

## THE MODIFIED BORESCOPE STYLET FOR DIFFICULT INTUBATIONS

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### ABSTRACT

**Background:** The difficult airway is a challenge in clinical anesthesia. Stylet has been used to help anesthetists approach the trachea easier. However, by using a traditional stylet, the views of larynx are sometimes not clear enough to distinguish the trachea from the esophagus. It leads to false intubation. **Objectives:** This research aims to develop an economical borescope stylet that can be used safely in difficult intubations and satisfy the anesthetists. **Materials and methods:** The modified borescope stylet used a 5.5-mm borescope camera, then the recorded images of glottis in real-time space are transferred to a smartphone screen. The product was tested successfully in two stages of modeling and clinic examination under the permission of the Board of Science and Technology at Can Tho City General Hospital. **Results:** 32 patients who needed general anesthesia for operation and predicted difficult intubations were intubated using the modified borescope stylet. This device provided successful intubation rates of 87.5% cases in first access, 12.5% cases in second access, and none of the cases could not be intubated. The average time to complete successful intubation using the device was 44.69 (15 – 90) seconds. Importantly, the larynx of patients was not completely injured after intubation using the device. 100% anesthetists were satisfied with the modified borescope stylet. **Conclusions:** The modified borescope stylet was developed successfully. It worked safely, satisfied all the anesthetists, possessed as an advanced device with easy and short-time operation and met all the requirements of DAS 2015.

**Keywords:** Difficult airway; video stylet; intubation; smartphone

### I. INTRODUCTION

Difficult airway leads to unable to intubate is a serious problem in clinical anesthesia. Anesthetists have been preparing equipment in the difficult airway trolley [2] for the difficult cases base on Difficult Airway Society 2015 Guidelines for Management of

Unanticipated Difficult Intubation in Adults (DAS 2015) [3]. During the intubation, the tip of the endotracheal tube (ETT) must pass around an acute angle at the larynx to enter the trachea. Even with the video laryngoscope, a good view of the larynx does not ensure faster or successful intubation because the oral-pharyngeal-laryngeal axes are not aligned [5]. Using stylet has been a good choice to help the ETT reach the trachea in this situation. Manufacturers recommend using a stylet angled between 45° and 90° to overcome these problems [5].

Recently, video stylet has become a new choice in difficult airway management. It is bendable to the curved shape of 45° – 90° manually after railroading into the ETT. The view of the larynx, therefore, appeared clearly on the screen. Thus, the anesthetists could find the best way to intubate the ENT into the trachea. Amir, S. H. found that the video stylet took a shorter time to intubate than the flexible fiberoptic bronchoscope [1]. Moreover, the video stylet also shows images inside the trachea. It helps to identify the position of the ETT tip. In the current clinical setting and training, the equipment is not available to all hospitals and medical schools in Can Tho city, Vietnam. This research aims to develop an economical borescope stylet for clinical training and daily medical practice conditions in Can Tho city.

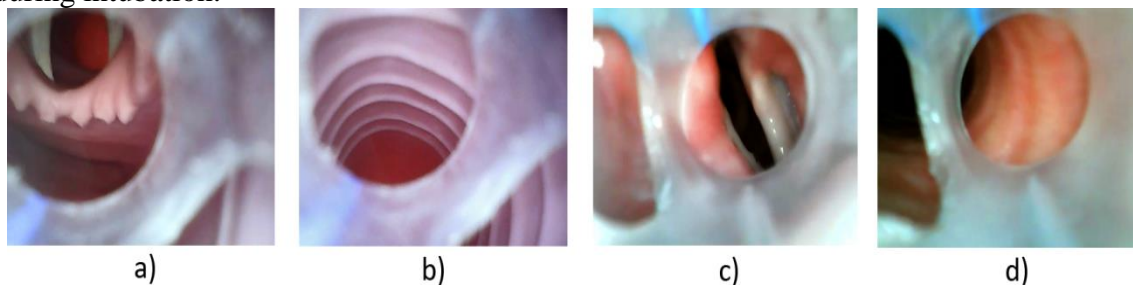
## II. MATERIALS AND METHODS

### 2.1. Study subjects

The first step of product testing was taken on training mannequin at Can Tho University of Medicine and Pharmacy. The second step of testing on patients was under the permission of the Board of Science and Technology of Can Tho City General Hospital. In 12 months, thirty-two patients undergoing general anesthesia for surgery were included in the study. Chosen patients were ASA 1 and ASA 2 (American Society of Anesthesiologists). All of the chosen patients had difficult airway predictors. Patients with potentially full stomachs were excluded from the study.

