REPORTS OF ORIGINAL INVESTIGATIONS

Topical lidocaine improves conditions for laryngeal mask airway insertion

La lidocaïne topique améliore les conditions d'insertion du masque laryngé

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Abstract

Purpose We hypothesized that optimal laryngeal mask airway (LMA^{TM}) insertion conditions might be achieved with topical lidocaine and a smaller dose of propofol. In this study, insertion conditions after topical lidocaine 40 mg followed by propofol 2 mg·kg^{-1} were compared with propofol 2 mg·kg^{-1} or propofol 3 mg·kg^{-1} alone.

Methods Ninety patients were recruited for this randomized prospective double-blind study. One group received four sprays of topical lidocaine (40 mg) over the posterior pharyngeal wall followed by propofol 2 mg·kg^{-1} (Group 2PL; n = 30). The other two groups received four sprays of 0.9% normal saline followed by propofol 2 mg·kg^{-1} (Group 2P; n = 30) or by propofol 3 mg·kg^{-1} (Group 3P; n = 30). The frequency of optimal insertion conditions (successful insertion at the first attempt without adverse responses) and side effects were recorded.

Results The frequency of optimal insertion conditions was greater in Group 2PL (20/30, 67%) and Group 3P (22/30, 73%) than in Group 2P (11/20, 37%) (P = 0.009). In Group 3P, the mean blood pressure was lower than in the other groups prior to LMA-Classic^{TM} insertion (P = 0.003) but was similar after insertion. The incidence of apnea was greater in Group 3P patients (17/30, 57%) than in Group 2P (2/30, 7%) or Group 2PL patients (1/30, 3%) (P < 0.001).

Conclusion Topical lidocaine 40 mg followed by propofol 2 mg·kg^{-1} can provide optimal insertion conditions of the LMA-Classic comparable to those of propofol 3 mg·kg^{-1}, with fewer hemodynamic changes and a lower incidence of apnea.

Résumé

Objectif Nous avons émis l'hypothèse que des conditions optimales d'insertion du masque laryngé (LMA^{TM}) pourraient être créées grâce à l'utilisation de lidocaïne topique et une dose moindre de propofol. Dans cette étude, nous avons comparé les conditions d'insertion après 40 mg de lidocaïne topique puis 2 mg·kg^{-1} de propofol, avec 2 mg·kg^{-1} de propofol ou 3 mg·kg^{-1} de propofol sans lidocaïne topique.

Méthode Quatre-vingt-dix patients ont été recrutés dans cette étude prospective randomisée à double insu. Un groupe a reçu quatre pulvérisations de lidocaïne topique (40 mg) sur la paroi pharyngée postérieure, puis 2 mg·kg^{-1} de propofol (groupe 2PL; n = 30). Les deux autres groupes ont reçu quatre pulvérisations de sérum physiologique à 0,9 %, puis 2 mg·kg^{-1} de propofol (groupe 2P; n = 30) ou 3 mg·kg^{-1} de propofol (groupe 3P; n = 30). La fréquence de conditions d'insertion optimales (insertion réussie à la première tentative sans réaction négative) et les effets secondaires ont été enregistrés.

Résultats La fréquence de conditions d'insertion optimales était plus élevée dans le groupe 2PL (20/30, 67 %) et le groupe 3P (22/30, 73 %) que dans le groupe 2P (11/30, 37 %) (P = 0,009). Dans le groupe 3P, la tension

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artérielle moyenne était plus basse que dans les autres groupes avant l'insertion du masque laryngé LMA-Classic™ (P = 0,003) mais semblable après l'insertion. L'incidence d'apnée était plus élevée dans le groupe 3P (17/30, 57 %) que dans les groupes 2P (2/30, 7 %) ou 2PL (1/30, 3 %) (P < 0,001).

