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Original Article

Low dose Atracurium for Laryngeal Mask Airway Insertion in Ophthalmic Surgeries: A Randomized Controlled Study

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Abstract

Background: Adequate relaxation of jaw muscles may influence both the ease and safety of laryngeal mask airway [LMA] insertion. This study aimed to assess whether low-dose atracurium could enhance LMA insertion conditions, reduce associated complications, and stabilize hemodynamic responses in patients undergoing ophthalmic surgery under general anesthesia induced by propofol.

Patients and Methods: In this prospective, randomized, double-blind study, 40 patients were allocated equally into two groups. Group A received 0.1 mg/kg intravenous atracurium, while Group B received 2 mL of normal saline. Following administration of fentanyl and propofol for anesthesia induction, variables such as insertion time, ease of placement, jaw relaxation, number of attempts, hemodynamic changes, and adverse events were recorded.

Results: Low dose atracurium [0.1 mg/kg] reduced LMA insertion time [4.05 ± 0.53 vs. 5.03 ± 0.72 seconds, $P < 0.001$] and improved ease of insertion compared to the control group. No significant differences were found in hemodynamic parameters or postoperative sore throat.

Conclusion: Low-dose atracurium enhances LMA insertion conditions in ophthalmic surgery, with stable hemodynamics, making it a valuable tool for short-duration procedures.

Keywords: Atracurium; LMA; Ophthalmic Surgery; Airway Management.

INTRODUCTION

The laryngeal mask airway [LMA] has become a valuable alternative to endotracheal intubation in routine general anesthesia and emergency airway management. Its simplicity and adaptability make it a reliable option, particularly in difficult airway scenarios where traditional intubation may fail or cause undue distress. Compared to endotracheal tubes, LMA insertion generally requires lower anesthetic concentrations and is associated with fewer adverse reactions such as hemodynamic instability, coughing, sore throat, and laryngospasm [1,2].

For optimal insertion, adequate anesthetic depth and mouth opening are essential [3]. Muscle relaxation, particularly of the jaw, significantly enhances the ease of LMA placement [4].

Although propofol is the induction agent of choice, using it alone may be insufficient and may lead to adverse airway responses like coughing or laryngospasm [5]. Higher doses of propofol improve insertion conditions but at the cost of cardiovascular depression [3].

More recent studies suggest that dexmedetomidine, when used during induction, can reduce the required dose of propofol by up to 38%, facilitating smoother LMA insertion with fewer respiratory or cardiovascular complications [6].

The use of neuromuscular blocking agents during positive pressure ventilation can suppress spontaneous breathing and mitigate ventilator-induced complications [7]. However, their benefit in facilitating LMA insertion remains debated. Some studies found muscle relaxants to be as effective as opioids in improving insertion conditions [8], while others argued that muscle relaxants add cost and prolong recovery without significant benefit [9].

Conversely, **Jarineshin H *et al.*** demonstrated that low-dose muscle relaxants combined with propofol significantly improved insertion ease [10].

AIM OF THE STUDY

This study aimed to assess whether low dose atracurium improved the success rate, insertion time, ease of placement, and ventilation quality with LMA in anesthetized patients undergoing ophthalmic surgery.

PATIENTS AND METHODS

This prospective, randomized, and double-blinded clinical trial was implemented at the Ophthalmic Center of Mansoura University Hospitals. Institutional ethical clearance was obtained [Approval No. R.23.04.2136], and the study was registered with the Pan African Clinical Trials Registry [PACTR202405675858601]. Data collection occurred between May and August 2023. All participants signed informed consent forms prior to enrollment. The study followed the 2013 revision of the Declaration of Helsinki and aligned with current good clinical practices.

Included patients were male and female patients over 18 years of age who were scheduled for ophthalmic operations and categorized as ASA I or II. Patients were excluded if they had neuromuscular disorders, known allergies to neuromuscular blocking drugs, current pregnancy, evidence of gastroesophageal reflux, a history of hiatal hernia, or predictors of difficult airway management.

Sample size calculation: Sample size estimation was performed using PASS software version 11.0.4 [2011], based on data from Nasseri K. [2017] [11], where the primary outcome was LMA insertion time. According to the referenced study, mean insertion times were 5.06 ± 0.52 seconds for the atracurium group and 5.76 ± 0.67 seconds for the control group. A sample of 34 patients was calculated to achieve 90% power using a two-sided t-test with unequal variances and a significance level of 0.05. To accommodate potential dropouts, the final sample included 40 patients [20 per group].

Randomization and blinding: Participants scheduled for ophthalmic surgery by the same surgeon were randomly and evenly assigned into two study arms. **Group A** received 0.1 mg/kg of intravenous atracurium diluted in 2 mL, while **Group B** received 2 mL of isotonic saline. The randomization sequence was generated by computer and concealed using sealed opaque envelopes. All data were gathered by an anesthesiologist who was unaware of the group allocations.

Methods

On arrival in the operating theater, each patient underwent standard monitoring: pulse oximetry, non-invasive blood pressure and electrocardiography. Pre-induction measurements of heart rate and blood pressure were documented. Intravenous Ringer's lactate [5 mL/kg] was administered before anesthesia began.

