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Research Article

Effect of Propofol Alone and Propofol + Muscle Relaxant Combination on Laryngeal Mask Airway Insertion and Hemodynamic Parameters During Anesthesia Induction: A Randomized Clinical Trial

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Abstract

Background: Successful insertion of a laryngeal mask airway (LMA) requires deep anesthesia, the proper opening of the mouth, and adequate suppression of upper airway reflexes. Propofol injection can effectively reduce laryngeal reflexes. This study aimed to compare the effectiveness of propofol alone versus propofol plus a muscle relaxant on LMA insertion and hemodynamic parameters during the induction of anesthesia.

Methods: This randomized, double-blind clinical study was performed on 70 patients in the age range of 18-65 years who were candidates for surgery in the operating room of Shahid Mohammadi Hospital in Bandar Abbas, Iran in 2020. The patients were randomly divided into two groups of 35. The first group received propofol and normal saline, and the second group received propofol plus cisatracurium. The parameters of ease of LMA insertion, jaw opening, cough and gag reflexes, head and limb movement, laryngospasm, and hemodynamic changes were recorded for investigation.

Results: The patients were almost matched in terms of demographic variables. No significant difference was found regarding the ease of LMA insertion and hemodynamic parameters. However, the overall score of ease of LMA insertion was considerably higher in the propofol plus muscle relaxant group ($P=0.029$). The extubation time was significantly shorter ($P<0.001$) and the surgery duration was considerably longer ($P=0.019$) in the propofol plus muscle relaxant group.

Conclusion: The findings demonstrated that both techniques were suitable for LMA insertion, and no significant hemodynamic changes were found between the two groups. However, the administration of propofol plus a muscle relaxant was more suitable due to ease of LMA insertion and shorter extubation time.

Keywords: Propofol, Airway management, Laryngeal masks

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Background

Management of airways is one of the central tasks of an anesthesiologist. In this regard, tracheal intubation is the safest technique for securing the airway. Numerous supraglottic airway devices are used to secure the airway and replace the endotracheal tube. The laryngeal mask airway (LMA) was designed by a British anesthesiologist called Dr. Brain. It was specifically used in difficult situations to secure the airway and can alone provide positive pressure ventilation for the patient (1). In comparison to endotracheal tubes, LMA reduces sympathetic stimulation that may cause less variation in blood pressure and heart rate, which consequently lead to less hemodynamic changes and a shorter period of recovery (2). Successful insertion of an LMA requires deep anesthesia, a proper opening of the mouth, and adequate suppression of upper airway reflexes to reduce cough and gag reflexes and laryngospasm (3).

Propofol is a short-acting intravenous anesthetic that can effectively reduce pharyngeal reflexes (4). Compared with thiopental, propofol largely reduces upper airway reflexes and the incidence of wheezing following endotracheal intubation under anesthesia in healthy and asthmatic patients, turning propofol into an appropriate drug for the manipulation of the airway, including the insertion of LMA (4). High doses of propofol should be injected to induce deep anesthesia for the insertion of LMA, which can lead to hemodynamic instability, apnea, hypotension, and bradycardia. An adjuvant is often added to propofol to resolve these problems (5). Numerous measures were taken to reduce high doses of propofol to induce deep anesthesia, including simultaneous injection of intravenous muscle relaxants, ketamine, opioids, and midazolam (3, 5-7). As a muscle relaxant, atracurium reduces oxygen consumption, prevents involuntary movements decrease intracranial pressure, and does not require dosing adjustments in hepatic and renal diseases. Cisatracurium is three times more potent than atracurium

