CARDIOVASCULAR RESPONSES TO OROTRACHEAL INTUBATION IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFTING SURGERY

Comparing Fiberoptic Bronchoscopy With Direct Laryngoscopy

NAHID AGHDAII*, RASOUL AZARFARIN**, FOROUZAN YAZDANIAN***
AND SEYEDE ZAHRA FARITUS***

Abstract

Background: The intubation by using fiberoptic brochoscop (FOB) can avoid the mechanical stimulus to oropharyngolaryngeal structures thereby it is likely to attenuate hemodynamic response during orotracheal intubation. Based on this hypothesis, we compared the hemodynamic responses to orotracheal intubation using an FOB and direct laryngoscope (DLS) in patients undergoing general anesthesia for coronary artery bypass grafting (CABG) surgery.

Methods: Fifty patients with ASA physical status II and Mallampati score I and II were scheduled for elective CABG surgery under general anesthesia requiring orotracheal intubation were randomly allocated to either DLS group (n = 25) or FOB group (n = 25). The same protocol of anesthetic medications was used. Invasive systolic and diastolic blood pressure (SBP & DBP) and heart rate (HR) were recorded before and after anesthesia induction, during intubation and in the first and second minutes after intubation. The differences among the hemodynamic variables recorded over time and differences in the circulatory variables between the two study groups were compared.

Results: Duration of intubation was shorter in DLS group (19.3 ± 4.7 sec) compared with FOB group (34.9 ± 9.8 sec; p = 0.0001). In both study groups basic SBP and DBP and HR were not significantly different (P >0.05). During the observation, there were no significant differences between the two groups in BP or HR at any time points or in their maximal values (all p values >0.05).

Conclusion: We conclude that the FOB had no advantage in attenuating the hemodynamic responses to orotracheal intubation in patients undergoing CABG surgery.

Keywords: Laryngoscopy-Hemodynamic responses-Fiberoptic bronchoscope-Orotracheal intubation.

* MD, Associated Professor of Anesthesiology, Department of Anesthesiology, Shahid Rajaii cardiovascular Medical Center, Iran University of Medical Sciences, Tehran, Iran.

** MD, Associated Professor of Anesthesiology, Fellow in Cardiac Anesthesia, Cardiovascular Research Center, Madani Heart hospital, Tabriz University of Medical Sciences, Tabriz, Iran.

*** MD, Assistant Professor of Anesthesiology.

Correspondence and Reprints to: Rasoul Azarfarin MD, Cardiovascular Research Center, Madani Heart Hospital, Tabriz University of Medical Sciences, Tabriz, Iran. Tel: +98 411 3373950, Fax: +98 411 3373950,
E-mail: azarfarinr@tbzmed.ac.ir, razarfarin@ yahoo.com

Introduction

The cardiovascular response to laryngoscopy and tracheal intubation has been extensively studied during the past three decades. Direct laryngoscopy and passage of a tracheal tube are noxious stimuli that can provoke adverse responses in the cardiovascular, respiratory, and other physiologic systems. Tracheal intubation causes a reflex increase in sympathetic activity that may result in hypertension, tachycardia, and arrhythmia[1-3]. The magnitude of the response is affected by many factors: the technique of laryngoscopy and tracheal intubation[4-6], and the use of various airway instruments, like flexible fiberoptic bronchoscope and light wand intubating device[1,3]. Premedication and induction drugs may attenuate the circulatory response[7-10], many drugs and techniques have been tried in an effort to attenuate adverse hemodynamic responses to laryngoscopy and endotracheal intubation[1-3,6-11]. A patient's medical condition affects his physiologic response[7-13]. The cardiovascular response to tracheal intubation, include elevation in arterial pressure and typically starts within 5 seconds of laryngoscopy, peaks in 1 to 2 minutes, and returns to control levels within 5 minutes. Such hemodynamic changes can result in myocardial ischemia but seem to cause little harm to most patients. However they are undesirable in patients with cardiac disease. There are limited studies comparing differences in the circulatory responses to DLS and FOB in cardiac patients and we cannot find the previously published study on patients who undergoing coronary artery bypass graft (CABG) surgery. However, Tsubaki et al[14] demonstrated that fiberoptic intubation should be used in patients with difficult airway, hypertension, ischemic heart disease, or cerebrovascular atherosclerosis. In this randomized clinical trial, we compared the circulatory responses to either direct laryngoscopy (DLS) or fiberoptic bronchoschopy (FOB) to determine whether there is a clinically relevant difference between the circulatory responses to FOB and DLS in patients undergoing CABG surgery.

