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SHORT COMMUNICATION **AIRWAY MANAGEMENT**

Borescope assisted intubation through Fekry intubating airway; a prospective observational study

Maha M. I. Youssef, MD[1], Omnia Y. Kamel, MSc[2], Ashraf R. Asswa, MD[13]
Sahar M. Kassem, MD[4], Reham A. Abdelhalim, MD[5], Inas Farouk, MD[6]

Author affiliations:

1. Maha Mohamed Ismail Youssef, Associate Professor of Anesthesiology, Cairo University, Cairo, Egypt; E-mail: maha11youssef@live.com
2. Omnia Yahia El Sayed Kamel, Assistant lecturer of Anesthesiology, Cairo University, Cairo, Egypt; E-mail: omniayehiakamel90@gmail.com
3. Ashraf Rady Ahmed Asswa, Professor of Anesthesiology, Cairo University, Cairo, Egypt; E-mail: ashrafrady83@gmail.com
4. Sahar Mahmoud Kassem, Lecturer of Anesthesiology, Cairo University, Cairo, Egypt; E-mail: Saharkasem@kasralainy.edu.eg
5. Reham Ali Abdelhalim, Lecturer of Anesthesiology, Cairo University, Cairo, Egypt; E-mail: rehamali72@hotmail.com
6. Inas Farouk Abdul-aal Ali, Lecturer of Anesthesiology, Cairo University, Cairo, Egypt; E-mail: inasfarouk@hotmail.com

Correspondence: Dr. Omnia Yahia El Sayed Kamel; E-mail: omniayehiakamel90@gmail.com; **Phone: +201270130326**

Abstract

Objectives: Airway management starts from the use of a nasal prong for oxygenation to successful endotracheal intubation for the ventilation. Intubation has been one of the most studied subject in anesthesiology. Various methods and gadgets have been advocated for its success. We aimed to evaluate the rate of successful intubations using the ordinary borescope and a stylet through Fekry Oral Intubating Airway (FOIA) in a manikin.

Methodology: This manikin-based study enrolled 35 trainees, who performed endotracheal intubation guided by the borescope and used FOIA as a conduit. Every trainee was allowed two attempts. The primary outcome was to assess the success rate of intubation. Secondary outcomes included the precise time to intubate, number of attempts, and the need for external manipulations.

Results: Our results revealed that 62.9% of the participants performed the intubation successfully (success rate) and 51.43% succeeded to intubate the manikin in the first attempt. External manipulation was needed by 71.4% of the participants in the form of cricoid pressure or laryngeal movement to visualize the glottic view. The time needed for a successful intubation ranged from 16 to 120 sec with a median of 50 sec and a mean of 69.37 ± 42.26 sec.

Conclusion: A combination of Fekry Oral Intubating Airway, a borescope and an intubating stylet can be used for endotracheal intubation in remote areas, where advanced airway management aids are not available. Future studies are warranted to optimize this technique.

Trial registration: The ethical approval was obtained from the Research Ethics Committee of Cairo University (Code: MD-79-2019), and registration of the trial was performed on www.clinicaltrials.gov with a registration number (NCT05094453).

Abbreviations: ETT: endotracheal tube; **FIOA:** Fekry Oral Intubating Airway; **OTG:** on-the-go; **VLS:** Video laryngoscopes;

Key words: Visually Assisted Intubation; Borescope; Fekry Oral Intubating Airway.

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1. Introduction

Endotracheal intubation has become a mandatory skill for every anesthesiologist. One of the main reasons of high mortality and morbidity associated with anesthesia is serious airway complications.[1]

Alignment of the three anatomical axes (e.g., oral, pharyngeal, and laryngeal axes) is an important step in endotracheal intubation. It is vital to align the visual axis with these axes to enable better visualization of the glottis.[2] Video laryngoscopes (VLS) can tackle this challenge efficiently because the camera is mounted to a bent blade, enabling the user to visually monitor the glottis.[3] However, the use of VLS in clinical practice is limited by its high cost and availability.[4]

Borescope is an optical instrument that is commonly used as an imaging tool in dental procedures, and essentially consists of a 5.5 mm diameter endoscopic camera connected to a flexible fiber cable, which can be bent as needed[5] (Figure 1). This instrument is illuminated by six circumferentially arranged LED lamps that are mounted on the camera head. The other end of the cable can be connected to an Android smart phone (Samsung Galaxy S5 etc.), which supports the OTG (on-the-go) function.[6] Borescopes have many advantages, such as that they are waterproof and can be sterilized by soap water and glutaraldehyde.[6] Furthermore, these are cost effective but user-friendly instruments, as they only function when connected to the USB ports of a laptop, computer, or smartphone.[6] Borescopes were used previously for visually assisted intubation but with difficulty in visualizing the glottic view.[7] Therefore, we hypothesized that using an oral airway as a conduit for borescope insertion would improve glottic visualization and increase the success rate of intubation.

