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The use of modified bite block to improve the safety and efficacy of oral fiber optic intubation in patients with limited neck mobility: a randomized comparative study

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Abstract

Background: One critical aspect of anesthesia is to provide airway management. Fiber optic intubation is the safest solution but can be difficult in patients with limited neck mobility. Insertion of the fiber optic bronchoscope through a modified bite block might facilitate intubation in such patients. Here, we performed fiber optic intubation without and with a bite block that was modified to compare the safety and efficacy of the two techniques.

Method: Sixty adult patients with limited neck mobility who were to undergo elective surgery with mandatory tracheal intubation under spontaneous ventilation were assigned to two groups. In group TR, the traditional technique of oral fiber optic intubation was performed without the use of a bite block. In group MB, the fiber optic was inserted through a modified bite block.

Results: Both groups showed statistically significant increases from baseline in mean arterial pressure and heart rate during the first 3 min after intubation; this increase was marked in the TR group than in the MB group. Hemoglobin oxygen saturation was significantly greater in the MB group than in the TR group. The time to successful intubation was significantly shorter in the MB group than in the TR group. The quality of intubation field shows a significant difference in *p* value between MB and TR groups with the best result observed in MB.

Conclusion: Oral fiber optic intubation with a modified bite block performed under spontaneous ventilation is safer and more effective than traditional fiber optic intubation for patients with limited neck mobility.

Keywords: Bite block, Oral fiber optic, Limited neck mobility

Introduction

Airway management for patients with limited neck mobility can be challenging to the anesthesiologist and may lead to cannot ventilate-cannot intubate scenarios. Fiber optic intubation is recommended as the safest technique for protecting the airway in difficult intubation situation (Wulf et al., 1997).

A variety of oropharyngeal intubation devices have been designed including the Ovassapian®, Williams®, and Berman II® airways, and the PatilSyracus® mask. The main advantage of these airway devices is that they facilitate oral intubation by the passage of a fiber optic (FBO) along the midline, which is essential for a successful fiber optic intubation (Wheeler & Ovassapian, 2007).

However, these devices do not provide a clear passage for oral fiber optic intubation, are more liable for malposition due to their inflexibility (Greenland & Irwin, 2004), and require various maneuvers to facilitate intubation, including patient positioning, jaw thrust maneuvers (Durga et al., 2001a), rotation of the endotracheal tube, and pulling the tongue with Magill forceps (Randell & Hakal, 1997).

A bite block has been recommended for oral intubation to prevent closure of the tracheal tube and damage

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to the fiber optic bronchoscope and to maintain a patent airway for suctioning (Stackhouse, 2002; Reed, 2001). However, the safety and efficacy of the use of bite blocks has not been systematically examined in patients with limited neck mobility.

Here, we compared two methods of oral FBO intubation under spontaneous ventilation technique: the traditional method (TR group) and a method involving passing the FBO through a longitudinally cut bite block (MB group). All study participants had a difficult airway, which is the most common dangerous and challenging problem for anesthesiologists.

The primary outcome of the present study was to compare oral fiber optic intubation with and without modified bite block as regards to the time of successful intubation (the time from insertion of the fiber optic till the passage of the tube through the vocal cord).

The secondary outcome was to compare the incidence and severity of bleeding (an estimation of the quality of the intubation field) after inserting the endotracheal tube.

Patients and methods

The present randomized control study was conducted at Al-Zahraa Hospital, AL-Azhar University, from February 2, 2018, to December15, 2018, after receiving institutional approval from the Research Ethics Committee under the registration number N 0 REC-AFHG 2018/2, and written consent was obtained from all participants.

Sixty adult patients, aged 25–55 years, were categorized as having ASA II and III physical status, with limited neck mobility due to huge goiter, burn, or chronic neck pain as thoracic outlet syndrome. All patients were prepared for elective surgery with mandatory tracheal intubation under spontaneous ventilation.

