The use of minidose muscle relaxant to facilitate insertion of a laryngeal mask airway

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Background Laryngeal mask airway (LMA) has gained wide acceptance for airway management especially in day case surgery. Although propofol is known to blunt laryngeal reflexes, smooth and successful insertion of LMA requires a proper mouth opening to minimize airway reflexes such as gagging, coughing, and laryngospasm. The concurrent use of mini-dose muscle relaxant with propofol could reduce the occurrence of airway reflexes and increase the success rate of LMA insertion.

Aim of the study The aim of this study is to evaluate the effect of minidose atracurium and succinylcholine, to facilitate LMA insertion and which is better of them to achieve more satisfaction and less complications following induction of anesthesia with propofol, in day case surgery patients.

Patients and methods This prospective, randomized, controlled, double-blind study was done on 90 healthy patients with American Society of Anesthesiologist physical status I or II, scheduled for elective surgery of less than 30 min under general anesthesia through LMA. These 90 patients were randomized by computer-generated and sealed opaque envelope method into three equal groups, according to the muscle relaxant given, with 30 patients ($n = 30$) each, after the induction of anesthesia with fentanyl.
Atracurium group (group A) received a bolus of atracurium 0.15 mg/kg diluted in 2 ml of 0.9% sodium chloride intravenously before propofol injection and 2 ml of 0.9% sodium chloride after propofol injection.
Succinylcholine group (group S) received 2 ml of 0.9% sodium chloride before propofol injection and a bolus of succinylcholine 0.25 mg/kg diluted in 2 ml of 0.9% sodium chloride intravenous after propofol injection.
Control group (group C) received 2 ml of 0.9% sodium chloride before and after propofol injection.
Two minutes after propofol injection, one disposable lubricated, semi-inflated classic LMA with appropriate size was inserted by an experienced anesthesiologist who was unaware of the drug used for injection and patient groups. Moreover, in the patient groups, a uniform general anesthesia technique was applied to all patients.
The primary outcome was ease and reactions to LMA insertion and postoperative sore throat.
The secondary outcome was hemodynamic changes, heart rate and mean arterial blood pressure before and after LMA insertion and postoperative myalgia.

Results The result of this study reveals that the first attempt in LMA insertion was successful in up to 27 (90%) patients in group S, whereas in only 23 (83.3%) patients in group A and 16 (60.0%) patients in group C. The difference was statistically significant ($P<0.001$).
Postoperative sore throat occurred in 11 (36.7%) of patients of control group, which was statistically significantly more than that in the studied groups. Postoperative myalgia was found in 12 (40%) patients in the succinylcholine group, which was statistically significant more than that in groups A and C ($P=0.001$). However, there was no difference in apnea times among all the groups. There was no significant difference in hemodynamic changes among all groups, although total propofol consumption was statistically highly significantly more in the control group ($P<0.001$).

Conclusion The concurrent use of minidose muscle relaxant with propofol and fentanyl significantly reduces the occurrence of airway reflexes, increases the success rate of LMA insertion, and decreases the incidence of postoperative sore throat. However, minidose of succinylcholine has a far better effect than minidose of atracurium with significant postoperative myalgia.

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Introduction

Laryngeal mask airway (LMA) is widely used in general anesthesia especially in day case surgery. Sufficient depth of anesthesia and mouth opening are needed for proper insertion of LMA and prevention of undesirable airway reflexes. Some complications including gagging, coughing, and laryngospasm, which may occur in response to LMA insertion, which may make correct positioning difficult or impossible [1].

Propofol is an induction agent of choice for LMA insertion as it blunts the laryngeal reflexes, when compared with other induction agents [2].

It has been seen that propofol as a sole agent for LMA insertion is accompanied by a higher failure rate, requires additional propofol doses to prevent these undesirable airway reflexes and multiple insertion attempts, and results in hypotension and prolonged apnea as adverse effects [3].

Drugs commonly used as sedative premedication include benzodiazepines, opioids, and lidocaine which blunt laryngeal reflexes and may be useful in facilitating LMA insertion [4].

