REDUCED HEMODYNAMIC RESPONSES TO TRACHEAL INTUBATION BY THE BONFILS RETROMOLAR FIBERSCOPE: A RANDOMIZED CONTROLLED STUDY

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Abstract

The Bonfils retromolar intubation fiberscope is a rigid endoscope designed to enable glottic visualization and facilitate intubation under endoscopic vision. Theoretically, avoiding direct-vision laryngoscopy and thus could produce less stimulation during intubation than the conventional direct laryngoscopic procedure. This prospective randomized study was designed to compare the effect of tracheal intubation with direct vision laryngoscopy (Macintosh blade) and the Bonfils retromolar intubation fiberscope on the hemodynamic responses in ASA I patients. Forty patients scheduled for elective surgery and requiring endotracheal intubation were randomly allocated to one of two groups according to the intubating tool under sevoflurane nitrous oxide Anaesthesia (n = 20 each). The retromolar group received tracheal intubation with the Bonfils retromolar fiberscope, while the direct laryngoscopy group received tracheal intubation by the direct vision laryngoscope (Macintosh blade). Heart rate and arterial blood pressure (systolic BP, diastolic BP, mean ABP) were recorded before induction of Anaesthesia, 3 minutes after induction of Anaesthesia (before intubation) and 5 successive recordings at one-minute interval after intubation. All the systolic BP, diastolic Bp, mean ABP and heart rate values in the direct laryngoscopy group were significantly higher in the 5 successive minutes after intubation in comparison with the retromolar group (P = 0.00). This might be attributed to the gentle intubating technique, by the Bonfils retromolar fiberscope, which allows quick endotracheal intubation without manipulations of the base of the tongue or epiglottis.

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Introduction

Tracheal intubation via direct laryngoscopy produces a marked stress response[1]. Although these hemodynamic responses are short lived and tolerated by most of the patients, they might provoke detrimental effect, on the coronary and cerebral circulation particularly in high-risk patients[2]. Several pharmacological agents have been suggested to attenuate these stress responses to laryngoscopic intubation such as the use of variety of anesthetic agents, sympatholytics, vasodilators, local anesthetics and magnesium[3,4,5,6,7].

In principle, tracheal intubation techniques that avoid or minimize oropharyngeal stimulation might attenuate the hemodynamic stress response. However, published studies have provided little or conflicting evidence for an attenuated response for a variety of non-laryngoscopic intubation devices[8,9,10,11,12].

Bonfils retromolar intubation fiberscope (Karl Storz, Gmb and Co, KG, TuttLingen, Germany) is 3.5-5.0mm optical stylet that allows a retromolar approach to the larynx. It is designed to position a 6.5mm I.D. or larger endotracheal tube directly between the vocal cords into the trachea with minimal or no manipulation of the epiglottis which is richly innervated[13]. The aim of this study was to compare the effect of tracheal intubation with direct vision laryngoscopy (Macintosh blade) and the Bonfils retromolar fiberscope on the hemodynamic responses in American Society of Anesthesiologist (ASA) physical status I patients.

Materials and Methods

After obtaining approval from our institutional research committee and informed consent from each patient, forty, ASA I patients scheduled for, less than two hours, elective surgery requiring tracheal intubation were solicited in this prospective, randomized, unblinded study.

Exclusion criteria were age <18 yr or >60 yr old, history gastroesophageal reflux, a history of difficult intubation or intercisal distance <3 cm, patients in whom tracheal intubation time was more than 30 seconds or the oropharyngeal (Guedel) airway was used to facilitate face-mask ventilation.

All patients were premedicated with diazepam 5mg PO and ranitidine 150mg PO 2 hrs before induction of Anaesthesia. Also, Mallampati score, thyromental, and sternomental distances were measured and recorded. In the pre-induction room, an IV cannula was inserted with infusion of lactated ringer at a rate of 15 $mL.kg_{-1}.hr_{-}$ throughout the operation. In the operating room, patients received standard anesthetic monitors, including noninvasive blood pressure, electrocardiogram lead II, and pulse oximeter (Zeus, Drager, Germany). Heart rate, systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean arterial blood pressure (MAP) were recorded as baseline values.