Conclusion *L'application de 40 mg de lidocaïne topique suivie par 2 mg·kg⁻¹ de propofol peut créer des conditions optimales pour l'insertion du LMA-Classic. Ces conditions sont comparables à celles obtenues lors de l'administration de 3 mg·kg⁻¹ de propofol, avec moins de changements hémodynamiques et une incidence d'apnée réduite.*

The laryngeal mask airway (LMA™) is widely used during minor or ambulatory surgery in spontaneously breathing patients. Among induction agents, propofol is often used to facilitate LMA insertion because it depresses airway reflexes effectively[1] and makes early recovery possible.[2] A propofol dose ranging from 2.5 to 3 mg·kg⁻¹ is recommended for LMA insertion,[3] but insertion of the device is not always smooth in unpremedicated patients. Larger doses of propofol carry the risk of cardiorespiratory depression. In an effort to improve the insertion conditions without increasing the dose of propofol, short-acting opioids, muscle relaxants, or midazolam may be co-administered with propofol to facilitate LMA insertion.[4-6]

Intravenous lidocaine is known to suppress cough reflexes and reduce cardiovascular responses associated with tracheal intubation.[7] Its use prior to induction has been reported to improve LMA insertion conditions,[8,9] but not to reduce propofol requirements.[6,9] Compared with lidocaine 1.5 mg·kg⁻¹ *iv*, the spraying of topical lidocaine 40 mg over the posterior pharyngeal wall has been shown to result in fewer airway incidents and LMA insertion failures in patients receiving thiopental as the induction agent.[10] The finding led us to hypothesize that the application of topical lidocaine might effectively reduce the dose of propofol required for smooth LMA insertion. In a double-blind randomized trial to test this hypothesis, we compared the LMA-Classic™ insertion conditions after the combination of topical lidocaine 40 mg and propofol 2 mg·kg⁻¹ with the insertion conditions of propofol 2 mg·kg⁻¹ or propofol 3 mg·kg⁻¹ alone. We further compared the incidence of apnea and hemodynamic changes during anesthesia induction.

Methods

This was a randomized prospective double-blind study, and the experimental protocol was approved by the Institutional Ethics Committee of the authors' institution. Written informed consent was obtained from each patient involved in the study. We enrolled 90 American Society of Anesthesiologists (ASA) physical status I-II patients aged 18-65 yr undergoing elective surgery, for whom a laryngeal mask was the airway of choice. Patients were excluded from the study if they had a history of gastroesophageal reflux, a history of allergy to the study drugs, or if they were taking any sedative drugs that would influence the anesthesia induction.

Using a computer-generated table of random numbers managed by one of the authors (V.C.H.L.), the patients were randomly assigned to one of three groups using a sealed envelope in the operating room. One group received two sprays of topical lidocaine (10% Xylocaine®) (AstraZeneca, Sweden) on each side of the posterior pharynx wall (40 mg, 10 mg per spray) three minutes before the induction of anesthesia with propofol 2 mg·kg⁻¹ *iv* (Group 2PL, n = 30). The other groups were given four sprays of 0.9% normal saline via an atomizer three minutes prior to propofol 2 mg·kg⁻¹ *iv* (Group 2P, n = 30) or propofol 3 mg·kg⁻¹ *iv* (Group 3P, n = 30), respectively. The doses of propofol were calculated based on total body weight. The authors (C.C.L. or P.H.L.) who were not involved in the data collection prepared, covered, administered, or sprayed all study drugs. In three groups, the bolus dose of propofol (2 mg·kg⁻¹ or 3 mg·kg⁻¹) was injected intravenously over 30 sec. In addition, 2% lidocaine 1 mL was mixed with each 20 mL syringe of propofol to minimize the pain associated with propofol injection. No other opioids, muscle relaxants, or sedatives were given as premedication.

Before the topical lidocaine or 0.9% normal saline was applied, each patient received lactated Ringer's solution 5 mL·kg⁻¹ *iv* and pre-oxygenation with a face mask for five minutes. All patients were monitored throughout the study using electrocardiography, noninvasive blood pressure, pulse oximetry, and capnography. Then the study drugs were given as mentioned above, and oxygen delivery via a face mask was continued until an effective airway was established in all patients with an LMA. One of the investigators (C.F.C.C., H.S.C. or K.C.H.), who was blinded to group allocation and the type of induction technique, recorded the time to loss of consciousness, which was defined as the interval between the end of the propofol injection until the patient reached loss of eyelash reflex and the inability to open the eyes on a verbal command. During induction of anesthesia, the patient received mask ventilation only when an arterial oxygen saturation < 95% was observed. The same investigator who recorded loss of consciousness inserted the classic laryngeal mask airway (cLMA) (LMA-Classic™ Laryngeal Mask Company Limited, Seychelles) when loss of consciousness was observed. These individuals (C.F.C.C., H.S.C. or K.C.H.) had inserted the cLMA successfully in more than 200