Methods

After the study protocol was approved by the Division Ethics Committee of our institute, all of the 50 adult patients signed informed written consent to participate in this study. These patients were ASA physical status II, 35-65 years old and ejection fraction (EF) ≥40% and scheduled for elective coronary artery bypass graft surgery under general anesthesia and orotracheal intubation. No difficulties with their airway management or intubation were predicted during preoperative visits (Table1). Exclusion criteria were a history of reactive airway disease, gastroesophageal reflux, morbid obesity, co-existing cardiovascular diseases except coronary artery disease and opium addiction. The patients taking their medications before surgery had similar protocol. All of them were taking metoprolol, nitrocontin and aspirin. Patients were randomly allocated to either the FOB group (n = 25) or the DLS group (n = 25) using online randomization software (URL: http://www.graphpad.com). Patients in the first group underwent orotracheal intubation using fiberoptic bronchoscope. For intubation in FOB group, after placing the patient's head in the sniffing position, a jaw thrust was performed by an experienced assistant. He placed the fingers behind the posterior ramus of the mandible, at the same time the thrust directed upward and the thumbs opened the mouth. After exposure of the glottis, the FOB was passed between the vocal cords and downward into the trachea. To avoid stimulation of the carina, we advanced the tip of the FOB into the trachea no more than 3-4 cm below the glottis. A tracheal tube was then advanced over the FOB while rotated counterclockwise. After insertion of the tracheal tube into the trachea, the jaw thrust maneuver was stopped. The FOB was then removed after confirmation of the correct tracheal tube placement by auscultation of both lungs. All of patients in DLS group underwent conventional orotracheal intubation using a rigid Macintosh 3 (in women) or 4 (in men) laryngoscope blade. Fiberoptic and laryngoscopy intubations were performed by one anesthesiologist who was experienced in both methods.

Before the induction of anesthesia, all patients were premedicated with intramuscular lorazepam 1 mg and morphine sulfate 0.1 mg/kg 1 hour before entering the operating room. Then, in the operating room, the electrocardiogram, invasive blood pressure, and arterial oxygen saturation by pulse oximetry were monitored. The electrodes of nerve stimulator were applied at the volar side of the wrist for stimulation of the ulnar nerve. With placement of these electrodes, electrical stimulation normally elicits only finger flexion and thumb adduction. Induction of anesthesia with Etomidate 0.2 mg/kg, sufentanil 2.5 µg/kg and cisatracurium 0.2 mg/kg in both groups was done. After achieving hypnosis, determined as a loss of any response to verbal command and before muscle relaxant was injected, the mode of nerve stimulation was changed to TOF (train of four). Then, cisatracurium (0.2 mg/kg) was administered. Trachea was intubated when the response to TOF stimulation disappeared. Procedures were then started according to the study protocol. During the observation, a third person acted as the time keeper using a digital stopwatch, time zero was (zero seconds) when the response to TOF stimulation disappeared and facemask was removed from the patient. When the jaw thrust maneuver was stopped and ventilation was restarted through the tracheal tube and carbon dioxide was detected by capnography, this was recorded as total intubation time. Blood pressure and heart rate were measured and recorded before induction (T0), post induction (T1), at endotracheal intubation (T2), 1 and 2 minutes afterwards (T3, T4).