Anaesthesia was induced with xylocaine 0.5 mg/kg with venous retention for 30 seconds to minimize propofol pain, propofol 3mg/kg IV, and cisatracrium 0.1 mg/kg IV. Anaesthesia was then maintained with sevoflurane 2% in oxygen and nitrous oxide 50%.

After 3 minutes of manual ventilation, arterial blood pressure (SBP, DBP, MAP), heart rate, end tidal CO_2 and sevoflurane concentrations were recorded. Both the Bonfils retromolar fiberscope and direct laryngoscope (Macintosh Blade) were ready to use on the anesthetic tray. Patients were assigned on a random number basis (using the sealed envelope method) into 2 groups: Group D, (n = 20) in which intubation was done by the direct vision laryngoscopy with Macintosh blade (Karl Storz, Germany) no.3 or 4 for female patients and no. 4 or 5 for male patients while in Group R, (n = 20) patients were intubated by the Bonfils retromolar fiberscope (Karl Storz, Gmb and Co, KG, TuttLingen, Germany). Cuffed Portex tracheal tubes (SIMS Portex, Inc., Keene NH) with internal diameter of 7 mm for female patients and 8mm for male patients were used after lubrication by K-Y Jelly.

As soon as the trachea was intubated and confirmed by positive end tidal CO_2, arterial blood pressure (SBP, DBP MAP) and heart rate were recorded for 5 successive recordings at one-minute interval.

The intubation time was recorded from the time the device passed into the oropharynx to the time of reconnection of the ventilator tubing system to the endotracheal tube. A single anesthetist experienced with the direct larygoscopy and the Bonfils retromolar fiberscope techniques performed all tracheal intubations. The Cromack and Lehane[14] grade without external laryngeal pressure was recorded in Group D. Intraoperative complications were recorded by an unblinded observer e.g. mucosal injury (blood detected on the intubation device after use), dental injury and lip injury.

Also, postoperative sore throat was assessed 12 hrs after surgery by using the visual analogue scale that ranges from zero (no Pain) to ten (the worst imaginable pain).

Statistical Analysis

Statistical analyses were performed with the Stat View SE Package (Abacus Concepts, CA, USA) on a Power Macintosh 7200 (Apple Computer Inc., CA, USA). Patients' characteristics were compared using student's-t-test. Between group differences were compared using analysis of variance (ANOVA) for factors. If significant differences were observed, Scheffe F was used for post hoc analysis. Data are presented as mean (SD). $P<0.05$ was considered statistically significant.

Results

There were no significant differences between the two groups in terms of age, sex, weight, or height (table 1). End tidal CO_2 and sevoflurane concentrations immediately before intubation were also similar between the two groups (table 1).

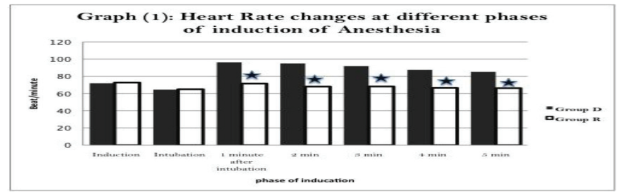
Table 1
Patients Demographic Data, Airway Assessment and Intubation Data

	Group D n=20	Group R n=20
Sex (Male/Female)	(16/4)	(15/5)
Age (yr)	29.85 ± 7.42	29.35 ± 5.63
Weight (kg)	69.5 ± 9.0	68.75 ± 4.36
Height (cm)	168.5 ± 4.58	167.47 ± 4.01
Intubation Time (sec)	14 ± 3.58	11.88 ± 2.58
Mallampati (n;1/2/3/4)	(16/4/0/0)	(15/5/0/0)
Thyromental distance (cm)	8.9 ± 1	9 ± 1
Sternomental distance (cm)	17 ± 2	17 ±3
ET sevoflurane at intubation (%)	1.4 ± 0.2	1.4 ± 0.4
ET CO2 at intubation (mmHg)	31 ± 9	31 ± 7