Patients were assigned to two groups: each patient had an equal and random probability of being chosen (the numbers arranged in ascending order and the lower half assigned to the control group and the upper half to the test group) by computer-generated random number. In the control group (group TR, n = 30), the traditional technique of oral FBO intubation was performed. In the test group (group MB, n = 30), the FBO was inserted through a modified bite block.

Patients with an ASA physical status IV or more, a BMI ˃ 35 kg/m^2, coagulopathy, anticipated regurgitation or aspiration hazards, or impossible oral intubation (e.g., lockjaw, ankylosis of the temporomandibular joint and trismus) were excluded from our study.

If intubation failed after two attempts, an alternative intubation plan was in place, i.e., a technique using supraglottic airway device was available to provide patient oxygenation. Patients in whom the alternative technique was used were excluded from this study.

Intubation was performed by an expert anesthetist. Before initiation of anesthesia, all participants were injected with intramuscular atropine as an anti-sialagogue, at a dose of 10–20 mcg/kg 30 min before surgery, and a suitable intravenous cannula was placed. Electronic vital signs monitors were secured to the patients to allow monitoring of pulse rate, temperature, respiration rate, and mean blood pressure throughout the procedure by a junior colleague. Hemodynamic parameters (mean blood pressure, pulse rate, and SpO_2) were recorded at the base line then at the first 3 min after intubation.

All patients were intubated with an oral fiber optic bronchoscope under spontaneous ventilation after placing the patient in a "sniffing" position. This position provides the best exposure of the vocal cords because the ear is at the same level as the sternum and the chin is along the same axis as the angle of the mandible (Brindley et al., 2010; Greenland, 2008).

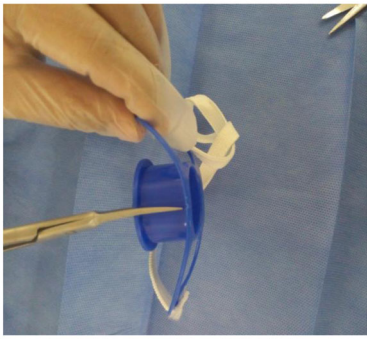
After placing the patient in a "sniffing" position, intubation was performed under spontaneous ventilation using inhalational sevoflurane and 100% oxygen for at least 5 min to ensure deep anesthesia. The fiber optic was lubricated with 2% lidocaine gel, and then the endotracheal tube was mounted around the shaft fiber optic. The light source was checked, and the oxygen source was attached to flow through the fiber optic during intubation. The camera was then attached with its landmark at 12 o'clock as a guide and connected to a monitor screen.

In the MB group, a sterile bite block cut longitudinally along the middle was inserted along the midline of the mouth. The fiber optic was advanced through the bite block to the oropharynx where the fiber optic curved anteriorly at a 45° angle to visualize the vocal cords (Fig. 1). In the TR group, the fiber optic was inserted directly into the mouth without the use of a bite block or a tongue forceps along the midline to the oropharynx, and the fiber optic curved anteriorly at a 45° angle to visualize the vocal cords.

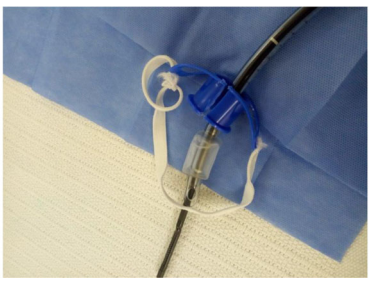
After visualization of the vocal cords just before the opening of the larynx, a small dose of propofol (0.5 mg/kg) was administered intravenously to prevent laryngospasm and irritation of the upper airway (Nawfal, 2002). The fiber optic was advanced through the trachea until the carina was visualized. The endotracheal tube was then advanced to the same point, and the modified bite block was removed. A stopwatch was used to record the time from insertion of the fiber optic device to successful intubation which is recorded as the time of successful intubation.

Successful intubation was confirmed by visualization of the endotracheal tube in the tracheal rings and $EtCO_2$ tracing. Once this was confirmed, the fiber optic was withdrawn to allow the tube to be secured and intravenous fentanyl at a dose of 1–2 μg/kg and cisatracurium at a dose of 0.15 mg/kg were administered. The procedure was continued with controlled ventilation.

