



Comparison of three airway conduits for fiberoptic-guided intubation: A randomized controlled trial

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ABSTRACT

Background: Many oral airways are used for aiding fiberoptic bronchoscope (FOB)-guided endotracheal intubation. This study was done to evaluate modified William's airway, modified Guedel's airway, and LMA MADgic airway as conduits for FOB-guided endotracheal intubation.

Methods: Sixty patients presented for elective surgery under general anesthesia were randomly allocated into three groups: Modified Guedel's airway group (G_G), modified Williams airway group (G_W), and LMA MADgic airway group (G_M). The three study groups were compared with regard to time of insertion of the airway, time of intubation, ease of airway insertion, number of intubation attempts, Laryngeal View Grade (LVG), and the incidence of complications.

Results: G_W had shorter time of airway insertion, shorter time of intubation, lower number of intubation attempts, and better laryngeal view compared to G_G and G_M . The anesthesiologist was more comfortable in G_W compared to the other two groups. The incidence of complications (sore throat, and blood-stained airway) was comparable between the three groups.

Conclusion: Modified Williams airway provided shorter time of endotracheal tube intubation, and lower number of intubation attempts in comparison to modified Guedel's airway and LMA MADgic airway when used as conduit for FOB-guided endotracheal intubation. This randomized controlled study was conducted in Cairo University Hospital. Research Ethics Committee approved the study (N-40-2016).

ARTICLE HISTORY

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KEYWORDS

Modified Williams airway;
modified Guedel's airway;
LMA MADgic airway;
fiberoptic intubation

1. Introduction

Fiberoptic bronchoscope (FOB) is an important tool for tracheal intubation. The use of oropharyngeal airways as a conduit for FOB-guided endotracheal intubation would allow the FOB to reach the laryngeal cavity in shorter time by bypassing the oral cavity and the soft palate [1].

Several oropharyngeal airways are available used for assistance of fiber optic intubation (FOI) such as Ovassapian, Williams, Berman, LMAMADgic, modified Guedel's, and modified William's airways [2]. However, the main limitation of most of these conduits is the inability to remove them after insertion of ETT.

The modifications of Williams [2] and Guedel's airways [3] are based on introducing a cleft in the lingual surface of both airways to allow removal of the airway after ETT insertion. The early removal of the airway would decrease the risk of pharyngeal or oral injury, and would also enable one-step ETT insertion and shortened the intubation time and the duration of apnea.

The LMA MADgic airway is characterized by having a syringe port for topical anesthesia injection to anesthetize the vocal cords and laryngeal mucosa and an oxygen connector that allows passive oxygenation during

FOI [4]. However, its main disadvantage is that it could not be removed after ETT insertion; therefore, it should be removed before sliding the ETT, which prolongs the ETT insertion time.

1.1. Aim of the study

This study hypothesis is that the configuration of the airways has the main effect in their performance. The less the curvature of the pharyngeal part, the better the LVG. The tip of the FOB is more in line with the laryngeal inlet. Also, it makes the slide of the ETT easier so shorter time of ETT intubation and less apnea time, considering the straight part as the lingual part and the curved part as the pharyngeal part.

2. Materials and methods

This randomized controlled study was conducted in Cairo University Hospital. The study was approved by Research Ethics Committee (Protocol no. N-40-2016). A written informed consent was obtained from all participants before inclusion in the study. Patients were randomized using computer-generated sequence. Concealment was guaranteed using closed sealed envelopes.

We included patients over 18 years old, ASA physical status I and II, Ganzouri Airway Score less than 4 [5] scheduled for elective surgeries under general anesthesia.

Patients with ASA physical status III and IV, patients with Ganzouri score equal and more than 4, patients with risk of aspiration of gastric contents, and patients with anatomical abnormalities which invalidate Ganzouri airway score were excluded from the study.

Patients were then randomized into one of the three study groups:

LMA MADgic group (G_M): FOB intubation was assisted by LMA MADgic airway.

Modified William's group (G_W): FOB intubation was assisted by modified William's airway.