The statistical analysis of data was performed with SPSS Version 15.0 statistical software (SPSS Inc, Chicago, IL). The intragroup differences among the circulatory variables recorded over time were analyzed using the repeated measures analysis of variance. Differences in mean values of circulatory variables were analyzed by using independent samples *t* test. The categorical variables in the two groups were analyzed by using Chi-square test or Fisher's exact test as appropriate. The differences in circulatory parameters in "the two consequent times" were analyzed by using paired *t* test. The hypothesis of this study was that there would be a clinically meaningful difference in the hemodynamic responses to two fiberoptic and laryngoscopy intubation methods. The quantitative data were expressed as mean ± SD. A P value of ≤ 0.05 was considered statistically significant for all tests.

Results

There were no significant differences between the two groups regarding the patients' gender, age, Mallampati score or ejection fraction. No significant differences were seen in the baseline values of BPs and HRs. The time required for intubation was significantly longer for the fiberoptic method compared with conventional intubation with laryngoscopy (34.9 ± 9.8 versus 19.3 ± 4.7 seconds, $P = 0.0001$; Table 1).

Table 1
Clinical characteristics of the patients

	DLS N = 25	**FOB* N = 25**	**P**
Age (yr)	53.0 ± 7.8	53.1 ± 6.9	0.970
Gender (male)	17 (68%)	16 (64%)	0.373
Ejection fraction	46.2 ± 3.9	47.4 ± 5.4	1.000
Mallampati score (I/II)	22/3	21/4	?
Intubation time(sec)	19.3 ± 4.7	34.9 ± 9.8	0.0001

- FOB: Fiberoptic bronchoscopy
- DLS: Direct laryngoscopy

After anesthesia induction, systolic and diastolic BP in the two groups decreased significantly compared with baseline values (p = 0.001). There was no statistically significant change in HR in FOB and DLS groups. Also, postinduction values of BP and HR were not significantly different between the two groups (p values >0.05). Compared with postinduction values, both FOB and DLS resulted in statistically significant increase in BP but not in HR (Fig. 1 and 2). There were no significant differences in the blood pressure or heart rate from before intubation to immediately after intubation between the FOB and DLS groups. At the second minute after intubation, no significant difference was observed between the two groups. BP and HR during intubation (T2) and after intubation were similar in both FOB and DLS group (p values> 0.05). The maximum values of SBP, DBP and HR during the observed periods were not statistically significantly different in the two study groups. During the observation, the times required to reach maximum values of SBP and HR were similar in the two groups, but the times required for recovery of SBP and HR to reach to the postinduction values were significantly slower in the FOB group than in the DLS group (Fig. 1 and 2).

Fig. 1
Variation in systolic (SBP) and diastolic blood pressure (DBP) in patients undergoing direct laryngoscopy or fiberoptic brnchoscopy (FOB) for orotracheal intubation

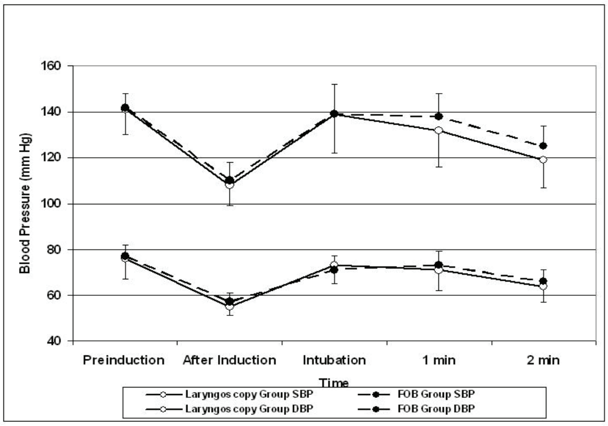
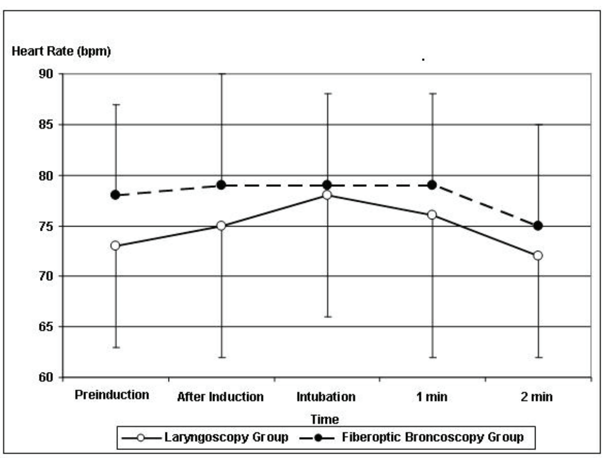