patients using a technique described by Brain.[11] The cLMA was placed on the hard palate with the cuff deflated and aperture anterior, and then it was advanced in a smooth movement using a digital technique. A size 3 cLMA was used in women and a size 4 in men. The author who inserted the cLMA also recorded the occurrence of coughing, gagging, laryngospasm, or body movement. Laryngospasm was defined as the presence of stridor or other evidence of upper airway obstruction that subsided with deepening of anesthesia. The conditions for cLMA insertion were described as "optimal" when there was an absence of coughing, gagging, laryngospasm, or body movement, and when the cLMA was inserted successfully on the first attempt. If it was impossible to open the patients mouth, further attempts were carried out at one-minute intervals, each attempt being preceded by propofol 0.5 mg·kg^{-1}. Also, when the airway reflexes prevented the cLMA insertion or when gross body movement requiring restraint in the patient was noted, an additional dose of propofol 0.5 mg·kg^{-1} was given.

After cLMA insertion, the correct position of the cLMA was checked by observing the patient's chest expansion and the end-tidal carbon dioxide (ETCO$_2$) during spontaneous or assisted breathing. If the cLMA was malpositioned on the first attempt, a further dose of propofol 0.5 mg·kg^{-1} was given, and another attempt was repeated up to a maximum of four times. However, the conditions during the cLMA insertion were only assessed at the first attempt. If the fourth attempt failed, endotracheal intubation was performed. Apnea was defined as absence of spontaneous breathing for > 30 sec after successful cLMA insertion. If apnea occurred, manual ventilation was applied to maintain an arterial oxygen saturation > 95% and an ETCO$_2$ level of 35 to 40 mmHg until the return of spontaneous breathing. Non-invasive blood pressure and heart rate were recorded before induction of anesthesia, immediately after loss of consciousness, and one minute after successful cLMA insertion. Clinically significant hypotension was defined as systolic blood pressure (SBP) < 90 mmHg and was treated with 8 mg of intravenous ephedrine. Anesthesia was maintained at 1-2 minimum alveolar anesthetic concentration sevoflurane in 50% oxygen and 50% air. At the end of the operation, the cLMA was removed and the patients were transferred to the postanesthesia care unit. A blinded investigator (S.W.H. or P.H.T.) visited all of the patients the morning after surgery to record whether they were satisfied with the induction technique (yes, no) or whether they experienced a sore throat (yes, no).

The primary outcome was the frequency of optimal cLMA insertion conditions. Additional analyses were done on the incidents of side effects (such as coughing, gagging, laryngospasm, body movement, and apnea) and hemodynamic changes during the induction of the anesthesia.

The proportion of optimal LMA insertion conditions following propofol 2.5 mg·kg^{-1} in unpremedicated patients was reported as 32.5%.[12] We assumed that 25-30% would be the proportion of optimal insertion conditions following propofol 2 mg·kg^{-1}, and we considered a > 70% proportion of optimal cLMA insertion conditions to be satisfactory in unpremedicated patients treated with topical lidocaine and propofol 2 mg·kg^{-1}. We needed 24 patients in each group to achieve 80% power at the 5% significance level. Considering that there may be dropouts, we decided to recruit 30 patients per group.

Group data are presented as the mean ± standard deviation (SD), number, or percentage. The Chi square test (with Fisher's exact test when appropriate) was used to compare cLMA insertion conditions or other adverse responses. We analyzed the continuous variables between groups by means of a variance (one-way ANOVA). If a significant difference was detected, a Tukey test was used for post-hoc comparisons. Repeated measures analysis of variance (ANOVA) was used to compare hemodynamic variables within groups. The P value of < 0.05 was considered significant. Statistical calculations were performed using the statistical package for the Social Sciences, SPSS/ PC Version 10.0 (Chicago, IL, USA).

