COMPARISON OF THE BONFILS INTUBATION FIBRESCOPE VERSUS C-MAC VIDEOLARYNGOSCOPE

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Background: This prospective, randomized, single blind, single operator study was conducted to compare hemodynamic responses when endotracheal intubation was performed using the Bonfils intubation fibrescope versus the C-MAC videolaryngoscope.

Method: Forty-four ASA I patients aged between 18 and 60 years, scheduled for elective surgery requiring endotracheal intubation were recruited. They were randomized into the Bonfils group or C-MAC group. Hemodynamic changes, laryngeal view, duration of intubation and post intubation complications were evaluated. Mean arterial pressure, heart rate and oxygen saturation were monitored pre and post-induction, pre and post-intubation, and at 1 minute intervals thereafter for 10 minutes.

Results: Endotracheal intubation was successful at first attempt in 90.9% in both groups. Heart rate was significantly higher in the Bonfils group (p<0.05) compared to the C-MAC group and values were sustained throughout the study. There was no difference in the mean arterial pressure (MAP) between the two groups. Mean time to intubation was significantly longer in the Bonfils group (28.8 vs. 24.7 seconds, p = 0.02). There were no significant differences in laryngeal view and post intubation complications between the groups.

Conclusion: Intubation using the Bonfils intubation fibrescope took longer, and resulted in significantly higher heart rate when compared with the C-MAC videolaryngoscope.

Introduction

Securing the airway with a cuffed endotracheal tube provides protection against aspiration and allows application of controlled mechanical ventilation. The Macintosh laryngoscope described in 1943 is most commonly used and remains the gold standard device for endotracheal intubation. Direct laryngoscopy and tracheal intubation causes marked stress responses, increasing heart rate and blood pressure due to direct stimulation at the tongue base and placement of endotracheal tube through the vocal cords1,2. These transient sympathetically-driven responses produce adverse respiratory and cardiovascular complications which may be hazardous in patients with pre-existing hypertension and severe cardiac diseases3.

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In recent years, video assisted laryngoscopes such as the Glidescope (Verathon, Bothell, Washington, USA), Pentax Airway Scope (Pentax, Tokyo, Japan), Airtraq (Prodol Meditec S.A., Vizcaya, Spain) and C-MAC (Karl Storz Endoscope Ltd, Tuttlingen, Germany) have been developed to improve laryngeal view, hence obviate the need for excessive manipulation which might provoke increased sympathetic responses. Video laryngoscopy has also increased the rate of successful endotracheal intubation in patients with difficult airway4-8. Other new intubation tools include the intubating laryngeal mask airway, lightwand intubating device (Trachlight), styletscope (NihonKohden, Tokyo, Japan), fibreoptic bronchoscope and the Bonfils intubation fiberscope (Karl Storz Endoscope Ltd, Tuttlingen, Germany) which all facilitate endotracheal intubation without direct laryngoscopy9-12.

The C-MAC (Karl Storz Endoscope Ltd, Tuttlingen, Germany) videolaryngoscope is a modification of the Storz Berci-Kaplan DCI. It consists of a Macintosh Blade with a light source and an integrated video camera connected via a cable to a video display monitor onto which the image at the blade camera is projected. Studies have shown that indirect laryngoscopy with the C-mac videolaryngoscope improved laryngeal view and caused less hemodynamic stress response compared to direct laryngoscopy4,5.

The Bonfils intubation fibrescope (Karl Storz Endoscope Ltd, Tuttlingen, Germany) described by Bonfils in 1983, is a 40 cm long, thin rigid fibreoptic endoscope used for endotracheal intubation. This video assisted intubation fibrescope allows visualization of the laryngeal inlet and placement of the endotracheal tube under direct vision. Theoretically, avoidance of direct laryngoscopy would cause less oropharyngeal stimulation thus attenuating the hemodynamic stress response10-12. Najafi et al found that the Bonfils intubation fibrescope compared well with the Macintosh laryngoscope in terms of intubation conditions and success rate, with less mechanical stress and hemodynamic disturbance12.

