded pilot balloon. Their purpose is to inflate the cuff in the patient's airway to prevent aspiration, support oxygenation and ventilation, and prevent the leakage of volatile gasses. Procedures of the head and neck occur in close proximity to the airway and may result in damage to any of these parts of the endotracheal tube (ETT).

Methods: The authors of this technical note describe a technique using an intravenous (IV) catheter, a Luer-Lock syringe, and tape to repair the cuff line in case of iatrogenic damage.

Results: Use of this technique allows for provisional reinflation of a non-damaged cuff until the patient is ready for extubation.

Conclusions: The authors of this technical note have described a method of re-inflating a cuff in the case of damage to the endotracheal tube's pilot tube. While damage to the tube rarely occurs, it is a simple technique requiring equipment readily found in modern operating rooms that can prevent harm to a patient from a deflated cuff.

Keywords: Trouble-shooting; endotracheal intubation; pilot tubing

Received: 24 December 2022; Accepted: 24 March 2023; Published online: 29 March 2023.
doi: 10.21037/joma-22-42
View this article at: https://dx.doi.org/10.21037/joma-22-42

Introduction

Cuffed endotracheal tubes (ETTs) are an essential component to the safe delivery of general anesthesia and airway management of the ventilator-dependent patient. They are used for the delivery of inhalational anesthetics, airway protection, and oxygenation and ventilation (1). The ETT is specifically designed to facilitate these functions.

The cuffed ETT is equipped with a pilot balloon, cuff, and the cuff inflation line. These are designed to work synchronously to inflate the cuff and provide a seal to the airway, therefore protecting the airway from aspiration and allowing a semi-closed circuit of oxygenation, ventilation, and delivery of inhalational anesthetics (*Figure 1*). A spring-loaded valve is attached to the pilot balloon, which permits inflation or deflation of the pilot balloon, and allows for visual confirmation of inflation or deflation of the cuff at the distal end of the ETT (2). Damage to any of these individual components may occur inadvertently during head and neck procedures or with faulty equipment. Damage to the pilot balloon, cuff line, or cuff would cause an air leak, deflation of the cuff, and consequently, loss of the protective seal. This could lead to air leakage, aspiration of secretions or blood, inadequate ventilation, and/or inadvertent exposure of the operating room staff to volatile gasses (1-3). The patient may also experience hypoxemia and/or hypercarbia, ultimately leading to the cessation of the surgical procedure.

Prior to all procedures, the integrity of the ETT and its

functional components should be checked by inflating and deflating the cuff prior to insertion. If the ETT is damaged while in use in the intraoperative or postoperative setting, techniques for provisional repair provide the necessary time to stabilize the airway prior to extubation. The purpose of this technical note is to present a technique for repair of the cuff inflation line.

Methods

Equipment needed (*Figure 1*):

(I) Endotracheal or nasotracheal tube;
(II) 20- or 18-gauge intravenous (IV) catheter;
(III) Syringe with Luer-Lock tip;
(IV) Tape.

Technique–pilot tubing repair: if the pilot tube is torn or cut, this technique will allow for simple repair of the tube (*Figure 2*). In order for this to work, the tear must leave about 1 cm of length of the pilot tube attached to the endotracheal or nasotracheal tube.

Next, use a 20-gauge or 18-gauge IV catheter to insert in the end of the pilot tube that is attached to the endotracheal tube (*Figure 3*). If both sizes are available, the practitioner may start with the 18-gauge catheter first as the larger size may create a better seal between the catheter and the tube. The size of the catheter should be changed to match the size of the pilot tube if the first catheter does not fit and/or if an adequate seal is not obtained. The catheter should fit snug and not be easily removed by light pulling. Ensure that the needle tip is pulled back slightly to prevent the needle from creating additional holes on the pilot tubing. Afterwards, remove the needle. Of note, if the pilot tubing is sheared or has ragged edges, the tubing can be cut more to allow easy passage of the IV catheter.