and needs a lower dose of action than atracurium. Cisatracurium also does not release histamine and no histamine and has no direct cardiovascular effect (8). In a study, hemodynamic changes were investigated after the injection of propofol and succinylcholine for the insertion of LMA. The results revealed that the injection of 0.25 mg/kg of succinylcholine significantly reduced laryngospasm and head movements in comparison with other groups. In addition, the injection of a muscle relaxant facilitated LMA insertion, but it had no effect on the gag reflex and cough (9). The effectiveness of rocuronium as a muscle relaxant plus propofol was assessed on LMA insertion in a study conducted in 2013. Based on the results, the muscle relaxant was unnecessary for LMA insertion, and even the extubation time was longer in the muscle relaxant group (10). However, another study reported that the administration of a muscle relaxant facilitated LMA insertion, and the injection of rocuronium led to higher successful insertion rates, higher sealing pressure, and lower mechanical leakage (7). The addition of adjuvants such as midazolam, fentanyl, ketamine, and remifentanil to propofol facilitated LMA insertion and improved hemodynamic responses. Further, the addition of remifentanil to propofol specifically provided an ideal situation for the insertion of LMA (3, 6, 11).

Objectives

This study aimed sought to compare the effectiveness of propofol alone versus propofol and cisatracurium as a muscle relaxant in facilitating LMA insertion and improving the hemodynamic parameters of patients.

Methods

This randomized, double-blind clinical study was conducted in the operating room of Shahid Mohammadi Hospital in Bandar Abbas, Iran in 2020. Overall, 87 patients who were candidates for elective surgery were enrolled in this study, while 17 patients were excluded from the study (Figure 1). All 70 patients, those in the age range of 18-65 years old with ASA (American Society of Anesthesiologists) I and II completed the study. The project was approved by the Ethics Committee of Hormozgan University Of Medical Sciences (Code: HUMS.REC.1394.104) and registered at with the code of IRCT20200108046052N1 The anesthesiologist visited all the patients the night before the surgery. The method and objective of the study were explained to the patients, and informed written consent forms were obtained from them. Demographic information (age, gender, height, body mass index [BMI], and weight) were collected as well. The patients with an ASA of greater than II, emergency cases, as well as patients with a full stomach, a history of upper respiratory tract infection in the last 4 weeks, asthma, chronic obstructive pulmonary disease, BMI > 40, drug sensitivity, elevated intracranial pressure, younger than 18 and older than 65 years of age, and limited mouth opening and maxillofacial anomalies, were excluded from the study.

Standard monitoring, including electrocardiogram (ECG), non-invasive blood pressure cuffs, pulse oximetry, and capnography, was performed on all patients. Hemodynamic parameters (heart rate, systolic and diastolic blood pressures, and mean arterial pressure)

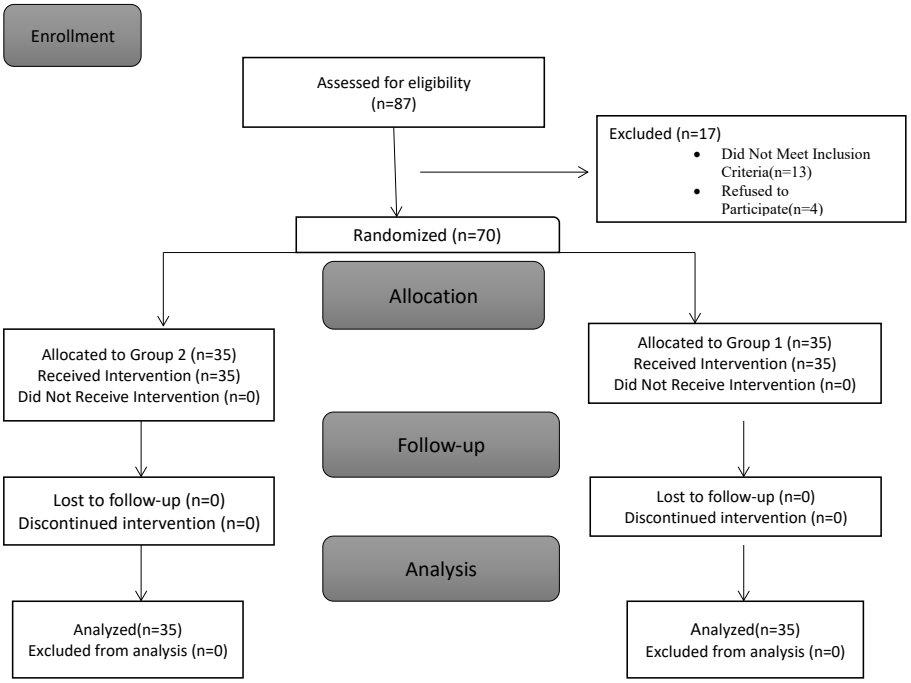

Figure 1. CONSORT Flow diagram.
Group 1, Propofol alone ; Group 2,Propofol + Cisatracurium.

