

Near Tracheal Extubation Because of Edema of the Face and Tongue

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Accidental endotracheal extubation in the operating room (OR) is more common than suggested by the number of case reports of this potentially disastrous complication (1–3). Its etiology is not always apparent (2–7). Upper airway edema reduces the chance of successful reintubation and, less obviously, can itself cause accidental tracheal extubation. We present a case of massive upper airway edema resulting in outward migration of the endotracheal tube (ETT).

Case Report

A 57-yr-old, 171-cm, 76-kg man with cirrhosis of the liver was scheduled for orthotopic liver transplantation. The trachea was easily intubated with an 8.0-mm ETT with the 22-cm marking at the incisors. The ETT cuff was filled with 3 mL of air, palpated in the suprasternal notch, and the ETT taped to the benzoin-tincture-treated skin of the face with two strips of 0.25-in. brown Hytape® (HyTape International, Patterson, NY) (from the ear to the upper lip, around the ETT twice, and then to the opposite ear). A chest roentgenogram taken before the incision for confirmation of central line placement showed the ETT tip to be located 4.5 cm proximal to the carina and 7.5 cm distal to the vocal cords. The surgery required massive transfusions because of unusually heavy surgical blood loss: 158 U of packed red blood cells, 32 L of cell-saver blood, 164 U of fresh frozen plasma, 160 U of platelets, 80 U of cryoprecipitate, and 33 L of crystalloid fluids were given over 16 h.

Towards the end of the operation, the patient was markedly edematous, and air bubbles were noted in the mouth with each ventilatory cycle. The tape on the ETT was still tightly secured to both the face and the ETT, the patient's head had not been moved, and the tension in the balloon was unchanged, as estimated by palpation. Because the patient's face was markedly edematous, we concluded that the

ETT had migrated proximally because of swelling of the face and tongue. No laryngoscopy was attempted for fear of dislodging the ETT further. Fiberoptic bronchoscopy revealed the right vocal cord protruding into the lumen of the oval hole near the tip of the ETT (Murphy eye) and the left vocal cord opposite, on the outside, of the ETT near the tip. The ETT was re-advanced over the bronchoscope to a midtracheal position and re-taped. Repeat chest roentgenogram showed the tip of the ETT to be 1 cm closer to the carina compared with the previous postcentral line insertion film, and the 27-cm, not 22-cm, mark on the ETT was now at the upper incisors. Thus, the ETT now traversed a pathway from the incisors to the distal tip of the ETT in the trachea that was 4 cm longer than the original. The case concluded uneventfully.

Discussion

Upper airway swelling as a cause of accidental tracheal extubation has not been reported. One case of accidental tracheal extubation in the OR was attributed to removal of an orogastric tube that had become entwined in the ETT (1), but the cause of extubation in the only two other known case reports remains unclear (2,3). In this case of massive fluid administration, we believe that internal tongue swelling, and to a lesser extent facial swelling, contributed to migration of the ETT.

Internal tongue swelling increases the radius of curvature of the ETT in the oropharynx. If the ETT is fixed at the teeth, then an increased oropharyngeal radius of curvature (Fig. 1) must move the ETT out of the trachea. The difference between the initial and final markings of the ETT at the teeth was 5 cm (22 versus 27 cm), with the final position of the ETT tip being 1 cm more distal than the initial tip position. We conclude that internal tongue swelling caused the ETT to move outward by 4 cm.

This conclusion is further supported by three additional independent observations of differences in distance traversed by an anterior versus posterior quarter turn (90 degrees) of an ETT through the oropharynx (Figs. 1 and 2). First, we calculate that to result in a 4-cm increase in length of the oropharyngeal quarter

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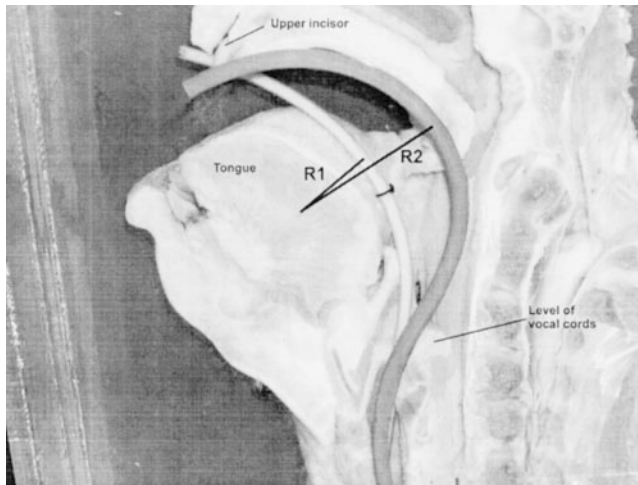


Figure 1. Sagittal section of upper airway. The lighter catheter represents the course of an endotracheal tube (ETT) from the upper incisors to the level of the vocal cords when the tongue is not swollen. The darker catheter represents the longer course of an identical ETT when the tongue is swollen. Using the simple mathematical model of a quarter circle (see text) $R2-R1$, i.e., swelling of the tongue, would have to be 2.54 cm to cause ETT retraction of 4 cm, as observed in this case. $R1$ = radius number one and $R2$ = radius number 2.

