Retroversion bronchoscopy: an innovative approach to percutaneous dilatational tracheostomy and more

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Abstract

Tracheostomy is one of the most performed procedures in intensive care unit. Dilatational techniques, such as those described by Ciaglia, Griggs, or Fantoni, are currently the best choices as they can be easily performed at the bedside. Like any other intervention, early and late complications can occur even if the procedure appears to be performed without any issues. Although using a bronchoscope can make tracheostomy easier and safer, its routine utilization remains controversial. We describe a new method to further reduce the incidence of some complications: retroversion bronchoscopy. This new approach is not difficult to master and may be useful in other intensive care unit scenarios as well.

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Introduction

In recent decades, tracheostomy has become the preferred method for managing the airway in patients requiring long-term ventilation,[1] facilitating earlier weaning, improving patient comfort, reducing sedation, and enabling more effective tracheobronchial toileting.[2] The advent of this procedure dates back many centuries: the first attempt was recorded on an Egyptian papyrus in 3100 BC,[3] and Asclepiades in the first century BC clearly described its use to relieve upper airway obstruction. In the following years, there was an increase in the execution of tracheostomies, which led to the refinement of the technique despite a high mortality rate. Jackson is credited with the standardization of the surgical tracheostomy procedure at the beginning of the 1900s, which underwent minor modifications during the 20th century.[4] The advent of mechanical ventilators and intensive care units in the 1950s led to a shift in the primary indication for tracheostomy, from the urgent relief of obstruction to elective support for prolonged ventilator dependence.[5,6] It was Toy and Weinstein in 1969 who introduced percutaneous tracheostomy, allowing the procedure to be performed at the bedside, although the greatest contribution to the use of this technique was made by Ciaglia *et al.* in 1985[7] by introducing the Seldinger principle for the percutaneous approach. In the following years, other methods were reported: Griggs *et al.* in 1990[5] using a one-step dilation of the tracheal stoma with rounded-tip forceps, Frova and Quintel in 2002[8] using a unique screw-like device (PercuTwist) for stomal dilation, followed by Zgoda and Berger in 2005 and Cianchi *et al.* in 2010 using a modification of the Blue Rhino device that employed balloon dilation. An additional retrograde tracheostomy technique called the trans-laryngeal method was described by Fantoni and Ripamonti in 1997. Even today, Ciaglia's PDT, although modified, is one of the most widely used methods in ICUs.[2]

From the latest reviews and meta-analyses,[9–11] it has emerged that percutaneous tracheostomies offer advantages over surgical tracheostomies not in terms of risk of potentially life-threatening events or mortality, but in terms of lower rates of wound infection, stomatitis, and unfavourable scarring, as well as costs up to two-fold lower.

Ciaglia technique

After correctly positioning the patient, identifying landmarks, and disinfecting the area, an introducer needle is inserted midline in the space between the first (or second) and second (or third) tracheal rings. Initially, Ciaglia's Percutaneous Dilatational Tracheostomy (PDT) technique described placement of the intro-

ducer needle between the cricoid cartilage and the first tracheal ring. Subsequently, it was noted that puncture below the first ring could reduce the risk of certain complications, such as stenosis with higher placements and bleeding with lower placements. To properly insert the needle, the Endotracheal Tube (ETT) must be withdrawn to the level of the vocal cords to allow ventilation during the procedure. In the original Ciaglia PDT technique, multiple dilators are then inserted up to the size of the chosen tracheostomy tube.[12] However, a more recent variation uses a single curved dilator coated with hydrophilic material that progressively increases in size.[13,14] Finally, the tracheostomy tube is inserted, mounted on an appropriately sized introducer dilator.

Complications

Percutaneous tracheostomy complications can be classified as perioperative, immediate postoperative, and late. The rate of perioperative complications for Ciaglia's technique ranges between 4.1% and 12%.[9,11]

While most are minor bleedings, a preoperative neck ultrasound scan can be decisive in identifying nearby vessels around the trachea.[15,16] Serious and potentially life-threatening complications can still occur, often triggered by technical errors during the procedure. For instance, a fistula between the trachea and innominate artery can occur if PDT is performed too low on the tracheal wall, whereas damage to the cricoid cartilage and stenosis may be common if the trachea is punctured at higher levels. Airway loss and accidental extubation - though less frequent - can happen if the endotracheal tube is improperly withdrawn above the vocal cords,[17] while balloon cuff perforation and tube impalement may occur if adequate withdrawal is not performed before needle insertion. Other complications include pneumothorax or mediastinal emphysema, cannula displacement, vocal cord paralysis, granulation tissue, residual open stoma, and swallowing difficulties.

The importance of using a bronchoscope

Fibroscopy guidance can be valuable in reducing the incidence of some of these complications. With the use of a bronchoscope, the bedside execution of PDT became easier and safer, as it allows the visualization of the introducer needle entering the airway. A bronchoscope is also necessary to confirm the correct withdrawal of the endotracheal tube to the subglottic region and to guide the insertion of the guide wire using Seldinger's technique into the tracheal lumen between the first and third tracheal rings.

