Original Article

Comparison of success of tracheal intubation using Macintosh laryngoscope-assisted Bonfils fiberscope and Truview video laryngoscope in simulated difficult airway

Bangaru Vivek, R. Sripriya, Gayatri Mishra, M. Ravishankar, S. Parthasarathy

Department of Anaesthesiology and Critical Care, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth University, Puducherry, India

Abstract

Background and Aims: Restriction of head and neck movements prevents the alignment of the oral, pharyngeal, and laryngeal axes and increases the incidence of difficult tracheal intubation in patients with cervical spine fractures. Video laryngoscopes have gained an important role in the management of difficult intubation, especially in situations with limited head and neck movements. This study compares the success of intubation using Macintosh laryngoscope assisted Bonfils® fiberscope (ML-BF) with Truview^{PCD} video laryngoscope (TV) in patients with simulated restricted head and neck movements.

Material and Methods: One hundred and fifty-two patients satisfying the inclusion criteria were randomly allocated to two groups of 76 each. Patients were made to lie supine on the table without a pillow and a soft collar was used to restrict head and neck movements. After a standardized premedication-induction sequence, tracheal intubation was done either with ML-BF or TV. Success of intubation, time taken for successful intubation, hemodynamic changes, airway trauma, and postoperative oropharyngeal morbidity were noted.

Results: Intubation was successful in all the 76 patients in direct laryngoscopy-Bonfils fiberscope group and 75 out of 76 patients in TV group within the specified time (90 s). The median time taken for successful intubation with TV and ML-BF were 44 (range 26–80) s and 49 (range 28–83) s, respectively. Hemodynamic changes, airway trauma, and postoperative oropharyngeal morbidity were similar in both groups.

Conclusion: Both TV and ML-BF are equally effective for successful tracheal intubation in patients with simulated restricted head and neck movements. In cases of difficult laryngeal visualization with routine Macintosh laryngoscope, Bonfils can be used as an adjunct to achieve successful intubation in the same laryngoscopy attempt.

Key words: Bonfils fiberscope, video laryngoscope, intubation, Macintosh laryngoscope, simulated

Introduction

The incidence of difficult tracheal intubation is about 8%.[1] Restriction of head and neck movements prevents the alignment of the oral, pharyngeal, and laryngeal axis and increases the incidence of difficult intubation to as high as 20% as seen in patients with cervical spine fractures.[2] Prediction of difficult intubation based on bedside screening tests has limitations.[3,4] The incidence of unanticipated difficult intubation in anesthesia has been reported to be between 1.5% and 8.5%.[5,6] One of the important causes of unanticipated difficult intubation is the inability to identify a mild restriction of head and neck movements. When we encounter an unanticipated difficult intubation, we are often not well prepared.

Address for correspondence: Dr. Gayatri Mishra,
Department of Anaesthesiology and Critical Care, Mahatma Gandhi
Medical College and Research Institute, Sri Balaji Vidyapeeth
University, Pillaiyarkuppam - 607 402, Puducherry, India.
E-mail: drgayatrimishra@gmail.com

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Use of Macintosh laryngoscope has been conventionally accepted as the first choice for tracheal intubation. When the Cormack and Lehane grade (CLG) on conventional laryngoscopy is >2b, the adjunct of choice is a stylet or a gum elastic bougie,[7,8] which has to be introduced blindly beneath the epiglottis. The rigid Bonfils® intubation fiberscope (Karl Storz GmbH and Co. KG, Tuttlingen, Germany) has a preformed 40° curved tip [Figure 1] with a proximal eyepiece, which facilitates targeted intubation under vision and has been used to facilitate intubation after failed laryngoscopy.[9,10] The Truview^{PCD} (Truphatek International Ltd., Netanya, Israel) has a prism and lens system that provides indirect visualization of the larynx at an angle of 46° refraction [Figure 2].[11] The endotracheal tube (ETT) has to be negotiated through the glottis using the OptiShape™ (a pre-formed) stylet, which is provided with the scope. This is another device which is useful for tracheal intubation in patients with limited head and neck movements.[12,13]

There are very few controlled studies comparing the success of intubation with alternative methods in cases of unanticipated difficult intubation.[14,15] Due to the low rate of occurrence of unanticipated difficult intubation, we have simulated this scenario using a collar to restrict head and neck movements. The aim of this study was to compare tracheal intubation with Macintosh laryngoscope-assisted Bonfils® fiberscope (ML-BF) with Truview^{PCD} video laryngoscope (TV) in simulated restricted head and neck movements. The primary outcome was to compare the success of intubation. The secondary outcomes were the mean duration for intubation, hemodynamic changes, airway trauma, and postoperative oropharyngeal morbidity.