were measured and recorded for all patients. The patients received 7 mL/kg of crystalloid fluid before the surgery. Premedication (0.05 mg/kg of midazolam and 2 μg/kg of fentanyl) was also injected into the patients.

The patients were randomly assigned to two groups of 35 using Random Allocation software, version 1.0.0). The first group received an intravenous injection of 2.5 mg/kg of propofol (Propofol 10 mg/1 mL, B. Braun Company, Germany) and normal saline in an equivalent volume to the other group. The second group received an intravenous injection of 2.5 kg/mg propofol and 0.2 mg/kg cisatracurium (muscle relaxant; cisatracurium 10 mg/5 mL, Rosamed, Iran).

The successful rate of LMA insertion in the propofol alone and the propofol plus muscle relaxant was 0.5 and 0.8667 in the study by Solanki and Solanki (1). According to the data of this study and $\alpha = 0.05$, $1-\beta = 0.9$, $Z_{1-\frac{\alpha}{2}} = 1.96$, and $Z_{1-\beta} = 1.28$, the minimum sample size was calculated as 29 in each group. Finally, the sample size was determined as 35 with regard to sample loss.

After 4 minutes of mask ventilation with pure oxygen, an anesthesiologist (who was blind to the intervention type) inserted a suitable size of LMA (with regard to patient weight) while the patient was in the sniffing position based on the standards of LMA placement. The cuff was filled with air, and ventilation was performed through the LMA. The ease of LMA insertion, jaw opening, cough and gag reflexes, head and limb movement, and laryngospasm, as well as hemodynamic parameters (heart rate, systolic and diastolic blood pressure, and mean arterial pressure), were assessed by the anesthesiologist assistant who was also blinded to intervention type. The data were recorded in a form.

The duration of LMA insertion (from the sniffing position to inflating the cuff and successful ventilation through the LMA), the number of attempts for LMA insertion, cuff inflation volume, and intra-cuff pressure (via VBM cuff pressure manometer, Germany) were evaluated in both groups. The endotracheal tube was inserted in the case of a large leak and LMA insertion failure, and the patient was excluded from the study. Hemodynamic parameters were measured at baseline, immediately after drug injection, before LMA insertion, immediately after LMA insertion, and 1, 3, and 5 minutes after the LMA insertion. Variations within the range of 20% and greater than 20% were assumed as normal and considerable hemodynamic changes, respectively. O_2, NO_2, and propofol infusion were used for the maintenance of anesthesia. At the end of the surgery, the effect of the muscle relaxant was reversed using neostigmine-atropine, and LMA was removed accordingly. The duration of surgery (from incision to the end of surgery and dressing) and the extubation time (from the discontinuation of anesthetic drugs to the removal of LMA) were recorded, and the presence or absence of postoperative complications (sore throat, nausea, and vomiting) was assessed in the recovery period.

Statistical Analysis

The collected data were analyzed through Chi-square, independent *t*-test, one-way analysis of variance, and descriptive statistics (mean, standard deviation, and percentage) using SPSS, version 19. The level of *P* value < 0.05 was considered statistically significant.

Results

The groups were matched in terms of demographic characteristics, and there was no statistically significant difference between them in this regard (Table 1).

Parameters such as ease of LMA insertion, jaw opening, gag reflex, head and limb movement, and laryngospasm were assessed in the two groups, and no statistically significant difference was found between them in this respect (Table 2).