Figure 1: Borescope/snake endoscope.

Fekry Oral Intubating Airway (FOIA) is a modification of the Williams airway that creates and maintains a patent, clear airway, as it prevents the tongue from falling back against the epiglottis, obstructing the upper airway. This can be attributed to its pharyngeal curved part that extends backward to correspond to the shape of the oropharynx, which ends near the laryngeal inlet.[8]

In FOIA, the roof of the proximal cylindrical tunnel is removed and opened from its oral straight part to allow the one-step insertion of endotracheal tube (ETT) and facilitate airway removal without the need to remove the international connection of the ETT.[8] Thus, FOIA can be gently removed from around the tube connected to the anesthesia machine, with low risk of accidental ETT dislodgement during airway removal[9] (Figure 2).

Figure 2: Fekry oral intubating airway (FOIA)

This study presents a novel use of FOIA with borescope being an economic device for educational purposes and emergency airway management when a proper fiberoptic bronchoscope or VLS is not available.

2. Methodology

This was a prospective observational study that was conducted at the Cairo University Hospital. The study included 35 anesthesia residents and assistant lecturers with experience ranging between 2 and 4 y in practicing anesthesia and they previously received adequate training regarding classic endotracheal intubation and fiberoptic endoscopy guided intubation.

The participants were asked to intubate a manikin using the borescope and a stylet through FOIA. The same manikin was used with all candidates. Before starting the intubation trial, the borescope/ETT assembly was prepared as follows: the borescope cable included a smart phone endoscopic camera connected to complementary metal oxide semiconductor sensors. The other end of the cable was connected to an Android smartphone (Samsung Galaxy S5).

The borescope was threaded into the appropriately sized ETT following efficient lubrication. The tip of the borescope was kept at 0.5 cm away from the tip of the ETT (proximal to the Murphy's eye) using a rubber stopper that was fixed around the shaft of the borescope at the level of the international ETT connection.

An intubating stylet was inserted inside the ETT next to the borescope to render the assembly more rigid.

The appropriate size of the FOIA (Ameco Tech, Cairo, Egypt) was selected by measuring the length from the manikin's mid incisors level to the angle of the mandible. Consequently, an airway size 5 (10 cm) was used in this study.

Steps of intubation

First, the manikin's mouth was opened, and FOIA was inserted with the curved pharyngeal tip facing anteriorly, and the flange was rested between the lips and teeth.

The borescope/endotracheal tube assembly was held in a pencil-like grip and introduced through FOIA. The entire passage journey was visualized in real time on the smartphone screen. Once the end of FOIA was reached, the assembly was directed upwards and forwards to visualize the glottis, and the tip of the borescope/endotracheal tube assembly was directed into the trachea until the carina was reached (Figure 3).

The stylet was removed from the endotracheal tube while pushing the borescope/endotracheal tube assembly into the trachea. The borescope was then removed gently, and the position of the ETT was

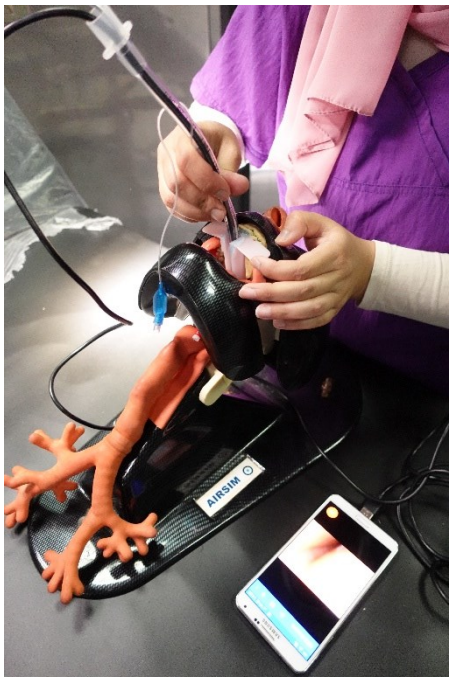

Figure 3: Introduction of the assembly through FOIA till intubation.

confirmed by connecting it to an Ambu bag and assessing lung inflation. If the laryngeal view was improperly visualized, external laryngeal manipulation was used to improve glottic visualization.

Each participant had only two attempts to perform this process on the manikin, and each attempt could not exceed a time period of two minutes. Following two unsuccessful intubation attempts, the case was recorded as a failed one.

