

Comparison of Plastic Single-use and Metal Reusable Laryngoscope Blades for Orotracheal Intubation during Rapid Sequence Induction of Anesthesia

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Background: Plastic single-use laryngoscope blades are inexpensive and carry a lower risk of infection compared with metal reusable blades, but their efficiency during rapid sequence induction remains a matter of debate. The authors therefore compared plastic and metal blades during rapid sequence induction in a prospective randomized trial.

Methods: Two hundred eighty-four adult patients undergoing general anesthesia requiring rapid sequence induction were randomly assigned on a weekly basis to either plastic single-use or reusable metal blades (cluster randomization). After induction, a 60-s period was allowed to complete intubation. In the case of failed intubation, a second attempt was performed using metal blade. The primary endpoint of the study was the rate of failed intubations, and the secondary endpoint was the incidence of complications (oxygen desaturation, lung aspiration, and oropharynx trauma).

Results: Both groups were similar in their main characteristics, including risk factors for difficult intubation. On the first attempt, the rate of failed intubation was significantly increased in plastic blade group (17 vs. 3%; $P < 0.01$). In metal blade group, 50% of failed intubations were still difficult after the second attempt. In plastic blade group, all initial failed intubations were successfully intubated using metal blade, with an improvement in Cormack and Lehane grade. There was a significant increase in the complication rate in plastic group (15 vs. 6%; $P < 0.05$).

Conclusions: In rapid sequence induction of anesthesia, the plastic laryngoscope blade is less efficient than a metal blade and thus should not be recommended for use in this clinical setting.

THE plastic single-use laryngoscope blade is widely used in anesthesia. It is inexpensive¹ and reduces the risk of transmission of infection. In contrast, the reusable metal laryngoscope blade exposed to infected tissues during tracheal intubation procedures represents a potential risk of iatrogenic transmission of infectious diseases.^{2,3} As a consequence, plastic blades have been recommended for use in routine tracheal intubation.^{2,4,5}

In the case of an emergency case with a full stomach,

rapid sequence induction of anesthesia is indicated to protect the lung against lung aspiration. In this context, with use of a plastic blade, it is possible that an increased duration of laryngoscopy leads to an increase in the rate of lung aspiration and a decrease in the rate of successful intubation, related to its lower rigidity.^{1,6} However, plastic blades have never been evaluated in rapid sequence induction under emergency conditions. The aim of this prospective randomized study was to compare the performance of plastic and metal blades for orotracheal intubation during rapid sequence induction of anesthesia.

Materials and Methods

The study was approved by an ethics committee (Comité de Protection des Personnes se Prêtant à la Recherche Biomédicale Cochin-St Vincent de Paul, Paris, France). Because of emergency conditions and regular use in clinical practice of the two types of laryngoscope blades, only waived informed consent was authorized by ethics committee. Patients older than 18 yr undergoing general anesthesia and requiring a rapid sequence induction were included from November 2004 to July 2005. Exclusion criteria were contraindication to the medication used for induction, upper respiratory tract abnormalities, and history of a difficult tracheal intubation requiring an alternative to direct laryngoscopy. The following risk factors for difficult tracheal intubation were routinely recorded: modified Mallampati class, mouth opening, thyromental distance, immobilization of the neck with a Minerva or neck rigidity, short neck, macroglossia, buck teeth, retrognathism, facial cellulitis, pregnancy, and cervical hematoma.

Experimental Protocol

Forty-six anesthesiologists, 26 senior (7–20 yr of professional experience) and 20 junior anesthesiologists (minimal of 3 yr of professional experience in anesthesiology for a total of 5 yr of training), and nurse anesthetists (minimum of 5 yr of professional experience in anesthesiology) were recruited to participate in the study to minimize possible observer bias. All of them used plastic and metal blades in routine tracheal intubation. The whole emergency anesthesiologist team, constituted of 5 members (2 senior anesthesiologists, 2 junior anesthesiologists, and 1 nurse anesthetist), was changed each day. Determination of the type of blade

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Received from Department of Anesthesiology and Critical Care and the Department of Emergency Medicine and Surgery, Centre Hospitalier Universitaire Pitié-Salpêtrière, Assistance Publique-Hôpitaux de Paris, Université Pierre et Marie Curie (Paris 6), Paris, France. Submitted for publication July 28, 2005. Accepted for publication September 26, 2005. Support was provided solely from institutional and/or departmental sources.