Errors such as posterior tracheal wall puncture and improper landmark identification can be minimized, avoiding incorrect cranial, caudal, and lateral punctures. Although bronchoscopy has been controversial, especially in neurocritical care settings where it can lead to hypoventilation and hypercarbia,[18,19] the technique's simplicity and potential benefits in avoiding serious complications have made it increasingly popular and recommended by several authors and guidelines in the absence of contraindications.[6]

Ciaglia PDT necessitates the involvement of two physicians: one performing the surgical procedure and the other utilizing the flexible bronchoscope to guide the surgeon. The bronchoscope operator must be experienced with the device, as significant immediate complications can occur during tube withdrawal, such as accidental extubation, which may lead to oxygen desaturation and, in severe cases, necessitate emergency airway intervention.[20]

Conversely, to prevent accidental extubation and the above mentioned complications, an inexperienced physician might fail to withdraw the endotracheal tube sufficiently to the level of the vocal cords, resulting in improper guide wire insertion. Ideally, the guide wire (and subsequently the cannula) should be inserted along the midline, between the first and third tracheal rings. Inserting the guide wire too distally (e.g., below the third tracheal ring) or too laterally could complicate cannula insertion, risking oxygen desaturation or bleeding. Furthermore, misplaced cannulas may face the tracheal wall or carina, impeding ventilation or spontaneous breathing. Lastly, improper positioning might cause tracheal ring damage during dilation, leading to a late complication known as tracheal stenosis that could hinder ventilator weaning efforts.

A new approach: a reverse fibroscopic view

As withdrawal and correct positioning of the ETT are the primary concerns and critical factors influencing immediate and later complications, we have developed a new method for precise placement of the ETT just below the vocal cords (Figure 1).

The traditional technique involves retracting the bronchoscope inside and simultaneously with the ETT. As the tube is slowly withdrawn, physicians assume it approaches the subglottic area and it is correctly positioned when the tracheal lumen enlarges, and no more tracheal rings are visible. However, identifying the subglottic area is not always straightforward. In patients with a narrow trachea, the lumen may not enlarge as expected, and anterior tracheal rings may not be easily visible due to common occurrences of blood or mucus in acute cases.

To overcome these challenges and prevent tube misplacement, we have adopted a retrograde fibroscopic view (or reverse view) during ETT withdrawal. This approach draws inspiration from gastroenterology, where endoscopists retrovert their scope tip to inspect the gastric fundus. Similarly, a retroversion fibroscopic view of the trachea can be invaluable in ICU settings for various scenarios: i) ensuring proper withdrawal and repositioning of the ETT during tracheostomy; ii) checking for cuff integrity if the ventilator detects a leak; iii) assessing upper tracheal trauma, especially in trauma centres,[21] to confirm suspicions raised by ambiguous CT scan findings; this method allows thorough inspection of the lumen while minimizing the risk of accidental extubation (which is particularly challenging in trauma cases).

During a tracheostomy, this approach can serve three major advantages: i) the withdrawal and re-positioning of the ETT is always correct and undoubtful: physicians do not have to presume the tube has gained the subglottic area; they can actually see the tube cuff reaching the vocal cords from below; we provide evidence of this statement, by showing actual footage and pictures

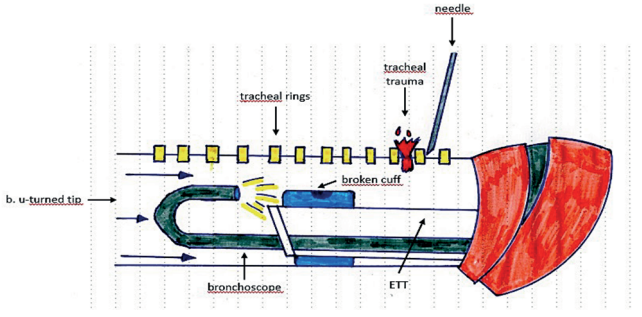

Figure 1. Schematic view of a retrograde fiberoptic bronchoscopy with the possible complications it may reveal.

taken during the procedures; ii) the risk of accidental extubation is remote: the bronchoscope is always placed about 3-4cm below the ETT and the u-turned tip gets a J (hook) shape; if extubation happens, the tube can be easily pushed down as the bronchoscope "hooked" tip always stands below in the tracheal lumen; iii) checking the correct placement of the cannula as final step is as easy as it gets: by introducing the fiberscope in the cannula and u-turning the tip, we can easily evaluate whether the canula was placed on the medial line and the cuff resides entirely in the tracheal lumen (avoiding the risk of an unrecognized false passage or cannula misplacement).