Succinylcholine is a rapid-onset, short-acting depolarizing muscle relaxant. It is easily available and is a time-tested and cost-effective drug. The use of succinylcholine to aid insertion of the LMA is favorable as it avoids depression of the respiratory center and has no effect on consciousness. Succinylcholine has been proven to facilitate LMA insertion, with and without an additional agent such as fentanyl or midazolam [5].

George *et al*. [6] investigate the optimum dose of succinylcholine required to facilitate LMA insertion, compared with placebo, with 0.1 mg/kg and 0.25 mg/kg of succinylcholine, and they concluded that 0.25 mg/kg of succinylcholine seems to be the optimum dose as it provides significantly better intubating conditions compared with 0.1 mg/kg and placebo, without significant adverse effects.

Atracurium besylate is a nondepolarizing muscle relaxant agent with an intermediate duration of action, ~20–30 min; it is administered intravenously to produce skeletal muscle relaxation and antagonizes the action of the neurotransmitter acetylcholine by competitively binding with cholinergic receptor sites on the motor endplate of the myoneural junction. These effects may be inhibited or reversed by the administration of anticholinesterases such as neostigmine or pyridostigmine [7].

Nasseri [8] evaluated the effect of low-dose atracurium (0.15 mg/kg) versus placebo on conditions of LMA insertion following induction of anesthesia with propofol and concluded that using low doses of atracurium increases jaw relaxation, facilitates the placement of LMA, and decreases postoperative sore throat.

Minidose of muscle relaxant has been used to aid better insertion condition for propofol as an induction agent. Depolarizing muscle relaxants have a far better effect than nondepolarizing drugs [9].

Keeping the day case setting in mind, the aim of this study is to evaluate ease and reactions to LMA insertion and postoperative sore throat as the primary outcome and hemodynamic changes, heart rate (HR), and mean arterial blood pressure (MAP) before and after LMA insertion and postoperative myalgia as the secondary outcomes.

Patients and methods

This prospective, randomized, controlled, double-blind study was conducted in Fakhry Hospital on 90 patients from January 2018 to May 2018. Following the local Ethics Committee's approval, a written informed consent was taken from the patients. All patients were older than 21 years, of both sexes, weighed 55–85 kg, had American Society of Anesthesiologist physical status I or II, and had Mallampati classification equal to I. They were scheduled for elective day case surgery of less than 30 min under general anesthesia through LMA.

Obese patients with a BMI more than 30, patients with a known difficult airway or posted for oral surgery, patient at risk of aspiration, patients having compromised renal or cardiac status, patients with an upper respiratory tract infection or asthma, patients with a history of pulmonary disease, patients with a history of succinylcholine apnea, and patients with a previous history of hypersensitivity to any of the studied drugs were excluded from the study.

The recruited 90 patients were divided randomly by computer-generated and sealed opaque envelope method into three equal groups, with 30 patients each.

The anesthesia nurse who prepared the studied medication opened the envelope just before the induction of anesthesia, and this person was not involved in data collection.

Patients were premedicated with injection of ondansetron 4 mg.

On the operating room table, all patients received standard monitoring including noninvasive blood pressure, pulse oximetry, and electrocardiography, and baseline values of systolic and diastolic blood pressure and HR were recorded before any intervention and after the induction of anesthesia with fentanyl.

Atracurium group (group A) received a bolus of atracurium 0.15 mg/kg diluted in 2 ml of 0.9% sodium chloride intravenous before propofol injection and 2 ml of 0.9% sodium chloride after propofol injection.

Succinylcholine group (group S) received 2 ml of 0.9% sodium chloride before propofol injection and a bolus of succinylcholine 0.25 mg/kg diluted in 2 ml of 0.9% sodium chloride after propofol injection.

Control group (group C) received 2 ml of 0.9% sodium chloride before and after propofol injection.

Two minutes after propofol injection, one disposable lubricated, semi-inflated classic LMA with appropriate size according to body weight was inserted, using classic method by an experienced anesthesiologist. The condition during LMA insertion was assessed for swallowing, gagging, or coughing; head or limb movement; laryngospasm; and overall ease of LMA insertion (easy, difficult, or impossible). Laryngospasm was defined as the presence of stridor or other evidence of upper airway obstruction that subsided with deepening of anesthesia.