(A): A disposable bite block.



(B): A sterile bite block cut longitudinally along the middle.



(C): A bite block have a wide lumen allowing easy passage of a cuffed endotracheal tube.

Fig. 1 **a** A disposable bite block. **b** A sterile bite block cut longitudinally along the middle. **c** A bite block having a wide lumen allowing easy passage of a cuffed endotracheal tube

The quality of the intubation field was estimated by the anesthesiologist during intubation and classified as follows:

1. Excellent: no bleeding or secretions interfering with the intubation field
2. Fair: mild bleeding or secretions requiring frequent suction to allow visualization of the intubation field
3. Poor: copious bleeding or secretions requiring constant suction to allow visualization of the intubation field

The sample size was based on previous study reporting that 25 subjects in each group had an alpha error of 0.05 and a power of 90%. Sample size calculation was based on the mean intubation time of 33.5 ± 20.8, and 18.75 ± 4.9 s was calculated from the median values from Stacey et al. (Stacey et al., 2005). To account for probable drop-out, 30 patients in each group were enrolled in this study.

Data were collected, revised, coded, and entered to the Statistical Package for Social Science (IBM SPSS) version 23. The quantitative data were presented as mean, standard deviations, and ranges. Also, qualitative variables were presented as number and percentages. The comparison between groups regarding qualitative data was done by using chi-square test. The comparison between two groups with quantitative data and parametric distribution was done by using independent t test. The confidence interval was set to 95%, and the margin of error accepted was set to 5%. So, the p value was considered significant at the level of < 0.05.

Results

There were no significant differences in patient demographics between the TR and MB groups (Table 1).

Both groups showed statistically significant increases from baseline in MAP and HR during the first 3 min after intubation. There were marked increases in HR and MAP in the TR group compared to the MB group during the first 3 min after intubation (Figs. 2 and 3)

SpO_2 showed no significant difference from baseline in either group during the 1st minute. In the 2nd and 3rd minutes, SpO_2 was significantly lower in the TR group than in the MB group (Fig. 4).

The time to successful intubation was significantly shorter in the MB group (90.68 ± 12.61 s) than in the TR group (120.0 ± 63.1 s; $p = 0.015$) (Table 2).

Bleeding was used as a reference point for the quality of the intubation field, and there was a significant

Table 1 Demographic data and patients' airways

		TR	MB	Test value	*p* value
		n = 30	*n* = 30		
Age[##]	Mean ± SD	37.65 ± 10.12	36.9 ± 9.64	0.294	0.769[##]
	Range	25–55	27–54		
Sex[#]	Males	17 (56.7%)	15 (50.0%)	0.268	0.605[#]
	Females	13 (43.3%)	15 (50.0%)		
Weight[##]	Mean ± SD	85.35 ± 2.46	86.2 ± 2.89	1.227	0.225[##]
	Range	80–90	81–92		
Height[##]	Mean ± SD	186.3 ± 2.7	186.8 ± 1.9	0.83	0.41[##]
	Range	180 – 190	182 – 190		
BMI	Mean ± SD	26.7 ± 1.3	27.1 ± 1.6	1.063	0.292
	Range	24.5–29.3	25.3–29.8		
ASA score[#]	II	26 (86.7%)	22 (73.3%)	1.667	0.196[#]
	III	4 (13.3%)	8 (26.7%)		
Mallampati score[#]	III	5 (16.7%)	7 (23.3%)	0.528	0.767[#]
	IV	25 (83.3%)	23 (76.7%)		
Thyromental distance > 6 cm[##]	Mean ± SD	5.0 ± 0.4	4.9 ± 0.3	1.095	0.277[##]
Steronomental distance > 12 cm[##]	Mean ± SD	9.7 ± 1.1	9.2 ± 1.3	1.608	0.113[##]
Type of operations	Open cholecystectomy	10 (33.3%)	12 (40.0%)	0.673	0.880
	Open hiatus hernia repair	7 (23.3%)	5 (16.7%)		
	Splenectomy	8 (26.7%)	7 (23.3%)		
	Umbilical hernia	5 (16.7%)	6 (20.0%)		
Duration of operation	Mean ± SD	56.30 ± 4.50	54.80 ± 4.80	− 1.249	0.217
	Range	45–60	50–60		