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used was performed weekly using a cluster randomization, the randomized type of blade being used during 7 consecutive days. Standard Macintosh metal reusable blades (Heine classic+[®]; Heine, Herrshing, Germany) or single-use plastic blades (Lite-blade[®]; Rusch, Kernen, Germany) were used during a given 1-week period, 34 weeks being required to complete the study. The single-use Lite-blade[®] was selected because it has been reported as one of the best plastic blades available.^{1,7}

After preoxygenation with 100% of oxygen for 4 min or the time required to obtain an end-tidal fractional oxygen concentration above 90% by facemask, anesthesia was induced with 5 mg/kg thiopental (Nesdonal[®]; Abbott, Campoverde di Aprilia, Italy) or 0.4 mg/kg etomidate (Hypnomidate[®]; Jansen, Beerse, Belgium) followed by neuromuscular blockade using 1 mg/kg succinylcholine (Celocurine[®]; Pharmacia, Espoo, Finland). Etomidate was the induction agent of choice in elderly patients and in case of any hemodynamic instability. After muscle fasciculations had been observed, tracheal intubation was performed using endotracheal tube (Portex, Tijuana, Mexico) systematically associated with a stylet inside and cricoid pressure (Sellick maneuver). The size of the blade (3 or 4) and size of the endotracheal tube (7.0 to 8.0 mm ID) were selected in accordance with the anesthesiologist's preference. The height of the operating table was adjusted so that the patient's forehead was at the level of the anesthesiologist's xiphoid cartilage. The patient's head was extended in the "sniffing" position in patients without neck collar and spine trauma. The duration of intubation was defined as the time between the insertion of the laryngoscope blade into the mouth until the inflation of the endotracheal tube cuff. A 60-s period was allowed to complete the first tracheal intubation attempt. When a second attempt was required, it was performed systematically using a metal blade and over 60 s. The view of the glottis was assessed on each attempt and was scored according to the four visual grades of the Cormack and Lehane scale.⁸ If the trachea could not be intubated within 60 s on the second attempt, the protocol was discontinued, and the airway was managed according the difficult airway algorithm of the American Society of Anesthesiologists and French Society of Anesthesia and Intensive Care.^{9,10}

Data were kept secret throughout the study, and the analysis of data was performed after closure of the study. No interim analysis was performed.

Statistical Analysis

The primary endpoint was the failure to intubate the trachea within the first 60-s attempt. Sample size was determined assuming an α risk of 0.05, a β risk of 0.20, and an incidence of failed tracheal intubation in the metal blade group of 5%. A correction of the calculation was applied to take into account the cluster randomization (estimation 32 weeks), as previously described.¹¹

Therefore, we calculated that at least 137 patients per group would be required to identify an increase of failed intubation of up to 20% with a plastic blade.

Data are expressed as mean \pm SD. An intention-to-treat analysis was performed. Comparison between the two groups was performed using the Student *t* test and the Fisher exact method, when appropriate. Comparison of the Cormack and Lehane score on the first and second attempt was performed using the Mac Nemar test. The 95% confidence of the difference of proportions between groups was also calculated. All statistical comparisons were two tailed, and a *P* value of less than 0.05 was required to reject the null hypothesis. Statistical analysis was performed using a computer and NCSS 2001 software (Statistical Solutions Ltd., Cork, Ireland).

Results

During a 34-week period, 284 patients were included in the study (fig. 1). The two groups did not differ significantly in terms of baseline characteristics or difficult intubation criteria (table 1). According to the protocol guidelines, all successful tracheal intubation procedures lasted less than 60 s, and only failures went over 60 s.

The proportion of patients who could not be intubated during the first attempt was significantly ($P < 0.001$) greater in the plastic blade group (table 2). The difference in the failure rate between the two groups was 14% (95% confidence interval, 7–21%). Two failed intubations in the metal blade group and one in the plastic group occurred because the endotracheal tube was too wide or because of buck teeth. These failures were probably not related to the type of blade used (table 2). In the metal blade group, the two other cases of failed intubation on the first attempt were definitely difficult intubation cases requiring other techniques of tracheal intubation after a second failure attempt (fig. 1). In contrast, in the plastic group, the failed intubations were all successfully intubated on the second attempt with a metal blade within a significantly shorter time (30 ± 13 vs. 68 ± 17 s; $P < 0.001$) and with a lower Cormack and Lehane grade (fig. 2). The distribution of intubation failures with plastic blades was similar between nurse anesthetists and junior and senior anesthesiologists (19, 16, and 18%, respectively; not significant).

