

## Airway ultrasound to detect endotracheal tube cuff herniation

### INTRODUCTION

Endotracheal tube (ETT) cuff herniation is not an uncommon event in Intensive Care Units and operating rooms. The cause for this can be displacement of the tube or overinflation of ETT cuff.<sup>[1]</sup> Usually, it is noticed by the sound of gas leaking around the tube or when there is a fall in tidal volume and end-tidal carbon dioxide (CO<sub>2</sub>). Confirmation and repositioning of the ETT require direct laryngoscopy which has disadvantages such as stress response<sup>[2]</sup> and is difficult to perform intra-operatively, particularly if the patient is not in supine position. We report a case of ETT cuff herniation from glottis which was detected with the use of ultrasound.

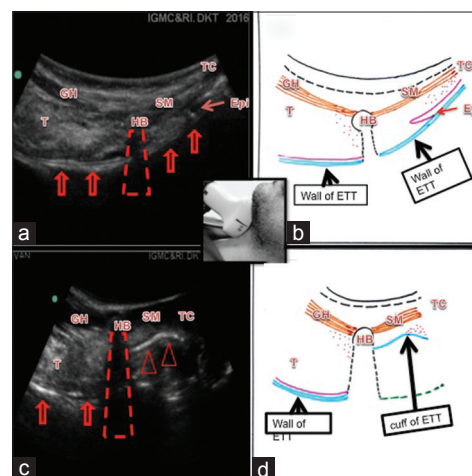
### CASE REPORT

A 28-year-old male, weighing 60 kg, of American Society of Anesthesiologists Class 1 and Mallampatti Grade 1, was posted for elective laparoscopic appendectomy. General anaesthesia was induced and tracheal intubation was performed with 8 mm ID size Portex® endotracheal tube, the cuff was inflated with 5 ml air using minimal occlusion method and the ETT was fixed at 20 cm (at the lower lip) after confirming position by auscultation and capnography. ETT cuff pressure of 20 cm of H<sub>2</sub>O was recorded. Anaesthesia was maintained with isoflurane, N<sub>2</sub>O and O<sub>2</sub> and controlled ventilation with the circle system. Surgery was commenced, peritoneal insufflation with CO<sub>2</sub> was done, and the patient was then positioned in the Trendelenburg position with the right side up. After positioning the patient, partial collapse of the pilot balloon was noticed, but there was no audible leak. Cuff pressure measured was 10 cm H<sub>2</sub>O. We inflated the cuff again with 5 ml of air, but the cuff pressure remained at 10 cm H<sub>2</sub>O. The pilot balloon remained partially collapsed, and there was no leak. Despite proper fixation of the ETT, we noticed that the tube was dragged to 19 cm at the lip level, but there was no change in the SpO<sub>2</sub> (100%) and end-tidal CO<sub>2</sub> (30 mmHg). No leak was heard over the trachea on auscultation. Suspecting ETT cuff damage or herniation, ultrasound examination of the neck was done using a curvilinear probe (2–5 MHz) of M-Turbo® Ultrasound Machine (Sonosite Inc., Bothell, WA, USA) in both sagittal and transverse planes. The sagittal scan of a properly placed ETT will show smooth concave hyperechoic line entering into the glottis as