Group D: Direct Laryngoscopy group, Group R: Retromolar group.
* P<0.05

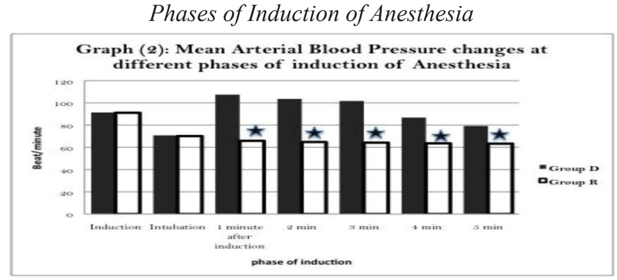
Before induction, there were no significant differences between the two groups as regards MAP and heart rate (Graph 1, 2). Furthermore, after induction and immediately before intubation, there were no significant changes among the groups as regards MAP or heart rate (P = 0.00) (Graph 1, 2).

Graph 1
Heart Rate Changes at Different Phases of Induction of Anesthesia



Group D: Direct Laryngoscopy group, Group R: Retromolar group.
* P<0.05.

Graph 2
Mean Arterial Blood Pressure Changes at Different Phases of Induction of Anesthesia



Group D: Direct Laryngoscopy group, Group R: Retromolar group.
* P<0.05.

Both MAP and heart rate values in Group D were significantly higher in the 5 successive minutes after intubation in comparison with Group R (P = 0.00) (Graph 1, 2). As regards the intubation time, it was significantly higher in Group D than Group R (P = 0.00) (table1).

In Group D, one case was recorded to have mucosal injury and another one for lip injury while no cases were recorded for intraoperative complications in Group R (table 2). Regarding the post-operative sore throat, it was significantly higher in Group D than Group R (P = 0.00) (table 2).

Table 2
Intra and Postoperative complications

	Group D n=20	Group R n=20
Intra operative		
Mucosal injury (n)	1	0
Dental injury (n)	0	0
Lip injury (n)	1	0
Esophageal intubation (n)	0	0
Postoperative		
VAS (sore throat)	* 4.8 ± 0.8	1.5 ± 0.5

Group D: Direct Laryngoscopy group, Group R: Retromolar group, VAS: visual analogue scale (0-10).
* P<0.05.

Discussion

This prospective study showed that tracheal intubation by Bonfils retromolar fiberscope produced lower level of hemodynamic responses in healthy patients. As an Anesthesiologist become more curious to use the new tools available, which are helping in management of the difficult airway, Bonfils retromolar intubation fiberscope is one of these new instruments that recently introduced to daily anesthetic practice as it permits clear visualization of the glottic area. Additionally, it has a unique option of direct oxygen insufflation through a side-port that disperses the secretions, prevents fogging of the view and allows oxygenation in cases of difficult ventilation during the intubation trials.

Also, it facilitates tracheal intubation in trauma patients with immobilized cervical spine[15] and being introduced through the retromolar space, it prevents teeth damage in vulnerable patients as caused by the direct vision laryngoscope.

Only few studies were done to evaluate the Bonfils retromolar fiberscope as intubating tool[16,17,18,19,20].

Orotracheal intubation using the direct vision laryngoscopy needs elevation of the epiglottis for laryngeal exposure. In order to elevate the epiglottis and to put the glottic aperature in one axis with the anesthetist eye, a forward and upward movement of the laryngoscope blade exerted along the axis of the laryngoscope handle, which may results in hemodynamic response[21].