If insertion was not possible at the first attempt, anesthesia was maintained with 2–3% of sevoflurane, and an additional dose of 0.5 mg/kg of propofol was given. Then, insertion was attempted 30 s later, and if the second attempt failed, the patient was intubated and excluded from the study. LMA insertion was considered correct when there was no or very low leakage of air during ventilation with bag, chest had expanded appropriately, and the patient's airway pressure was less than or equal to 20 cmH_2O on capnogram reading taken in spontaneously breathing patients or during assisted breaths in apneic patients.

The number of attempts was recorded, but the ease of insertion was only assessed during the first attempt. Following successful LMA insertion, anesthesia was maintained with 2–3% sevoflurane and a mixture of O_2 and N_2O 50 : 50. Apneic patients were ventilated manually via the LMA to maintain arterial oxygenation above 95% and end-tidal carbon dioxide concentration between 35 and 45 mmHg. The duration of apnea was recorded. All patients were assessed after surgery for postoperative sore throat and myalgia.

Statistical analysis

Data were coded and entered using the statistical package SPSS, version 22 (IBM Corp., Armonk, NY, USA). Data were summarized using mean and SD for normally distributed quantitative variables, and comparisons between groups was done using analysis of variance followed by post-hoc test if there is significance. Qualitative data were presented as frequencies (n) and percentages (%) and χ^2 test was used to compare between the three groups. The significance level was set at P value less than 0.05.

Results

The demographic data were comparable among all groups in terms of age and sex ratio. There was no significant difference between groups with respect to age, sex, BMI, duration of surgery, and anesthesia (Table 1).

Regarding coughing and gagging, there was no significant difference between groups, although it was clinically more in patients of the control group.

The patient movement was clinically more in the control group but not statistically significant, with P value equal to 0.01. Groups A and S had similar values.

Partial laryngospasm occurred in only two patients in the control group. None of the other patients had laryngospasm.

The first attempt for LMA insertion was successful in up to 27 (90%) patients in group S whereas only in 23 (83.3%) patients in group A and 16 (60.0%) patients in group C. LMA was successfully inserted in the second attempts in three (10%), seven (16.7%), and 14 (40.0%) of patients in succinylcholine, atracurium, and the control groups, respectively. The difference was statistically highly significant ($P<0.001$).

The standard dose of propofol for induction of anesthesia was 2 mg/kg, and if there a need to excess doses of propofol, bolus doses of 0.25 mg/kg were administered again. Average propofol dose was statistically highly significant more in the control group, with P value less than 0.001.

Table 1 Patients demographic data, surgical and anesthesia duration

	Group A (N=30)	Group S (N=30)	Group C (N=30)	P value
Age (years)	43.6±3.15	45.8±6.37	44.9±4.23	0.205
BMI (kg/m^2)	28.1+3.15	26.7+2.75	27.5+2.45	0.157
ASA				
I	21 (70)	23 (76.7)	20 (66.7)	0.303
II	9 (30)	7 (23.3)	10 (33.3)	
Total surgical duration (min)	20.6±5.2	21.6±6.4	19.8±4.2	0.428
Duration of anesthesia (min)	30.22±2.54	29.87±2.68	31.32±3.19	0.121

Data are presented as mean±SD or n (%). A, atracurium group; ASA, American Society of Anesthesiologist; C, control group; S, succinylcholine group.

Additional propofol was required in 14 (46.7%) patients in group C, whereas this rate was three (10%) for group S and six (20%) for group A. The difference among them was statistically significant (P=0.003) (Table 2).

HR was comparable in all the groups at preinduction, postinduction, and postinsertion periods. There was no significant difference among all groups (Table 3).

MAP was comparable in all the groups at preinduction, postinduction, and postinsertion periods. There was no significant difference among all groups (Table 4).

Postoperative sore throat occurred in 11 (36.7%) patients of the control group, whereas the incidence was five (10%) and three (16.7%) of patients in atracurium and succinylcholine groups, respectively, which were statistically significantly less than that of the control group (P=0.031).

Postoperative myalgia was found in 12 (40%) patients who had minidose of succinylcholine, which was statistically significant in comparison with groups A and C (P=0.001), whereas there is no difference in apnea times among all groups. The duration of apnea was 12.34±5.3, 11.37±3.6, and 12.81±2.4 min in atracurium, succinylcholine, and the control groups, respectively (Table 5).