[#]Independent test
[##]Chi-square test

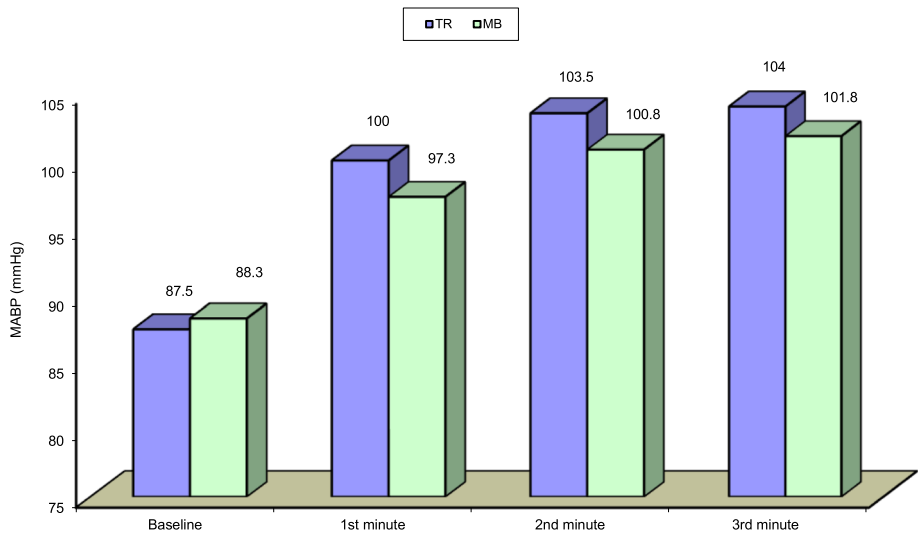


Fig. 2 Mean arterial pressure measured pre-procedurally and during the first 3 min of the procedure

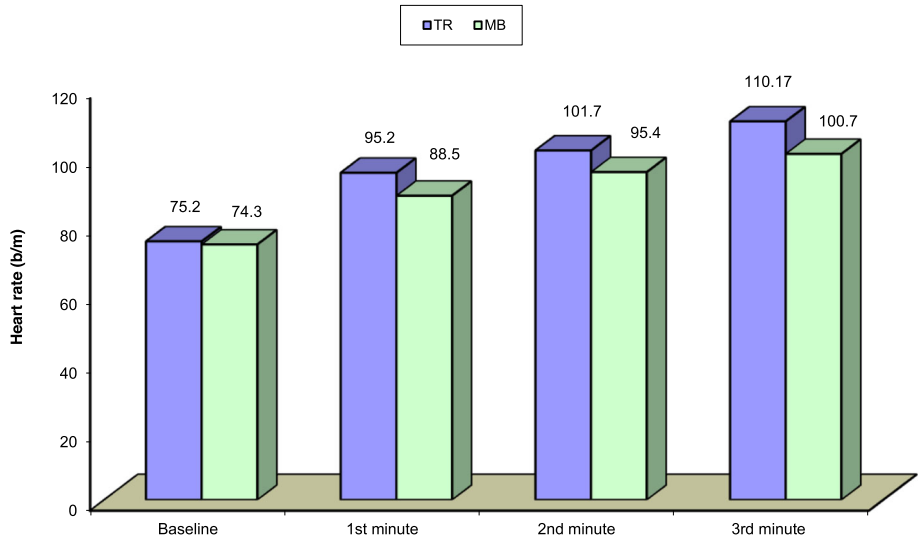


Fig. 3 Heart rate measured pre-procedurally and during the first 3 min of the procedure

difference in the *p* value between MB and TR groups with the best result observed in the MB group. In the TR and MB groups, 66.7% and 93.3% of patients, respectively, had no bleeding or secretions interfering with the intubation field (excellent quality); 10.0% and 3.3% of patients, respectively, had mild bleeding or secretions requiring frequent suction to allow visualization of the intubation field (fair quality); and 23.3% and 3.3% of patients, respectively, had copious bleeding or secretions requiring constant suction to allow visualization of the intubation field (poor quality) (Table 3).

