"Drowned Airway" - New Method of Endotracheal Intubation

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INTRODUCTION

The "drowned airway" refers to massive regurgitation of blood or "vomitus" that prevents either endotracheal (ET) intubation or mask ventilation. We have developed a model of "drowned airway" using cadavers and the intubation manikin with the attached plastic stomach. In this model we have tested a novel technique of ET tube guidance with a mini-endoscope and videolaryngoscopy (VL).

METHODS

Fresh, non-embalmed cadavers were used in the study. The Laerdal Airway Management Trainer with the attached plastic stomach (**Fig. 1 A,B**) was used to test the concept of the model. The plastic stomach was filled with the sodium alginate solution (**Fig. 1 C,E,F**). In the cadaver (**Fig. 1G**) the stomach was inflated by the retrograde infusion of sodium alginate through the oro-gastric catheter (**Fig. 1H**). The level of inflation was monitored using ultrasound (**Fig. 1I**) and the lower esophagus was occluded with the balloon catheter (**Fig. 1 B, J**). The balloon could be rapidly deflated to allow an expulsion of alginate, which had a consistency of a dense, particulate "vomitus" (**Fig. 1 C,F**). In this study we combined VL with a novel technique of mini-endoscopy (**Fig. 2 A,B,C).** Mini-endoscopes with six LED lights and a mini-camera at the tip (**Fig. 2 B**) were placed in the Parker flexible tip^{TM} ET tube or the regular side-beveled ET tube and connected to a laptop computer (**Fig. 2 C)** or an Android phone (**Fig. 2 A)** to display images of the upper airway.

RESULTS

The advancement of both types of ET tubes (**Fig. 2 D, E)** was displayed on the screen of the VL (**Fig. 2 C left)**. The mini-endoscope in the ET tube allowed an independent verification of its position in the airway, displayed on the screen of the laptop (**Fig. 2 C right**). The **Fig. 2 F** a close up of the vocal cords obtained by the ET tube mini-endoscope in **Fig. 2 E**. The double imaging techniques and two sources of light became very important during experiments in cadavers (**Fig. 2 G - I**). As expected, VL as a sole technique of ET intubation was difficult if not impossible as the camera was blocked by the "vomitus". However, when the blade was kept away from the "vomitus", its light allowed the guidance of the ET tube with the mini-endoscope towards the glottic opening. The ET intubation was confirmed by the visualization of tracheal rings and carina. The strong focused light of the mini-endoscope was able to penetrate through the "vomitus" (**Fig. 2 H,I),** but the penetration was remarkably much better when the Parker ET tube was used. The flexible tip of the Parker ET tube which was placed above the

LED lights and the camera could protect it from the "vomitus". We confirmed this by observing the advancement of both tubes in the alginate *in vitro.*

DISCUSSION

This study shows that the use of a disposable mini-endosope placed in the Parker flexible tip™ ET tube markedly improved intubating conditions in the cadaveric model of the "drowned airway".