Fig. 2
Variation in heart rate in direct laryngoscopy and fiberoptic brnchoscopy groups



Discussion

One advantage of the fiberoptic intubation is that it can avoid the mechanical stimulus to the base of tongue, epiglottis and the receptors in the pharyngeal muscles exerted by direct laryngoscope. Some studies have shown that the cardiovascular responses to tracheal intubation are greatly inhibited by attenuating or avoiding the oropharyngolaryngeal stimuli[15-18]. The primary goal of this investigation was to determine whether there is a clinically relevant difference between the circulatory responses to FOB and DLS in coronary artery disease patients anesthetized for CABG surgery. We examined whether fiberoptic intubation attenuated hemodynamic responses to orotracheal intubation, compared with those that occurred with laryngoscopy. The results of this investigation suggest that bronchoscopy do not suppress the hemodynamic response to endotracheal intubation more than the response to laryngoscopy. It is well known that the stimuli to airway structures are the main causes of circulatory responses to tracheal intubation[19]. Laryngoscopy itself is one of the most invasive stimuli during orotracheal intubation[20-21]. Many anesthesiologists agree that a skilled anesthesiologist applies only a small force to the patient's larynx when using a laryngoscope and that reducing the force on the larynx might prevent excessive hyperdynamic responses to orotracheal intubation[22-24]. It is possible to separate the factors that contribute to the hemodynamic responses to orotracheal intubation[21]. The first is the response to laryngoscopy and the second is the response to endotracheal intubation. Hemodynamic changes start within seconds of direct laryngoscopy, and there is a further increase in heart rate and blood pressure with passage of the tracheal tube. It is not known which component is more responsible for the hyperdynamic response to orotracheal intubation. Although we attempted to reduce the hyperdynamic responses to intubation by using fiberoptic bronchoscopy without deep insertion in the trachea, there was no statistically significant difference in the cardiovascular variables between the fiberoptic bronchoscopy (FOB) and direct laryngoscopy (DLS) groups. The results of our study correspond with those of other previous studies[25-29]. whereas other investigators demonstrated the effectiveness of avoiding laryngoscopy using new devices[4,13-17,22-25]. This study shows that under the general anesthesia orotracheal intubation using the FOB and DLS caused similar increases in BPs and HRs. This suggests that the FOB can not attenuate the cardiovascular responses to orotracheal intubation compared to the DLS. This can be due to the longer intubation time in FOB group that cause hypercapnia, which can result in hypertention and tachycardia[7,29], the airway clearance maneuver (jaw thrust maneuver) that is necessary for FOB intubation, or irritation of trachea by insertion and removal of FOB. In our study, the mean intubation time is significantly longer in the FOB group than in the DLS group. The lifting of the jaw upward to make a clear passage for the FOB and for the tracheal tube to enter the glottis can cause cardiovascular responses. Hirabayashi et al[30].

demonstrated that, in anesthetized adults receiving lightwand-guided tracheal intubation, the magnitude of stimulus from the jaw thrust maneuver was sufficient to cause circulatory responses similar to those observed in laryngoscopic intubation. Thus, one might argue that the differences in nociceptive stimulation from the jaw thrust maneuver cause the differences in the circulatory responses between the fiberoptic and laryngoscopic intubation methods. In addition, the successful intubation (the advancement of the tracheal tube over the FOB) often requires some specific maneuvers e.g. rotating the tracheal tube, further lifting jaw upward and adjusting the patient's head-neck position. All these procedures are blind and invasive, and may further stimulate pharyngolaryngeal structures and the trachea. In contrast, with the direct laryngoscopic intubation, only the tracheal tube is inserted into the trachea under direct vision. The laryngoscopy produces a balanced stimulation of vagal and cardiac accelerator fibers, whereas the intratracheal manipulation produces less vagal stimulation[31].