Material and Methods

After approval from the Institutional Ethics Committee (PG/2014/06), this randomized prospective single-blinded study was conducted at a tertiary care hospital from January 2014 to July 2015. American Society of Anesthesiologists (ASA) 1 and 2 patients, between the age group 18 and 60 years, admitted for elective surgeries under general anesthesia formed the study population.

The sample size was calculated based on the previous study by Malik *et al.*,[16] who reported 80% success of the first attempt intubation with TV. With power of 80%, alpha error of 0.05 (5%) to detect 15% reduction in frequency of failed intubation at first attempt with ML-BF.

The sample size was estimated as 76 patients for each group.

After preanesthetic checkup, consecutive 152 patients who gave written informed consent for participation and satisfying inclusion criteria were enrolled for the study. Exclusion criteria were anticipated difficult mask ventilation, obese patients (body mass index [BMI] >30), patients with risk of aspiration, patients with mouth opening <2.5 cm, and patients with respiratory tract pathologies/previous surgeries on the respiratory tract. Patients were randomized to either TV or ML-BF group by sealed envelope technique.

All patients who participated in the study were kept fasting for at least 6 h for solids and 2 h for clear fluids. They were premedicated with tablet diazepam 10 mg and tablet ranitidine 150 mg orally at night before surgery and on the morning of surgery. On the day of surgery, an 18-gauge intravenous (IV) line was secured in the preoperative holding area, and injection glycopyrrolate 0.2 mg and midazolam 0.03 mg/kg administered IV.

In the operating theater, standard monitoring (pulse oximetry, electrocardiogram, noninvasive blood pressure) was instituted. Patients were made to lie supine on the table without a pillow, and head and neck movements were restricted by using a soft collar, medium or large depending on the neck circumference of the patient as per manufacturers' recommendation. The patients were preoxygenated with 100% oxygen for 5 min. Anesthesia was induced with 2 μg/kg fentanyl and 2 mg/kg propofol IV. Following verification of adequate bag-mask ventilation, neuromuscular blockade was achieved with IV

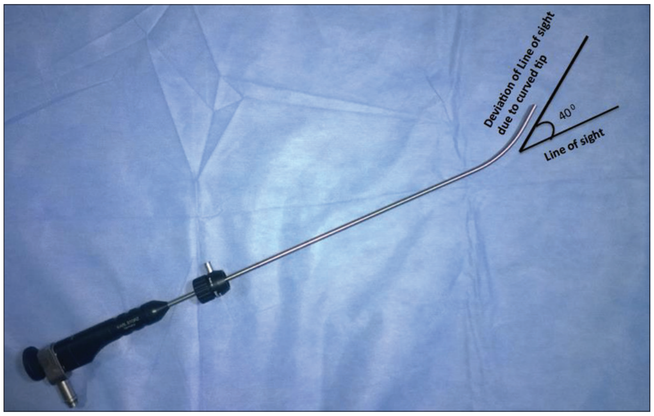

Figure 1: The Bonfils fiberscope. The tip of the scope has a 40 degree angle. This provides improved visualization of anteriorly placed structures

Figure 2: Truview^{PCD} video laryngoscope blade. The 46 degree angle of refraction produced by the prism enables visualization of anteriorly placed structures

vecuronium 0.1 mg/kg and ventilation continued with oxygen, nitrous oxide, and isoflurane 1.5% for 4 min. All intubations were done by a single anesthesiologist who was well versed with using the devices before the study in more than fifty cases.

In the ML-BF group, direct laryngoscopy (DL) was performed using a Macintosh blade size 3 or 4 as appropriate, and CLG of the laryngeal view was noted. Creating sufficient pharyngeal space with Macintosh blade, Bonfils fiberscope (BF) mounted with ETT was inserted using the right hand to guide the tip under the epiglottis until the vocal cords could be visualized. The ETT was then slid into trachea under vision. In TV group, Truview^{PCD} laryngoscope was inserted from midline and CLG as seen on the monitor was noted. Patients were intubated using the OptiShape™ stylet, by visualizing the monitor. No laryngeal manipulation was done either to improve the CLG or to aid intubation. To avoid fogging of the lens in both TV and ML-BF, 10 L/min of oxygen was insufflated through the specified port in the respective scopes. Intubation was stopped either after 90 s or if oxygen saturation (SpO_2) fell below 92% and the intubation was considered unsuccessful. Only one attempt with either device was permitted.