Modified Guedel's group (G_G): FOB intubation was assisted by modified Guedel's airway.

Upon arrival to the preparation room, A 20-gauge venous catheter was inserted, and 0.02 mg/kg (intravenous) midazolam and 0.005 mg/kg atropine (intravenous) were administered. Basic monitors, including non-invasive blood pressure monitor, pulse oximeter and ECG, were applied. Capnography was attached after induction of anesthesia. Anesthesia was induced by propofol (2 mg/Kg), fentanyl (1 mcg/kg), and atracurium (0.5 mg/kg).

In all groups, manual positive-pressure ventilation was started with 100% oxygen and 1–1.5% isoflurane through the bag-facemask for 3 min. When complete muscle relaxation was confirmed (when train-of-four count becomes zero [TOFC = 0]), the airway conduit was inserted according to the patient group. Positive-pressure ventilation was resumed after airway conduit insertion. Adaptation of the airway was determined by adequacy of ventilation, fitness to the oral cavity, and appearance of successive $ETCO_2$ waves.

ETT-loaded and FOB was inserted for intubation through the airway conduit according to the patient group. The FOB was advanced until the vocal cords were visualized. Laryngeal View Grade (LVG) was recorded using Brimacombe and Berry scale [6].

FOB was advanced in the trachea until the carina was visualized. Then, the ETT was advanced. After insertion of ETT, the airway conduit was removed in G_W group and G_G group; however, in the G_M group, the LMA MADgic airway was removed directly before insertion of the ETT. The time needed to insert the airway device, and ETT were recorded by a research assistant.

2.1. Outcomes

2.1.1. Primary outcome

Time for endotracheal intubation is defined as the time, in seconds, from cessation of manual ventilation using a facemask until restarting of ventilation through the endotracheal tube.

2.1.2. Secondary outcomes

Time of insertion of the device is defined as the time, in seconds, from touching the patients' mouth with the airway until capnographic confirmation of ventilation by facemask.

The ease of insertion was determined by number of attempts of airway insertion. Numbers of attempts for endotracheal intubation were recorded as only two attempts allowed if failed, endotracheal intubation done without airway.

Tracheal intubation was facilitated by tube rotation, jaw thrust, neck extension or flexion and adjustment of the airway was allowed and was recorded.

The ease of airway removal was evaluated by the anesthesiologist.

Incidence of sore throat and hoarseness was assessed by (Y/N) question.

2.2. Sample size calculation

Power analysis was performed using G-power (3.1.9.2) software. We used the analysis of variance test (ANOVA) on the duration of intubation as it is the main outcome of the present study. A previous study [1] showed that the time of intubation was 43 ± 11 minutes with the Modified Williams airway. We calculated a sample size that could detect difference of at least 25% in the intubation time. Considering a study power of 0.8, and an alpha error of 0.05, the calculated sample size was at least 60 patients (20 in each group).

2.3. Statistical analysis

Data were coded and entered using the statistical package SPSS version 22. Data were summarized using mean and standard deviation or median and interquartile range for quantitative variables and frequencies (number of cases) and relative frequencies (percentages) for categorical variables. Comparisons between groups were done using analysis of variance (ANOVA) with multiple comparisons *post-hoc* test in normally distributed quantitative variables, while non-parametric Kruskal–Wallis test and Mann–Whitney test were used for non-normally distributed quantitative variables [7]. For comparing categorical data, χ^2 test was performed. Exact test was used instead when the expected frequency is less than 5 [8]. *P*-values <0.05 were considered as statistically significant.

3. Results

Sixty patients were recruited, all of them completed this study and were available for final analysis. Demographic data and baseline line characteristics were comparable between the three groups (Table 1).

Table 1. Demographic data (age and gender) in the three groups.

	Modified Williams group (n = 20)	Modified Guedel's group (n = 20)	LMA MADgic group (n = 20)	P-value
Age (years) Mean± SD	39.30 ± 16.53	41.85 ± 17.26	41.90 ± 13.75	0.840
Gender				0.420
Male n (%)	8(40)	11(55)	12(60)	
Female n (%)	12(60)	9(45)	8(40)	

-P < 0.05 was considered statistically significant.

