ORIGINAL ARTICLE

Mohammadreza SAFAVI[1]
Azim HONARMAND[2]

[1] Department of Anesthesiology and Intensive Care Medicine, Isfahan University of Medical Sciences, Isfahan - IRAN

[2] Department of Anesthesiology and Intensive Critical Care, Isfahan University of Medical Sciences, Isfahan - IRAN

A comparison of different doses of remifentanil and tracheal lidocaine on attenuation of cardiovascular responses to laryngoscopy and tracheal intubation

Background: The efficacy of remifentanil infusion versus tracheal lidocaine for attenuation of the cardiovascular responses to tracheal intubation has been previously reported. This study compared hemodynamic stability during anesthesia induction and intubation using tracheal lidocaine and remifentanil.

Materials and Methods: The study included 90 patients that were scheduled for elective surgery under general anesthesia and randomly allocated to 3 treatment groups: remifentanil $1 \ \mu g \ kg^{-1} \ min^{-1}$ bolus over 30 s, followed by an infusion of $0.5 \ \mu g \ kg^{-1} \ min^{-1}$ (R1); remifentanil $0.5 \ \mu g \ kg^{-1} \ min^{-1}$ over 30 s and an infusion of $0.25 \ \mu g \ kg^{-1} \ min^{-1}$ (R2); tracheal lidocaine (TL) (10%, 1.5 ml) spray 3 min after anesthesia induction (TL). Then the laryngoscope was removed and 3 min later, laryngoscopic intubation was performed. Heart rate, systolic arterial pressure, diastolic arterial pressure, mean arterial pressure, and rate-pressure product (RPP) were measured before induction of anesthesia (baseline), immediately before endotracheal intubation, and 1, 3, and 5 min after endotracheal intubation.

Results: Just before endotracheal intubation, systolic, diastolic, and mean arterial pressure, heart rate, and RPP were significantly lower than at baseline in the R1 and R2 groups (P < 0.05). One minute after endotracheal intubation, systolic, diastolic, and mean arterial pressure, and RPP were significantly higher in the TL group than in the R1 group (P < 0.05). Heart rate was significantly higher in the TL group than in the R1 group 1, 3, and 5 min after laryngoscopy (P < 0.05).

Conclusion: For attenuation of chronotropic response to tracheal intubation, remifentanil bolus and infusion was more effective than tracheal lidocaine.

Key words: Remifentanil, tracheal lidocaine, tracheal intubation, cardiovascular responses

Correspondence
Azim HONARMAND
Department of Anesthesiology and Intensive Critical Care, Isfahan University of Medical Sciences, Isfahan - IRAN

Honarmand @med.mui.ac.ir

Introduction

The pressor response to tracheal intubation, resulting in tachycardia and hypertension is well known (1). Plasma concentration of catecholamine increases (2,3), and there may be associated myocardial ischaemia (4) and cerebral hemorrhage (5). Hemodynamic responses may be attenuated by several methods (6-10). Remifentanil is a new opioid agent that is structurally unique. An ester bond renders it subject to rapid hydrolysis by nonspecific blood and tissue esterases, and thus it has a short half-life (11). Thompson and colleagues (12,13) showed that remifentanil significantly attenuates the haemodynamic response to laryngoscopy and orotracheal intubation, but that it was associated with bradycardia unresponsive to glycopyrrolate. Wilhelm et al. (14) reported that hemodynamic responses to tracheal intubation were controlled more effectively with remifentanil during anesthetic induction with propofol, thiopental, or etomidate; however, in the remifentanil group, mean arterial pressure significantly decreased during induction.

Intratracheal administration of lidocaine (tracheal lidocaine) is also widely used for the attenuation of cardiovascular responses to endotracheal intubation.

This method may avoid unexpected or excessive hypotension and bradycardia, which can be associated with remifentanil or antihypertensive drug use. The efficacy of tracheal lidocaine for attenuation of the cardiovascular responses to tracheal intubation has been reported by Takita et al. (15). Denlinger et al. (16) showed that a simple tracheal spray with lidocaine attenuated the hypertensive responses to endotracheal intubation more effectively than a saline tracheal spray. Others reported that the application of topical anesthesia to the upper airway and trachea failed to prevent the pressor responses to endotracheal intubation. Denlinger et al. (16) performed endotracheal intubation more than 2 min after administering a local anesthetic tracheal spray, whereas endotracheal intubation was performed less than 1 min after topical anesthesia in studies that indicated the ineffectiveness of tracheal lidocaine (10,17,18).