Methods

This was a prospective, randomized, single blind study, which was conducted in Universiti Kebangsaan Malaysia Medical Centre (UKMMC) between November 2014 and April 2015, following approval from the Medical Research and Ethics Committee UKMMC.

Forty-four patients aged between 18-60 years, of body mass index (BMI) <35 kg/m², physical status of American Society of Anesthesiologists (ASA) class I, without anticipated difficult airway, scheduled for elective surgery under general anesthesia requiring endotracheal intubation were recruited. Patients were briefed on the study and written informed consent was obtained. Each patient was assigned by a computer-generated randomization to either the Bonfils group or C-MAC group. Endotracheal intubation using both devices was performed by a single operator, who was a postgraduate anesthesiology trainee with experience of more than 20 successful intubations each with the Bonfils intubation fibrescope and C-MAC videolaryngoscope, prior to commencement of the study.

All patients were fasted for at least 6 hours, and received oral midazolam 3.75 mg or 7.5 mg the night and morning before surgery. In the operating theatre, the patient was randomly assigned to either the Bonfils group or C-MAC group. Cuffed Portex endotracheal tubes with internal diameters of 7.0 or 7.5 mm were used for the female patients and 7.5 or 8.0 mm for the male patients.

Before induction of anesthesia, the patient was positioned supine with the head rested on a silicon head rest, in optimal intubation position. Standard monitoring comprising non-invasive blood pressure (NIBP), electrocardiography (ECG) and pulse oximetry was instituted, and the patient was commenced on maintenance infusion of Ringer’s lactate solution. Baseline mean (MAP), systolic (SBP) and diastolic (DBP) blood pressures, heart rate (HR) and oxygen
Hemodynamic Changes: Bonfils versus C-MAC

After 3 minutes of preoxygenation, anesthesia was induced with IV fentanyl 2 mcg/kg and propofol 2 mg/kg till loss of eyelash reflex, followed by paralysis with rocuronium 0.6 mg/kg. The patient was then manually ventilated via facemask with sevoflurane in 100% oxygen, targeted to a minimum alveolar concentration (MAC) of 1.0 to 1.2. Three minutes after administration of rocuronium, endotracheal intubation was performed using either the Bonfils intubation fibrescope or C-MAC videolaryngoscope. The endotracheal tube cuff was inflated and correct tube placement confirmed by the presence of end tidal carbon dioxide (ETCO₂) via capnography. The patients were subsequently connected to the ventilator and put on volume control mode with ETCO₂ ranging 35 to 40 mmHg. Anesthesia was maintained with sevoflurane, titrated to a MAC of 1.0 to 1.2, in a mixture of air and oxygen at a ratio of 1:1, with gas flows at 1 L/min. Mean arterial pressure, SBP, DBP, HR and SpO₂ were recorded by an observer before and after induction of anesthesia, before and immediately after intubation, and every 1 minute thereafter for the subsequent 10 minutes. Hemodynamic parameters were documented before induction of anesthesia as time A, after induction as time B, prior to intubation as time C, and after intubation as time D.

In the Bonfils group, endotracheal intubation was performed using the Bonfils intubation fibrescope via midline approach. The endotracheal tube was loaded on and taped to the proximal end of the lubricated shaft of the Bonfils intubation fibrescope. After adjusting the fibrescope to optimal view on the display monitor, anti-fog solution was applied to its distal tip. The operating bed was adjusted to allow the operator optimal manipulation of the Bonfils intubation fibrescope. The assisting anesthetic doctor performed a gentle jaw thrust maneuver, or the operator performed the tongue jaw lift on the patient to lift the tongue from obstructing subsequent viewing with the fibrescope. The fibrescope was held in the operator’s dominant hand and introduced midline into the patient’s oral cavity, angled end of the scope faced anteriorly and the length of the fibrescope at 60 degree angle to the patient’s body. Upon visualization of the uvula, the fibrescope was tilted gradually towards the operator while advancing it down the oropharynx towards the epiglottis. The fibrescope was further advanced posterior to the epiglottis and the laryngeal inlet sought. The view of the retropharyngeal space was improved by careful re-adjustment of the jaw thrust or tongue jaw lift maneuver. If the tongue or epiglottis persistently obstructed laryngeal view, intubation was re-attempted with a Macintosh laryngoscope in the left hand, used to laterally displace the tongue, with or without the jaw thrust. The rigid fibrescope was advanced just past the vocal cords and the endotracheal tube railroaded into the trachea by the assistant allowing intubation under direct vision.