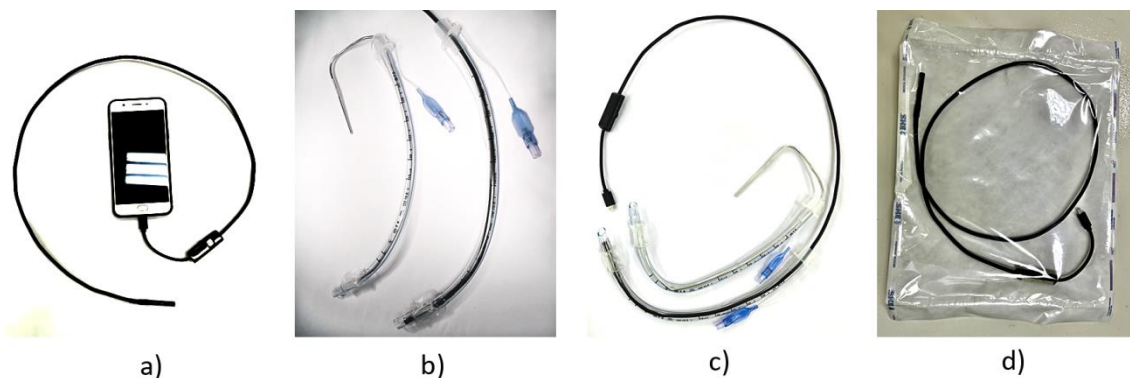
### 2.2. Study methods

After a routine conduction, patients were intubated by anesthetists with a normal laryngoscope, Macintosh blade number 3, the borescope stylet, and ETT number 6.5, 7.0, or 7.5. The borescope stylet was connected to an android smartphone via available OTG, micro-USB, or type-C port (**Figure 2a**) then railroaded into an ETT (**Figure 2c**). An android smartphone with a free “USB CAMERA” application was used to display real-time images during intubation.



**Figure 1.** The borescope stylet in performance: a) view of the vocal cords on mannequin; b) view of the trachea on mannequin; c) view of the vocal cords on patient; d) view of the trachea on patient.

The borescope stylet was one 5.5 mm diameter borescope. The borescope was modified to be 100 centimeters long in total. It could be bent to a curve of 45°–90°. The scope was modified to be water resisting and available for STERRAD sterilization (**Figure 2**).



**Figure 2.** The borescope stylet available for clinical use: a) borescope stylet connected to smartphone via OTG hub; b) stylet and borescope stylet railroaded into ETT; c) stylet and borescope stylet bent to 45° – 90° angle; d) borescope stylet after STERRAD sterilization.

Study design was a cross-sectional descriptive study. Since the product was new, no previous study was available in the literature to the best of our knowledge. The sampling method was convenience sampling, and number of cases was  $n \geq 30$ . Statistical analysis was performed using Microsoft Excel 2010.

### III. RESULTS

In 12 months, 32 patients ASA 1, 2, who needed general anesthesia with at least one predictor of difficult airway were intubated with one modified borescope stylet.

Eight difficult airway predictors were used in the test (**Table 1**) [6]. The most common predictor is Mallampati 3 and Mallampati 4; meanwhile, the least common predictor is neck tumor (**Table 1**).

**Table 1.** Difficult airway predictors.

Predictors	Number of patients (n)	Percentage (%)
Mallampati 3, 4	25	78.13
Toothless	9	28.13
Mandibular space < 6cm	15	46.88
Inter-incisor distance < 3cm	19	59.39
Limited head and neck movement	11	34.38
Neck tumor	1	3.13
Cormack – Lehane 3	21	65.62
BMI $\geq 25$ kg/m <sup>2</sup>	6	18.75

As presented in **Table 2**, all 32 patients had at least 2/8 agents. Among them, 3 patients (9.37%) had 6/8 predictors.