Discussion

Fiber optic intubation enables the vocal cords to be visualized with minimal force, but the need for additional maneuvers to allow smooth insertion of the tube (Asai & Shingu, 2004) or devices to clear the airway results in hemodynamic changes, especially during difficult intubation.

Although various oropharyngeal airway devices have been designed to solve this difficulty, they have some disadvantages: their unappreciated size may cause trauma during insertion; the cuff of the endotracheal

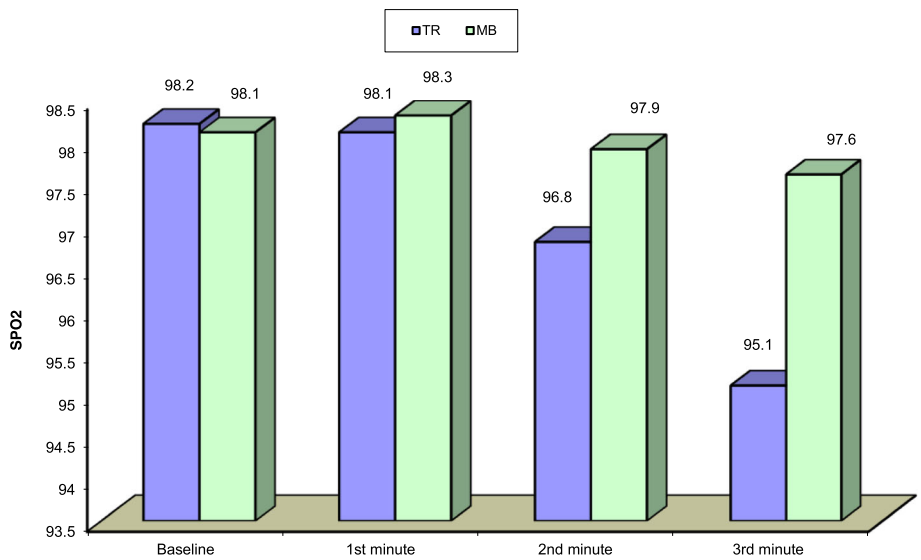


Fig. 4 Hemoglobin oxygen saturation (SpO_2, %) measured pre-procedurally and during the first 3 min of the procedure

Table 2 Time to successful intubation

Time to successful intubation	Mean (s) ± SD	*t* test	*p*
TR group	120.0 ± 63.1	2.496	0.015
MB group	90.68 ± 12.61		

tube may be impeded by them; and their terminal openings may displace the glottis or come in front of the posterior pharyngeal wall (Xue et al., 2000).

We have examined the use of a modified bite block as an alternative to traditional oropharyngeal airway devices for difficult intubation. Modified bite blocks have the following advantages: they are readily available (i.e., easy and inexpensive to obtain); they are of suitable length to act as a passage to the vocal cords; they have a wide lumen allowing easy passage of a cuffed endotracheal tube; they can safeguard the fiber optic bronchoscope from the tongue; and the upper and lower rims of the bite block fix the glottis on the midline and inhibit movement toward the tongue and palate.

Both groups showed statistically significant increases from baseline in the hemodynamic parameters MAP and HR during the first 3 min after intubation which can be explained by stimulation of the sympathetic response during passing of the endotracheal tube through the vocal cord (Ko et al., 2012). This increase is more in the TR group than in the MR group as insertion of the modified bite block in the MR group facilitates fiber optic bronchoscope insertion which leads to shorter tracheal stimulation.

SpO_2 showed no significant difference from baseline in either group during the 1st minute after intubation. The results of the present study are consistent with those findings by Finfer et al. (Finfer et al., 1989), who reported that intubation was achieved within 1 min, and SpO_2 did not fall below 98%, which indicate that sniffing position improves pre-oxygenation (Lane et al., 2005).