In the C-MAC group, endotracheal intubation was done using the C-MAC videolaryngoscope with blades size 3 or 4. Backward and upward pressure on the cricoid cartilage was applied by the assisting anesthetic doctor as necessary, to improve laryngeal view.

The duration before successful intubation or time to intubation (TTI) was recorded by an observer, commencing from insertion of the intubating device into the patient’s mouth until confirmation of endotracheal tube placement. The number of intubation attempts was defined as the number of insertions of the intubation device into the patient’s oral cavity. Cormack and Lehane grades of I to IV was recorded based on the observed laryngeal view on the monitor, on the first attempt at endotracheal intubation. In the event of unsuccessful intubation, the patient was manually ventilated via facemask in between intubation attempts with sevoflurane in 100% oxygen. The operator was allowed to use the same intubation device during the second intubation attempt with modification in technique of intubation such as readjustment of jaw thrust in the Bonfils group, and application of external laryngeal pressure, repositioning of the patient’s head, varying the lifting force on the laryngoscope or use of airway adjuncts such as the gum elastic bougie in the C-MAC group. The number of intubation attempts and techniques of manipulation were recorded by an observer. Subsequent analysis was based on data pertaining to successful intubation at first attempt.

Failed intubation was defined as intubation requiring more than 180 seconds or more than 2
attempts, or resulting in reduction in SpO₂ to less than 95% or esophageal intubation. These patients were subsequently intubated with the conventional laryngoscope and managed accordingly as guided by the American Society of Anesthesiologists Difficult Airway Algorithm¹⁷. Complications such as SpO₂ less than 95%, soft tissue trauma or post-operative sore throat were documented. The observer who was in charge of all data collection was not blinded to the intubation device used.

**Statistical Analysis**

Sample size was calculated using the G power sample size calculator 3.1.7 based on Najafi et al’s study¹². Forty-four subjects were required for this study taking into consideration a 20% drop-out rate. The power of the study was taken at 0.8 with a Type I error of 0.05.

Chi-square test was used to analyze categorical data such as race and gender, Cormack and Lehane grade and post-intubation complications. The independent t-test was used to determine significant differences in hemodynamic data and continuous variables such as age, weight, height, BMI and intubation time between the two groups. Paired-sample t-test was used to compare the hemodynamic changes between baseline and post-intubation time within the groups. For non-parametric data, the Wilcoxon Signed-Rank test was used to examine the variables. A p-value <0.05 was considered statistically significant.

**Results**

Forty-four patients were recruited with equal numbers in each group. Endotracheal intubation at first attempt was successful in 20 out of 22 patients (90.9%) in both the Bonfils and C-MAC group. Four patients required a second intubation attempt where they were successfully intubated with the same initial intubation device and by the same operator. Hence, 40 patients were subsequently analyzed. Demographic data are shown in Table 1. There was no significant difference between the groups with regards to age, weight, height, BMI, gender and race. Intubation related data are shown in Table 2. The mean TTI was significantly longer in the Bonfils group compared with the C-MAC group. (p = 0.02). All patients in both groups who were successfully intubated at first attempt had a Grade I Cormack and Lehane view. None of the patients required rescue intubation by the specialist or consultant in charge. No patient had oxygen saturation (SpO₂) less than 95%. Patients in both groups sustained postoperative soft tissue trauma and sore throat, but the difference was not significant.


**Fig. 1** shows comparable baseline mean MAP between the groups. Mean MAP was significantly higher in the Bonfils group at 2 minutes post intubation (87.4 ± 15.0 vs 80.4 ± 10.3 mmHg, \(p < 0.05\)), however the values in both groups were below baseline.