Results

Ninety-six patients met the eligibility criteria. Six patients refused to participate and were excluded. Ninety ASA I or II patients undergoing general anesthesia were equally and randomly divided into three groups. All patients completed the standard protocol. The characteristics of patients in the three groups were similar (Table 1). The characteristics of anesthetic induction and cLMA insertion conditions following either topical lidocaine or normal saline co-administration with propofol are shown in Table 2. Group 3P had a shorter time to loss of consciousness and incidence of apnea than the other two groups (Table 2). Group 2P patients required additional propofol more often and had a lower incidence of optimal insertion conditions than subjects in Groups 2PL and 3P. No significant differences were found in the success rate of first attempt insertion across the three groups, and the cLMA was inserted in all patients within two attempts. The frequency of optimal insertion conditions was greater in Group 2PL (67%) and Group 3P (73%) than in Group 2P (37%) ($P < 0.05$). Apnea occurred frequently in Group 3P (57%), but not in Group 2P (7%) or Group 2PL (3%) ($P < 0.001$). As shown in Table 3, adverse responses, such as coughing, gagging, and body movement were found mainly in Group 2P. Adverse responses during cLMA insertion were similar in Groups 2PL and 3P.

Table 1 Characteristics of patients

	Group 2P (n = 30)	Group 2PL (n = 30)	Group 3P (n = 30)
Age (yr)	46.5 ± 14.7	45.7 ± 12.7	46.0 ± 11.7
Gender (M/F)	18 / 12	17 / 13	15 / 15
Weight (kg)	62.1 ± 12.3	64.7 ± 11.1	63.2 ± 11.3

Values are mean ± standard deviation (SD) or numbers where applicable. Group 2P = laryngeal mask airway (LMA^{TM}) inserted following propofol 2 mg·kg^{-1}; Group 2PL = LMA inserted following topical lidocaine 40 mg and propofol 2 mg·kg^{-1}; Group 3P = LMA inserted following propofol 3 mg·kg^{-1}

Table 2 Characteristics of anesthetic induction and LMA-Classic^{TM} insertion

	Group 2P (n = 30)	Group 2PL (n = 30)	Group 3P (n = 30)	P value overall
Time to loss of consciousness (sec)	43.0 ± 18.6*	39.7 ± 18.6*	34.3 ± 5.2	0.034
Additional propofol required	8 (27%)	2 (7%)†	2 (7%)†	0.031
Incidence of apnea	2 (7%)**	1 (3%)**	17 (57%)	<0.001
First attempt insertion	26 (87%)	28 (93%)	27 (90%)	0.69
Optimal insertion conditions	11 (37%)	20 (67%)†	22 (73%)†	0.009

Values are mean ± standard deviation (SD) or number of patients (proportion) where applicable. * Denotes $P < 0.05$ (Pairwise comparisons between groups) compared with Group 3P. † Denotes $P < 0.05$ (Pairwise comparisons between groups) compared with Group 2P; ** Denotes $P < 0.001$ (Pairwise comparisons between groups) compared with Group 3P

Group 2P = laryngeal mask airway (LMA^{TM}) inserted following propofol 2 mg·kg^{-1}; Group 2PL = LMA inserted following topical lidocaine 40 mg and propofol 2 mg·kg^{-1}; Group 3P = LMA inserted following propofol 3 mg·kg^{-1}

Table 3 Adverse responses during LMA-Classic^{TM} insertion

Adverse responses	Group 2P (n = 30)	Group 2PL (n = 30)	Group 3P (n = 30)	P value overall
Coughing	10 (33%)	2 (7%)*	1 (3%)*	0.001
Gagging	8 (27%)	1 (3%)*	2 (7%)*	0.012
Laryngospasm	0	0	1 (3%)	0.36
Body movement	17 (57%)	5 (17%)*	7 (23%)*	0.002

Values are number (proportion). * Denotes $P < 0.05$ (Pairwise comparisons between groups) compared with Group 2P

Group 2P = laryngeal mask airway (LMA^{TM}) inserted following propofol 2 mg·kg^{-1}; Group 2PL = LMA inserted following topical lidocaine 40 mg and propofol 2 mg·kg^{-1}; Group 3P = LMA inserted following propofol 3 mg·kg^{-1}

Mean blood pressure in the three groups decreased significantly throughout the study period ($P < 0.001$) (Table 4). Group 3P had lower mean blood pressure than the other groups before cLMA insertion ($P < 0.05$), but not one minute after cLMA insertion. Clinically significant hypotension (SBP < 90 mmHg) was found infrequently in all three groups (Group 2P: 1/30; Group 2PL: 4/30; Group 3P: 3/30). Two patients in Group 3P suffered from severe hypotension (SBP < 70 mmHg), and both were treated successfully with ephedrine. No postoperative cardiovascular complications were found in any of our patients.