The occurrence of complications (oxygen desaturation $< 90\%$ requiring mask ventilation and thus exposing the patient to lung aspiration, and surface wounds of oropharynx) was significantly greater in the plastic group (table 2). The difference in the complication rate between the two groups was 9% (95% confidence interval, 2–16%). Two cases of lung aspiration were diagnosed during intubation in the plastic group. One of them was associated with failed intubation (table 2).

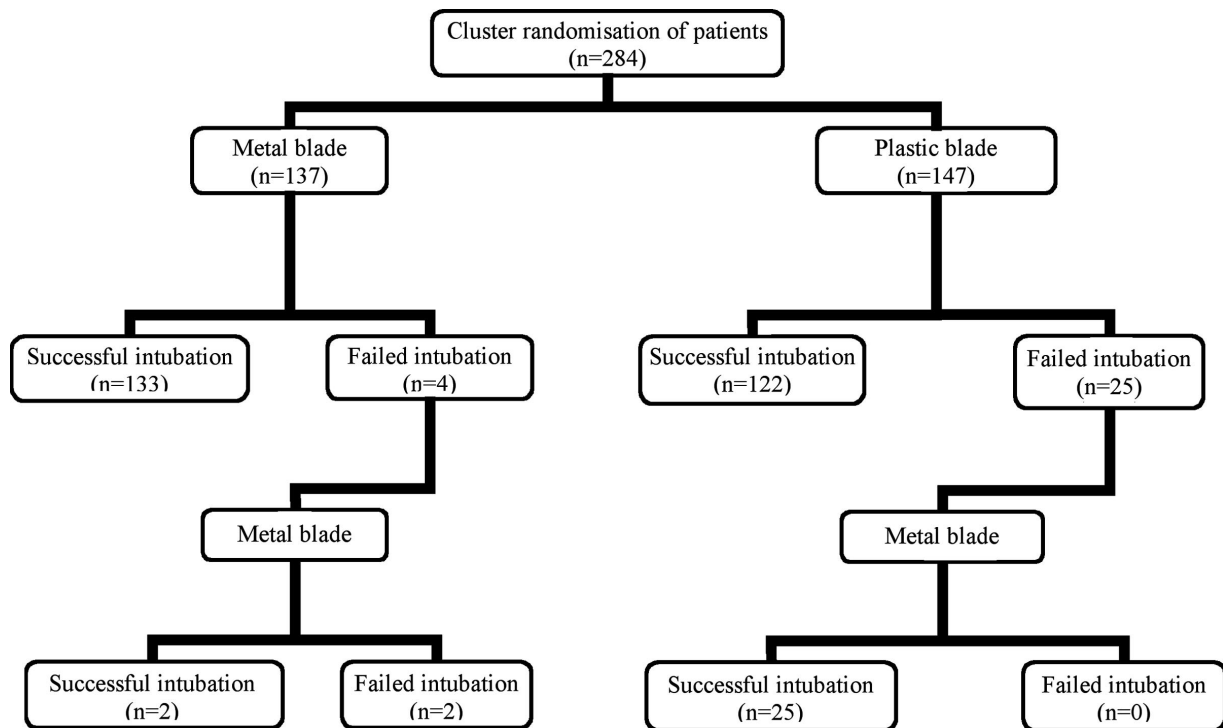


Fig. 1. Flow diagram of the study. The second attempt after failed intubation was performed systematically using a reusable metallic laryngoscope blade.

Discussion

This study showed that intubation failure was more frequent with a plastic single-use blade than with a metallic reusable blade in patients requiring a rapid sequence induction of anesthesia. In addition, there was a significant increase in the rate of complications related to the procedure when plastic blades were used.

Difficult tracheal intubation is a situation that is encountered infrequently by anesthesiologists but can lead to severe consequences for the patient. In our study, the failure rate using metal blades was 3%, which is in agreement with previous studies.^{7,12} This finding is in marked contrast with the use of plastic blades in rapid sequence induction, where a failure rate of 17% was observed. Moreover, all of the patients who had failed intubations with use of a plastic blade were successfully intubated on the second attempt, with use of a metal blade. The analysis of the Cormack and Lehane grade in these patients with previous failure also demonstrated an improvement in the laryngeal exposure with metal as compared with plastic blades (fig. 2).