Our results provide further evidence that SpO_2 was significantly higher in the MB group than in the TR group during the 2nd and 3rd minutes of intubation. The desaturation observed in the TR group did not reach critical value which may be due to the more manipulation and longer time required to intubate the trachea without the insertion of the modified bite block.

Table 3 Quality of the intubation field

Quality of the intubation field	TR		MB		Test value	*p* value
	No.	%	No.	%		
Excellent	20	66.7	28	93.3	6.833	0.033(S)
Fair	3	10.0	1	3.3		
Poor	7	23.3	1	3.3		

Desaturation is defined as oxygen saturation < 90% from the initial SpO_2 of ˃ 90% or a decrease from a baseline of less than 90% (Dunford et al., 2003).

The time to successful intubation (the time from insertion of the fiber optic till the passage of the tube through the vocal cord) was significantly shorter in the MB group (90.68 ± 12.61 s) than in the TR group (120.0 ± 63.1 s; $p = 0.015$).

This is likely to be because the technique used in the MB group provided easy visualization of the glottis, as the upper and lower rims of the bite block fix the glottis on the midline and inhibit movement toward the tongue and palate.

Jaw thrust alone often fails to produce full airway clearance, but combining two jaw thrust maneuvers with fiber optic assisting airway devices improves the chance of successful visualization of the glottis (Durga et al., 2001b).

Langeron et al. (Langeron et al., 2001) used a fiber optic bronchoscope for oral intubation of patients expected to have a difficult intubation and reported that the time to tracheal intubation was 151 s and 130 s with the ILMA and FIB techniques, respectively.

Bleeding was used as a reference point for quality of the intubation field, and there was a significant difference in the *p* value between MB and TR groups with the best result observed in the MB group. In the TR and MB groups, 66.7% and 93.3% of patients, respectively, had no bleeding or secretions interfering with the intubation field (excellent quality); 10.0% and 3.3% of patients, respectively, had mild bleeding or secretions requiring frequent suction to allow visualization of the intubation field (fair quality); and 23.3% and 3.3% of patients, respectively, had copious bleeding or secretions requiring constant suction to allow visualization of the intubation field (poor quality).

This could be because first, our study was based on an elective procedure in which intramuscular atropine was administered to all patients as an ant sialagogue to decrease secretions. Atropine has been advised as a premedication for fiber optic techniques to decrease bronchial secretions for many years (Koerner & Brambrink, 2005; Murrin, 1997).

Second, the use of modified bite block decreased the contact between the endotracheal tube and the laryngeal structure, decreasing the risk of mucosal injury and bleeding (Hakala & Randell, 1995).

Also, the attachment of oxygen source through the working channel of the fiber optic helps to blow away bronchial secretion and blood from the intubation field.

Limitations of this study

Our sample size is only limited to adult patients with limited neck mobility. However, we recommended

studying the efficacy of a modified bite block on wilder population and on pediatric patients by both expert and inexpert anesthesiologist to prove its efficacy and safety.

Conclusion

Oral fiber optic intubation with a modified bite block performed under spontaneous ventilation is safer and more effective than the traditional method and allows early visualization of the vocal cords with improved intubation field quality for patients with limited neck mobility.

Abbreviations

ASA: American Society of Anesthesia; BMI: Body mass index; FBO: Fiber optic; HR: Heart rate; MABP: Mean arterial blood pressure

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Author's contributions

AS has made the design of the work and the acquisition, analysis, and interpretation of the data; drafted the work; and prepared the manuscript. AS is the sole contributor of the study. The author read and approved the final manuscript.

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Availability of data and materials

All datasets used and/or analyzed during this study are included in this published article.

Ethics approval and consent to participate

This study was conducted after receiving institutional approval from the Research Ethics Committee under the registration number N 0 REC-AFHG 2018/2 from AL-Azhar University, and informed written consent was obtained from all participants.

Consent for publication

Not applicable.

Competing interests

The author declares that there are no competing interests.

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