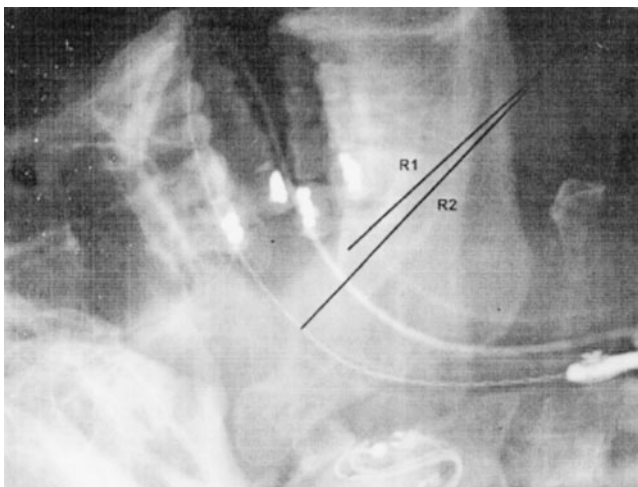


Figure 2. Example of lateral neck roentgenogram in an intubated patient. The two lines taking the more anterior route from the teeth to the vocal cords are the walls of the endotracheal tube (ETT). The line taking the more posterior route from the teeth to the vocal cords is the wire inside an esophageal stethoscope. In this example, the difference in distance from the upper incisors to the vocal cords between these two routes is 3.9 cm, requiring an increase in thickness of the tongue, $R2-R1$, of 2.48 cm (see text). $R1$ = radius number one and $R2$ = radius number 2.

circle, the thickness of the tongue would have to increase by 2.54 cm. This follows from solving the equation $C = 2\pi R$, where C is the circumference, R is the radius of a circle, and $C/4 = 2\pi R/4 = \pi R/2$. However, this simple geometrical model may not always accurately reflect upper airway anatomy (Fig. 1).

Second, we reviewed a series of five lateral neck roentgenograms in intubated patients from the radiology files of our hospital (typical example shown in Fig. 2). The average difference in distance from the upper incisors to the vocal cords, when taking the most anterior route to the vocal cords compared with taking the most posterior route to the vocal cords, was 3.8 cm (range, 3.4–4.3 cm).

Third, the distance from the incisors to the vocal cords, taking the most anterior course through the oropharynx, is normally 15 cm in a 70-kg adult (8). Assuming that this patient's airway anatomy was initially normal, with the 22-cm marking at the upper incisors, 7 cm of the ETT would be located below the vocal cords. If tongue swelling had increased the distance from the incisors to the vocal cords by 4 cm, only 3 cm of ETT would remain. We theorize that facial swelling contributed 2 cm of additional ETT retraction, leaving 1 cm of ETT inside the trachea. If in this situation the ETT marking at the incisors had been noted, it would likely have been 20 cm. Once <1.9 cm of the ETT is left inside the trachea, an air leak occurs because the 12- × 8-mm Murphy eye is situated 0.7–1.9 cm from the ETT tip. The progressive protrusion of the Murphy eye into the oropharynx caused a detectable air leak and heralded an impending extubation.

Considering the possibility of outward migration of the ETT as a result of facial and upper airway edema is obviously pertinent to all anesthesiologists. The number of cases with potential for massive fluid and blood product administration that results in severe edema is substantial. When facial swelling is identified, tongue swelling should also be expected, and this, as discussed, causes 1.57 times the amount of ETT retraction for the same degree of edema as does facial swelling. Head and neck movement should be minimized to prevent dislodging the ETT further. It may be prudent to advance the ETT prophylactically to situate the tip just proximal to the carina (9).

In conclusion, the consequences of ETT migration out of the trachea in a patient with severe upper airway edema can be disastrous and is another example of prevention being infinitely better than treatment. In our case, it was indeed very fortunate to have discovered the outward migration and impending extubation at the stage that we did. The Murphy eye introduced a margin of safety by allowing an air leak to occur before complete extubation.

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