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LETTER TO THE EDITOR

Using submandibular ultrasonography to assess intraoperative changes in the laryngeal anatomic structures: a pilot study

Dear Editor,

Airway evaluation is a critical part of preoperative assessment. Classical bedside airway examinations include Mallampati scoring, thyromental and sternomental distances, as well as mouth opening. However, these physical assessments on their own lack the power to effectively predict cases of difficult intubation and just 50% of difficult airways are anticipated.[1]

Point of Care Ultrasound (POCUS) provides the potential for more predictive airway assessment and is a useful tool for mitigating the risk of unanticipated difficult airway. It is quick and inexpensive, portable, and does not expose the patient to the radiation of other imaging tests.[2] Various airway measurements have been investigated as predictors for difficult intubation, including measurements of the hyomental distance and multiple measurements of the soft tissue of the anterior neck, including the Skin to Epiglottis Distance (STED).[2] Patients with difficult airways have consistently larger STED.[3] Given that the evidence suggests STED is beneficial at predicting difficult airway, the purpose of this study was to assess whether there is a significant change in that measurement in patients undergoing surgery under general anesthesia with placement of an Endotracheal Tube (ETT) or Supraglottic Airway (SGA). ETT has been shown to cause postoperative laryngeal edema which may have effects on the STED and clinical implications in the scenario when a patient fails an extubation trial and needs to be reintubated.[4]

This observational study was conducted at the George Washington University Hospital from June 2022 to July 2022. A series of 46 adult patients scheduled for elective surgery requiring general anesthesia were prospectively enrolled. Informed consent was obtained prior to enrollment in the study. Patients underwent a variety of surgical procedures, and 39 patients received general anesthesia with an ETT, while 7 had an SGA for airway management. Exclusion criteria included patients undergoing or with history of any surgery that would involve the neck or airway, including facial, thyroid, pharyngeal or tracheal, or cervical spine, to name a few.

Ultrasound assessment was first conducted in the preoperative area using a portable ultrasound machine (Sonosite X-Porte Ultrasound System). The patient was placed supine with his/her neck in a neutral position. A high-frequency linear probe was placed in the transverse plane at the level of the thyrohyoid membrane, and measurements were taken from the skin to the deepest, posterior aspect of the epiglottis. The same procedure was repeated in the postoperative area, following extubation. Pre- and postoperative measurements for each patient were completed by a single researcher to ensure consistent technique and interrater reliability.

Additional intraoperative data was collected including length of intubation, intravenous (IV) fluid received, intraoperative positioning, as well as patient demographics (age, sex, and BMI).

In patients who had general anesthesia with an ETT or SGA, the net change in STED was 14.03 $\pm$ 17.19%. A multitude of variables were considered and compared, as shown in Table 1. When separating ETT and SGA cases the net change in STED was 14.85 $\pm$ 17.71% and 9.46 $\pm$ 14.20%, respectively. For men and women, the percent change was 11.52 $\pm$ 9.92% and 15.64 $\pm$ 20.58%, respectively.

For surgeries in which an ETT was in place for $<$ 120 minutes or $\geq$ 120 minutes, the percent change in STED was 10.98 $\pm$ 12.48% and 17.03 $\pm$ 20.15%, respectively. For patients with BMI $<$ 30 or $\geq$ 30, the percent change was 16.30$\pm$16.78% and 10.48$\pm$17.70%, respectively. For patients receiving $<$ 1000 cc of intraoperative fluid or $\geq$ 1000 cc, the percent change was 11.12 $\pm$ 15.12% and 17.24 $\pm$ 19.53%, respectively. All results, except for SGA data alone, were found to be statistically significant with p-values $<$ 0.05.

Our data demonstrates a significant increase in STED following surgery under general anesthesia with placement of an ETT. This increase was not significant when considering SGAs alone, likely due to the small sample size. We also saw a difference in the STED when comparing surgeries less than 120 minutes to those greater than 120 minutes, however their confidence intervals did overlap, preventing us from declaring statistical significance. Similarly, a significant difference could not be established when comparing obese to non-obese patients, men to women, or patients who received less than 1000 cc of IV fluid intraoperatively to patients who received 1000 cc or more of IV fluid intraoperatively.

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Table 1 **Skin to Epiglottis Ultrasonographic Measurements.** Comparison of various clinical features and the average preoperative STED, as well as the net and percent changes associated. The 95% CI is also reported. Note that all values, sans the changes reported for SGA in isolation, are significant with $p < 0.05$.

	Pre-Op Average (cm)	Net Change (cm)	Percentage Change (%)	95% Confidence Interval (%)
Overall	2.251	0.2803	14.03	9.06–18.99
Airway (number of patients)				
ETT (39)	2.247	0.2916	14.85	9.29–20.40
SGA (7)	2.277	0.2183	9.46	-1.06–19.98
Sex (number of patients)				
Male (18)	2.424	0.2595	11.52	6.93–16.10
Female (28)	2.142	0.2936	15.64	8.01–23.26
BMI (number of patients)				
< 30 (28)	2.168	0.3117	16.30	10.09–22.52
≥ 30 (18)	2.382	0.2314	10.48	2.31–18.66
Length of intubation (number of patients)				
< 120 min (11)	2.390	0.2689	10.98	3.60–18.36
≥ 120 min (25)	2.213	0.3147	17.03	9.13–24.93
Intraoperative fluids (number of patients)				
< 1000cc (21)	2.232	0.2333	11.12	4.65–17.58
≥ 1000cc (22)	2.304	0.3388	17.24	9.08–25.40

Despite numerous initial studies showing ultrasound measurements of the STED as an accurate assessment tool for predicting difficult airways,[3] the authors are not aware of any study that assesses the intraoperative STED changes in patients after undergoing general anesthesia with an ETT. Although the increase in STED could be multifactorial and needs further investigation, our data suggests that ETT placement can increase the STED.

The reason for increased STED is not known however, and it may potentially arise secondary to edema caused by the airway device. There is evidence that an ETT can cause laryngeal edema.[4] Furthermore, it has been shown that long-term intubation and prone positioning can be associated with tongue edema.[5] Identifying a marker for laryngeal edema would be useful and could prevent respiratory complications due to premature extubation of an edematous airway.

Our data suggests that there are postoperative changes to ultrasound measurements of the STED. Further studies are needed to clarify to what degree an ETT tube is causing these changes and if there are other modifiable factors — such as IVF, positioning, or length of intubation — which may decrease changes in the postoperative period.

IRB approval

This study was approved by the George Washington University institutional review board (IRB # NCR203147). Our IRB exempted us from written consents and all participants provided informed verbal consent.

Conflicts of interest

The authors declare no conflicts of interest.

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