Cardiothoracic Anesthesia, Respiration and Airway

Endotracheal intubation with a lightwand or a laryngoscope results in similar hemodynamic variations in patients with coronary artery disease

[L'intubation endotrachéale avec stylet lumineux ou laryngoscope produit des variations hémodynamiques comparables chez des malades atteints de cardiopathie ischémique]

Félix R. Montes MD, Juan C. Giraldo MD, Luis A. Betancur MD, José D. Rincón MD, Ismael E. Rincón MD, María V. Vanegas MD, Hernán Charris MD

Purpose: To asses the cardiovascular changes after either lightwand or conventional laryngoscopic endotracheal intubation (EI) in patients with coronary artery disease.

Methods: Following Institutional approval and informed consent, 80 consecutive patients undergoing elective coronary artery bypass grafting were enrolled in this prospective, controlled, single-blinded study. General anesthesia was induced with fentanyl 5 $\mu \cdot kg^{-1}$ and thiopental 5 $mg \cdot kg^{-1}$ followed by pancuronium 0.1 $mg \cdot kg^{-1}$. After loss-of-eyelash reflex the lungs were manually ventilated with 2% isoflurane in oxygen for five minutes. Patients were then randomly allocated to receive either the lightwand (lightwand group, $n = 41$) or direct-vision laryngoscopy (laryngoscopy group, $n = 39$). Heart rate (HR) and direct blood pressure were recorded before induction, after induction but before EI, during EI, immediately after EI and at ten-second intervals for the following five minutes. Hemodynamic management during induction was standardized. Hypotension was treated with volume replacement, ephedrine, or phenylephrine as indicated; hypertension was treated with *iv* nitroglycerin; tachycardia was treated with boluses of esmolol; and, bradycardia was treated with atropine or ephedrine.

Results: In both groups, mean arterial blood pressures and HR increased significantly after EI. There was a tendency for the lightwand group to have lower arterial blood pressures and slower HR. However, the differences between the two groups did not reach statistical significance. Requirements for drugs to control HR and mean arterial pressure were similar in both groups.

Conclusion: In patients with coronary artery disease using a lightwand intubation technique does not modify the hemodynamic response associated with EI as compared with standard direct-vision laryngoscopy.

Objectif : *Évaluer les modifications cardiovasculaires suivant l'intubation endotrachéale (IE) avec un stylet lumineux ou un laryngoscope traditionnel chez des malades atteints de cardiopathie ischémique.*

Méthode : *Ayant reçu l'approbation de l'institution et le consentement éclairé des participants, nous avons recruté 80 patients consécutifs, qui devaient subir un pontage aortocoronarien, pour notre étude prospective, contrôlée et à simple insu. L'anesthésie générale a été induite avec 5 $\mu g \cdot kg^{-1}$ de fentanyl et 5 $mg \cdot kg^{-1}$ de thiopental, suivis de 0,1 $mg \cdot kg^{-1}$ de pancuronium. Après la perte du réflexe ciliaire, les poumons ont été ventilés manuellement avec de l'isoflurane à 2 % dans de l'oxygène pendant cinq minutes. Les patients ont été répartis au hasard pour l'intubation avec le stylet lumineux ($n = 41$) ou par laryngoscopie à vision directe ($n = 39$). La fréquence cardiaque (FC) et la tension artérielle (TA) directe ont été enregistrées avant l'induction, après l'induction mais avant l'IE, pendant l'IE, immédiatement après l'IE et à 10 s d'intervalle pendant les cinq minutes suivantes. La prise en charge hémodynamique a été normalisée pendant l'induction. L'hypotension a été traitée par remplissage vasculaire, éphédrine, ou phényléphrine selon l'indication ; l'hypertension, par nitroglycérine iv ; la tachycardie, par de l'esmolol en bolus et la bradycardie, par de l'atropine ou de l'éphédrine.*

From the Department of Anesthesiology, Fundación Cardio Infantil – Instituto de Cardiología, Universidad del Rosario, Bogotá, Colombia, South America.

Address correspondence to: Dr. Félix R. Montes, Apartado Aéreo 104006, Bogotà, Colombia, South América. Phone: 57-1-271-07-20; Fax: 57-1-679-11-40; E-mail: cfmont@col1.telecom.com.co

Presented in part at the annual meeting of the International Anesthesia Research Society, San Diego, California, USA, March 18–22, 2002. This study was supported by departmental funding.