In our study we anticipated that orotracheal intubation through a gentle intubating technique using the Bonfils retromolar fiberscope would cause less hemodynamic responses. The study showed a significant increase in heart rate, SBP, DBP and MAP in the direct laryngoscopy group when compared with the retromolar group ($P<0.005$) in the 5 successive minutes after intubation. During orotracheal intubation using the direct vision laryngoscopy sympathetic activation occurs due to two possible causes; the direct contact of the blade to the tongue especially the posterior third and the vallecula with a force to elevate the epiglottis, while the second cause is the introduction of the endotracheal tube in the trachea. In our study, the hemodynamic responses were lower in the retromolar group as one of the causes of sympathetic activation is minimized which is the oropharyngeal stimulation. The introduction of the retromolar fiberscope into the oropharynx is under vision, through a camera connected to the fiberscope and a screen, which gives us the opportunity to direct the endotracheal tube into the larynx with minimal or no contact with the epiglottis. Furthermore, in order to make a clear passage in the oropharynx for introduction of the retromolar fiberscope, upward chin lift is achieved by grasping the jaw with the anesthetist thumb and index finger to separate the tongue and epiglottis away from the posterior pharyngeal wall.

Shinji et al[22] showed that hemodynamic changes are likely to occur because of direct tracheal irritation rather that direct stimulation of the larynx in their study, which contained 3 groups, the light wand group received tracheal intubation with Trachlight®, the laryngoscope intubation group received tracheal intubation with a direct vision laryngoscope (Macintosh blade), and the laryngoscope alone group received the laryngoscope alone without intubation. The maximum heart rate and systolic blood pressure were significantly higher in both Trachlight® and Macintosh laryngoscope group than those in the laryngoscope alone group. On the contrary, the study of Hirabayashi et al[11] showed non-significant changes in mean arterial blood pressure and heart rate to tracheal intubation with using either the light wand or the Macintosh laryngoscope. They attributed the cause of similarity in hemodynamic response of the light wand group to Macintosh laryngoscope group to the technique for light wand intubation in which the jaw is grasped and lifted upward using the thumb and index finger of the intubator's hand to facilitate passage of the endotracheal tube to the larynx, which considered by them a sufficient stimulus to cause circulatory responses. We concur that chin lift stimulus may cause stress response but, in our opinion, not to the same degree as the Macintosh blade laryngoscope does. Although we used a similar technique of chin lift, the difference lies in using the retromolar fiberscope instead of the light wand. The light wand technique is a blind one in which the endotracheal tube may touch the tongue base, vallecula, epiglottis or the piriform fossa during the introduction trials. That may be an added cause to the chin lift to increase the hemodynamic response. Alternatively, the retromolar fiberscope introduces the endotracheal tube to the larynx under vision to avoid touching and stimulating the oropharyngeal structures with subsequent minimization of the circulatory responses.

However, Nishikawa et al[23] showed in their study attenuated hemodynamic changes in the light wand technique in comparison to the laryngoscopic technique.

In their study, they had different anesthetic technique as induction of general Anaesthesia was by fentanyl 2 mcg/kg followed after 3 minutes by IV propofol and vecronium. Fentanyl could attenuate the hemodynamic responses associated with tracheal intubation[24,25,26].

Prolongation of the duration of intubation has been reported to increase hemodynamic changes after tracheal intubation[27]. Nishikawa et al[28] concluded that tracheal intubation using a light wand is more effective than flexible fiberoptic intubation in attenuating hemodynamic changes after tracheal intubation in normotensive elderly patients. They attributed the cause to the rapidity of intubation; the intubation times in the light wand group were significantly shorter that those in the fiberoptic group. In our study, the intubation time was significantly shorter in the retromolar group ($P<0.05$) thus, sharing in causes of attenuation of the hemodynamic responses during intubation with the Bonfils retromolar fiberscope. Another contributing factor in the hemodynamic response to direct vision laryngoscopy using the Macintosh blade is the degree of force applied to elevate the tongue base and epiglottis as revealed by the study of McCoy et al[29] in which the stress response was less marked with the use of McCoy blade than the Macintosh blade due to reduction of force necessary to obtain clear view of the larynx by the McCoy blade. Hassan et al[30] reported that, by activating proprioceptors, direct laryngoscopy induces stress responses proportional to the intensity of the stimulus exerted against the base of the tongue. Therefore, the retromolar group in our study experienced lower hemodynamic responses than the direct laryngoscopy group as there was not any force applied to the base of the tongue or epiglottis during introduction of the Bonfils Fiberscope towards the larynx which also was reflected on the lower incidence of sore throat (VAS = 1.5 ± 0.5) than in the direct laryngoscope group (VAS = 4.8 ± 0.8) ($P<0.05$).

