TRACHEAL INTUBATION: THE PROOF IS IN THE BEVEL

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Abstract—Background: Efficient airway management is paramount in emergency medicine. Our experience teaching tracheal intubation has consistently identified gaps in the understanding of important issues. Here we discuss the importance of the endotracheal tube (ETT) bevel in airway management. Discussion: The ETT bevel orientation is the main determinant of which mainstem bronchus the ETT enters when advanced too distally, despite a common belief that attributes a higher incidence of right mainstem bronchial intubation to the straighter angle sustained by the right mainstem bronchus. Likewise, a bougie- or fiberscope-assisted tracheal intubation can be impeded by the ETT tip hooking onto laryngeal structures; a 90-degree counterclockwise turn of the ETT (such that the bevel is facing posteriorly) prior to advancing it toward the larynx produces a first-pass success rate of 100%. Similarly, a posterior-facing bevel is believed to improve the ease of passage through the back of the nasal cavity when performing nasotracheal intubation. If resistance is met after the ETT tip has reached the laryngeal vicinity, further counterclockwise rotation may change the plane and incident angle of the ETT tip, facilitating passage through the vocal cords. Clockwise twisting of the ETT reduces the incident angle in the sagittal plane, thereby facilitating videolaryngoscopy-assisted tracheal intubation. Finally, a posterior-facing ETT bevel is the least likely to intubate a tracheoesophageal fistula. Conclusions: Understanding the implications of the ETT bevel direction may significantly change the efficiency of deliberate endobronchial, nasal, and bougie/fiberscope-, and videolaryngoscopy-assisted intubations, and while managing the patient with a tracheoesophageal fistula.

INTRODUCTION

When an endotracheal tube (ETT) is inserted, its asymmetrically tapered end is aligned with the laryngeal opening for ease of trespassing the larynx (Figure 1). The bevel is left-facing to avoid obscuring the laryngeal view during insertion from the right side of the mouth. The modern adult ETT has a bevel that is slightly less pointy at its tip, although a more pointy design can also often be found (Figure 2).

Our experience teaching tracheal intubation has consistently identified gaps in the understanding of several important issues. These knowledge gaps negatively affect the efficiency of tracheal intubation and thus may increase patient discomfort, cause trauma, and delay the establishment of airway protection and proper ventilation. We herein discuss how the ETT bevel is our friend in airway management. Notably, our discussion stems from the anesthesiology literature (given the paucity of emergency medicine studies on the topic) and from several decades of anesthesia practice experience. Nevertheless, the technical/procedural aspects outlined herein are not unique to anesthesiology and are no doubt of interest to all airway management practitioners.
DISCUSSION

Selective Endobronchial Intubation

Left mainstem bronchial intubation may be unexpectedly required, such as in cases of systemic air embolism after right lung injury, pus or blood spilling from the right lung, right pneumothorax, and pneumatocele (1,2). In such cases, and especially when there is already an ETT in situ, or a bronchial blocker or double-lumen tube is not readily available (as would be the case in the emergency department), the bevel orientation can be used to influence the direction of the ETT when bronchial intubation is desired. Kubota et al. advanced the ETT beyond the carina in 359 children and adults and found that 99% of the time it entered the right mainstem bronchus (3). When these authors rotated the ETT 180° once the tip had passed the larynx, such that the bevel faces right, as mentioned, and turn the patient’s head to the right, such that the ETT is coming into the mouth from the left. This latter maneuver simulates a left-handed intubation with the ETT now slightly concave to the left. Kubota et al. found with this technique that the chance of a left mainstem intubation is 92% in their cohort of 359 patients (3). These findings suggest that the bevel orientation is the main determinant of which mainstem bronchus the ETT enters when advanced too far, and serve to debunk the myth that a distally placed ETT most frequently enters the right mainstem bronchus because of its larger size and straighter angle with the trachea. Indeed, the fact that we intubate with our right hand with the ETT slightly concave to the right is also contributory, whereas the carinal asymmetry and the fact that the right mainstem bronchus is larger have only a small contribution. In our experience, one only needs to rotate the ETT by 180° once the ETT tip has passed the larynx, and either turn the head to the right (if no cervical spine concerns) or slightly turn the ETT so that it is slightly concave to the left, to achieve left mainstem bronchial intubation.

Use of Gum Elastic Bougie or Fiberoptic Bronchoscopy

In difficult intubation, the gum elastic bougie or fiberscope is sometimes used to guide the ETT into the trachea. Occasionally, the ETT tip is impeded at the epiglottis, corniculate, or cuneiform cartilages, the right vocal cord or aryepiglottic fold. Clinicians typically rotate the ETT clockwise and counterclockwise to try to “screw” the ETT through the larynx. After a few trials they usually succeed, but at the expense of increased trauma and patient distress, not to mention the delay in securing the airway. Indeed, twisting the ETT or changing the direction of the bevel may help reduce (and thus, improve) the incident angle of the ETT tip in relation to the airway structure the tip is against. This may be true when the tip is twisted away from the sagittal plane to a different plane. Twisting the ETT may also free the tip from the structure it has inadvertently caught onto during advancement into the airway. In addressing this latter point, we suggest that the efficient way is to simply turn the ETT counterclockwise 90°, such that it is concave to the left, prior to advancing it toward the larynx (5). Figure 2 shows how the overhanging tip of the bevel of an ETT before the 90-degree counterclockwise twist can hook onto some of the laryngeal structures, as mentioned, and how the bevel of a rotated ETT hugs the curvature (on the concave side) of the bougie or fiberscope and has much less chance of catching some structure on the way through the larynx. The first-pass success rate.
without the 90-degree twist is 44%, 73%, and 23%–46% in studies (6–8). With the bevel facing posteriorly after the 90-degree counterclockwise twist, the first-pass success rate was 100% in a small (n = 27 adults) study (6).