Time for intubation was defined as the time interval between cessation of mask ventilation until the reappearance of a square wave capnograph trace. In ML-BF group, to assess the individual performance of BF, instrument time was recorded separately as the time between picking Bonfils in the right hand to the appearance of square wave capnograph. In the event of failure to intubate, airway would be secured after removing the cervical collar and using a Macintosh laryngoscope in sniffing position.

The primary outcome was success of ETT placement as evidenced by the appearance of a square wave capnograph trace. Secondary outcome measures were time taken for intubation, hemodynamic changes, airway trauma, and post-operative oropharyngeal morbidity. Systolic blood pressure, diastolic blood pressure, mean arterial pressure, and heart rate were recorded at baseline, 4 min after induction (before intubation), and five successive recordings at 1-min interval after intubation. Trauma to the airway that occurred during manipulation regarding injury to gums and blood on the tube at extubation was noted. Once the airway was secured, anesthesia was conducted as per the choice of the attending anesthesiologist. Postoperative oropharyngeal morbidity was assessed by questioning the patients for a sore throat, 2 h and 12 h after extubation. Statistical analysis was performed using SPSS version 16.0 (SPSS Inc., Chicago, IL, USA) software. Descriptive analyses were reported as a mean and standard deviation, median and range of continuous variables. The analysis was performed using unpaired Student's *t*-test for parametric data and Chi-square test for nonparametric data. Hemodynamic data were analyzed using one-way ANOVA to find the statistical difference within group and unpaired Student's *t*-test for comparison between the groups.

Results

Both groups were comparable regarding age, sex distribution, BMI, ASA physical status, and Mallampati classification (MPC) grade [Table 1]. All patients in group ML-BF and 75 out of 76 patients in group TV were successfully intubated within the fixed period of 90 s. The median time taken for successful intubation with TV and ML-BF was 44 (range 26–80) and 49 (range 28–83) s, respectively ($P = 0.03$). None of the patients had fall in SpO_2 below the specified 92%. There was no significant difference in heart rate and BP between the two groups at different time intervals. Glottic view assessed with CLG was superior with Truview^{PCD} when compared to Macintosh laryngoscope in group ML-BF [Table 2].

In group TV, four patients had gum injury and two patients had blood in the tube. In group ML-BF, five patients had gum injury. No patient had blood in the tube. Postoperative sore throat was noted in eight patients in group TV and four patients in group ML-BF. There was no significant difference between the two groups with regard to airway trauma ($P = 0.347$) and postoperative sore throat ($P = 0.229$).

Discussion

Emphasizing vocal cord visualization, a number of indirect laryngoscopes were invented to enhance the view. Studies have shown that indirect laryngoscopes provide significantly better glottic view and improve the success rate of intubation.[16-18] As an optical intubating stylet, the BF has also been used to facilitate intubation with Macintosh laryngoscope after failed laryngoscopy.[10]

Table 1: Demographic data

	TV	BIF-DL	*P*
AGE (years): median (range)	30 (18-60)	34 (18-60)	0.34
SEX (M/F)	36/40	41/35	0.074
BMI (kg/M^2): median (range)	21 (16-29)	22 (14-28)	0.64
ASA (1/2)	56/20	60/16	0.44
MPC (1/2/3)	24/38/14	26/36/14	0.94

We simulated a difficult intubation scenario by making the patients lie supine on the table without a pillow and using a soft collar around the neck to restrict head and neck movements. There was no restriction in mouth opening in any patient because of the application of soft collar. We were successful in simulating the difficult airway scenario as evidenced by CLG ≥ 2b in 75 out of 76 patients in group ML-BF [Table 2]. We expect a similar scenario in group TV too as the MPC scores in both the groups were comparable [Table 1]. Although visualization of the larynx was better in group TV, it is an indirect view and needs an the OptiShape™ stylet for intubation. While using Bonfils, angle for visualization is similar, and intubation is done under direct vision. Hence, the observation that the CLG was better in group TV does not carry significance when comparing these two devices.