Discussion

Nowadays, day case surgery is widely growing, as it is more economic, allows earlier ambulation, decreases the risk of nosocomial infection, and is more convenient to the patient. Most of these surgeries are under general anesthesia, through LMA, as regional or neuraxial anesthesia is associated with slower recovery and delayed discharge [10].

Successful and easy placement of LMA needs comfortable mouth opening and depression of airway reflexes. Various methods have been evaluated to make LMA insertion smooth, with least adverse effects and being cost effective [3].

Table 3 Heart rate changes in different studied groups

HR	Group A (N=30)	Group S (N=30)	Group C (N=30)	P value
Baseline HR	80.44 ±8.32	78.1±7.40	81.14 ±8.85	0.328
After induction	69.6±3.94	71.9±4.75	70.9±4.64	0.140
1 min after insertion of LMA	89.6±4.92	88.9±5.73	91.6±4.57	0.109
5 min after insertion of LMA	71.56 ±7.77	73.1 ±10.24	70.67 ±8.14	0.557

Data are presented as mean±SD. A, atracurium group; C, control group; HR, heart rate; LMA, laryngeal mask airway; S, succinylcholine group.

Table 4 Mean arterial blood pressure (mmHg) changes in different studied groups

MAP	Group A (N=30)	Group S (N=30)	Group C (N=30)	P value
Baseline MAP	90.65 ±7.30	91.2±8.32	89.45 ±7.64	0.672
After induction	81.60 ±5.37	80.19±6.5	79.51 ±6.22	0.397
1 min after insertion of LMA	88.50 ±7.37	89.09±8.5	90.32 ±5.73	0.619
5 min after insertion of LMA	83.35 ±6.13	82.21 ±7.90	81.83 ±6.47	0.673

Data are presented as mean±SD. A, atracurium group; C, control group; LMA, laryngeal mask airway; MAP, mean arterial blood pressure; S, succinylcholine group.

Table 5 Postoperative sore throat, myalgia and duration of apnea

	Group A (N=30)	Group S (N=30)	Group C (N=30)	P value
Sore throat	5 (16.7)[a]	3 (10)[a]	11 (36.7)	0.031*
Myalgia	3 (10)[b]	12 (40)[a,b]	2 (6.7)	0.001*
Duration of apnea (min)	12.34±5.3	11.37±3.6	12.81±2.4	0.328

Data are presented as mean±SD or n (%). A, atracurium group; C, control group; S, succinylcholine group. [a]Significance with control group (C). [b]Significance between A and S groups. *P value less than 0.05 among the three groups.

Table 2 Patient response laryngeal mask airway insertion, propofol dose, and number of attempts

	Group A (N=30)	Group S (N=30)	Group C (N=30)	P value
Gagging	2 (6.7)	0 (0.0)	4 (13.3)	0.117
Coughing	1 (3.3)	0 (0.0)	3 (10.0)	0.160
Partial laryngospasm	0 (0.0)	0 (0.0)	2 (6.7)	0.355
Head or limb movement	2 (6.6)	2 (6.6)	7 (23.3)	0.055
1st attempt insertion	23 (83.3)[a,b]	27 (90)[a,b]	16 (60)	<0.001*
2nd attempts insertion	7 (16.7)	3 (10)	14 (40)	
Excess propofol	6 (20)[b]	3 (10)[b]	14 (46.7)	0.003*
Average propofol dose (mg)	165±33.5[b]	155±35.7[b]	210±45.1	<0.001*

Data are presented as mean±SD or n (%). A, atracurium group; C, control group; S, succinylcholine group. [a]Significance with control group (C). [b]Significance between A and S groups. *P value less than 0.05 among the three groups.

Propofol is the induction agent of choice for LMA insertion as it blunts the laryngeal reflexes; nevertheless, using propofol alone results in patient movement, coughing, and gagging. These reactions require further doses of propofol to facilitate insertion of LMA, ensuing hypotension and prolonged duration of apnea. Salem [11] found that failed insertion attempts of LMA were owing to coughing and gagging in 75% of patients when propofol was the only agent used for insertion, and the rate of successful insertion at the first attempt was only 60%.