All patients tolerated the spraying of lidocaine over the posterior pharynx wall well. The number of patients who had a sore throat or were satisfied with the induction techniques was similar in the three groups (Table 5).

Discussion

The purpose of this study was to evaluate whether optimal LMA insertion conditions could be achieved following a lower dose of propofol in unpremedicated patients receiving topical lidocaine administered as an oropharyngeal spray. Our major finding was that propofol 2 mg·kg^{-1} preceded by topical lidocaine 40 mg provided optimal LMA insertion conditions as often as propofol 3 mg·kg^{-1},

Table 4 Mean blood pressure and heart rate changes during induction of anesthesia

	Group 2P (n = 30)	Group 2PL (n = 30)	Group 3P (n = 30)	P value overall*
Mean blood pressure (mmHg)				
Baseline	105 ± 18[†]	99 ± 19[†]	99 ± 15[†]	0.35
After anesthetic induction	89 ± 16*	86 ± 16*	76 ± 12	0.003
1 min after cLMA insertion	83 ± 14	81 ± 18	79 ± 13	0.58
Heart rate (beats·min^{-1})				
Baseline	77 ± 11	73 ± 13	75 ± 12	0.56
After anesthetic induction	77 ± 13	74 ± 10	74 ± 12	0.44
1 min after cLMA insertion	77 ± 10	71 ± 10	76 ± 12	0.11

Values are mean ± standard deviation. SD. * Denotes for between-group comparison. [†] Denotes $P < 0.001$ compared with the value recorded after anesthetic induction (within groups). Group 2P = laryngeal mask airway (LMA^{TM}) inserted following propofol 2 mg·kg^{-1}; Group 2PL = LMA inserted following topical lidocaine 40 mg and propofol 2 mg·kg^{-1}; Group 3P = LMA inserted following propofol 3 mg·kg^{-1}

Table 5 Postoperative interview

	Group 2P (n = 30)	Group 2PL (n = 30)	Group 3P (n = 30)
Postoperative sore throat	5 (17%)	3 (10%)	2 (7%)
Satisfied with induction technique	30 (100%)	28 (93%)	28 (93%)

Values are number of patients (proportion). There were no statistically significant differences between groups. Group 2P = laryngeal mask airway (LMA^{TM}) inserted following propofol 2 mg·kg^{-1}; Group 2PL = LMA inserted following topical lidocaine 40 mg and propofol 2 mg·kg^{-1}; Group 3P = LMA inserted following propofol 3 mg·kg^{-1}

with fewer hemodynamic changes and a lower incidence of apnea.

Seavell *et al*. reported the frequency of coughing, gagging, and laryngospasm in their patients receiving thiopental 5 mg·kg^{-1} and topical lidocaine 40 mg to be 2.2%, 28%, and 4.3%, respectively, during LMA insertion, which was comparable with those receiving propofol 2.5 mg·kg^{-1}.[13] Propofol is known to suppress both pharyngeal and laryngeal reflexes more effectively than thiopental.[1] Therefore, we evaluated the effectiveness of using topical lidocaine 40 mg and a lower dose of propofol (2 mg·kg^{-1}) in improving LMA insertion conditions. The conditions we achieved were comparable with those of propofol 3 mg·kg^{-1}. In addition, the finding that body movement was reduced in Group 2PL (17%) and Group 3P (23%) compared with that in Group 2P (57%) suggests that the supplement of topical lidocaine 40 mg can increase patient tolerance of an LMA in the hypopharynx, even though topical lidocaine may not increase anesthetic depth.