Figure 1

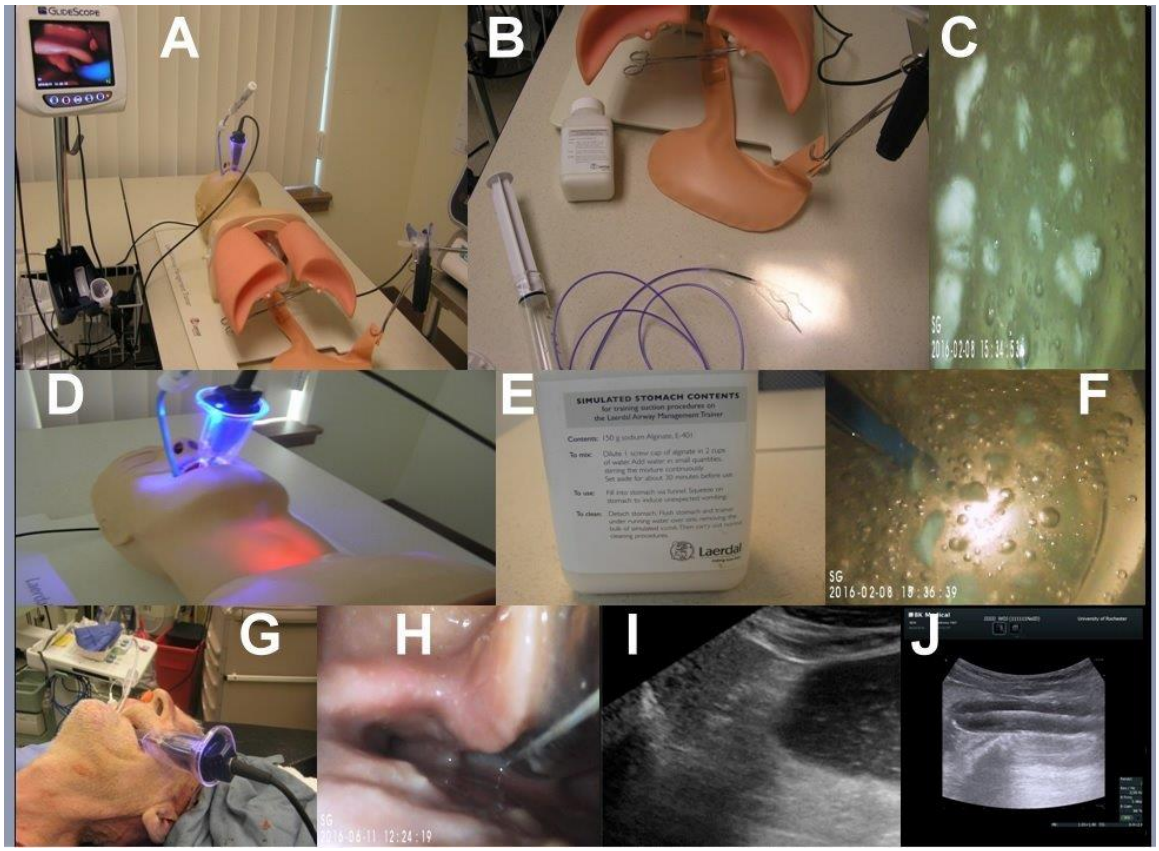
A, B, D - manikin model

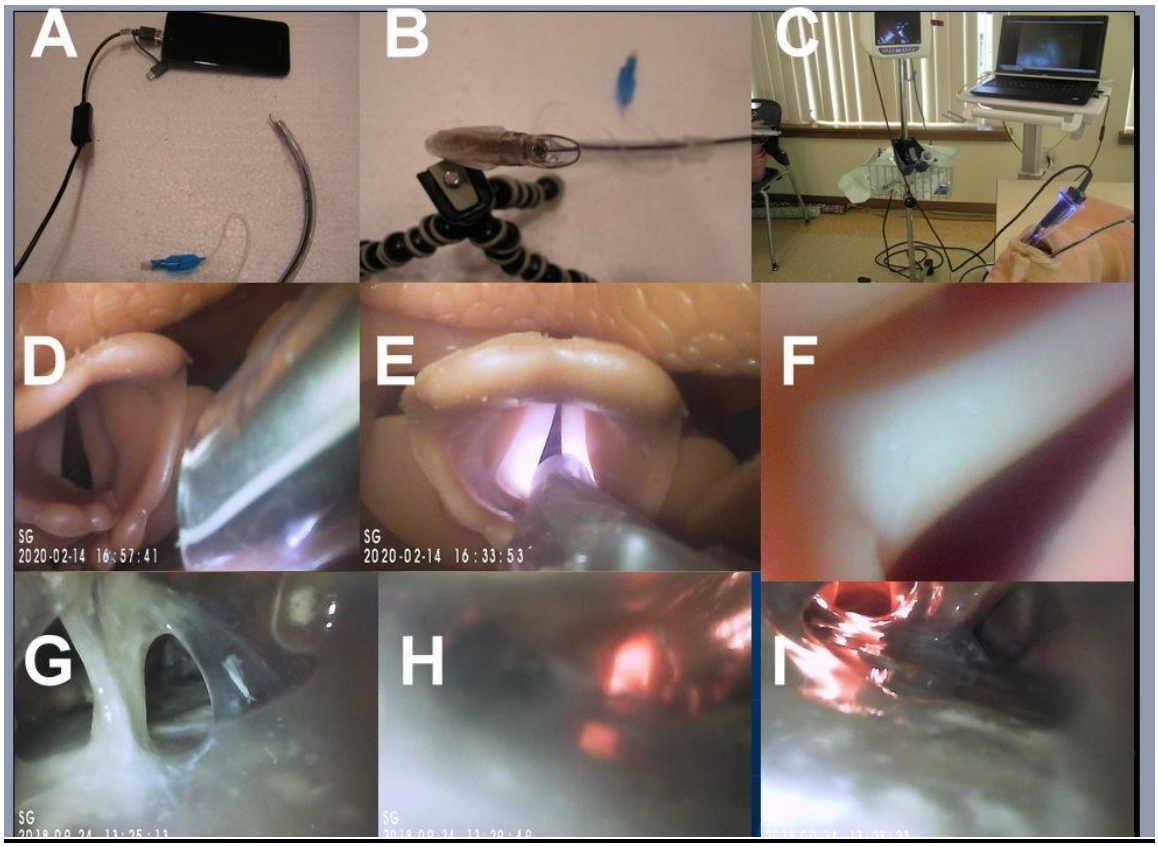
G - J - cadaveric model

Figure 2

A, B - disposable mini-endoscope placed in the Parker flexible tip™ ET tube.

D - F - manikin intubation, **F -** close up image of the vocal cords (**E**) obtained with the mini-endoscope. **G, H, I -** "drowned airway" of the cadaver.

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