Our results differed markedly from those of previous studies performed during scheduled surgery that did not use rapid sequence induction of anesthesia. In scheduled surgery conditions of induction of anesthesia in 100 patients, Asai *et al.*¹³ reported that a plastic blade was not significantly different from a reusable metal blade. However, most of these patients were easy to intubate. In contrast, Evans *et al.*⁶ reported that the efficiency was different according to the type of plastic blades used. Using

Table 1. Baseline Characteristics of Patients in the Metal Reusable Laryngoscope Blade and Plastic Single-use Laryngoscope Blade Groups

	Metal Group (n = 137)	Plastic Group (n = 147)
Age, yr	50 ± 22	47 ± 19
Men	77 (56%)	86 (59%)
Women	60 (44%)	61 (41%)
Body mass index, kg/m ²	24 ± 5	24 ± 4
Body mass index > 30 kg/m ²	14 (10%)	15 (10%)
Modified Mallampati score		
Class I or II	113	123
Class III or IV	21	17
Not assessable	3	7
Mouth opening, mm	43 ± 9	42 ± 9
Thyromental distance, mm	70 ± 17	70 ± 14
Associated criteria		
Immobilized neck or neck rigidity	11	12
Short neck	7	2
Macroglossia	3	2
Buck teeth	1	0
Retrognathism	1	4
Facial cellulitis	1	0
Pregnancy	2	0
Cervical hematoma	2	1
Any criteria	25 (18%)	17 (12%)
Anesthesia induction		
Thiopental	85 (62%)	94 (64%)
Etomidate	52 (38%)	54 (36%)
Intubation provider		
Nurse anesthetist	43 (31%)	32 (22%)
Junior anesthesiologist	67 (49%)	82 (56%)
Senior anesthesiologist	27 (20%)	33 (22%)

Data are expressed as mean ± SD or n (%). There were no significant differences between the two groups.

Table 2. Efficiency of the Reusable Metal Laryngoscope Blade and Single-use Plastic Laryngoscope Blade

	Metal Group	Plastic Group
First attempt	n = 137	n = 147
Number of failed intubations at first attempt	4 (3%)	25 (17%)*
Intubation time, s	29 ± 13	38 ± 20*
Cormack and Lehane score		
Grades 1 or 2	126 (92%)	115 (78%)†
Grade 3	8 (6%)	20 (14%)†
Grade 4	2 (2%)	12 (8%)†
Second attempt‡	n = 4	n = 25
Failed intubations after second attempt	2 (50%)	0 (0%)
Intubation time, s	106 ± 132	30 ± 13
Cormack and Lehane score		
Grades 1 or 2	2	21
Grade 3	0	4
Grade 4	2	0
Overall procedure	n = 137	n = 147
Complication		
Oxygen desaturation < 90%	8	20
Inhalation	0	2
Surface wound of oropharynx	0	2
Any complication	8 (6%)	22 (15%)†
Failed intubation requiring other techniques	2 (1%)	0 (0%)

Data are expressed as mean ± SD or n (%).

* $P < 0.01$ vs. metal group. † $P < 0.05$ vs. metal group. ‡ No statistical comparison was performed for variables on the second attempt because of the small sample size.

a manikin, Rassam *et al.*¹ tested 20 single-use blades and concluded that the Rüsch Lite-blade has one of the best performances, a result that was confirmed in other studies.^{7,14} This is why this plastic blade was chosen in our study for the plastic group. Despite this, our study demonstrated that the risk of failed intubation during rapid sequence induction of anesthesia was significantly greater with the plastic blade. We think that this poor performance is clinically unacceptable, at least when a rapid induction sequence is required. The results could have been even worse in the prehospital setting or in the emergency room, where conditions of intubation are more difficult.¹⁵⁻¹⁸

A number of hypotheses are possible to explain the

differences in rate of success for tracheal intubation observed between plastic and metal blades. First, insufficient rigidity of the plastic blade could explain the higher rate of failed intubation in such conditions. A previous study reported that the peak force exerted at laryngoscopy was greater using a plastic blade than with a metal blade (39.6 ± 16.2 vs. 32.8 ± 12.7 N).⁶ We confirmed these results because using a metal blade after initial failure with a plastic blade allowed significant improvement in laryngeal exposure (fig. 2) and thus successful intubation of the patients (table 2 and figs. 1 and 2). Second, rapid sequence induction of anesthesia requires the application of cricoid pressure. However, a recent randomized study using reusable metal blades demonstrated that the Sellick maneuver does not significantly increase the rate of failed intubations.¹⁹ The light intensity and the illumination of larynx are usually similar or better with a plastic rather than a metal blade.¹

Many emergency medical teams have already adopted the use of plastic laryngoscope blades either because of their low cost or for reduction of the risk of infection. However, in rapid sequence intubation under emergency conditions, we observed that the single-use plastic blades were less efficient in term of success rate of intubation and led to a slight increase in complications compared with metal blades. Therefore, plastic seems to be associated with potential dangerous hazards and thus should not be recommended in this clinical setting. To resolve the three issues of infection, cost, and efficiency, the single use metal laryngoscope blade could be the solution, but further studies are required to verify this hypothesis, particularly either in emergency situations or during rapid sequence intubation.

Several points should be mentioned regarding the potential limitations of our study. First, blinding of the investigators was not possible in this study because of the clear difference of aspect of the materials used in the two groups. Nevertheless, the assessors were not informed of the primary hypothesis of the study, data were

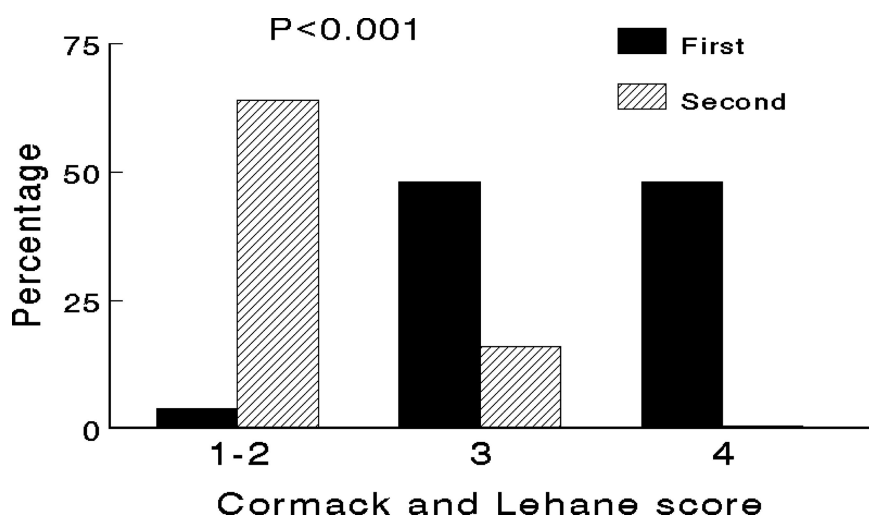


Fig. 2. Comparison of Cormack and Lehane grades repartition between the first attempt (plastic blade) and the second attempt (metallic blade) in patients from the plastic group with a failure to intubate on the first attempt. The difference was significant ($P < 0.001$).

kept secret throughout the study, and the data analysis was performed after closure of the study to limit the risk of observer bias. Second, the choice of the duration of intubation attempt of 60 s has not been well defined in the literature but was defined *a priori* because it seems to represent a reasonable duration for intubation during a rapid sequence. Third, neuromuscular blockade was not monitored. However, our objective study was to test both plastic and metal blades in real conditions of emergency in which monitoring of neuromuscular blockade is rarely performed, and we used succinylcholine in a manner and at a dose that represented four times the ED₉₅. That provides satisfactory intubation conditions in 98% of patients.²⁰ Last, junior anesthesiologists and nurse anesthetists were recruited to participate in the study in association with senior anesthesiologists. Nevertheless, the efficiency was found to be similar among these three groups, which represent the classic population of intubation providers in emergency and critical care departments.

In conclusion, single-use plastic blades, although proven to be efficient in routine scheduled surgery, are associated with a significantly higher rate of failure of tracheal intubation during rapid sequence induction of anesthesia and may increase the rate of complications in this clinical setting.