The overall score of ease of LMA insertion was calculated by summing the above-mentioned five parameters. The overall score of ease of LMA insertion in the propofol plus muscle relaxant was significantly higher than the propofol alone ($P = 0.029$, Table 3).

Based on the results, no significant difference was observed between the two groups with regard to the duration of LMA insertion, cuff pressure, LMA size, cuff volume, and the number of LMA insertion attempts. However, the extubation time in the propofol alone group was significantly longer than in the propofol plus muscle relaxant group ($P<0.001$). The duration of surgery was significantly longer in the propofol plus muscle relaxant than in propofol alone ($P = 0.019$, Table 4).

The results revealed no significant difference between the two groups in terms of heart rate, systolic and diastolic blood pressure, and mean arterial pressure at any period (Table 5).

There was no incidence of postoperative complications (nausea, vomiting, and sore throat) during the recovery

Table 1. Demographic Characteristics and ASA Class of Patients in the Two Groups

Parameter		Group		*P* Value
		Propofol	MR + Propofol	
Age (y)		48.91 ± 15.77	46.03 ± 16.22	0.617
Weight (kg)		61.09 ± 9.77	65.17 ± 11.69	0.117
Height (cm)		165.37 ± 9.65	167.03 ± 7.41	0.423
BMI (kg/m²)		22.34 ± 3.31	23.71 ± 3.29	0.086
Gender	Female, % (n)	40% (14)	34.3% (12)	0.621
	Male, % (n)	60% (21)	65.7 (23)	
ASA	I, % (n)	54.3% (19)	51.4% (18)	0.811
	II, % (n)	45.7% (16)	48.6% (17)	

Note. ASA: American Society of Anesthesiologists; MR: Muscle relaxant; BMI, body mass index;.

Table 2. Assessment and Comparison of Parameters of ease of LMA Insertion (1)

Parameter	Grade	Description	Group				*P* Value
			Propofol		MR + Propofol		
			No.	%	No.	%	
Ease of LMA insertion	1	Impossible	0	0.0	0	0.0	0.673
	2	Difficult	4	11.4	2	5.7	
	3	Easy	31	88.6	33	94.3	
Jaw opening	1	Nil	1	2.9	0	0.0	0.151
	2	Partial	6	17.1	2	5.7	
	3	Total	28	80	33	94.3	
Gag reflex	1	Vigorous	1	2.9	0	0.0	1.000
	2	Mild	0	0.0	1	2.9	
	3	Nil	34	97.1	34	97.1	
Patient movement	1	Vigorous	1	2.9	0	0.0	0.110
	2	Moderate	8	22.9	3	8.6	
	3	Nil	26	74.3	32	91.4	
Laryngospasm	1	Total	0	0.0	0	0.0	-
	2	Partial	0	0.0	0	0.0	
	3	Nil	35	100	35	100	

Note. LMA: Laryngeal mask airway; MR: Muscle relaxant.
Source: Solanki and Solanki (1).

Table 3. Overall Score of Ease of LMA Insertion

Grade	Score	Group P (n = 35)	Group P + MR (n = 35)	*P* Value
Excellent	15	60% (21)	80% (28)	0.029
Satisfactory	13-14	22.9% (8)	20% (7)	
Poor	≤12	17.1% (6)	0% (0)	

Note. MR: Muscle relaxant; LMA: Laryngeal mask airway; *Significant at $P<0.05$.

Table 4. Parameters of LMA Insertion and Removal and Duration of Surgery

Parameter	Group		*P* Value
	Propofol	Propofol + MR	
	Mean ± SD	Mean ± SD	
Surgery time (min)	22.37 ± 10.16	33.69 ± 24.32	0.019*
Insertion time (s)	23.94 ± 14.60	19.17 ± 7.56	0.342
Extubation time (s)	198.20 ± 6.30	116.76 ± 6.62	<0.001*
Sealing pressure (cmH_2O)	63.75 ± 3.59	64.35 ± 3.11	0.065
LMA size	3.76 ± 0.65	3.80 ± 0.53	0.4000
Cuff inflation (mL)	5.96 ± 3.96	8.69 ± 3.05	0.610
Attempt (n)	1.14 ± 0.43	1.09 ± 0.28	0.668

$P<0.05$ surgery time G1&2.
$P<0.001$ between extubation time G1&2.
MR, muscle relaxant.
*Significant at $P<0.05$.

period among patients.