In comparison with remifentanil use, tracheal lidocaine administration is a simple and inexpensive technique. To the best of our knowledge there are no studies that compare their effectiveness, regarding the stress of intubation. In the light of previous findings and the reported association between remifentanil, and bradycardia (19) and hypotension, the present study aimed to compare the effectiveness of tracheal lidocaine and remifentanil in blunting the cardiovascular responses to laryngoscopy and intubation.

Materials and Methods

After obtaining institutional approval and written informed consent, 90 patients aged 18-65 years without cardiovascular disease (ASA physical status I-II) that were scheduled to undergo elective surgery under general anesthesia were enrolled in this randomized double blind clinical trial. Those that had taken any drug that could influence hemodynamic and autonomic function were excluded from the study. Further exclusionary criteria were as follows: patients with predictably difficult airways or obesity (body weight exceeding 100 kg), more than 15-s duration laryngoscopy, electrocardiographic abnormalities (a cardiac rhythm other than sinus, premature ventricular contractions, or heart rate was less than 55 min^{-1}),

congestive heart failure, diabetes mellitus, hypertension, or coronary artery, respiratory, renal, or cerebral disease. No premedication was given. Upon arrival in the operating room an IV infusion of lactate Ringer solution was started. Routine monitoring of arterial blood pressure (AP), electrocardiogram (ECG), and oxygen saturation (SpO_2) was performed. AP was measured automatically and registered by an automated non-invasive AP monitor. Heart rate (HR) was monitored by ECG. Patients were randomly assigned to 1 of 3 treatment groups, each consisting of 30 patients, to receive the following in a randomized, double-blind manner: remifentanil 1 $\mu g\ kg^{-1}\ min^{-1}$ bolus over 30 s, followed by an infusion of 0.5 $\mu g\ kg^{-1}\ min^{-1}$ (R1); remifentanil 0.5 $\mu g\ kg^{-1}\ min^{-1}$ over 30 s and an infusion of 0.25 $\mu g\ kg^{-1}\ min^{-1}$ (R2); tracheal lidocaine (TL) (10%, 1.5 ml) spray 3 min after anesthesia induction (TL). Then the laryngoscope was removed and 3 min later laryngoscopic intubation was performed. The duration of laryngoscopy was recorded in all 3 groups.

All remifentanil treatments were administered immediately before induction of anesthesia and continued for 5 min after laryngoscopy. Actual time of induction of anesthesia (from injection of treatment drugs to just before laryngoscopy) was 3 min in the R1 and R2 groups, and was 6 min in the group TL.

To ensure proper patient allocation and double blinding, treatment group assignments (an equal number in each of the 3 groups) were written on sheets of paper that were then folded up and shuffled in a large envelope. A physician randomly took 1 folded sheet from the envelope for each patient, who was assigned to the treatment indicated on the sheet. The patient's name was written on the sheet to record the group assignment. Thereafter, the sheet was sealed in another envelope, which was not opened again until the evaluation was finished. Neither the patient nor the interviewer was notified of the allocation results.

Anesthesia was induced with a bolus dose of thiopental 4 mg kg^{-1}, followed by atracurium 0.6 mg kg^{-1} to facilitate endotracheal intubation, which was maintained with 1% isoflurane and 66% nitrous

oxide in oxygen. The patients' lungs were mechanically ventilated with a tidal volume of 10 ml kg^{-1} and a respiratory rate of 12 min^{-1} to maintain end-tidal $PaCO_2$ at around 38 mmHg. Baseline values for mean arterial pressure (MAP), systolic arterial pressure (SAP), diastolic arterial pressure (DAP), and heart rate (HR) were measured 1 min before induction of anesthesia. In the R1 and R2 groups subsequent measurements were made immediately before endotracheal intubation, and 1, 3, and 5 min after endotracheal intubation. In the TL group subsequent measurements were made immediately before tracheal lidocaine, 2 min after administration of tracheal lidocaine (immediately before endotracheal intubation), and 1, 3, and 5 min after endotracheal intubation by another physician who was blinded to the treatment groups and did not perform laryngoscopy or tracheal intubation. Laryngoscopy views were graded according to Cormack-Lehane classification (20):

Grade I: Most of the glottis was seen;

Grade II: Only the posterior portion of the glottis was seen;

Grade III: Only the epiglottis was seen;

Grade IV: Neither the epiglottis nor the glottis were seen.