The primary outcome was the rate of intubation success guided by Borescope and FOIA. (Successful intubation was considered when either the first or the second attempt was performed successfully within the indicated time interval). Secondary outcomes included the number of intubation attempts and the successful attempts and the total intubation time: calculated from the introduction of the borescope/endotracheal tube assembly through FOIA and introducing the tube into the vocal cords until it reached the carina, and the need for external manipulations to visualize the glottic view.

Statistical analysis

Power analysis was performed by G-power software using the level of the overall success rate of intubation, binomial tests, and one sample case as a primary outcome. Based on the assumption that 90% success rate was clinically significant, a minimum number of 33 candidates was calculated to have a study power of 0.8 and an alpha error of 0.05. The sample size was increased to 35 to compensate for dropouts.

Data were coded and entered using the Statistical Package for the Social Sciences (SPSS) version 26 (IBM Corp., Armonk, NY, USA). Quantitative data were summarized using the mean, standard deviation, median, minimum, and maximum while categorical data were classified according to the frequency (count) and relative frequency (percentage). The non-parametric Mann-Whitney U test was used to perform comparisons between quantitative variables.[10] Categorical data were compared using the chi square ($\chi 2$) test. When the expected frequency was less than five, an exact test was performed instead.[11] $P < 0.05$ was considered as statistically significant.

3. Results

Eighteen (51.4%) residents and 17 (48.6%) assistant lecturers participated in this study. The overall success rate for endotracheal intubation was 63% (66.7% in residents and 58.8% in assistant lecturers, respectively).

The overall success rate in the first attempt was 51.43%.

External laryngeal manipulation was required in 71.4% of attempts (66.7% in residents and 76.5% in assistant lecturers, respectively) (Table 1).

Table 1: Study outcomes

Outcome	Results
Success rate of intubation	22 (63%)
Total time needed for intubation (seconds)	69.37 ± 42.26
Total number of attempts needed - One attempt - Two attempts	 18 (51%) 17 (49%)
Need for external manipulations to visualize the glottic opening	25 (71.4%)

Data are presented as frequency (%) or mean ± SD

The total time needed for intubation ranged from 16 to 120 sec with a median of 50 sec and a mean of 69.37 ± 42.26 sec.

There were no significant differences between residents and assistant lecturers regarding the success rate of intubation, number of attempts, need for external manipulations to visualize the glottic opening, and the total time needed for intubation.

4. Discussion

To our knowledge, the present study is the first to evaluate the success rate of intubation using a borescope through FOIA. Our findings revealed a moderate success rate (63%) when FOIA was used for assisting the insertion. This success rate is relatively higher compared to previous studies, which did not use oral airways during borescope-guided intubation.

According to the findings of a few previous trials, use of the borescope for guiding endotracheal intubation has demonstrated a promising success rate when used in combination with the Miller's blade of an ordinary laryngoscope,[6] and in nasotracheal intubation.[12] One study tested the borescope guided endotracheal intubation alongside a stylet in the ETT, and the success rate was 56% for the first attempt. However, that study did not use any adjuvant airway devices during intubation.[7] In our study we used FOIA as a conduit for the assembly, which improved the success rate of this technique due to better visualization of the larynx.

Our results showed that this novel method might provide a simple alternative for endotracheal intubation, especially in remote stations, where newer and more costly equipment is not provided. The comparable success rate among participants of different levels of experience might denote that the borescope represents a simple tool, which is suitable for physicians with little experience. Furthermore, insertion of the ETT without the use of an ordinary laryngoscope might attenuate the pressor response of the intubation. However, this assumption needs to be confirmed by further research studies. Future studies are warranted to improve this novel technique and perform comparison with other routes for intubation.

5.Limitations

It was an observational study, just to assess the possibility of using the cheaper and common gadgets as an aid to intubate in difficult cases. However, the success rate needs some randomized, comparative studies to compare it with intubation with conventional laryngoscope to reach some conclusion.

6. Conclusion

A combination of Fekry Oral Intubating Airway, a borescope and an intubating stylet can be used for endotracheal intubation in remote areas, where advanced airway management aids are not available. Future studies are warranted to optimize this technique.

7. Data availability

The data generated in this study can be requested from the corresponding author.

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9. Conflicts of interest:

There is no conflict of interest.

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11. Author contributions

MIY, ARA: Concept

IFA, SMK: Study design

RAA: Data collection, analysis, interpretation, and writing of the manuscript

All authors have read, revised, and approved the final manuscript. The corresponding author agreed to be accountable for all aspects of the work.

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