Accepted for publication January 23, 2003.

Revision accepted June 3, 2003.

Résultats : *Dans les deux groupes, les tensions artérielles moyennes (TAM) et la FC ont significativement augmenté après l'IE. Dans le groupe d'intubation au stylet lumineux, les TA avaient tendance à baisser et la FC à ralentir. Cependant, les différences intergroupes n'étaient pas statistiquement significatives. Les besoins de médicaments pour contrôler la FC et la TAM ont été similaires dans les deux groupes.*

Conclusion : *Chez les malades atteints de cardiopathie ischémique, l'intubation avec un stylet lumineux, comparée à la laryngoscopie traditionnelle à vision directe, ne modifie pas la réponse hémodynamique associée à l'IE.*

ENDOTRACHEAL intubation (EI) by direct vision using a laryngoscope is frequently associated with an increase in arterial blood pressure and heart rate (HR).[1–3] These changes may be detrimental in patients with coexisting conditions such as coronary artery disease due to the attendant increase in myocardial oxygen demand, decrease in oxygen supply, and the possibility of myocardial ischemia.

The lightwand transillumination technique is an effective and safe intubating technique, in which no direct-vision laryngoscopy is required.[4,5] Avoiding direct-vision laryngoscopy by using the lightwand transillumination technique could theoretically result in less stimulation than direct laryngoscopy and may protect from sympathetic hyperactivity.

We therefore conducted a prospective, randomized study to assess the cardiovascular changes after either lightwand or direct-vision laryngoscopic EI in patients with coronary artery disease.

Methods

Following study approval from the Ethics Committee of the Fundación Cardio Infantil – Instituto de Cardiología and informed consent of patients, we prospectively enrolled 80 consecutive patients scheduled for elective coronary artery bypass grafting (CABG). Patients with a documented history of difficult intubation or an anticipated difficult airway determined during preoperative assessment were excluded from the study, as were patients with previous CABG or valvular heart operation, and preoperative inotropic or intra-aortic balloon pump support.

All patients received oral lorazepam 2 mg immediately before being transferred to the operating room, and their cardiac medications were continued through the morning of surgery. Upon arrival to the operating room, patients were monitored with electrocardiogram lead II and V5, and a 14-gauge *iv* catheter was inserted in an upper extremity vein. A 20-gauge catheter was inserted in a radial artery to permit continuous recording of arterial pressure. General anesthesia was induced with fentanyl 5 $\mu g \cdot kg^{-1}$ and thiopental 5 $mg \cdot kg^{-1}$ followed by pancuronium 0.1 $mg \cdot kg^{-1}$. After loss of eyelash reflex the lungs were ventilated manually with 2% isoflurane in oxygen for five minutes. Then via a computer-generated randomization table, patients were randomized to receive EI with either lightwand (Trachlight; Laerdal Medical Corp., Wappingers Falls, NY, USA) or direct-vision laryngoscopy using a Macintosh blade.

Failure of intubation was defined as the inability to intubate after three attempts. The duration of intubation was defined as the sum of the duration of all intubation attempts with each technique. HR and direct systolic, diastolic and mean arterial blood pressure (MAP) were recorded at the following times: a) before induction; b) after induction but before EI; c) during EI; d) immediately after EI; e) at ten-second intervals for the first minute after EI; and f) every 30 sec for the next four minutes. Maximum MAP and HR values and the times when these values were obtained were determined. The isoflurane concentration was maintained at 0.4% during the first five minutes after EI. After the study period, anesthesia was left at the discretion of the attending anesthesiologist.

Hemodynamic management during induction was standardized. Hypotension (systolic blood pressure < 90 mmHg) was treated with volume replacement, ephedrine, or phenylephrine as indicated; persistent

TABLE Demographic characteristics, associated disease and concurrent medications

Variable	*Ligthwand group*	*Laryngoscopy group*
n	41	39
Age (yr)	58 ± 9	61 ± 11
Weight (kg)	68 ± 10	68 ± 13
Height (cm)	162 ± 8	161 ± 7
Sex (female/male)	14/27	13/26
Left ventricular ejection fraction (%)	49 ± 10	51 ± 10
Previous myocardial infarction	24	21
History of hypertension	22	23
History of diabetes mellitus	7	7
Preoperative medications		
ß-adrenergic antagonist	28	27
Calcium-channel blocker	5	4
Nitrates	22	21
Angiotensin-converting enzyme inhibitor	8	7

Data are provided as incidence or as means ± standard deviation as appropriate.

hypertension (systolic blood pressure > 140 mmHg lasting more than one minute) was treated with *iv* nitroglycerin; tachycardia (HR > 110 beats·min^{-1}) was treated with successive boluses of esmolol 30 mg *iv*; and, bradycardia (HR < 50 beats·min^{-1}) was treated with atropine or ephedrine.