The rate-pressure product (RPP) was calculated by multiplying SAP by HR. Hypotension (SAP: 80 mmHg for more than 60 s) was treated with ephedrine 3 mg. Bradycardia (heart rate < 45 beats min^{-1} for more than 60 s) was treated with atropine 300 μg-increments IV.

Data are expressed as mean ± standard deviation (SD). MAP was taken as DAP plus [1/3 × (SAP–DAP)]. Statistical comparisons between the groups were performed using 2-way analysis of variance (ANOVA), followed by an unpaired t-test with Bonferroni correction. Hemodynamic responses to induction and intubation in a given group were analyzed using a repeated-measures ANOVA (one-way ANOVA), followed by a paired t-test with Bonferroni correction. SPSS for Windows v.14.0. was used of all statistical analyses and $P < 0.05$ was considered statistically significant.

Results

Demographic characteristics and duration of laryngoscopy were similar in the 3 groups (Table 1). There were no significant differences between the 3 groups in terms of Cormack-Lehane grades (Table 2). Preoperative AP, HR, and RPP values were comparable in all 3 groups (Table 3). SAP, DAP, MAP, HR, and RPP were significantly different between the 3 groups just before endotracheal intubation and 1-5 min after laryngoscopy in response to the administration of either drug (Table 3).

Induction of General Anesthesia

SAP, DAP, MAP, and RPP fell immediately after the injection of 1 or 0.5 μg kg^{-1} remifentanil, but BP levels tended to remain near baseline values in the TL group (Table 3). HR decreased in the 3 groups (Table 3). There were significant differences in terms of BP, HR, and RPP responses to induction

Table 1. Demographic characteristics and duration of laryngoscopy in the 3 study groups (mean ± SD or n).

	Group R1	Group R2	Group TL
No. of patients	30	30	30
Sex (female/male)	16/14	17/13	14/16
ASA (I/II)	18/12	17/13	16/14
Age (years)	35.6 ± 12.0	34.1 ± 13.0	33.0 ± 13.5
Weight (kg)	74.3 ± 10.0	70.0 ± 10.4	72.4 ± 9.4
Height (cm)	172.2 ± 8.0	171.0 ± 8.4	174.4 ± 7.3
Duration of laryngoscopy (s)	8.4 ± 1.1	8.7 ± 1.4	8.6 ± 1.3

R1: Remifentanil 1 μg kg^{-1}; R2: remifentanil 0.5 μg kg^{-1}; TL: tracheal lidocaine. No significant difference between groups.

Table 2. Cormack-Lehane laryngoscopic grades (n).

	Group R1	Group R2	Group TL
No. of patients	30	30	30
Cormack-Lehane 1	19	20	22
Cormack-Lehane 2a	9	8	7
Cormack-Lehane 2b	2	2	1

R1: Remifentanil 1 μg kg^{-1}; R2: remifentanil 0.5 μg kg^{-1}; TL: tracheal lidocaine.
No significant difference among groups.

Table 3. Patient hemodynamic data.