In this study, all except one patient was intubated successfully in group TV. Similar success was reported in studies by Joseph *et al.*[19] (100% success), Bhola *et al.*[17] (100% success) and Malik *et al.*[16] (93% success – two failed intubation) in patients with restricted neck mobility. In group ML-BF, all our patients were successfully intubated at the first attempt. Byhahn *et al.*[18] have reported 82% success of intubation with BF, in patients with simulated difficult airway. They explained the inability to negotiate the rigid scope below epiglottis as the reason for failure and recommended increasing angle from 40° to 60° may help overcome the problem. However, they had used hard collar restricting mouth opening. They reported fogging of the lens as a cause of failure in one case. We have not experienced any fogging of BF in our study. Kim *et al.*[20] evaluated tracheal intubation with BF and fiberoptic bronchoscopy assisted by DL in midline approach in forty patients with CLG 3. They reported 90% success with two failed intubations in BF group. In one case, they failed to visualize the vocal cord and in the other case, the ETT had got stuck between BF shaft and teeth.

Table 2: Comparison of intubation time with CLG in the two groups

CLG Grade	Intubation time (sec): Mean ± SD (number of cases)	
	ML-BI	TV
1	None	42.8 ± 6.5 (23)
2A	47 (1)	46.6 ± 9.4 (35)
2B	50.0 ± 9.4 (20)	48.2 ± 12.7 (16)
3	48.6 ± 11 (43)	40 (1)
4	49.7 ± 7.7 (12)	None

The mean time taken by TV in our study was longer than the mean time reported by Malik *et al.*[16] (22.5 ± 7.5 s) and Joseph *et al.*[19] (33.2) s. Both the studies defined time taken as the time between insertions of the blade to placing ETT below vocal cords as evidenced by visual confirmation by the anesthetist. However, we defined time taken as the time interval between cessation of mask ventilation until the reappearance of a square wave capnograph trace which is the total apnea time.

The median time for intubation from taking BF to successful intubation and appearance of a square wave capnograph was 35 s (range 18–57 s). Hames *et al.*[21] have reported a median time of 37 s (19–46) when using gum elastic bougie, in similar simulated difficult airway scenario with only a 50% success against a 100% success in this study.

In TV group, we experienced difficulty in advancing ETT to the field of vision near the glottis, which increased the intubation time even after good glottic visualization. We also had one case in which intubation failed despite best glottic visualization (CLG 1). Similar problems have been observed by Malik *et al.*[16] and Bag *et al.*[22] To get the ETT tip into the field of vision of the TV scope requires training to acquire the adequate skill. We also noted that the midline insertion of TV blade failed to push tongue to one side, offering less working space to manipulate ETT, a finding again reported by Bag *et al.*[22] In this study, as the BF has been used along with the Macintosh laryngoscope, it required less manipulation and the glottis could be viewed once the tip was beneath the epiglottis.

Rigid BF needs less preparatory time to assemble to use[13] and could be the method of choice in already paralyzed patients with unanticipated difficult conventional laryngoscopy. Using a battery-powered light-emitting diode light source and eyepiece for viewing makes the Bonfils as portable as a stylet or a bougie.

None of the patients had a fall in SpO_2 below 92%. Although both TV and Bonfils fiberscope offered oxygen insufflation, patients in group ML-BF received oxygen only during instrumentation with BIF and not during laryngoscopy with ML.

The design of the TV blade with a flat tip followed by a bulky portion of the prism increases the chances of gum injury. The need for more hand-eye coordination for the introduction of the OptiShape™ stylet to the field of vision increases the chances of unrecognized deeper insertion and injury to the perilaryngeal and pharyngeal mucosa. In group ML-BF, five patients, had gum injury. This could be because of introducing and manipulating two instruments at the same time. As Bonfils has no blind leading edge, it offers a better orientation of ETT with oral anatomy reducing the chance of airway trauma. None of the patients had blood in the tube in group ML-BF. Postoperative sore throat was noted in four patients in group ML-BF and in 8 patients in group TV.

The limitation of this study was that all intubations were done by the same anesthetist, but the study device could not be blinded to the performer. Intubation time was more in group ML-BF. However, a separate glottic visualization time and instrumentation time to intubate was not recorded in the TV group.

Conclusion

We conclude that both TV and ML-BF are equally effective for successful tracheal intubation in patients with simulated restricted head and neck movements. As the Macintosh laryngoscope has been conventionally accepted as the first choice for intubation, when confronted with unanticipated difficult laryngeal visualization, BF can be used as an adjunct in the same laryngoscopy attempt enabling intubation under direct visualization.

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Conflicts of interest

There are no conflicts of interest.

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