To reduce side effects, such as apnea or hypotension, caused possibly by a large dose of propofol and to evaluate the effectiveness of topical lidocaine, a small dose of propofol 2 mg·kg^{-1}, which has been shown to produce loss of response to verbal contact at this dosage,[14] was administered after applying topical lidocaine 40 mg. Although the hemodynamic profile was within clinically acceptable limits in our relatively healthy patients after cLMA insertion, Group 3P had lower mean blood pressure than the other groups prior to cLMA insertion, suggesting that a larger dose of propofol 3 mg·kg^{-1} should be used carefully. Also, the incidence of apnea was higher in Group 3P (57%) than in Group 2PL (3%). Siddik-Sayyid *et al*. also reported that the incidence of apnea might reach 84% after a propofol 3 mg·kg^{-1} bolus injection.[15] Based on these findings, a larger dose of propofol may not be advisable if maintenance of a stable hemodynamic profile and rapid resumption of spontaneous breathing are required.

Bapat *et al*. reported a 66% frequency of optimal LMA insertion conditions following propofol 2.5 mg·kg^{-1} and fentanyl 1 μg·kg^{-1},[16] which is similar to the conditions we found in Group 2PL or Group 3P. Although opioids are frequently used with propofol to improve LMA insertion conditions in clinical practice,[17] co-administration of both agents may increase the incidence and duration of apnea due to their synergistic effect on respiratory depression.[18,19] The incidence of apnea may reach 70% following the use of propofol 2.5 mg·kg^{-1} alone and 83.3% following the use of propofol 2.5 mg·kg^{-1} plus fentanyl 1 μg·kg^{-1}.[20] Apnea is probably of little consequence when the airway is protected with the LMA. However, since the cLMA, which is commonly used in our institution, may not provide protection against gastric insufflation during positive pressure ventilation, it may be advisable to maintain spontaneous breathing in patients using a cLMA. In addition, the occurrence of apnea may be undesirable during minor or ambulatory surgery wherein spontaneous ventilation is desired with an LMA. Considering that opioids

may increase the incidence of apnea, we did not co-administer short-acting opioids, such as fentanyl with propofol, in the current study.

The LMA is widely used for airway management and can be inserted blindly into the hypopharynx, which makes successful LMA insertion possible with propofol doses of 2-2.5 mg·kg^{-1} under unfavourable conditions.[17,21] Therefore, the success rate of cLMA insertion was high and similar in our three groups. A smaller size LMA may be inserted more easily when the jaw relaxation is not satisfactory. Hui *et al.* have suggested that the Asian population has a smaller jaw than the Caucasian population for whom the LMA was designed originally;[4] therefore, in our study, we chose a size 3 cLMA for women and a size 4 for men.

Although there may be systemic absorption of topical lidocaine administered as an oropharyngeal spray, Mostafa *et al.*[22] found that the plasma lidocaine concentrations after topical lidocaine 3 mg·kg^{-1} (0.8 ± 0.41 µg·mL^{-1}) were well below the toxic range (5-9 µg·mL^{-1}). We chose to use an even lower dose of topical lidocaine (40 mg) because this dose has been found to be effective in improving LMA insertion conditions.[10] In addition, the topical effect of lidocaine on the pharyngeal wall lasts from 20 to 40 min,[23] which may allow the patient to tolerate the LMA in the hypopharynx during the transition from intravenous induction to maintenance with an inhaled agent.[24]

There are several limitations in our study. First, one may argue that spraying topical lidocaine 40 mg over the posterior pharyngeal wall may be uncomfortable and increase patients' anxiety; however, the satisfaction rate in all three groups was high, suggesting that this technique may be acceptable in anesthesia clinical practice. There might be potential bias in the satisfaction rates because patients who consented to be in the study knew their pharynx would be sprayed. Second, the time from administering propofol to cLMA insertion was shorter than that required to achieve the peak effect of propofol (about 1.6 min),[25] which might have led us to underestimate the frequency of optimal cLMA insertion conditions in the three groups.

In conclusion, our study demonstrates that the frequency of optimal LMA insertion conditions achieved by the combination of propofol 2 mg·kg^{-1} and topical lidocaine 40 mg was comparable to that achieved using propofol 3 mg·kg^{-1} alone, with greater hemodynamic stability and a lower incidence of apnea.

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