In conclusion, our study demonstrated that the orotracheal intubations using a FOB and a DLS produced similar hemodynamic responses. The FOB had no special advantage in attenuating hemodynamic responses to orotracheal intubation compared to the DLS.

References

1. McCoy EP, Mirakhur RK, McCloskey BV: A comparison of the stress response to laryngoscopy. The Macintosh versus the McCoy blade. *Anaesthesia*; 1995, 50:943-946.
2. Shinji T, Taro M, Masayuki M, Hidenori T: Hemodynamic responses to tracheal intubation with laryngoscope versus lightwand intubating device (Trachlight®) in adults with normal airway. *Anesth Analg*; 2002, 95:480-4.
3. Choyce A, Avidan MS, Harvey A, et al: The cardiovascular response to insertion of the intubating laryngeal mask airway. *Anaesthesia*; 2002, 57:330-333.
4. Yoshihiro H, Shuji D: Differences in cardiovascular response to airway stimulation at different sites and blockade of the responses by lidocaine. *Anesthesiology*; 2000, 93:95-103.
5. Latorre F, Hofmann M, Kleemann PP, Dick WF: Stress response to nasotracheal intubation: a comparative evaluation of fiberendoscopic vs. laryngoscopic intubation with and without topical anaesthesia of the larynx. *Anaesthetist*; 1993, 42:423-6.
6. Rose DK, Cohen MM: The airway: Problems and predictions in 18,500 patients. *Can J Anaesth*; 1994, 41:372-383.
7. Takita K, Morimoto Y, Kemmotsu O: Tracheal lidocaine attenuates the cardiovascular response to endotracheal intubation. *Can J Anaesth*; 2001, 48:732-736.
8. Schaefer HG, Marsch SC, Strebel SP, Drewe J: Cardiovascular effects of fibreoptic oral intubation. A comparison of a total intravenous and a balanced volatile technique. *Anaesthesia*; 1992, 47:1034-1036.
9. Mustola ST, Baer GA, Metsa-Ketela T, Laippala P: Haemodynamic and plasma catecholamine responses during total intravenous anaesthesia for laryngomicroscopy. Thiopentone compared with propofol. *Anaesthesia*; 1995, 50:108-113.
10. Maguire AM, Kumar N, Parker JL, Rowbotham DJ, Thompson JP: Comparison of effects of remifentanil and alfentanil on cardiovascular response to tracheal intubation in hypertensive patients. *Br J Anaesth*; 2001, 86:90-3.
11. Neidhart PP, Champion P, Vogel J, Zsigmond EK, Tassonyi E: A comparison of pipecuronium with pancuronium on haemodynamic variables and plasma catecholamines in coronary artery bypass patients. *Can J Anaesth*; 1994, 41:469-474.
12. Kirvela M, Scheinin M, Lindgren L: Haemodynamic and catecholamine responses to induction of anaesthesia and tracheal intubation in diabetic and non-diabetic uraemic patients. *Br J Anaesth*; 1995, 74:60-65.
13. Nishikawa K, Omote K, Kawana S, Namiki A: A comparison of hemodynamic changes after endotracheal intubation by using the lightwand device and the laryngoscope in normotensive and hypertensive patients. *Anesth Analg;* 2000, 90:1203-7.
14. Tsubaki T, Aono K, Nakajima T, Shigematsu A: A Blood pressure, heart rate and catecholamine response during fiberoptic nasotracheal intubation under general anesthesia. *J Anesth;* 1992, Oct. 6(4):474-9.
15. Hawkyard SJ, Morrison A, Doyle LA, Croton RS, Wake PN: Attenuating the hypertensive response to laryngoscopy and endotracheal intubation using awake fiberoptic intubation. *Acta Anaesthesiol Scand*; 1992, 36:1-4.