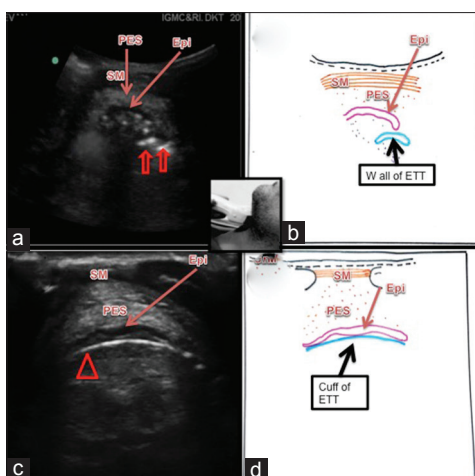
shown in Figure 1a and b. This hyperechoic line is because of the ultrasound beam hitting the air inside the ETT. We refer to this line as the air-airway device (AAD) interface, similar to the air-mucosal (A-M) interface described in ultrasound of the airway without an airway device.<sup>[3]</sup> In contrast to these findings, we found a convex the AAD interface of ETT cuff just above the glottic opening [Figure 1c and d]. Similarly, the transverse scan (at infrahyoid level) with a properly placed ETT will show a small convex AAD interface (ETT in short axis) below the epiglottis toward the right side (if the tube is fixed to the right angle of mouth) as shown in Figure 2a and b. In our case, a large AAD interface, i.e., the ETT cuff was found to be compressing the epiglottis as shown in Figure 2c and d. These findings suggest that there was herniation of cuff out of the glottis, which was also confirmed by direct laryngoscopy. As the cuff was at the glottis and over inflated, adequate ventilation was possible with a minimal leak. The ETT cuff was deflated, and the ETT was advanced by 2 cm under direct laryngoscopy. ETT position was checked with bilateral equal air entry. The cuff was inflated with 5 ml of air and cuff pressure of 22 cm H<sub>2</sub>O was recorded. The ETT and cuff position were also confirmed with ultrasound.

### DISCUSSION

We report this case to describe the ultrasound image of cuff herniation through the glottis with the use of



**Figure 1:** Sagittal view at the glottis inlet with curvilinear probe. (a) Ultrasonography image and (b) line diagram showing correct placement of endotracheal tube with the cuff inside the trachea. (c) Ultrasonography image and (d) line diagram showing endotracheal tube with herniated cuff outside the glottis. Hollow arrows - air-airway device (AAD) interface line artefact of the endotracheal tube wall (long axis), dotted line-shadow of hyoid bone, Hollow triangles - air-airway device (AAD) interface line of the endotracheal tube cuff. TC - Thyroid cartilage, GH - Geniohyoid muscle, HB - Hyoid bone, T - Tongue, Epi - Epiglottis. Insert-probe position and orientation



**Figure 2:** Infrahyoid transverse view with the curvilinear probe. (a) Ultrasonography image and (b) line diagram showing correct placement of the endotracheal tube with the cuff inside the trachea. (c) Ultrasonography image and (d) line diagram - endotracheal tube with the cuff herniated outside the glottis. Hollow arrows - air-airway device (AAD) interface line of the endotracheal tube wall (short axis), dotted line-shadow of hyoid bone. Hollow triangles - air-airway device (AAD) interface line artefact of the endotracheal tube cuff. SM - Strap muscle, PES - Pre-epiglottic space, Epi - Epiglottis. Insert-probe position and orientation

point of care ultrasound (POCUS). Ultrasound has become a universal tool for the anaesthesiologist. It has been used for various indications in the pre- and intra-operative period.<sup>[3-5]</sup> Airway ultrasound to confirm ETT position can avoid unnecessary laryngoscopy and its complications, particularly in the critical care unit or in the emergency wards, where patients are conscious and direct laryngoscopy is a challenge.

In our case, the cuff might have partially come out of the glottis during change in position of the patient; however, there was no audible leak and since the seal was maintained, there was no change in SpO<sub>2</sub> and capnograph. The ETT cuff got over inflated after extra 5 ml of air was injected into the cuff which was seen as herniation of ETT cuff in on ultrasound.

Undiagnosed overinflated ETT cuff at the glottic opening can produce hoarseness voice, laryngitis and traumatic injury to the vocal cord. There are a few case reports about herniation of the ETT cuff inside the tube causing airway obstruction.<sup>[6,7]</sup> There are various factors which can cause ETT cuff herniation such as manufacturing defect, poor tube material, nitrous oxide diffusion into the cuff and multiple uses of the tube. However, the most common cause for herniation of ETT cuff is overinflation of cuff.<sup>[8]</sup>

## CONCLUSION

In case of suspected ETT cuff herniation, airway ultrasound can be used to confirm the diagnosis.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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