-Numerical data were presented as Mean ± Standard deviation.

-Categorical data were presented as Frequency (%).

G_W group showed the shortest airway insertion time, and intubation time compared to other two groups (Table 2).

As regards the need for manipulation, all patients in the three groups needed manipulation except four patients in the G_W and one patient in the G_G (P = 0.001) (Figure 1).

Regarding LVG, G_M was the only group which showed LVG III (30%) and the highest % of the LVG II (60%)(Figure 2).

The three airways were properly adapted to the oral cavity (adaptation was assessed by adequacy of ventilation, fitness to the oral cavity and appearance of successive ETCO₂ waves) (Table 3).

Considering the ease of airway removal, it was easy to remove the airways from all the patients in G_W group and G_G group, while in G_M group the anesthetist faced difficulties in removal of the airway in 20% of the patients. (P = 0.030) (Table 3).

Table 2. Data regarding time of airway insertion and time of ETT Intubation by FOB in the three groups.

	Modified William's group (n = 20)	Modified Guedel's group (n = 20)	LMA MADgic group (n = 20)	P-value
Insertion time (s) Mean± SD	5.25 ± 1.21	7.15 ± 1.57	6.85 ± 1.46	< 0.001
Intubation time (s) Mean± SD	40.10 ± 6.66	59.40 ± 18.84	69.95 ± 11.34	< 0.001

-P < 0.05 was considered statistically significant.

-Numerical data were presented as Mean ± Standard deviation.

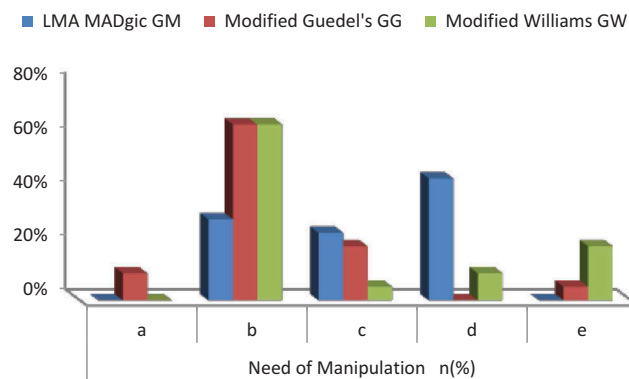
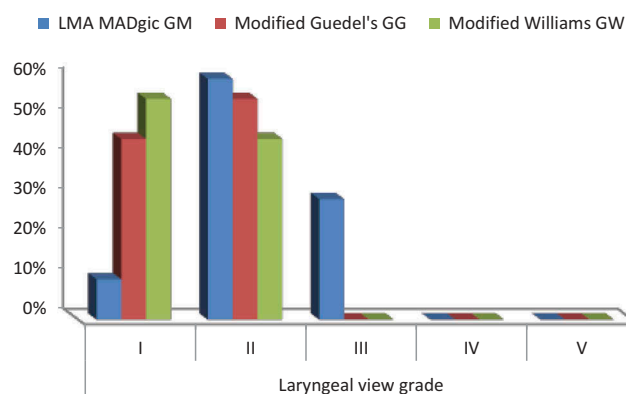
**Figure 1.** Need of manipulation. Manipulation used: (a) tube rotation, (b) jaw thrust, (c) neck extension or flexion, (d) adjustment of airway and (e) no manipulation was done.**Figure 2.** Laryngeal View Grade.

Table 3. Data about using the airways and incidence of complication.