16. Kitamura T, Yamada Y, Chinzei M, Du HL, Hamaoka K: Attenuation of haemodynamic responses to tracheal intubation by the StyletScope. *Br J Anaesth;* 2001, 86:275-7.
17. Nishikawa K, Kawana S, Namiki A: Comparison of the lightwand technique with direct laryngoscopy for awake endotracheal intubation in emergency cases. *J Clin Anesth;* 2001, 13:259-63.
18. Kimura A, Yamakage M, Chen X, Kamada Y, Namiki A: Use of the fibreoptic stylet scope (Styletscope) reduces the hemodynamic response to intubation in normotensive and hypertensive patients. *Can J Anaesth;* 2001, 48:919-23.
19. Xue FS, Li CW, Liu KP, Sun HT, Zhang GH, Xu YC, Liu Y: Circulatory Responses to Fiberoptic Intubation in Anesthetized Children: A Comparison of Oral and Nasal Routes. *Anesth Analg;* 2007, 104:283-288.
20. Kovak AL: Controlling the hemodynamic response to laryngoscopy and endotracheal intubation. *J Clin Anesth;* 1996, 8:63-79.
21. Adachi YU, Satomoto M, Higuchi H, Watanabe K: Fentanyl attenuates the hemodynamic response to endotracheal intubation more than the response to laryngoscopy. *Anesth Analg*; 2002, Jul. 95(1):233-7, table of contents.
22. Bishop MJ, Harrington RM, Tencer AF: Force applied during tracheal intubation. *Anesth Analg;* 1992, 74:411-4.
23. Bucx MJ, Snijders CJ, Van Geel RT, et al: Forces acting on the maxillary incisor teeth during laryngoscopy using the Macintosh laryngoscope. *Anaesthesia;* 1994, 49:1064-70.
24. Tong JL, Ashworth DR, Smith JE: Cardiovascular responses following laryngoscope assisted, fibreoptic orotracheal intubation. *Anaesthesia;* 2005, 60:754-8.
25. Adachi YU, Takamatsu I, Watanabe K, Uchihashi Y, Higuchi H, Satoh T: Evaluation of the cardiovascular responses to fiberoptic orotracheal intubation with television monitoring: comparison with conventional direct laryngoscopy. *J Clin Anesth*; 2000, 12:503-8.
26. Barak M, Ziser A, Greenberg A, Lischinsky S, Rosenberg B: Hemodynamic and catecholamine response to tracheal intubation:direct laryngoscopy compared with fiberoptic intubation. *Journal of Clinical anesthesia*; 2003, 15:132-6.
27. Xue FS, Zhang GH, Li XY, Sun HT, Li P, Li CW, Liu KP: Comparison of hemodynamic responses to orotracheal intubation with the GlideScope videolaryngoscope and the Macintosh direct laryngoscope. *J Clin Anesth*; 2007, Jun, 19(4):245-50.
28. Xue FS, Zhang GH, Sun HT, Li CW, Li P, Liu KP, Xu YC, Liu Y, Liu J: A comparative study of hemodynamic responses to orotracheal intubation with fiberoptic bronchoscope and laryngoscope in children. *Paediatr Anaesth*; 2006, Jul. 6(7):743-7.
29. Xue FS, Zhang GH, Li XY, Sun HT, Li P, Sun HY, et al: Comparison of haemodynamic responses to orotracheal intubation with glidescope (R) videolaryngoscope and fibreoptic bronchoscope. *Eur J Anaesthesiol;* 2006, 23:522-526.
30. Hirabayashi Y, Hiruta M, Kawakami T, Inoue S, Fukuda H, Saitoh K, Shimizu R: Effects of lightwand (Trachlight) compared with direct laryngoscopy on circulatory responses to tracheal intubation. *Br J Anaesth*; 1998, 81:253-5.
31. Shribman AJ, Smith G, Achola KJ: Cardiovascular and catecholamine responses to laryngoscopy with and without tracheal intubation. *Br J Anaesth;* 1987, 59:295-9.