Variable	Group	Baseline	Before TL	Before EI	After laryngoscopy (min) 1	3	5
SAP	R1	121.5 ± 9.4		96.2 ± 7.3	106.9 ± 8.9	103.6 ± 8.4	101.6 ± 8.9
	R2	120.1 ± 7.8		104.4 ± 8.2	113.6 ± 7.8	110.7 ± 7.6	109.8 ± 8.3
	TL	119.4 ± 7.2	119.4 ± 7.7	119.4 ± 7.6*†	120.7 ± 9.5*†	104.7 ± 8.6†	100.6 ± 9.6†
DAP	R1	76.5 ± 9.4		51.2 ± 7.3	61.9 ± 8.7	58.7 ± 8.4	56.6 ± 8.9
	R2	75.1 ± 7.8		59.4 ± 8.2	68.6 ± 7.8	65.8 ± 7.6	64.8 ± 7.9
	TL	74.4 ± 7.2	74.4 ± 7.7	74.4 ± 7.7*†	75.7 ± 8.6*†	59.8 ± 8.7†	55.6 ± 9.5†
MAP	R1	91.5 ± 9.4		66.2 ± 7.3	76.9 ± 8.9	73.7 ± 8.4	71.6 ± 8.9
	R2	90.1 ± 7.8		74.4 ± 8.2	83.6 ± 7.8	80.8 ± 7.6	79.8 ± 7.4
	TL	89.4 ± 7.2	89.4 ± 7.7	88.2 ± 7.6*†	90.8 ± 8.7*†	74.7 ± 8.9†	70.6 ± 9.6†
HR	R1	73.9 ± 7.3		62.8 ± 8.1	64.2 ± 9.2	63.1 ± 7.6	61.2 ± 7.3
	R2	72.2 ± 6.6		64.2 ± 6.3	73.2 ± 7.6	65.2 ± 7.8	61.9 ± 6.9
	TL	74.9 ± 6.5	73.9 ± 5.5	67.9 ± 5.3*	74.5 ± 5.4*	71.9 ± 7.8*	68.9 ± 6.4*
RPP	R1	9005.4 ± 1434.8		6071.4 ± 1102.9	6886.3 ± 1324.8	6564.1 ± 1164.9	6323.2 ± 1288.3
	R2	8666.6 ± 968.8		6695.8 ± 816.3	8306.1 ± 989.8	7228.1 ± 1069.7	6688.3 ± 657.6
	TL	8948.5 ± 914.4	8832.6 ± 860.2	8043.5 ± 882.8*†	9008.4 ± 1105.1*†	7564.5 ± 1223.7*	6959.8 ± 1149.9

Data are presented as mean ± SD. R1: Remifentanil 1 μg kg^{-1}; R2: remifentanil 0.5 μg kg^{-1}; TL: tracheal lidocaine; EI: endotracheal intubation; SAP: systolic arterial blood pressure (mmHg); DAP: diastolic arterial blood pressure (mmHg); MAP: mean arterial blood pressure (mmHg); HR: heart rate (bpm). *$P < 0.05$ compared with R1 group. †$P < 0.05$ compared with R2 group.

between the TL and R1 groups. Just before endotracheal intubation, SAP, DAP, MAP, HR, and RPP were significantly lower than baseline in the R1 and R2 groups ($P < 0.05$) (Table 3). HR was significantly lower than baseline in the TL group just before endotracheal intubation ($P < 0.05$) (Table 3). HR decreased significantly (by 14.8%) in the R1 group ($P < 0.05$ vs. TL), and decreased by 11.2% in the R2 group and by 9.4% in the TL group.

Tracheal Intubation

One minute after endotracheal intubation, SAP, DAP, MAP, and RPP were significantly higher in the TL group than in the R1 group ($P < 0.05$), while these variables were comparable between the 2 groups at 3 and 5 min after laryngoscopy (Table 3). HR was significantly higher in the TL group than in the R1 group 1, 3, and 5 min after laryngoscopy ($P < 0.05$) (Table 3). The increases in MAP and RPP to above pre-intubation levels were significant in the R1 group, ($P < 0.05$) and the levels were significantly below baseline in the R1 and TL groups ($P < 0.05$) (Table 3). At the post-intubation time-point in the TL group, SAP, DAP, MAP, and RPP remained unchanged or decreased, as compared with their