Our study has limitations.

First, it lacks the double blinding, which is not practical to do. Second, only normotensive patients were included in this study so hemodynamic responses to tracheal intubation by the Bonfils fiberscope in hypertensive patients could not be predicted. Collectively, we recommend a further study to evaluate the hemodynamic effect of intubation by the Bonfils fiberscope in hypertensive patients.

Third, patients anticipated to have difficult intubation and whom intubation time exceeds 30 seconds were excluded from the study. Consequently, we could not assess the hemodynamic responses in repeated trials and prolonged intubation times. Finally, we measured the hemodynamic parameters as an indicator for stress response to intubation without measuring the serum catecholamine levels as it is of high cost and also, the study of Michal et al[31] concluded that catecholamine levels do not correlate with the hemodynamic changes during their comparative study between the direct vision laryngoscopy and fiberoptic bronchoscopy as regards the stress response.

In summary, tracheal intubation by the Bonfils retromolar fiberscope caused hemodynamic responses significantly lower than tracheal intubation by the direct laryngoscope (Macintosh blade) in ASA I patients.

References

1. AM Forces and FG Dally, Acute hypertension during induction of Anaesthesia and endotracheal intubation in normotensive man. *Br J Anaesth*; 1970, 42:618-624.
2. Hung, Orlando: Understanding hemodynamic responses to tracheal intubation. *Can J Anesth*; 2001, 48:723-726.
3. Kautto UM: Effect of combinations of topical Anaesthesia, fentanyl, halothane or N2O on circulatory intubation response in normo and hypertensive patients. *Acta Anesthesiol Scand;* 1983, 27:245-51.
4. Lui PL Gatts, Gugino LD, Mallampati Sr, Govino BG: Esmolol for control of increases in heart rate and blood pressure during tracheal intubation after thiopentone and succinyl choline. *Can Anaesth Soc J*; 1986, 33:556-62.
5. Stoelting RK: Attenuation of blood pressure response to laryngoscopy and tracheal intubation with sodium nitroprusside. *Anesth Analg*; 1979, 58:116-9.
6 Hamill JF, Bedford RF, Weaver DC, Colohan AR: Lidocaine before endotracheal intubation: intravenous or laryngotracheal? *Anesthesiology*; 1981, 55:578-81.
7. Puri GD, Marudhachalam KS, Chari P, Suri RK: The effect of magnesium sulphate on hemodynamics and its efficacy in attenuating the response to endotracheal intubation in patients with coronary artery disease. *Anesth Analg*; 1998, 87:808-11.
8. Finfer SR, Mackenzie SI, Saddler JM, Watkins: Cardiovascular responses to tracheal intubation: a comparison of direct laryngsocopy and fiberoptic intubation. *Anaesth Intensive Care*; 1989, 17:44-8.
9. Imai M, Matsumura C, Hanaoka Y, Kemmotsu O: Comparison of Cardiovascular responses to airway management: using a new adaptor, laryngoscopic intubation. *J Clin Anesth*; 1995, 7:14-8.
10. Pernestorfer T, Krafft P, Fitzgerald RD et al: Stress response to tracheal intubation: direct laryngoscopy compared with blind oral intubation. *Anaesthesia*; 1995, 50:17-22.
11. Hirabayashi Y, Hirata M, Kawakami T et al: Effect of lightwand (Trachlight® compared with direct laryngsocopy on circulatory responses to tracheal intubation. *Br J Anaesth*; 1998, 81:253-5.