A power analysis based on a previous study[6] revealed a sample size of 36 patients per group was required to achieve a power of 80% and an α of 0.05 for detection of 10 mmHg or 10-beats·min^{-1} differences in paired hemodynamic data. Within group changes over time were analyzed with ANOVA for repeated measures with Scheff test used for multiple comparisons. Between group differences were compared using one-way ANOVA. $P < 0.05$ was considered statistically significant.

Results

Thirty-nine subjects were intubated using a laryngoscope, and 41 were intubated using a lightwand. One patient in the trachlight group required more than three attempts: his trachea was intubated uneventfully with conventional laryngoscopy, and he was excluded from data analysis. There were no significant differences between the groups with regard to demographic characteristics, concurrent medication and associated diseases (Table).

After anesthesia induction, MAP and HR decreased to a similar extent in both groups. MAP and HR increased after tracheal intubation. In both groups the maximum increases in MAP occurred 30 sec after EI and significant increases in MAP persisted up to two minutes (Figure 1). Significant increases in HR, compared to pre-intubation values, were observed within 120 sec, and 150 sec after insertion of the endotracheal tube in the lightwand group and the laryngoscope group respectively (Figure 2). Throughout the time course of the study there was a tendency for the lightwand group to have lower MAP and slower HR, however, the differences between the two groups did not reach significance. The time necessary to intubate the patients in the direct laryngoscopy group was 21 ± 19 sec, whereas patients in the lightwand group had a median time to intubation of 24.5 ± 22 sec; this difference was not statistically significant.

Eight patients in the direct laryngoscopy group required short-acting beta-blockers in order to control HR, compared to six patients in the lightwand group; this difference was not statistically significant. Four patients in the lightwand group and two patients in the direct laryngoscopy group were treated for hypertension with *iv* nitroglycerin. There were no differences in the incidences of hypotension and bradycardia between the two groups. No adverse event (myocardial ischemia, infarction) could be attributed to the use of any EI technique. No deaths occurred in either of the groups.

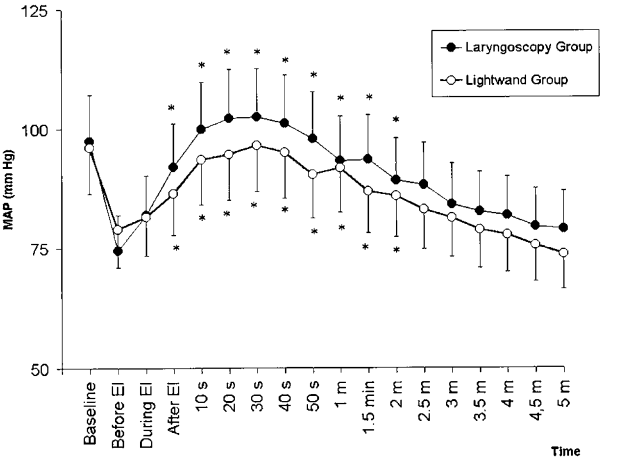

FIGURE 1 Mean arterial pressure (MAP) in the lightwand (open symbols) and laryngoscope (closed symbols) groups. EI = endotracheal intubation. *$P < 0.05$ compared with before EI. Values are expressed as mean ± standard deviation.