pre-intubation levels. HR increased to above the pre-intubation level and was significant only in the R2 group (P < 0.05) (Table 3). HR increased to above the pre-intubation level and was not significantly different between the TL and R1 groups; the level reached was significantly below baseline only in the R1 group (P < 0.05) (Table 3). MAP increased to 13.5% above the pre-intubation level in the R1 group, to 16.7% above the pre-intubation level in R2, and to 3.4% above the pre-intubation level in TL (P < 0.05 vs. R1 and R2). The maximum MAP value was significantly higher in the TL group than in the R1 group (90.8 ± 8.6 vs. 78.2 ± 9.5, P < 0.05). The tracheal intubation maneuver caused HR to increase to 13.1% above the pre-intubation level in the R2 group (P < 0.05 vs. R1 and TL), to 8.8% above the pre-intubation level in the TL group (P > 0.05 vs. R2), and to 1.6% above the pre-intubation level in the R1 group (P < 0.05 vs. TL). The maximum HR value was significantly higher in the TL group than in the R1 group (75.7 ± 7.1 vs. 65.8 ± 8.9, P < 0.05). Additionally, the tracheal intubation maneuver caused HR to increase to above the baseline level by 1.4% in the R2 group (P <0.05 vs. R1), and to decrease below the baseline level by 1.1% and 13.5% in the TL and R1 groups, respectively (P < 0.05 R1 vs. TL and R2). The maximum RPP value was significantly higher in the TL group than in the R1 group (9026.6 ± 1111.9 vs. 7081.6 ± 1293.3, P < 0.05). Four patients in the R1 group, 2 patients in the R2 group, and none in the TL group had bradycardia or hypotension requiring treatment (P > 0.05).

Discussion

The present study compared the cardiovascular responses to endotracheal intubation after remifentanil infusion and tracheal lidocaine. This study shows that the direct application of lidocaine to the larynx and trachea more than 2 min before intubation attenuated the cardiovascular pressor response. In addition, the changes in blood pressure in the TL group were significantly different than those in the R1 group. Moreover, the present study shows that endotracheal intubation with tracheal lidocaine was not associated with an increased risk of hypotension during the induction of anesthesia.

Tracheal lidocaine blocked the cardiovascular responses to endotracheal intubation. Several studies have examined the efficacy of tracheal lidocaine for attenuation of the cardiovascular responses to endotracheal intubation. The results of these studies have been contradictory. Denlinger et al. (16) reported that a simple tracheal spray with lidocaine attenuated the hypertensive responses to endotracheal intubation when compared with a saline tracheal spray. Others reported that the application of topical anesthesia to the upper airway and trachea failed to prevent the pressor responses to endotracheal intubation (10,17,18). In the study by Denlinger et al. (16) endotracheal intubation was performed more than 2 min after a tracheal spray with local anesthetic, while endotracheal intubation was performed less than 1 min after topical anesthesia in the studies that reported that tracheal lidocaine was ineffective (10,17,18).

Results of the present study show that endotracheal intubation performed more than 2 min after tracheal lidocaine attenuated the cardiovascular responses to endotracheal intubation. The administration of lidocaine as an orolaryngeal spray before the induction of anesthesia might have been expected to modify the cardiovascular pressor response, partly as a result of topical anesthesia and partly because of systemic absorption of lidocaine.

Yusa et al. (21) reported that intratracheal lidocaine spray depresses the circulatory response to intubation via its local surface analgesic effect. The results of Takita et al. (15) show that endotracheal intubation performed 2 min after administration of tracheal lidocaine attenuates the cardiovascular responses to endotracheal intubation. In addition, Takita et al. (15) reported that endotracheal intubation with tracheal lidocaine is not associated with an increased risk of hypotension during the induction of anesthesia. This study suggests that tracheal lidocaine can enable a reduction in the dose of narcotics required to block the cardiovascular responses to endotracheal intubation, and may be a useful strategy when combined with other drugs to decrease the risk of hypotension or bradycardia.

We observed that a bolus dose of remifentanil 1 $\mu g\,kg^{-1}\,min^{-1}$ over 30 s followed by an infusion of 0.5 $\mu g\,kg^{-1}\,min^{-1}$ at induction of anesthesia attenuated hemodynamic response to orotracheal intubation. MAP decreased in all 3 groups after induction of anesthesia. This decrease was maximal in the remifentanil group and was associated with bradycardia.

Tracheal lidocaine (10%, 1.5 ml) sprayed 3 min after induction attenuated the bradycardia caused by remifentanil. The decrease in BP after induction of anesthesia was less significant in the TL group. Intubation had no significant effect on HR in the remifentanil or TL groups. Remifentanil significantly attenuated increases in HR after intubation, as compared to tracheal lidocaine. After intubation MAP did not change significantly in the R1 or TL groups, and did not exceed baseline pre-induction values. Hypotension and bradycardia associated with remifentanil have been reported by other researchers.