Numerous agents have been used to aid propofol for LMA insertion. These include opioids such as fentanyl, alfentanil, remifentanil, and butorphanol; muscle relaxants such as mivacurium, atracurium, and rocuronium; and other drugs such as midazolam, clonidine, dexmedetomidine, ketamine, and lignocaine. Adverse effects such as sedation, postoperative nausea, and vomiting; residual neuromuscular blockade; and cost remain a concern with these drugs, especially in the day care setting.

Minidose of muscle relaxant has been used to aid better insertion condition for propofol as the induction agent. Depolarizing muscle relaxants have a far better effect than nondepolarizing drugs [9].

The results of this study revealed that concurrent use of minidose of muscle relaxant with propofol and fentanyl provides better insertion conditions for LMA when compared with placebo. However, group S is significantly better than group A, as there is no airway reactions to group S, whereas this reaction was significantly less observed in group A compared with group C. Total propofol consumption was significantly more in the placebo group; nevertheless, hemodynamic stability was similar in all groups.

The results of many studies are support by this study regarding the effect of small doses of muscle relaxant on improving LMA insertion.

Yoshino *et al.* [12] believed that adding low doses of muscle relaxants to both thiopental and propofol significantly improves conditions of LMA insertion.

Ho and Chui compared 0.1 mg/kg succinylcholine and placebo, using high dose of propofol 2.5 mg/kg, without an opioid at induction and found it to be better, with lesser insertion attempts. There was a significant reduction in total dose of propofol needed to insert LMA when low-dose succinylcholine was used [13].

Similarly, Aghamohammadi *et al.* [14] also compared 0.1 mg/kg succinylcholine with placebo using standard dose of propofol 2 mg/kg in combination with midazolam 0.01 mg/kg and fentanyl 1.0 μg/kg, at induction and found smoother insertion conditions with this minidose of succinylcholine, with reduction in total dose of propofol needed to insert LMA.

These findings are consistent with those by George and colleagues, who compared two doses of succinylcholine with placebo and found that the number of insertion attempts was clinically more in placebo group but not statistically significant. Total propofol consumption was significantly more in the placebo group, although hemodynamic stability was similar in all groups [6].

Liou and colleagues, in their study, concluded that concurrent use of 2.0 μg/kg of fentanyl with etomidate might significantly reduce the occurrence of airway reflexes in response to LMA insertion and increase the success rate of insertion. However, concurrent use of 1.0 mg/kg succinylcholine with etomidate might provide better results in terms of shortened time for the LMA insertion, jaw relaxation, and the success rate of LMA insertion than that of fentanyl [5].

Nasseri [8] evaluated the effect of low-dose atracurium versus placebo on conditions of LMA insertion following induction of anesthesia with propofol and concluded that using low doses of atracurium increases jaw relaxation and facilitates placement of LMA, with no significant difference observed between the two groups in terms of hemodynamic responses [8].

On the contrary, some studies revealed that by using muscle relaxants, either depolarizing or nondepolarizing, one does not facilitate LMA insertion, rather than it results in long recovery time and increases hospital costs.

Salem [11] compared 0.1 mg/kg of succinylcholine and midazolam 0.04 mg/kg using 2.5 mg/kg of propofol for induction, without fentanyl, and concluded that midazolam had the advantages of better insertion conditions, shorter duration of apnea, less fasciculations, and myalgia. However, previous studies infer that 0.1 mg/kg of succinylcholine is not sufficient to facilitate smooth insertion of the LMA, unless it is used in combination with fentanyl [14].

Chui and Cheam compared the effect of injecting two different doses of mivacurium with normal saline on LMA insertion in patients undergoing anesthesia with

propofol. In their study, both doses of mivacurium significantly facilitated LMA insertion in a similar manner when compared with normal saline [15].

Similarly, Cheam and Chui in another study compared the effect of the addition of mivacurium, fentanyl, or placebo to propofol for facilitation of LMA insertion. They concluded that fentanyl and mivacurium were equally effective in facilitating LMA insertion [16]. However, in a previous study, the dose of mivacurium is too small, and maybe, there was no sufficient time after injection of mivacurium to produce its relaxant effect before LMA insertion.