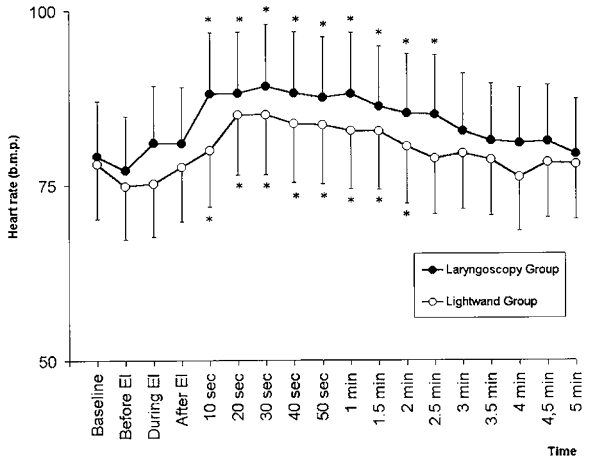

FIGURE 2 Heart rate in the lightwand (open symbols) and laryngoscope (closed symbols) groups. b.p.m. = beats·min^{-1}; EI = endotracheal intubation. *$P < 0.05$ compared with before EI. Values are expressed as mean ± standard deviation.

Discussion

Orotracheal intubation using direct-vision laryngoscopy requires elevation of the epiglottis and exposure of the glottic opening, which is obtained by a forward and upward movement of the laryngoscope blade. This procedure is associated with hemodynamic changes. Although a transient hemodynamic change presents low risk to healthy people, it may be hazardous to patients with coronary artery disease because of the detrimental effects of sympathetic hyperactivity. The results of this study demonstrate that for patients undergoing CABG the use of a lightwand EI technique is associated with similar hemodynamic changes when compared to patients intubated with a rigid laryngoscope and that requirements for drugs to control HR and MAP were similar in both groups.

Several groups have investigated the possibility that lightwand intubation may result in less stimulation than direct laryngoscopy and may protect from sympathetic hyperactivity. A study comparing two direct laryngoscope blades, the Macintosh 3, and the Miller 2, with lighted stylet intubation showed no significant difference in hemodynamic changes among the three groups.[7] More recently, Casati *et al.*,[8] Hirabayasi *et al.*,[9] Friedman *et al.*[10] and Takahashi *et al.*[11] have studied the effects of lightwand technique on circulatory responses to tracheal intubation in adult patients: no differences between the lightwand technique and direct-vision laryngoscopy in changes in arterial pressure and HR, during and after EI, were found, while the time taken to achieve tracheal intubation was comparable. These studies were conducted in American Society of Anesthesiologists physical status I and II patients.

In contrast, Nishihawa *et al.* studied 40 normotensive and 40 hypertensive patients scheduled for noncardiac elective surgery.[12] They found that the lightwand technique significantly attenuated hemodynamic changes to intubation in comparison with the laryngoscopic technique in normotensive patients, however, in hypertensive patients there were no differences in hemodynamic changes between the two techniques. In that study arterial blood pressures were measured only every minute, using a non-invasive device. This method of measuring blood pressure might overlook the maximal changes in this variable, which would explain the differences with our results.

Intubation using the lightwand device is a light-guided technique without visualization of the laryngeal structures that appears gentler than direct-vision laryngoscopy. The results of the present and other studies,[8–11] however, suggest that the circulatory response to EI is mainly due to stimulation of the trachea by the endotracheal tube rather than stimulation of the glottis by the laryngoscope. Furthermore, one of the studies mentioned[9] suggested that, in the lightwand intubation technique, grasping of the jaw and lifting it upward to make a clear passage for the endotracheal tube to enter the glottic opening was sufficient to cause a circulatory response similar to that found with conventional laryngoscopy. This observation could be relevant to our study because this maneuver was used in all of our patients intubated with the lightwand device.

Close attention to hemodynamic control and rapid treatment of abnormalities is a fundamental principle of intraoperative management of the patient with coronary artery disease.[13] In the present study because of the pathologic condition of the patients, a therapeutic intervention was initiated promptly to control hemodynamic variables. Fourteen patients received short-acting beta-blockers to control HR (eight in the direct laryngoscopy group *vs* six in the lightwand group) and six patients received *iv* nitroglycerin in order to manage hypertension (two in the direct laryngoscopy group and four in the lightwand group). Given that the number of patients requiring this intervention was similar in both groups, we believe that the hemodynamic responses were comparable. We consider that requirements for drugs to control HR and MAP are reflective of the sympathetic response to EI. As such, they constitute a measure of outcome supporting the hypothesis that both techniques are equally stimulating.