Schuttler and colleagues (22) compared remifentanil and alfentanil, using an induction drug combination and dosage for their remifentanil group similar to that used in the present study. All patients received either atropine or glycopyrrolate, and were pre-hydrated with a crystalloid solution (5 $\mu g\ kg^{-1}$) before induction of anesthesia. They reported that 53% of the patients had significant hypotension during surgery and 4% had significant bradycardia. However, the patients underwent major abdominal surgery and no distinction was made with respect to the timing of episodes or whether or not the etiologies were in fact surgery or drug related.

Two multicenter studies reported on the use of remifentanil as part of a total IV anesthesia regimen (23,24). Both studies used pre-hydration with a crystalloid solution, but a vagolytic agent was not given. Hogue et al. (23) reported a hypotension incidence rate of 10% upon induction of anesthesia with a dose of remifentanil identical to that used in the present study. In a second group that received a higher infusion rate (1 $\mu g\ kg^{-1}\,min^{-1}$) the incidence of hypotension was 15%, although the difference was not statistically significant. Bradycardia

occurred in 7% and 19% of patients, respectively, but this difference was not significant.

Philip et al. (24) also used a remifentanil bolus dose of 1 $\mu g\ kg^{-1}$ and an infusion of 0.5 $\mu g\ kg^{-1}$ after induction of anesthesia with propofol 2 $\mu g\ kg^{-1}$. In patients that underwent gynecological laparoscopic surgery they reported a 17% incidence of hypotension/bradycardia throughout the operative period, but no distinction was made between the induction and intubation phases. It is possible that pre-hydration or absence of a volatile anesthetic agent, or both, prevented the development of bradycardia and hypotension.

In the present study 13.3% of patients that received remifentanil had hypotension and bradycardia that required rescue medication. We observed no difference between a bolus dose of remifentanil 0.5 $\mu g\ kg^{-1}$, followed by infusion of 0.25 $\mu g\ kg^{-1}\,min^{-1}$ and treatment with twice these doses in attenuating the potential cardiovascular responses to laryngoscopy and orotracheal intubation. HR decreased after induction of anesthesia and remained significantly lower than in the TL group.

The pressor response reaches a peak 1-2 min after laryngoscopy and intubation, and usually subsides within 5-6 min, although tachycardia may persist for 10 min (25). The effect site half-life of a remifentanil bolus is only 3.2 min, and use of a bolus-infusion regimen is therefore rational (26).

Conclusion

Tracheal lidocaine was an effective method for attenuating the cardiovascular responses to endotracheal intubation and was not associated with an increased risk of hypotension. Endotracheal intubation should be performed more than 2 min after tracheal lidocaine is administered in order to attenuate the cardiovascular responses to endotracheal intubation. We observed only slight changes in HR and arterial pressure after laryngoscopy and tracheal intubation when remifentanil 1.0 or 0.5 $\mu g\ kg^{-1}$ IV was given over 30 s, followed by an infusion of 0.5 or 0.25 $\mu g\ kg^{-1}\,min^{-1}$ at induction of anesthesia in healthy patients. HR was higher in patients in whom endotracheal

intubation was performed more than 2 min after tracheal lidocaine was administered. Therefore, for attenuation of chronotropic response to tracheal

intubation, the remifentanil bolus and infusion dose described herein would be more effective than the tracheal lidocaine spray.

References

1. Shribman AJ, Smith G, Achola KJ. Cardiovascular and catecholamine response to laryngoscopy with and without endotracheal intubation. Br J Anaesth 1987; 59: 295-299.

2. Derbyshire DC, Chmielewski A, Fell D, Vater M, Achola K, Smith G. Plasma catecholamine response to tracheal intubation. Br J Anaesth 1983; 55: 855-859.

3. Russell WJ, Morris RG, Frewin DB, Drew SE. Changes in plasma catecholamine concentrations during endotracheal intubation. Br J Anaesth 1981; 53: 837-839.

4. Edwards DN, Alford AM, Dobson PMS, Peacock JE, Reilly CS. Myocardial ischaemia during tracheal intubation and extubation. Br J Anaesth 1994; 72: 537-539.

5. Fox EJ, Sklar GS, Hill CH, Villanueva R, King BD. Complications related to the pressor response to endotracheal intubation. Anesthesiology 1977; 47: 524-5.

6. Crawford DC, Fell D, Achola KJ, Smith G. Effects of alfentanil on the pressor and catecholamine responses to tracheal intubation. Br J Anaesth 1987; 59:707-712.