Table 3 shows significant reduction of mean MAP in both groups, from values before induction of anesthesia compared to values after induction and prior to intubation. Following intubation, mean MAP was significantly lower from baseline values, from 2 to 10 minutes in the Bonfils group, and from 1 to 10 minutes in the C-MAC group.

**Fig. 2** shows comparable baseline mean HR between the groups. Mean HR was significantly higher in the Bonfils group at 2 (94.3 ± 14.3 vs 84.6 ± 16.4), 3 (91.6 ± 12.7 vs 82.5 ± 17.8), 5 (88.5 ± 12.5 vs 79.0 ± 17.0), 6 (87.8 ± 14.1 vs 78.6 ± 18.5), 9 (84.8 ± 13.2 vs 76.6 ± 16.8) and 10 (84.6 ± 13.9 vs 74.8 ± 17.2) minutes post intubation.

Table 4 shows significant increase in mean HR from baseline values in both groups immediately after intubation. In the C-MAC group, mean HR was not significantly different from baseline values from 1 to 9 minutes after intubation. However in the Bonfils group, mean HR was significantly higher than baseline after intubation, and in subsequent measured time intervals thereafter.
**Fig. 1**
*Mean MAP between Bonfils and CMAC groups*

**Fig. 2**
*Mean heart rate between Bonfils and CMAC groups*
Discussion

The Bonfils intubation fibrescope and C-MAC videolaryngoscope are video assisted indirect laryngoscopic devices which have been shown to improve laryngeal view while inducing minimal stress responses\(^4,5,11,12\). The C-MAC videolaryngoscope, with its simplicity of use, has gained widespread popularity in contrast to the Bonfils intubation fibrescope which is not widely used in routine clinical practice. However, the Bonfils intubation fibrescope has its advantage over the C-MAC videolaryngoscope in difficult airway situations where restricted mouth opening may limit use of the latter.

Several studies have reported desirable hemodynamic parameters with use of the Bonfils intubation fibrescope. Boker et al found that increase in MAP and HR was greater during laryngoscopy with the conventional laryngoscope than with the Bonfils intubation fibrescope\(^11\). Najafi et al also found better hemodynamic profile with the latter and comparable intubation conditions even without neuromuscular blockade\(^12\). To date, there has been no study comparing hemodynamic changes during intubation with the Bonfils intubation fibrescope compared to the C-MAC videolaryngoscope. We found significant increase in HR although the MAP remained comparable following intubation with the Bonfils intubation fibrescope compared to the C-MAC videolaryngoscope. The sustained sympathetic response throughout our study was only seen with regards to the relative tachycardia following intubation with the Bonfils intubation fibrescope. Mean arterial pressures decreased below baseline values and this could be due to the vasodilatory effects of the anesthetic induction agents. King et al found that laryngoscopy and intubation during deep anesthesia obtunded any anticipated increase in MAP but reflex tachycardia was intense and persistent\(^13\). The persistently high HR in the Bonfils group could also be due to the jaw thrust or tongue jaw lift maneuver. Neither of these maneuvers was applied in our patients in the C-MAC group. Park et al found that the jaw thrust increased MAP and HR irrespective of the magnitude of thrust force applied\(^16\). Our patients in the C-MAC group had transient increase in HR immediately following laryngoscopy and intubation which was most likely due to oropharyngeal stimulation during laryngoscopy. McCoy et al reported that minimal force and movement during laryngoscopy could lead to the absence of the stress response\(^17\). This was possible when using the C-MAC videolaryngoscope which has been known to produce better Cormack and Lehane view without the need for excessive manipulation, thus enabling higher rates of successful endotracheal intubation in predicted difficult airways\(^7,8\).

Stoelting et al found it necessary to attenuate pressor responses using topical or IV lignocaine during laryngoscopy and intubation which exceeded 30 seconds\(^2\). This may explain the hemodynamic changes in the Bonfils group as the TTI in our study was longer with a mean of 28.8 ± 6.6 seconds, compared to the C-MAC group with mean TTI of 24.7 ± 5 seconds, \(p=0.02\). Although the longer TTI in the Bonfils group produced a significantly increased heart rate, clinically we found that heart rate did not exceed 110 beats per minute with the highest documented increase of 22% above baseline. There was also no clinically associated cardiorespiratory compromise recorded. However our patients were of ASA I physical status, thus precautionary measures to attenuate undesirable pressor responses in susceptible patients may be necessary. Despite the longer TTI with the Bonfils intubation fibrescope, the use of either device had similar rates of successful intubation at the first attempt, and post-intubation complications. There were no serious complications, and oxygenation was well maintained throughout the study in both groups.