Other anesthesia-related factors, such as premedication, general anesthetics, and drugs used during induction, are also known to affect the hemodynamic response to tracheal intubation.[14–16] The use of 5 $\mu g \cdot kg^{-1}$ of fentanyl together with inhalational anesthesia can blunt the cardiovascular responses to intubation.[17,18] In spite of similar maneuvers in both groups we obtained a significant and similar increase in MAP and HR with both techniques, reinforcing our belief that direct laryngoscopy and lightwand intubation behave similarly in this clinical setting.

In conclusion, this study has shown that, in patients with coronary artery disease, a lightwand intubation technique does not reduce the hemodynamic responses associated with EI when compared to standard direct-vision intubation with a laryngoscope. In this type of patient, pharmacologic manipulations might prove more effective to control the changes in HR and MAP associated with tracheal intubation.

References

1 *Stoelting RK.* Circulatory changes during direct laryngoscopy and tracheal intubation. Influence of duration of laryngoscopy with or without prior lidocaine. Anesthesiology 1977; 47: 381–3.

2 *Ebert JP, Pearson JD, Gelman S, Harris C, Bradley EL.* Circulatory responses to laryngoscopy: the comparative effects of placebo, fentanyl and esmolol. Can J Anaesth 1989; 36: 301–6.
3 *Stone DJ, Gal TJ.* Airway management. *In:* Miller RD (Ed.) Anesthesia, 5th ed. New York: Churchill Livingstone Inc.; 2000: 1444–6.
4 *Hung OR, Pytka S, Morris I, et al.* Clinical trial of a new lightwand device (Trachlight) to intubate the trachea. Anesthesiology 1995; 83: 509–14.
5 *Hung OR, Pytka S, Morris I, Murphy M, Stewart RD.* Lightwand intubation: II-clinical trial of a new lightwand for tracheal intubation in patients with difficult airways. Can J Anaesth 1995; 42: 826–30.
6 *Montes FR, Sanchez SI, Giraldo JC, et al.* The lack of benefit of tracheal extubation in the operating room after coronary artery bypass surgery. Anesth Analg 2000; 91: 776–80.
7 *Knight RG, Castro T, Rastrelli AJ, Maschke S, Scavone JA.* Arterial blood pressure and heart rate response to lighted stylet or direct laryngoscopy for endotracheal intubation. Anesthesiology 1988; 69: 269–72.
8 *Casati A, Aldegheri G, Fanelli G, et al.* Lightwand intubation does not reduce the increase in intraocular pressure associated with tracheal intubation. J Clin Anesth 1999; 11: 216–9.
9 *Hirabayashi Y, Hiruta M, Kawakami T, et al.* Effects of lightwand (Trachlight) compared with direct laryngoscopy on circulatory responses to tracheal intubation. Br J Anaesth 1998; 81: 253–5.
10 *Friedman PG, Rosenberg MK, Lebenbom-Mansour M.* A comparison of light wand and suspension laryngoscopic intubation techniques in outpatients. Anesth Analg 1997; 85: 578–82.
11 *Takahashi S, Mizutani T, Miyabe M, Toyooka H.* Hemodynamic responses to tracheal intubation with laryngoscope versus lightwand intubating device (Trachlight®) in adults with normal airway. Anesth Analg 2002; 95: 480–4.
12 *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.
13 *O'Connor JP, Ramsay JG, Wynands JE, Kaplan JA.* Anesthesia for myocardial revascularization. *In:* Kaplan JA (Ed.). Cardiac Anesthesia, 3th ed. Philadelphia: W.B. Saunders Company; 1993: 587–628.
14 *Milocco I, Lof BA, William-Olsson G, Appelgren LK.* Haemodynamic stability during anaesthesia induction and sternotomy in patients with ischaemic heart disease. A comparison of six anaesthetic techniques. Acta Anaesthesiol Scand 1985; 29: 465–73.
15 *Atlee JL, Dhamee MS, Olund TL, George V.* The use of esmolol, nicardipine, or their combination to blunt hemodynamic changes after laryngoscopy and tracheal intubation. Anesth Analg 2000; 90: 280–5.
16 *Takita K, Morimoto Y, Kemmotsu O.* Tracheal lidocaine attenuates the cardiovascular response to endotracheal intubation. Can J Anesth 2001; 48: 732–6.
17 *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.
18 *Splinter WM, Cervenko F.* Haemodynamic responses to laryngoscopy and tracheal intubation in geriatric patients: effects of fentanyl, lidocaine and thiopentone. Can J Anaesth 1989; 36: 370–6.