7. Stoelting RK. Attenuation of blood pressure response to laryngoscopy and tracheal intubation with sodium nitroprusside. Anesth Analg 1979; 58: 116-119.

8. Vucevic M, Purdy GM, Ellis FR. Esmolol hydrochloride for the management of the cardiovascular stress responses to laryngoscopy and tracheal intubation. Br J Anaesth 1992; 68: 529-530.

9. Mikawa K, Obara H, Kusunoki M. Effect of nicardipine on the cardiovascular response to tracheal intubation.Br J Anaesth 1990; 64: 240-2.

10. Hamill JF, Bedford RF, Weaver DC, Colohan AR. Lidocaine before endotracheal intubation: intravenous or laryngotracheal? Anesthesiology 1981; 55: 578-81.

11. Thompson JP, Rowbotham DJ. Remifentanilan opioid for the 21st century. Br J Anaesth 1996; 76: 341-343.

12. Thompson JP, Hall AP, Russell J, Cagney B, Rowbotham DJ. Effect of remifentanil on the haemodynamic response to orotracheal intubation. Br J Anaesth. 1998; 80: 467-9.

13. Hall AP, Thompson JP, Leslie NA, Fax AJ, Kumar N, Rowbotham DJ. Comparison of different doses of remifentanil on the cardiovascular response to laryngoscopy and tracheal intubation. Br J Anaesth 2000; 84: 100-2.

14. Wilhelm W, Biedler A, Huppert A, Kreuer S, Bücheler O, Ziegenfuss T et al. Comparison of the effects of remifentanil or fentanyl on anaesthetic induction characteristics of propofol, thiopental or etomidate. Eur J Anaesthesiol 2002; 19: 350-6.

15. Takita K, Morimoto Y, Kemmotsu O. Tracheal lidocaine attenuates the cardiovascular response to endotracheal intubation. Can J Anaesth 2001; 48: 732-6.

16. Denlinger JK, Ellison N, Ominsky AJ. Effects of intratracheal lidocaine on circulatory responses to tracheal intubation. Anesthesiology 1974; 41: 409-12.

17. Derbyshire DR, Smith G, Achola KJ. Effect of topical lignocaine on the sympathodrenal responses to tracheal intubation. Br J Anaesth 1987; 59: 300-4.

18. Mostafa SM, Murthy BVS, Barrett PJ, McHugh P. Comparison of the effects of topical lignocaine spray applied before or after induction of anesthesia on the pressor response to direct laryngoscopy and intubation. Eur J Anesthesiol 1999; 16: 7-10.

19. Glass PSA. Pharmacology of remifentanil. Eur J Anesthesiol 1995; 12(Suppl 10): 73-4.

20. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia 39: 1105, 1984

21. Yusa T, Taira Y, Sasara T, Yoza K. Effects of intratracheal lidocaine spray on circulatory responses to endotracheal intubation. Masui. 1990; 39: 1325-32.

22. Schüttler J, Albrecht S, Breivik H, Osnes S, Prys-Roberts C, Holder K. A comparison of remifentanil and alfentanil in patients undergoing major abdominal surgery. Anesthesia. 1997; 52: 307-17.

23. Hogue CW Jr, Bowdle TA, O'Leary C, Duncalf D, Miguel R, Pitts M. A multicenter evaluation of total intravenous anesthesia with remifentanil and propofol for elective inpatient surgery. Anesth Analg. 1996; 83: 279-85.

24. Philip BK, Scuderi PE, Chung F, Conahan TJ, Maurer W, Angel JJ. Remifentanil compared with alfentanil for ambulatory surgery using total intravenous anesthesia. The Remifentanil/Alfentanil Outpatient TIVA Group. Anesth Analg. 1997; 84: 515-21.

25. Singh H, Vichitvejpaisal P, Gaines GY, White PF. Comparative effects of lidocaine, esmolol, and nitroglycerin in modifying the hemodynamic response to laryngoscopy and intubation. J Clin Anesth. 1995; 7: 5-8

26. McAtamney D, O'Hare R, Hughes D, Carabine U, Mirakhur R. Evaluation of remifentanil for control of haemodynamic response to tracheal intubation. Anesthesia. 1998; 53: 1223-7.