Intubation time was defined as the total time of a process when the laryngoscope first entered the mouth of the patient until the borescope stylet was successfully withdrawn. In this study, the average time of intubation using the borescope stylet was 44.69 s (15 – 90 s). As the tip of the ETT reached the larynx, the images on screen were epiglottis (100%),

vocal cords (100%), and trachea cartilages (90.63%). A number of 28/32 cases (87.5%) were successfully intubated at the first time; 4 cases needed the second attempt.

**Table 2.** Number of predictors.

Number of predictors	Number of patients (n)	Percentage (%)
1	0	0
2	10	31.25
3	4	12.50
4	7	21.88
5	8	25.00
6	3	9.37
7	0	0
8	0	0
Total	32	100

**Table 3.** Larynx damages.

Damages of the larynx	Number of patients (n)	Percentage (%)
Swelling	0	0
Bleeding	1	3.13
None	31	96.87
Total	32	100

Among 32 cases intubated with the borescope stylet, there was only one case that got the bleeding of the epiglottis. The bleeding was caused by the blade of the laryngoscope, not from the stylet.

**Table 4.** Satisfaction of anesthetists

Satisfaction of anesthetists	Number of patients (n)	Percentage (%)
Satisfaction with the view of larynx	32	100
Satisfaction with the stylet intubation	32	100
None	0	0

There were 100% anesthetists who agreed that the borescope stylet helped observe the larynx better. There were 100% anesthetists satisfied with the borescope stylet in intubation.

#### IV. DISCUSSION

The borescope stylet was tested at Can Tho City General Hospital. In 12 months, 32 ASA 1, 2 patients, who met the criteria of having difficult airway predictors were intubated with one reused borescope stylet for general anesthesia. The cost of the borescope and the price of modifying was 500.000 VND in total. STERRAD sterilization after each intubation was available at the hospital.

Eight difficult airway predictors were used in the test. Mallampati 3 and 4 were the most common, and neck tumor was the rarest predictor. There were 21 patients (65.62%) with Cormack – Lehane 3. There was not any case with Cormack – Lehane 4 in the test. Cormack – Lehane 3 was the situation that anesthetists observed the patients' larynx with a laryngoscope, and they could only see the epiglottis. Cormack – Lehane 3 indicated difficult intubation [4]. However, with the borescope stylet, 100% of cases showed the vocal cords on the screen. Therefore, anesthetists could find the correct way to reach the trachea and avoid the mistake of esophagus intubation.

Most of the cases were successfully intubated at the first attempt, 4 cases needed the second attempt. At the first access, the tips of ETT were stopped at the level of the larynx and could not pass through the vocal cords. At the second attempt, the anesthetists turned the ETT 45° clock-wise then successfully went through the larynx. Inside the larynx, the borescope stylet allowed to show the images of the trachea with cartilages. If the ETT went deeply, the anesthetists could see the carina; so that anesthetists could offer the appropriate position of the tip of ETT in order to avoid intubating the ETT into the bronchi.

The average time of intubation with the borescope stylet was 44.69 s (15-90 s). The longest time of intubation was 90 seconds, none of the cases needed the third attempt to finish the intubation. This result met the requirement of DAS 2015 that an intubation was not longer than 2 minutes for each attempt, and not more than 3 attempts [2]. Among 32 patients, there was only one case having laryngeal bleeding caused by the blade of the laryngoscope, not by the borescope stylet. Therefore, the borescope stylet was safe to use for difficult intubations.

After performing intubation procedure using the modified borescope stylet, 100% of anesthetists were satisfied with the real-time images of the larynx, vocal cords and trachea showed on the screen. 100% of anesthetists were satisfied with the intubation.

## V. CONCLUSIONS

Using modified borescopes as video stylets in difficult intubation is recommended as an economical solution for difficult airway management in Can Tho City General Hospital. In conclusion, the new equipment worked safely, satisfied the anesthetists, helped intubation easier in a short time and met the requirements of DAS 2015.

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(Received: 15/3/2021 – Accepted: 12/6/2021)

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