Lastly, connect the syringe with the Luer-Lock attachment and administer air to the tubing (*Figure 4*). If needed, tape can be applied to the plunger end of the syringe to prevent the air from pushing the plunger out.

Highlight box

Key findings

- Cuffed endotracheal tubes are routinely used for the delivery of general anesthesia and are equipped with a cuff in order to protect the airway and to oxygenate/ventilate the patient.
- Damage to the pilot tubing can result in deflation of the cuff. This can lead to air leakage, aspiration, inadequate oxygenation/ventilation, patient hypoxemia/hypercarbia, staff exposure to the volatile gasses, and cessation of the surgical procedure.
- Repair of the pilot tubing is possible using equipment readily found in modern day operating rooms, including an IV catheter, syringe with Luer lock tip, and tape.
- While damage to the pilot tubing rarely occurs, knowledge of this technique should lead to a quick and reliable method of salvaging the endotracheal tube cuff, evading the potential consequences associated with a deflated cuff.

What is known and what is new?

- Variations of this technique has been previously reported in the literature.
- The authors wish to rediscuss this complication with a review of previously used techniques, while emphasizing the importance of using materials readily available to the practitioner.

What is the implication and what should change now?

- Practitioners and supporting staff involved in the delivery of general anesthesia should be prepared to manage complications associated with damaged equipment.
- Education on the management of equipment damage should be routinely discussed so that the providers are ready to manage such complications promptly.

Results

In the case of damage to the pilot tubing and an undamaged cuff, use of this technique will result in reinflation of the cuff and restoration of the seal. Airway protection will be restored, mitigating the complications previously listed. Once the cuff is re-inflated, the surgical and anesthesia teams will need to decide how to proceed with the case. This decision will depend on various factors, including the stability of the patient and the duration of the remaining procedure.

Discussion

While the centuries of innovation have led to the ETTs we routinely use in practice today, these devices are still subject to potential damage during higher risk procedures. Such procedures include those that are in close proximity to the tube (head and neck), or patients with difficult airways. Care should be taken when manipulating the ETTs or when working with sharp instruments in close proximity to the lines and tubing.

Other techniques for the repair of damaged pilot tubing have been described (2-5). These techniques have used similar instrumentation, including IV catheters, syringes, three-way stop-cocks, pressure gauges, and normal saline. The authors of this technical note wish to emphasize that

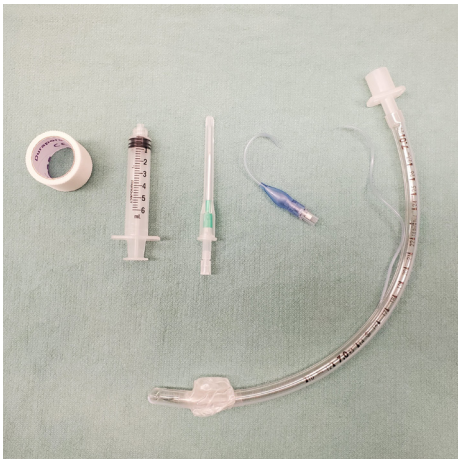

Figure 1 Supplies needed for pilot tubing repair technique.

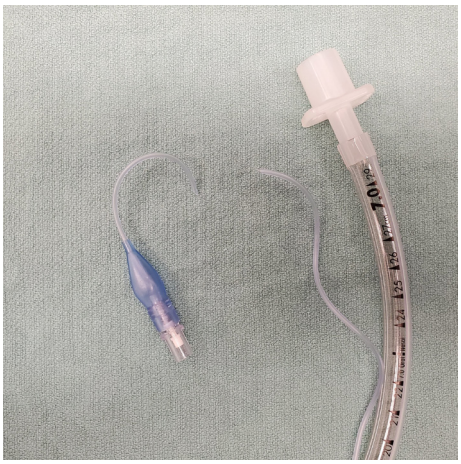

Figure 2 Damaged/cut pilot tubing.