Koh *et al.* [17] compared insertion conditions of LMA produced by propofol and a thiopental – low-dose atracurium combination and propofol only and concluded that there was no difference in insertion conditions and hemodynamic changes between the groups. The reason for this difference can be attributed to high dose of propofol 2.5 mg/kg, which causes respectable depression of airway reflexes and low-dose atracurium–thiopental combination.

The results of this study revealed that concurrent use of minidose of succinylcholine with propofol provides better insertion conditions for LMA than minidose of atracurium with propofol.

These findings are consistent with those by Korula *et al.* [18], who compared succinylcholine 0.35 mg/kg with 0.08 mg/kg of atracurium for LMA insertion during thiopentone induction, and they found that succinyl choline provided better insertion conditions as there was no coughing or gagging, and minimal patient movement.

Similarly, Monem and Chohan also compared the relaxants of succinylcholine0.35 mg/kg and atracurium 0.06 mg/kg with thiopental on the conditions of LMA insertion, and they concluded excellent insertion conditions with succinylcholine group in 83% as against 46% for that of atracurium. There was no failure in the succinylcholine group compared with 17% failure rate with atracurium. The results of these studies agree with this study [19].

The results of this study revealed that postoperative sore throat in the study groups S and A was significantly less than that of group control C. These findings are consistent with those by Chui and Cheam [15] in their study and concluded that the use of low doses of mivacurium with propofol for insertion of LMA reduces postoperative complications such as inflammation, laryngospasm, and sore throat. Moreover, Nasseri [8] evaluated the effect of low-dose atracurium on conditions of LMA insertion following induction of anesthesia with propofol and concluded that using low doses of atracurium decreases the time needed for LMA insertion and sore throat after the operation. Similarly, Aghamohammadi *et al.* [14] also compared 0.1 mg/kg succinylcholine with placebo using midazolam 0.01 mg/kg, fentanyl 1.0 μg/kg, and propofol 2 mg/kg at induction and found that there is a significant reduction of sore throat.

However, Chen *et al.* [20] and Ho and Chui [13] concluded that the use of relaxant had no effect on the incidence of sore throat which is contrary to our results. The reason for this difference can be attributed to the time use for muscle relaxant injection, and the type of LMA employed. Chen and colleagues investigated laparoscopic gynecologic surgery patients where airway management was carried out through the use of ProSeal LMA.The results of this study revealed that postoperative myalgia was significantly more in group S in comparison with groups A and C, whereas there were no differences in apnea times among all groups.

In agreement with this results, Chui and Ho [13] compared 0.1 mg/kg succinylcholine and placebo, using 2.5 mg/kg of propofol without an opioid at induction, and conclude that myalgia after the use of low-dose succinylcholine was common, with same duration of apnea.

Koh *et al.* [17] compared the LMA insertion conditions produced by propofol and a thiopental – low-dose atracurium combination, and they conclude that there were no differences in hemodynamic changes and apnea times among all four groups.

Monem and Chohan [19] compared succinylcholine 0.35 mg/kg with atracurium 0.06 mg/kg under thiopentone induction, and they reported a similar incidence of postoperative myalgia (3.3%) in each group. This result is not in line with this study.

Usually atracurium is not associated with postoperative myalgia, but the incidence of myalgia in atracurium group has been reported and could be because of factors like positioning of patient during surgery and early ambulation in day case.

Similarly, George *et al.* [6] investigated the optimum dose of succinylcholine required to facilitate LMA insertion compared with placebo, examining 0.1 mg/

kg and 0.25 mg/kg of succinylcholine, and they conclude that 0.25 mg/kg of succinylcholine seems to be the optimum dose that facilitates insertion of the LMA; myalgia was very low, and the duration of apnea was the same in all groups. Lately, it has been observed that myalgia is common after ambulatory surgery, and the causes are multifactorial.

Conclusion

As an induction agent to facilitate insertion of LMA, propofol and fentanyl were far from perfect. The concurrent use of minidose muscle relaxant with propofol and fentanyl significantly reduces the occurrence of airway reflexes, increases the success rate of LMA insertion, and decreases the incidence of postoperative sore throat. However, minidose of succinylcholine has a far better effect than minidose of atracurium, with significant postoperative myalgia.

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Conflicts of interest

There are no conflicts of interest.

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