Discussion

According to this study, demographic characteristics (age, gender, weight, height, and BMI) and ASA class were consistent in the two groups, and no statistically significant difference was observed between them, which is consistent with the results of Dhamotharan et al (3), Fujiwara et al (7), and George et al (9). The results also showed no statistically significant difference regarding ease of LMA insertion, jaw opening, cough and gag reflexes, head and limb movement, and laryngospasm between the two groups. However, the overall score of ease of LMA insertion (sum of the above-mentioned five parameters) was significantly higher in the propofol plus muscle relaxant than propofol alone. The findings of Nasseri (12) and George et al (9) demonstrated that the degree of jaw relaxation was significantly higher in the muscle relaxant group, which is in line with our result in terms of ease of LMA insertion. However, the coughing rate was lower in the muscle relaxant group in the study by Nasseri (12), which is inconsistent with our findings. George et al (9) investigated whether using a small dose of succinylcholine, combined with propofol, facilitates LMA insertion. They observed that the degree of head movement and laryngospasm was higher in the control group, which contradicts our results. However, their findings concerning gagging and coughing reflexes were not significantly different from our findings. These differences in head movement and laryngospasm may be due to the type and dose of the applied muscle relaxants. In line with our results, Nada (13) found that using a low-dose rocuronium (0.15 mg/kg) did not affect coughing, gagging, and laryngospasm. However, decreased LMA insertion time in their study does not match our findings. Among the probable causes of inconsistency is the use of a small dose and different types of muscle relaxants. Solanki and Solanki (1) revealed that coughing, gagging, and laryngospasm were not significantly different

Table 5. Assessment and Comparison of Systolic, Diastolic, Mean Arterial Pressure (mm Hg) and Heart Rate (bpm) at Different Periods Between the Two Groups

Parameter	Group		*P* Value
	Propofol	MR + Propofol	
	Mean ± SD	Mean ± SD	
SBP1	143.07 ± 17.89	145.48 ± 14.98	0.577
SBP2	111.80 ± 20.44	117.45 ± 20.94	0.299
SBP3	120.10 ± 22.88	115.97 ± 24.99	0.510
SBP4	114.10 ± 20.29	114.55 ± 20.91	0.933
SBP5	112.63 ± 19.68	113.55 ± 17.14	0.849
SBP6	112.33 ± 18.91	116.93 ± 19.68	0.364
DBP1	85.13 ± 14.68	84.07 ± 10.84	0.753
DBP2	70.80 ± 16.42	70.45 ± 17.11	0.936
DBP3	74.53 ± 19.72	71.28 ± 16.04	0.490
DBP4	70.70 ± 15.59	69.48 ± 15.46	0.764
DBP5	71.37 ± 15.42	69.14 ± 12.37	0.544
DBP6	71.30 ± 13.89	71.10 ± 11.84	0.954
MAP1	102.71 ± 13.84	106.06 ± 14.50	0.208
MAP2	85.09 ± 16.47	86.09 ± 18.32	0.456
MAP3	87.24 ± 18.37	89.03 ± 23.00	0.895
MAP4	83.56 ± 15.20	85.34 ± 18.77	0.638
MAP5	83.60 ± 15.47	87.00 ± 15.71	0.360
MAP6	83.340 ± 14.25	88.43 ± 14.73	0.194
HR 1	77.40 ± 17.72	78.06 ± 17.10	0.875
HR 2	76.74 ± 14.23	77.11 ± 15.75	0.918
HR 3	75.89 ± 14.79	76.40 ± 15.80	0.889
HR 4	72.69 ± 13.22	74.23 ± 13.01	0.624
HR 5	72.74 ± 13.51	72.57 ± 12.23	0.956
HR 6	70.20 ± 13.04	69.57 ± 12.68	0.839

MR, muscle relaxant.

between the two groups, which conforms to our results; however, the degree of movement was higher in the propofol group, which is inconsistent with the findings of our study. The probable reasons for incontinence are the use of succinylcholine as the muscle relaxant that has more relaxant and a rapid onset effect compared to non-depolarizing muscle relaxants.