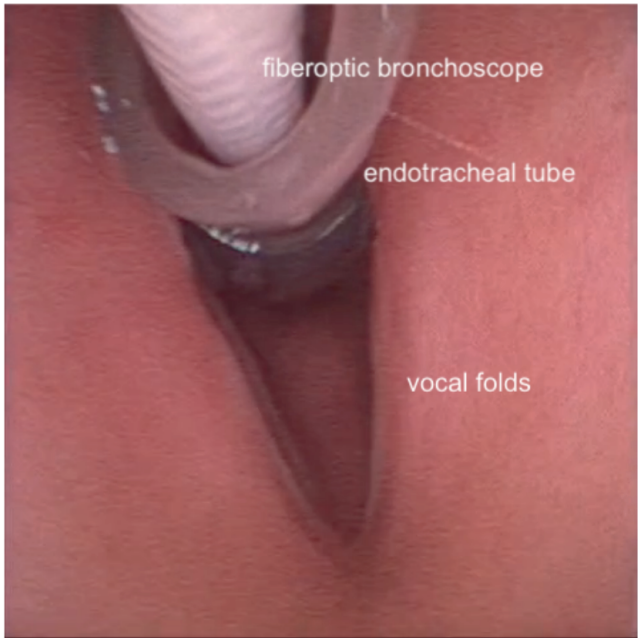

Figure 2. Visualization of the vocal cords and endotracheal tube with retrograde fiberoptic bronchoscopy.

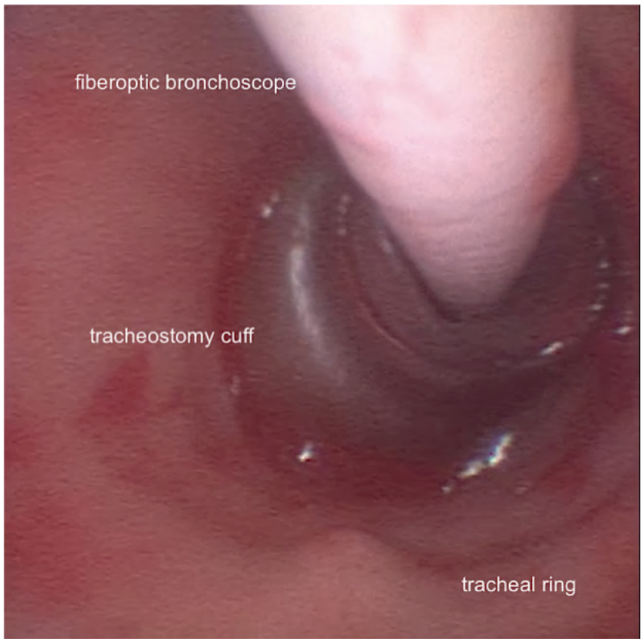

Figure 3. Visualization of the tracheostomy cuff with retrograde fiberoptic bronchoscopy.

The major pitfalls are the following.

Physicians using the fiberscope must be experienced, as this technique requires the tip to be turned 180° to look upwards to the vocal cord. Usually, this procedure is not difficult to perform, but in patients with a narrow tracheal lumen where manoeuvrability can be an issue, the tip can be pushed down-rightwards, and the emergence of the right upper bronchus can be used to U-turn the bronchoscope. Even in the latter case, the learning curve is not steep; the technique can be easily mastered by an expert physician in just a few tries (great skill is required anyway while dealing with advanced airway management, such as making a tracheostomy, thus it should not be a big deal). In addition, after successfully u-turning the tip, physicians must gain confidence with the new field of view that can result as upside-down.

The bronchoscope must be flexible enough to allow a 180° tip turn. In our ICU, we use disposable Ambu bronchoscopes (Ambu® aScope™ 4 Broncho, Copenhagen DEN) whose tip can be easily u-turned. Ambu bronchoscopes have great manoeuvrability and the detachable HD screen is useful to detect tracheal rings. Additionally, Ambu aScope 4 has great suction capabilities despite being extra slim (three different sizes are available).

Just like any fibroscopic procedure, eyesight must be as clear as possible to achieve a good FOV. The humidifier must be turned off. Lastly, since blood and mucus often accumulate around the ETT cuff, it is recommended to clear most of the secretions after u-turning the tip (Figures 2 and 3).

Conclusions

In our opinion, bronchoscopy can be very useful in multiple scenarios in ICUs. It can provide a safer approach to percutaneous tracheostomy and help reduce the incidence of some known complications. It is also useful for diagnosing a broken tube cuff whenever a leak is detected, and it can facilitate the identification of upper tracheal trauma, thereby reducing the risk of accidental extubation. Retroversion is not hard to master, and any physician can learn this technique in just a few tries. The only necessary equipment is a bronchoscope with a tip flexible enough to turn 180°. As retroversion can be beneficial in multiple scenarios, it is an additional tool that intensivists can have in their arsenal.

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