Theoretically, it is even more important to use the 90-degree counterclockwise twist to facilitate placement of ETTs with a straight pointy tip.

Nasotracheal Intubation

Nasotracheal intubation is applicable in spontaneously breathing patients who may have a difficult airway, possible cervical spine injury, limited mouth opening, or head injury. Smooth passage reduces stress and secures the airway efficiently. A dreaded complication of nasotracheal intubation is epistaxis, which can occur despite nasal instillation of a vasoconstrictor and pre-softening of the ETT. Theoretically, the pointier portion of the ETT tip causes more trauma than the receding side of the bevel during advancement. On the one hand, the Kisselbach plexus, the most common site of epistaxis, is in the nasal septum. Based on that consideration, the bevel should be facing medially during ETT insertion. On the other hand, trauma to the turbinates in the lateral nasal wall has been described (9). Among emergency medicine textbooks, there is no consensus on which direction the bevel should face, with examples of those recommending the bevel to face medially, laterally, or having no recommendation (10–13). None provide any explanation or reference. No major anesthesia textbook has a recommendation on bevel direction either. Given the rarity of major epistaxis and the lack of strong evidence, it is unknown which direction is safer. In our practice, we have the bevel facing medially, which means a concave caudally orientation for the ETT if going through the right nostril, and a concave toward the forehead if through the left nostril.

Sometimes, the ETT meets considerable resistance at the back of the nasal passage. Some practitioners opt to twist and turn and increase the force and eventually the ETT gets through. Figure 3 illustrates how a posterior facing bevel may improve the ease of negotiating the ETT around the curve at the nasopharyngeal wall. In other words, a 90-degree counterclockwise twist should improve the ease of passage through the back of the nasal cavity. Sugiyama et al. go one step further (14). They insert a stylet that is bent 60° at the distal end into the ETT to facilitate the passage and withdraw the stylet once the ETT tip has passed the back of the nasal passage. This is an option if there are indeed great difficulties and the patient is not tolerating the discomfort.

Even after the ETT tip has reached the laryngeal vicinity, it may still be caught on the arytenoid cartilages (usually the right one), the epiglottis, or the pyriform fossa (Figure 4) (15,16). When one meets resistance in this...
situation, one should rotate the ETT counterclockwise to change the plane and the incident angle of the ETT tip (15).

Finally, even if the ETT tip has cleared the epiglottis, it can still be unwilling to slide into the trachea because of a high incident angle. This happens usually when a McGill forceps is used to lift the tip of the ETT toward the tracheal entrance when mouth opening allows (see Figure 5, left panel, which is an illustration also applicable to a similar situation occasionally encountered in videolaryngoscopy, discussed below). At this point, rotating the ETT clockwise such that the bevel faces anteriorly may reduce that angle and improve the chance of success.

The Endotracheal Tube that Will Not Go into the Trachea During Videolaryngoscopy

This high incident angle, made worse as the stylet is removed, is also one factor occasionally making it difficult to pass an ETT even after its tip has already passed the larynx (Figure 5, left panel). Readers are encouraged to experiment by loading an ETT with a curved stylet and witness how the ETT rises at a steep angle as the stylet is removed. Theoretically, twisting the ETT by 180-degree would align the path of the ETT with that of the trachea when the stylet is withdrawn but rotating the ETT by that amount is very
difficult, as is preloading an ETT that has not been prewarmed with its curvature 180° opposite that of the stylet. Turning the bevel to face anteriorly (clockwise twist) has the advantage of reducing the incident angle (Figure 5, right panel), is less difficult to accomplish, and is superior to random or counterclockwise twisting.

**Tracheoesophageal Fistula**

Emergency physicians may encounter patients with tracheoesophageal fistula (TEF). Because most congenital and acquired TEFs are at the posterior aspect of the trachea, and some can be large and most have a slanted orientation (Figure 6), it is important to orientate the ETT with the bevel facing posteriorly to minimize the chance of intubating the fistula, which has been described before (17–20). Once the ETT tip is distal to the fistula, the ETT (one without a Murphy eye) can be rotated 180°, if necessary, to avoid ventilating the fistula. Similar considerations apply whenever the ETT position has to be adjusted.

**CONCLUSIONS**

The direction of the ETT bevel may significantly change the efficiency of tracheal intubation in situations that include deliberate endobronchial, nasal, and bougie/fiberscope- and videolaryngoscope-assisted intubations, and in patients with a tracheoesophageal fistula.

**REFERENCES**