The parameters of cuff pressure, cuff volume, LMA size, and the number of LMA insertion attempts, as well as the duration of surgery, LMA insertion, and extubation time were also assessed in this study. The duration of surgery was longer in the muscle relaxant plus propofol group, and the extubation time was longer in the propofol and saline group. No statistical changes were found in other parameters between the two groups. Unlike our findings, Nasseri (12) reported no difference between the groups in terms of operation time. It may be due to the use of an atracurium muscle relaxant with the lowest dose. In the study of Chen et al (10), the recovery time was shorter in the control group, which contradicts our findings and could be due to the use of succinylcholine and the different operation type, while our study was conducted only in elective ophthalmic surgery. Chen et al (10) also found similar results except in the cases of the extubation time, which was longer in the muscle relaxant group. These confounding results might be due to the type of muscle relaxant (rocuronium) and surgery (laparoscopic gynecology in women). Fujiwara et al (7) reported an increase in the cuff pressure and a decrease in gas leakage in the rocuronium group in comparison with the saline group. However, they concluded that the number of LMA insertion attempts was higher in the propofol alone group, and the duration of surgery was longer in the propofol and saline group. These confounding results might be due to different doses and types of muscle relaxants, as well as the dose of propofol. The type of surgery was not mentioned in the study by Fujiwara et al (7) although different types of surgeries (ocular, orthopedic, urological, and general surgeries) were performed in this study. Nevertheless, LMA size was similar in these two studies.

Hemodynamic parameters (heart rate, systolic and diastolic blood pressure, and mean arterial pressure) were assessed at different periods of LMA insertion and removal, and no significant difference was found in these parameters at different periods between the two groups. The results of Solanki and Solanki (1) and Nasseri (12) revealed the least changes in the heart rate and mean arterial blood pressure during LMA insertion and extubation, which is in line with our findings. Kim et al (5) concluded that the heart rate and mean arterial blood pressure decreased, which does not match our results and could be attributed to the use of remifentanil that decreased the heart rate and blood pressure.

The incidence of postoperative complications (nausea, vomiting, and sore throat) was also examined in the recovery period, and no difference was observed between the two groups. These results corroborate with those of Fujiwara et al (7) and Chen et al (10). The findings of Nasseri (12) showed lesser postoperative sore throat in the muscle relaxant group, which could be attributed to the use of atracurium and different operation types. Finally, Griffith et al (14) reported that there was no difference in the prevalence of postoperative nausea and vomiting with LMA insertion between the two groups, which is in line with the results of the current study.

Limitations

The dose of anesthetic agents could not be measured in this study since the depth of anesthesia was not monitored, and this factor could affect some parameters, including the extubation time.

Conclusion

The findings of this study demonstrated that both techniques (propofol alone and propofol plus muscle

relaxant) were suitable for LMA insertion and caused no tangible hemodynamic changes. However, the addition of muscle relaxants to propofol is recommended due to easier LMA insertion and shorter extubation time.

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Author Contributions

Conceptualization: MKR ;Methodology: HJ ; Investigation: MZ; Formal analysis:MKR,HJ;Data curation: HJ,MZ;Writing-original:HJ; Writing-Review and Editing:All authors; Resources: All authors; Supervision:HJ.

Conflict of Interests

The authors declared no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

Ethical Approval

The project was approved by the Ethics Committee of Hormozgan University of Medical Sciences (Code: HUMS.REC.1394.104) and registered with the code IRCT20200108046052N1.

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