Our TTI compared well with Halligan et al\(^13\) and Najafi et al\(^12\) who recorded median TTI of 33 seconds and 40 seconds respectively, using the Bonfils intubation fibrescope. Boker et al on the other hand, demonstrated good hemodynamic profiles with successful Bonfils retromolar intubation at a mean TTI of 14 seconds\(^11\).

The C-MAC group had a shorter TTI as it was easier to use due to familiarity with the device which was physically similar to the conventional direct laryngoscope. However, not all patients had optimal laryngeal views when intubated with the C-MAC videolaryngoscope. In our study, two patients required two intubation attempts due to unanticipated difficult
airway requiring additional airway manipulation. These patients had Cormack and Lehane grades II and III and were successfully intubated using the C-MAC videolaryngoscope, and a gum elastic bougie with cricoid pressure applied. Ng et al found that the C-MAC videolaryngoscope produced good laryngeal views which did not always guarantee ease and success in endotracheal tube insertion. Two patients in the Bonfils group required more than one intubation attempt due to pooling of oropharyngeal secretion that was obstructing the laryngeal view. Oropharyngeal secretion blocked the distal viewing port and absence of a suction channel hindered further advancement of the Bonfils intubation fibrescope as airway structures were obscured. Halligan et al found that postural adjustment and intubation with the aid of the direct conventional laryngoscope was rarely required in patients planned for intubation with the Bonfils intubation fibrescope. They too however encountered difficulties due to pooling of oropharyngeal secretion in 30% of their patients, although this did not result in failed intubation.

There are several limitations in this study. Firstly, it was not possible to blind the investigator of the device being used. Nevertheless, all intubations were performed by a single operator with adequate clinical experience using both devices, hence the variability in technique would have been minimized. Presumably, intubation using the Bonfils intubation fibrescope would require greater skill, hence success of intubation is dependent on the capability of the operator. A clinician is considered experienced in using the Bonfils intubation fibrescope after 20 successful intubations with the Bonfils intubation fibrescope. However, Corbanese et al found that the learning curve plateaued only after the 50th intubation. In contrast, the C-MAC videolaryngoscope which is similar in design as the direct conventional laryngoscope requires no or minimal additional skill. The longer intubation time and greater airway manipulation may have also impacted on the hemodynamic changes produced during intubation with the Bonfils intubation fibrescope. Patient awareness accounting for the rise in heart rate, increases with time as delivery of anesthetic gases is suspended during airway manipulation. Another possible limitation is that the airway assessment performed during premedication rounds may have not excluded an unexpected difficult airway encountered in our study.

Future studies on the Bonfils intubation fibrescope could look at the hemodynamic responses during intubation of difficult airways, for which it was intended for. This could determine if the hemodynamic parameters produced during such situations are more comparable with other conventional laryngoscopes or videolaryngoscopes. It would also be useful to study the determinants of tachycardia such as jaw thrust or tongue jaw lift maneuvers, and if this can be reduced by measures such as topical or intravenous local anesthetics.

**Summary**

This study showed that endotracheal intubation success rates were similar using the Bonfils intubation fibrescope or C-MAC videolaryngoscope. However, intubation time was significantly longer using the former, and resulted in increased heart rates. Nevertheless this did not result in any remarkable clinical consequence on cardiorespiratory parameters amongst healthy ASA I patients.

**Conflict of interest:** The authors have no financial conflicts of interest to disclose.

**Acknowledgement:** We would like to thank Mr Muhamad Rahimi Che Hassan for his help with statistical analysis in this study.
HEMODYNAMIC CHANGES: BONFILS VERSUS C-MAC

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