12. Joo HS, Rose DK: The intubating laryngeal mask airway with and without fiberoptic guidance. *Anesth Analg*; 1999, 88:662-6.
13. Liancai MU, Ira Sanders: Sensory nerve supply of the human oro - and laryngopharynx: A preliminary study. The Anatomical Record Part A: Discoveries in Molecular, Cellular, and Evolutionary Biology. March 2000, 258:406-420.
14. Cromack RS, Lehane J: Difficult tracheal intubation in obstetrics. *Anaesthesia*; 1984, 39:1105-11.
15. Byhahn C, Meiniger D, Walcer F, Hofstetter C, Zwissler B: prehospital emergency endotracheal intubation using the Bonfils intubation fiberscope. *Eur j Emerg Med*; 2007, 14:43-6.
16. Halligan M, Charters P: Learning curve for the Bonfils intubation fiberscope. *Br J Anaesth*; 2003, 90:826.
17. Halligan M, Weldon B, Charters P: A Clinical appraisal of the Bonfils intubating fiberscope. *Br J Anaesth;* 2002, 89:671-2.
18. Halligan M, Charters P: A clinical evaluation of the Bonfils intubation fiberscope. *Anaesthesia*; 2003, 58:1087-91.
19. Maybauez MO, maier S, Thierbach AR: An unexpected difficult intubation: Bonfils rigid fiberscope. *Anesthetist*; 2005, 54:35-40.
20. Bein B,. Yan M. Tonner PH, Scholz J, Steinfath M,. Dorgers V: Tracheal intubation using the Bonfils intubation fiberscope after failed direct laryngoscopy. *Anaesthesia;* 2004, 59:1207-9.
21. Shribman AJ, Smith G and Achola KJ: Cardiovascular and catecholamine responses to laryngoscopy with and without tracheal intubation. *Br J Anaesth*; 1987, 59:295-299.
22. Shinji T, Taro M, Masayuki M and Hidenori T: Hemodynamic responses to tracheal intubation with laryngoscope versus lightwand intubating device (Trachelight®) in adults with normal airway. *Anesth Analg*; 2002, 95:480-484.
23. Nishikawa K, Omote K, Kawana S, Namiki A: A comparison of hemodynamic changes after endotracheal intubation by using the light wand device and the laryngoscope in normotensive and hypertensive patients. *Anesth Analg*; 2000, 90:1203-7.
24. Dahlgren N, Messeter K: Treatment of stress response to laryngoscopy and intubation with fentanyl. *Anaesthesia;* 1981, 36:1022-6.
25. Martin DE, Rosenberg H, Aukburg SJ et al: Low-dose fentanyl blunts circulatory responses to tracheal intubation. *Anesth Analg;* 1982, 61:680-4.
26. KO SH, Kim DC, Han YJ, Song HS: Small dose fentanyl: optimal time of injection for blunting the circulatory responses to tracheal intubation. *Anesth Analg*; 1998, 86:658-61.
27. Stoelting RK: Circulating changes during direct laryngoscopy and tracheal intubation: influence of duration of laryngoscopy with and without prior Lidocaine. *Anesthesiology*; 1977, 47:381-3.
28. Nishikawa,Kohki, Kawamata, Mikito, Namiki and Akiyoshi: Light wand intubation is associated with less hemodynamic changes than fiberoptic intubation in normotensive, but not in hypertensive patients over the age of 60. *Can J Anesth*; 2001, 48:1148-53.
29. McCoy EP, Mirakhur RK and McCloskey BV: A comparison of the stress response to laryngoscopy. *Anaesthesia*; 1995, 50:943-946.
30. Hassan HG, El-Sharkawy TY, Renck H et al: Hemodynamic and catecholamine responses to laryngoscopy with and without endotracheal intubation. *Acta Anesthesiol Scand*; 1991, 35:442-7.
31. Mochal B, Avishai Z, Avital G, Sophie L, Beno R. Hemodynamic and catecholamine response to tracheal intubation: direct laryngoscope compared with fiberoptic intubation. *Journal of Clinical Anaesthesia*; 2003, 15:123-136.