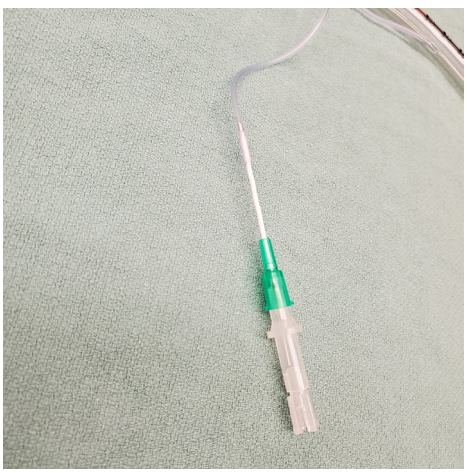

Figure 3 Insertion of catheter into the cut end of the pilot tube.

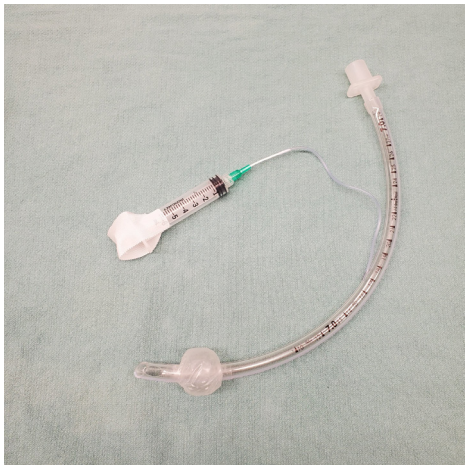

Figure 4 The needle is removed and the syringe is secured in order to re-inflate the balloon.

while various other options exist, the importance of using what is readily available in the operating room at the time of the incident is most important to minimize further complications.

There are several advantages to using this repair technique. If damage occurs peri-operatively, the technique described provides a quick solution that can be implemented with supplies that are readily available in operating rooms and outpatient clinic settings. The size of the needles used for this procedure can vary with the size of the cuff, but there are usually enough options available in a standard inventory. Creating the new connection with the syringe, catheter, and taping allows for re-inflation of the cuff and re-establishes the seal in the airway. This can permit for additional time to extubate the patient in a more controlled fashion.

There are a few disadvantages associated with this technique. One disadvantage is that it does not allow for tactile or visual feedback of cuff inflation. In other words, the cuff will be re-inflated blindly and the degree of inflation cannot be directly assessed as it would be if the pilot balloon were still attached. This might lead to under or over-inflation of the cuff. If available, adding a pressure transducer to a three-way stop-cock would provide this information and prevent over-inflation. Care should also be used when inserting the catheter needle into the pilot tubing as it may further damage the line. This technique is not beneficial if there is damage to the cuff itself or if an extended operation time is anticipated.

In the case of early damage to the ETT during a lengthy

procedure, the ETT may need to be exchanged for a new ETT. Dayan and Epstein (2016) compared intact versus repaired pilot balloons with the technique described and found there was no pressure drop or air leakage after an 8-hour interval (6). While the repair has been found to maintain pressure and prevent air leakage according to this one study, the monitoring practitioner should maintain a high degree of suspicion for pressure drops or air leakage if the tube is not exchanged.

Conclusions

The authors of this technical note have described a method of re-inflating a cuff in the case of damage to the endotracheal tube's pilot tube. While damage to the tube rarely occurs, it is a simple technique requiring equipment readily found in modern operating rooms that can prevent harm to a patient from a deflated cuff.

Acknowledgments

Funding: None.

Footnote

Peer Review File: Available at https://joma.amegroups.com/article/view/10.21037/joma-22-42/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://joma.amegroups.com/article/view/10.21037/joma-22-42/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study did not involve any human or animal subjects. Ethical approval from the institutional review board was not required.

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doi: 10.21037/joma-22-42
Cite this article as: Lam D, Mañón VA, Shum J. Pilot tubing repair: a technical note. J Oral Maxillofac Anesth 2023;2:3.