		Modified William's group (n = 20)	Modified Guedel's group (n = 20)	LMA MADgic group (n = 20)	P-value
Adaptation n(%)		20(100)	20(100)	20(100)	–
Ease of removal	Yes	20(100)	20(100)	16(80)	0.030
n(%)	No	0(0)	0(0)	4(20)	
Comfort with use	Yes	20(100)	20(100)	15(75)	0.009
n(%)	No	0(0)	0(0)	5(25)	
No. of attempts	1 st	19(95)	16(80)	14(70)	0.150
n(%)	2 nd	1(5)	4(20)	6(30)	
Sore throat	Yes	2(10)	4(20)	2(10)	0.710
n(%)	No	18(90)	16(80)	18(90)	
Blood stained device		0(0)	0(0)	0(0)	–
n(%)					

-P < 0.05 was considered statistically significant.

-Categorical data were presented as frequency (%).

As regards the anesthetist comfort with use of the airway, they were 100% comfortable with the use of the airways in G_W and G_G. However, they confronted difficulties in 25% of cases in G_M. This was statistically significant ($P = 0.009$) (Table 3).

As regards number of attempts of endotracheal tube intubation and incidence of complication, the three groups were comparable (Table 3).

4. Discussion

In this study, we compared the three oropharyngeal airways with a spotlight on the airway curvature and its effect on the intubation time.

In the modified William's group, insertion time and intubation time was shorter compared to the other two groups; this is most probably due to the less curvature of the pharyngeal part of the Modified William's airway which improved visualization of the laryngeal inlet, and allowed easier introduction of the FOB. The longer intubation time in LMA MADgic airway group was most probably due to the time consumed during removal of the LMA MADgic airway before sliding of the ETT.

We reported lower incidence of manipulation (mostly jaw thrust), higher incidence of grade I laryngeal view, and higher incidence of successful first intubation attempt in the Modified Williams group. That is explained by the shape of the Modified William's airway being characterized by having longer lingual part, and less-curved pharyngeal part. This configuration was more adapted with the anatomy of the oropharynx, and enabled it to guide the FOB tip to the laryngeal inlet; hence, this modification facilitated the advancement of the ETT compared to the original Williams airway intubator, and allowed removal of the airway after the intubation.

We found that each of Modified Williams and Modified Guedel's airways were easier in removal and more comfort with use than LMA MADgic airway. As a result of LMA MADgic configuration, we remove the airway before ETT insertion that leads to displacement in the tip of the bronchoscope in (20%) of the patients in LMA MADgic group.

Few number of our patients developed sore throat which was mostly related to repeated trials of ETT placement.

In line with our findings, *Abbas et al.* [1] compared air-Q intubating laryngeal airway and modified Williams intubating airway as aids for training in fiberoptic tracheal intubation. They found shorter insertion time, shorter intubation time, less manipulation, and higher rate of unobstructed bronchoscopic view in the modified Williams group compared to the air-Q group; however, they used jaw thrust in all patients. Besides, only 78% of patients in modified Williams group were intubated in the first attempt versus 95% in our patients. This difference might be due to the less experience of the operators (residents in a training course). They were significantly more comfortable with the modified Williams airway ($P = 0.032$). There was no statistically significant difference in sore throat and hoarseness of voice in both groups in *Abbas et al.* [1] study.

In line with our findings, *Greenland et al.* had evaluated William's Airway Intubator in comparison to two other devices [9,10] and they reported that manipulation was needed in 43% and 42.9% and the incidence of unobstructed view ranged between 68% and 80%.

In contrary to the current study, *Varghese et al.* [11] reported different findings from ours with regard to modified Guedel's airway. They also reported longer intubation time (142.00 ± 55.37 s), higher frequency of manipulation (77%), and lower frequency of successful first trial (20%). Varghese et al. study differed from our study in the included age group (children). Another difference was the intubation technique, as they remove the Guedel's airway before the ETT railed over the fiberoptic bronchoscopy and that prolong their total intubation time.

Modified Williams airway facilitates FOI and help reducing apnea time. We recommend Jaw thrust to be a step with FOI through the modified Williams airway.

5. Conclusion

Modified Williams airway provided better LVG, shorter time of airway insertion, and shorter time of endotracheal

tube intubation in comparison to both modified Guedel's airway and LMA MADgic airway as a conduit for fiberoptic intubation.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix

Flow Chart:

