



SCIENTIFIC ARTICLE

## Nondepolarizing muscle relaxant improves direct laryngoscopy view with no effect on face mask ventilation

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### KEYWORDS

Nondepolarizing muscle relaxants;  
Laryngoscopy view;  
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### Abstract

**Background:** Difficult or impossible face mask ventilation complicated with difficult tracheal intubation during anesthesia induction occurs in 0.4% of adult anesthesia cases, possibly leading to life-threatening complications. Because of such catastrophes, muscle relaxants have been recommended to be administered after confirming adequate face mask ventilation without a solid scientific validation of this principal.

**Methods:** In this observational study, the ease of ventilation and the scores of direct laryngoscopy views before and after administration of cisatracurium were assessed in ninety young healthy adults, without anesthetic risks and without foreseen difficult intubation and who were scheduled for general elective surgeries.

**Results:** Before muscle relaxation, 43 patients (48%) were Cormack Grade I, while the remaining 47 patients (52%) were either Cormack Grade II (28 patients, 31%) or Cormack Grade III (19 patients, 21%). Following muscle relaxation with cisatracurium, the number of patients with Cormack Grade I significantly increased from 43 patients (48%) to 65 patients (72%) ( $p = 0.0013$ ). Only 1 patient out of 19 patients (5%) improved his Cormack grade from Grade III to Grade I while 16 out of 19 patients (84%) improved their Cormack grade from Grade III to Grade II after the use of cisatracurium. The quality of face mask ventilation did not differ with and without muscle relaxants in all patients.

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## PALAVRAS-CHAVE

Relaxantes musculares não despolarizantes; Visibilidade em laringoscopia; Ventilação via máscara facial

**Conclusion:** The use of cisatracurium in healthy young adults undergoing general elective surgeries with no anticipated difficult endotracheal intubation had no effect on the quality of face mask ventilation despite resulting in a quantifiable improvement in the laryngeal view.

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## Relaxantes musculares não despolarizantes melhoram a visibilidade em laringoscopia direta sem efeito sobre a ventilação via máscara facial

### Resumo

**Justificativa:** A ventilação difícil ou impossível via máscara facial complicada pela intubação traqueal difícil durante a indução da anestesia ocorre em 0,4% dos casos de anestesia em adultos, possivelmente levando a complicações fatais. Devido a tais catástrofes, recomendou-se que a administração de relaxantes musculares seja feita após a confirmação de ventilação adequada via máscara facial, sem uma validação científica sólida dessa conduta.

**Métodos:** Neste estudo observacional, a facilidade de ventilação e os escores de visibilidade em laringoscopia direta antes e após a administração de cisatracúrio foram avaliados em 90 adultos jovens e saudáveis, sem riscos anestésicos e sem intubação difícil prevista, agendados para cirurgias eletivas gerais.

**Resultados:** Antes do relaxamento muscular, 43 pacientes (48%) eram Cormack Grau I, enquanto os 47 pacientes (52%) restantes eram ou Cormack Grau II (28 pacientes, 31%) ou Cormack Grade III (19 pacientes, 21%). Após o relaxamento muscular com cisatracúrio, o número de pacientes com Cormack Grau I aumentou significativamente de 43 (48%) para 65 pacientes (72%) ( $p=0,0013$ ). Apenas um paciente (5%) dos 19 melhorou sua classificação de Cormack do Grau III para o Grau I, enquanto 16 dos 19 pacientes (84%) melhoraram suas classificações de Cormack do Grau III para o grau II após o uso de cisatracúrio. A qualidade da ventilação via máscara facial não diferiu com ou sem relaxantes musculares em todos os pacientes.

**Conclusão:** O uso de cisatracúrio em adultos jovens saudáveis submetidos a cirurgias eletivas gerais sem intubação traqueal difícil prevista não teve efeito sobre a qualidade da ventilação via máscara facial, mesmo resultando em melhora quantificável da visibilidade da laringe.

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## Introduction

Adequate Facemask Ventilation (FMV) and tracheal intubation are the most fundamental and important skills for safe airway management during anesthesia induction. Difficult or impossible FMV combined with difficult tracheal intubation during anesthesia induction occurs in approximately 0.4% of adult anesthesia cases, leading to life-threatening complications.<sup>1</sup> Because of possible development of such catastrophes, administration of muscle relaxants has been recommended after confirming adequate FMV.<sup>2,3</sup>

Recently, Ikeda et al. showed that nondepolarizing muscle relaxants did not impact FMV in anesthetized patients with normal upper airway anatomy.<sup>4</sup> Furthermore, additional evidence suggest that muscle relaxants not only did not influence FMV in anesthetized subjects with normal upper airway anatomy, but nevertheless it improved the intubating conditions.<sup>5,6</sup>

The aim of this study is to compare the ease of ventilation as well as to grade the laryngoscopic view assessed by the Cormack-Lehane<sup>7,8</sup> score in the same patients before and after administration of nondepolarizing muscle relaxants during general elective surgeries.

## Materials and methods

Ethical approvals for this study (Ethical Committee n° ANES.CA.06) were provided by the Ethical Committees of the American University of Beirut (Chairperson Prof. Fuad Ziyadeh) on 19 December 2011 and the Lebanese American University (Ethical Committee n° UMCRRH.VA3.17/Apr/12; Chairperson Prof. Costantine Daher) on 17 April 2012. Written informed consent was obtained from all the study participants. Ninety consecutive adult patients who were between 18 and 60 years old, with American Society of Anesthesiologists physical status I or II who required general anesthesia with orotracheal intubation for elective orthopedic, gynecologic or abdominal surgery were enrolled in this cohort prospective observational study. Exclusion criteria included patients with cardiovascular, respiratory, hepatic, renal, neuromuscular diseases or American Society of Anesthesiologists physical status III, IV, or V. Uncooperative patients, those with a history of gastroesophageal reflux or having an increased risk of aspiration and patients with coagulation disorders were also excluded. Patients with congenital or acquired abnormalities of the upper airway, tumors, polyps, trauma, abscesses, inflammation, or foreign

**Table 1** Criteria for the assessment of the quality of face mask ventilation.

<i>Easy</i>
SpO <sub>2</sub> > 97%
One hand technique
Good chest rise
<i>Difficult</i>
Important gas flow leak by the face mask
↑ gas flow above 15 L/min and use of O <sub>2</sub> flush valve > 2 times
No perceptible chest movement
2 handed mask ventilation technique
Change of operator required
<i>Impossible</i>
Need an alternative to FMV in emergency condition to maintain SpO <sub>2</sub> > 90%

bodies in the upper airway were not enrolled in the study.

During the preoperative visit, a staff anesthesiologist noted the age, sex, weight, height, and Mallampati classification as modified by Samssoon and Young and performed with the patient in the sitting position with the head in full extension, tongue out and with phonation.<sup>9</sup> The thyromental distance was measured with the patient in sitting position and head in extension. The mouth opening was measured as the interincisor distance.<sup>10</sup> In addition, the anesthesiologist's subjective assessment of anticipated Difficult Mask Ventilation (DMV) was also noted. This subjective assessment included presence or absence of macroglossia, receding mandible, lack of teeth, the presence of beard and if the patient is a snorer or not.<sup>11</sup>

On the day of surgery and upon arrival to the operating room, all patients were placed in the "sniffing position" with their head placed on a pillow, connected to standard monitoring devices and breathed 100% oxygen until the end-tidal oxygen concentration reached 90%. Values of noninvasive arterial blood pressure, heart rate, and oxyhemoglobin saturation were initially obtained as baseline and then measured every 3 minutes throughout induction of anesthesia. Anesthesia was induced with midazolam 30 mcg/kg<sup>-1</sup>, 1–2 mcg/kg<sup>-1</sup> of fentanyl intravenously injected in 60s, followed by 2 mg/kg<sup>-1</sup> of propofol intravenously injected within 30s and the lungs were manually ventilated through a face mask using 2% sevoflurane in oxygen. Following induction of anesthesia, FMV was assessed using the mask ventilation scale adapted from Langeron et al. as "Easy", "Difficult" or "Impossible" (Table 1).<sup>11</sup> At least on item of the respective list should be encountered to classify mask ventilation as "Easy" or "Difficult". After approximately 4 min, an independent anesthesiologist, not involved in the study, performed an initial direct laryngoscopy using a classic metal Macintosh (Heine Optotechnik GmbH & Co. KG, Herrsching, Germany) blade III, without attempts of intubation. Laryngoscopic view was scored according to the Cormack & Lehane (C&L) grading system where Grade I indicates that most of the glottis is seen and Grade 4 indicates that neither epiglottis nor glottis can be seen. After withdrawal of the blade, cisatracurium

**Table 2** Patients characteristics.

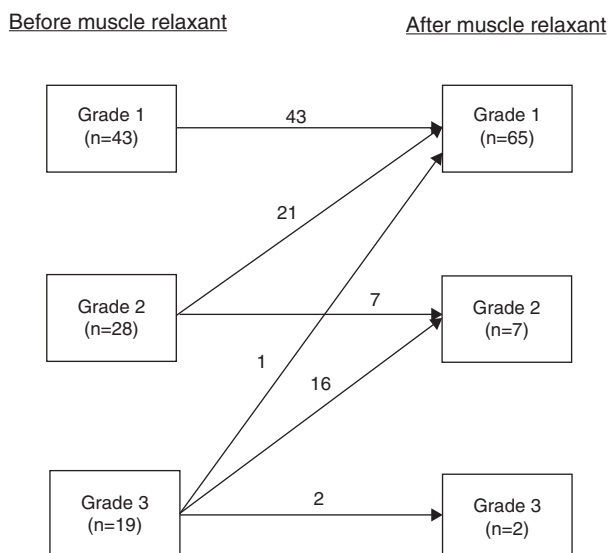
Age (yrs)	47 ± 18
Weight (kg)	74 ± 16
Height (cm)	168 ± 8
Body mass index (kg/m <sup>2</sup> )	26 ± 5
Male/female	42/48
Mouth opening (mm)	45 ± 6
Thyromental distance (mm)	53 ± 14
Mallampati class (n)	
1	31
2	37
3	22
4	0
Cormack & Lehane Grade (n)	
I	43
II	28
III	19
IV	0
Difficult mask ventilation risk factors (yes/no)	
Macroglossia	13/77
Receding mandible	5/85
Lack of teeth	9/81
Beard	8/82
Snoring	15/75

0.15 mg/kg was administered. Following confirmation of an adequate neuromuscular blockade (train-of-four monitoring), a second independent anesthesiologist was called in to ventilate the patient using the same face mask for an additional 4 min after which FMV was again assessed.<sup>11</sup> Then the glottis was visualized and again scored according to C&L grading system. Finally, the anesthesia managing team assigned to the patient performed the intubation using the same metal Macintosh blade used in the previous airway assessments. All anesthesiologists involved in the study were senior staff and well experienced anesthesiologists.

The quality of face mask ventilation as well as the grading of the laryngoscopic view were analyzed and compared with the chi-squared test. Statistical significance was considered at  $p < 0.05$ . Based on our experience and previously published data, the percentage of patients with Cormack II, III, or IV is about 50%.<sup>12</sup> Considering a Type I error of 5%, Type II error of 10%, a statistical significance level of 5%, and a reduction in the percentage Cormack II, III, and IV grade from 50% to 35%, a power analysis indicated that at least 85 patients will be needed. Our intention is to include 90 patients in the study.

## Results

A total of 90 patients were identified and recruited into the study. Patients' enrollment started as of May 15, 2012. Patients' demographics and characteristics are presented in Table 2. Before muscle relaxation with cisatracurium, 43 patients (48%) were Cormack Grade I, while the remaining 47 patients (52%) were either Cormack Grades II (28 patients, 31%) or Cormack Grade III (19 patients, 21%). Following the use of cisatracurium, the number of patients with Cormack



**Figure 1** Changes in Cormack & Lehane grades of the laryngeal view after the administration of non-depolarizing muscle relaxant.

Grade I significantly increased from 43 patients (48%) to 65 patients (72%) ( $p = 0.0013$ ) (Fig. 1). Almost all of this increase in the number of patients with Cormack Grade I after the use of cisatracurium resulted from improving the Cormack grade in 21 patients out of 28 patients (75%) from Cormack Grade II to Grade I. Only 1 out of 19 patients (5%) improved the Cormack grade from Grade III to Grade I after the use of cisatracurium. Furthermore, 16 patients (84%) improved their Cormack grade from Grade III to grade II while the remaining 2 patients maintained their Cormack Grade III (Fig. 1).

There were no significant changes in the quality of mask ventilation for patients with Cormack Grade I before (93% easy; 7% difficult; 0% impossible) compared to after (98% easy; 2% difficult; 0% impossible) the use of cisatracurium ( $p = 0.299$ ). Similarly, no statistically significant differences were observed in the quality of mask ventilation for patients with Cormack Grade II or III before (68% easy; 32% difficult; 0% impossible) compared to after (60% easy; 40% difficult; 0% impossible) the use of cisatracurium ( $p = 0.605$ ).

## Discussion

In the current study, we showed that the use of Nondepolarizing Muscle Relaxant (NDMR) did not affect the ease of face mask ventilation; however, there was a quantifiable improvement in the laryngeal view. In fact, the use of nondepolarizing muscle relaxant resulted in a 1 grade improvement of the laryngeal view in a significant number of patients who were initially scored as a Cormack & Lehane Grade II and III prior to the use of the relaxant.

The effect of administration of NDMR on the ease of mask ventilation is controversial. Full neuromuscular blockade might facilitate mask ventilation by increasing chest wall compliance or by reducing upper airway tone<sup>13</sup>; alternatively, it could make mask ventilation more difficult by inducing upper airway collapse.<sup>14,15</sup> In accordance with

Ikeda et al., our data showed that FMV was not significantly affected with the use of NDMR.<sup>4</sup> We observed only a minimal and non-significant increase in the percentage of patients with C&L Grade I who were easy to ventilate before (93% of patients) and after (98% of patients) administration of NDMR. Furthermore, patients with C&L Grades II and III exhibited a statistically non-significant trend toward a change in the quality of FMV before (68% easy, 32% difficult) and after (60% easy, 40% difficult) administration of NDMR. The non-significant increase in the percentage of difficult FMV in patients with C&L Grades II and III before (32%) and after (40%) NDMR could be attributed to the relaxation of the oropharyngeal muscles and subsequent obstruction of the submandibular tissues, in an already group of patients predisposed (i.e., C&L II and III) to difficult FMV. It is worth mentioning that impossible FMV was not encountered in our patient population before and after administration of NDMR similar to previous studies.<sup>3,15,16</sup>

Similar to previous findings reported by Baillard et al., our current study confirms that the use of NDMR may improve the intubation conditions secondary to the improvement in the Cormack & Lehane scoring of the laryngeal view following the administration of NDMR.<sup>17</sup> Furthermore, other studies also confirmed improvement in the laryngeal view and intubation conditions following the administration of NDMR.<sup>18–20</sup> However, none of these studies provided neither quantitative changes in the scoring of the laryngeal view, nor plausible mechanisms for the reported improvements. Our study clearly shows that the use of NDMR prior to intubation improved the C&L Grade by 1 grade in 75% of patients with Grade II and 84% of patients with Grade III. Of clinical interest, in our study, none of the patients worsened their laryngeal view following the use of NDMR (Fig. 1). We postulate that the improvement in the C&L grade is mainly due to two separate mechanisms. First, the use of NDMR will result in the loss of muscle contraction and a subsequent increase in the compliance of the submandibular tissues. These tissues will be easier compressed into the available submandibular space, and the laryngeal exposure will become adequate and easy to manipulate by the laryngoscopist with minimal exerted force and torque efforts.<sup>21,22</sup> Second, with the use of NDMR, the relaxation of the masticatory muscles responsible for approximately the first 25 mm of the mouth opening will contribute to the improvement of the retropalatal and velopharyngeal airway that is considered essential part of the effective dynamic phase of direct laryngoscopy.<sup>21</sup> However, it seems that the effects of NDMR on the laryngeal views are not dramatic as evidenced by the fact that in the current study, only one patient (5%) who was initially C&L Grade III had greater than 1 grade change in the C&L score (Fig. 1).

Few limitations related to our study need to be mentioned. First, our study was performed on healthy and relatively young patients with normal airways and with no known risk factors for difficult ventilation or intubation undergoing elective surgical procedures. Accordingly, our results may not be generalized to an older population or to a population with known history of difficult airway where awake intubation is indicated.

In our study, each patient served as his/her own control. It might be argued that a randomized study design could have been a superior design to test our hypothesis;



however we strongly believe that having the patient as his/her own control will significantly reduce potential confounding factors particularly the anatomical features that could have influenced the changes seen or not seen in the ease of ventilation as well as the scoring of the direct laryngoscopy view from before to after administration of the nondepolarizing muscle relaxant. Assessing the ease of ventilation and the Cormack and Lehane grade before and after administration of the nondepolarizing muscle relaxant in the same patient is more helpful in identifying and quantifying the changes seen as a result of the administration of NDMR.

## Conclusion

In conclusion, our study confirms that NDMR have no effect on the ease of face mask ventilation despite a quantifiable improvement in the laryngeal view. In general, nondepolarizing muscle relaxants can improve the laryngeal view by 1 grade as per the C&L classification.

## Conflicts of interest

The authors declare no conflicts of interest.

## References

1. Kheterpal S, Han R, Tremper KK, et al. Incidence and predictors of difficult and impossible mask ventilation. *Anesthesiology*. 2006;105:885–91.
2. Calder I, Yentis SM. Could 'safe practice' be compromising safe practice? Should anaesthetists have to demonstrate that face mask ventilation is possible before giving a neuromuscular blocker? *Anaesthesia*. 2008;63:113–5.
3. Pandit JJ. Checking the ability to mask ventilate before administering long-acting neuromuscular blocking drugs. *Anaesthesia*. 2011;66:520–2.
4. Ikeda A, Isono S, Sato Y, et al. Effects of muscle relaxants on mask ventilation in anesthetized persons with normal upper airway anatomy. *Anesthesiology*. 2012;117:487–93.
5. Goodwin MW, Pandit JJ, Hames K, Popat M, Yentis SM. The effect of neuromuscular blockade on the efficiency of mask ventilation of the lungs. *Anaesthesia*. 2003;58:60–3.
6. Combes X, Andriamifidy L, Dufresne E, et al. Comparison of two induction regimens using or not using muscle relaxant: impact on postoperative upper airway discomfort. *Br J Anaesth*. 2007;2:276–81.
7. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. *Anaesthesia*. 1984;39:1105–11.
8. Yentis SM, Lee DJ. Evaluation of an improved scoring system for the grading of direct laryngoscopy. *Anaesthesia*. 1998;53:1041–4.
9. Samsoun GL, Young JR. Difficult tracheal intubation: a retrospective study. *Anaesthesia*. 1987;42:487–90.
10. Wilson ME, Spiegelhalter D, Roberston JA, Lesser P. Predicting difficult intubation. *Br J Anaesth*. 1998;61:211–6.
11. Langeron O, Masso E, Huraux C, et al. Prediction of difficult mask ventilation. *Anesthesiology*. 2000;92:1229–36.
12. Gupta A, Sharma B, Kumar A, Sood J. Improvement in Cormack and Lehane grading with laparoscopic assistance during tracheal intubation. *Indian J Anaesth*. 2011;55:508–12.
13. Abrams JT, Horrow JC, Bennett JA, Van Riper D, Storella RJ. Upper airway closure. A primary source of difficult ventilation with sufentanil induction of anesthesia. *Anesth Analg*. 1996;83:629–32.
14. Odeh M, Schnall R, Gavriely N, Oliven A. Effect of upper airway muscle contraction on supraglottic resistance and stability. *Respir Physiol*. 1993;92:139–50.
15. Van Lunteren E, Strohl KP. The muscles of the upper airways. *Clin Chest Med*. 1986;7:171–88.
16. Warters RD, Szabo TA, Spinale FG, DeSantis SM, Reves JG. The effect of neuromuscular blockade on mask ventilation. *Anaesthesia*. 2011;66:163–7.
17. Baillard C, Adnet F, Borron SW, et al. Tracheal intubation in routine practice with and without muscular relaxation: an observational study. *Eur J Anaesth*. 2005;22:672–7.
18. Sivarajan M, Joy JV. Effects of general anesthesia and paralysis on upper airway changes due to head position in humans. *Anesthesiology*. 1996;85:787–93.
19. Alexander R, Olufolabi AJ, Booth J, El-Moalem HE, Glass PS. Dosing study of remifentanyl and propofol for tracheal intubation without the use of muscle relaxants. *Anaesthesia*. 1999;54:1037–40.
20. Trabold F, Casetta M, Duranteau J, et al. Propofol and remifentanyl for intubation without muscle relaxant: the effect of the order of injection. *Acta Anaesthesiol Scand*. 2004;48:35–9.
21. Greenland KB. A proposed model for direct laryngoscopy and tracheal intubation. *Anaesthesia*. 2008;63:156–61.
22. Hastings RH, Marks JD. Airway Management for trauma patients with potential cervical injuries. *Anesth Analg*. 1991;73:471–82.