The authors thank all staff members of the Department of Anesthesiology and Amélie Liou, Pharm.D. (Department of Pharmacy, Centre Hospitalier Universitaire Pitié-Salpêtrière, Paris, France), who participated in the study, and David Baker, D.M., F.R.C.A. (Staff Anesthesiologist, Department of Anesthesiology, Centre Hospitalier Universitaire Necker-Enfants Malades, Paris, France), for reviewing the manuscript.

References

- Rassam S, Wilkes AR, Hall JE, Mecklenburgh JS: A comparison of 20 laryngoscope blades using an intubating manikin: Visual analogue scores and forces exerted during laryngoscopy. *Anaesthesia* 2005; 60:384-94
- Hirsch N, Beckett A, Collinge J, Scaravilli F, Tabrizi S, Berry S: Lymphocyte contamination of laryngoscope blades: A possible vector for transmission of variant Creutzfeldt-Jakob disease. *Anaesthesia* 2005; 60:664-7
- Foweraker JE: The laryngoscope as a potential source of cross-infection. *J Hosp Infect* 1995; 29:315-6
- Anderson KJ, Bhandal N: The effect of single use laryngoscopy equipment on illumination for tracheal intubation. *Anaesthesia* 2002; 57:773-7
- Laurenson IF, Whyte AS, Fox C, Babb JR: Contaminated surgical instruments and variant Creutzfeldt-Jakob disease (letter). *Lancet* 1999; 354:1823
- Evans A, Vaughan RS, Hall JE, Mecklenburgh J, Wilkes AR: A comparison of the forces exerted during laryngoscopy using disposable and non-disposable laryngoscope blades. *Anaesthesia* 2003; 58:869-73
- Fourmeret-Vivier A, Rousseau A, Shum J, Frenca S, Fargnoli JM, Mallaret MR: Evaluation des lames de laryngoscopes à usage unique. *Ann Fr Anesth Reanim* 2004; 23:694-9
- Cormack RS, Lehane J: Difficult tracheal intubation in obstetrics. *Anaesthesia* 1984; 39:1105-11
- Practice guidelines for management of the difficult airway: An updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. *ANESTHESIOLOGY* 2003; 98:1269-77
- Boisson-Bertrand D, Bourgain JL, Cambouliès J, Crinquette V, Cros AM, Dubreuil M, Eurin B, Haberer JP, Pottecher T, Thorin D, Ravussin P, Riou B: Intubation difficile. Société Française d'Anesthésie-Réanimation. Conférence d'experts. *Ann Fr Anesth Reanim* 1996; 15:207-14
- Kerry S, Bland J: The intracluster correlation coefficient in cluster randomisation. *BMJ* 1998; 316:1445-60
- McIntyre JW: The difficult tracheal intubation. *Can J Anaesth* 1987; 34:204-13
- Asai T, Uchiyama Y, Yamamoto K, Johmura S, Shingu K: Evaluation of the disposable Vital View laryngoscope apparatus. *Anaesthesia* 2001; 56:342-5
- Twigg SJ, McCormick B, Cook TM: Randomized evaluation of the performance of single-use laryngoscopes in simulated easy and difficult intubation. *Br J Anaesth* 2003; 90:8-13
- Deakin C, Peters R, Tomlinson P, Cassidy M: Securing the prehospital airway: a comparison of laryngeal mask insertion and endotracheal intubation by UK paramedics. *Emerg Med J* 2005; 22:64-7
- Slagt C, Zondervan A, Patka P, de Lange J: A retrospective analysis of the intubations performed during 5 years of helicopter emergency medical service in Amsterdam. *Air Med J* 2004; 23:36-7
- Reid C, Chan L, Tweeddale M: The who, where, and what of rapid sequence intubation: Prospective observational study of emergency RSI outside the operating theatre. *Emerg Med J* 2004; 21:296-301
- Peterson GN, Domino KB, Caplan RA, Posner KL, Lee LA, Cheney FW: Management of the difficult airway: A closed claims analysis. *ANESTHESIOLOGY* 2005; 103:33-9
- Turgeon AF, Nicole PC, Trepanier CA, Marcoux S, Lessard MR: Cricoid pressure does not increase the rate of failed intubation by direct laryngoscopy in adults. *ANESTHESIOLOGY* 2005; 102:315-9
- Naguib M, Samarkandi A, Riad W, Alharby SW: Optimal dose of succinylcholine revisited. *ANESTHESIOLOGY* 2003; 99:1045-9