Induction began with oxygen preloading followed by dexmedetomidine at 1 µg/kg infused over 10 minutes and propofol at 2 mg/kg. Group A received atracurium [0.1 mg/kg IV, 2 mL], whereas Group B was given an equivalent volume of saline. Once verbal communication ceased, a properly sized LMA was placed by a trained anesthesiologist blinded to the drug used. The classic insertion technique was followed for all patients.

LMA placement was judged successful if chest expansion was appropriate, air leak was minimal or absent during manual ventilation, lung auscultation was normal, and peak airway pressure did not exceed 20 cm H_2O. Maintenance anesthesia was provided via 1.2% isoflurane in a 50:50 oxygen-air mixture. Ondansetron 4 mg IV was administered prophylactically for postoperative nausea and vomiting.

Data recorded included:

1. Age, sex, and operative time

2. LMA insertion time: defined from the moment the device touched the lips until successful lung inflation was confirmed.

3. Ease of insertion, categorized as:

- Easy: completed within 15 seconds with **no** patient movement [limb motion, coughing] or resistance to ventilation in the two minutes following cuff inflation.
- Mild difficulty: over 15 seconds or within 15 seconds but with minor movement, resistance or needing readjustment in the same attempt.

- Difficult: major movement or resistance or more than one attempt or over 30 seconds required.

4. Number of attempts: count of separate insertion trials.

5. Hemodynamics: heart rate and systolic/diastolic blood pressures measured at baseline, post-induction, and at 1 and 5 minutes after LMA placement.

6. Adverse events: including sore throat, nausea, vomiting, or laryngospasm after removal of the device.

At surgery's end, inhaled anesthetics were discontinued. Manual ventilation continued until patients resumed adequate spontaneous breathing, at which point the LMA was removed.

Statistical Software and Analysis: Data analysis was conducted using IBM SPSS Statistics version 26.0 [IBM Corp., Armonk, NY, USA]. The normality of continuous variables [such as age, operative duration, insertion time, heart rate, and mean arterial pressure] was assessed using the Shapiro-Wilk test. Since the data followed normal distribution, comparisons between the two groups were carried out using the independent t-test. Categorical variables [including sex distribution, ease of insertion and postoperative sore throat] were evaluated using the Chi-square test, with Fisher's exact test applied when expected cell counts were small. Statistical significance was determined at a P-value < 0.05. Continuous data are presented as mean ± standard deviation, while categorical data are expressed as frequencies and percentages. Line graphs with error bars representing standard deviations were used to illustrate trends in hemodynamic parameters and were created using SPSS graphical tools.

RESULTS

A total of 40 patients scheduled for ophthalmic surgery under general anesthesia were enrolled and equally assigned to two groups. Group A received atracurium at a dose of 0.1 mg/kg, while Group B [control group] received an equivalent volume of normal saline. Each group comprised 20 participants. No statistically significant differences were observed between the two groups regarding age, sex distribution, or duration of surgery. The results are summarized in [Table 1]. The mean time to successful LMA insertion was significantly shorter in the atracurium group [4.05 ± 0.53 seconds] than in the control group [5.03 ± 0.72 seconds], with a highly significant statistical difference [**P < 0.001].**

Regarding ease of insertion, all patients in Group A experienced "easy" placement. In contrast, Group B had a broader distribution: 80% were easy, 15% were a little difficult, and 5% were very difficult. Although these differences suggested a trend favoring the atracurium group, the difference did not reach statistical significance **[P = 0.108].** [See Table 2]

All patients in Group A had successful insertions on the first attempt. In Group B, one patient required a second attempt. Due to the limited variation, no formal statistical comparison was conducted for this variable. Heart rate [HR] and mean arterial pressure [MAP] values were comparable between groups at all recorded time points: baseline, post-induction, 1-minute post-insertion, and 5 minutes post-fixation. There were no statistically significant differences observed at any interval [P > 0.2 across all comparisons] [tables 3,4 and figures 1,2]. Sore throat was reported in 2 patients from Group A and in 5 patients from Group B. However, the difference was not statistically significant [P = 0.405].

Table [1]: Demographic data

	Group A	Group B	p-value
Age [years]	55.5± 11.58	53.15±10.74	0.510
Sex [male/ female]	8/ 12	10/ 10	0.527
Operative time [min]	43±7	41±10	0.326

Table [2]: Ease of insertion

	Group A	Group B
Easy	20	16
Little difficult insertion	0	3
very difficult insertion	0	1

Table [3]: Heart Rate [beat per min]

Time point	Group A [bpm]	Group B[bpm]	P-value
Baseline	81.2±5.87	83.1±4.62	0.262
After induction of anesthesia	77.1±4.07	77.3±3.89	0.875
1 min after LMA insertion	73.1±3.12	74.3±3.25	0.241
5 min after LMA fixation	69.5±1.55	69.7±2.01	0.726

Table [4]: Mean arterial pressure [MAP] [mm Hg]

Time point	Group A [mm Hg]	Group B [mm Hg]	P- value
Baseline	94.2±5.02	95.1±6.33	0.621
After induction of anesthesia	90.2± 4.12	90.5±3.87	0.814
1 min after LMA insertion	88.1±2.56	89.3±3.17	0.196
5 min after LMA fixation	85.7±3.22	86.6± 4.13	0.447

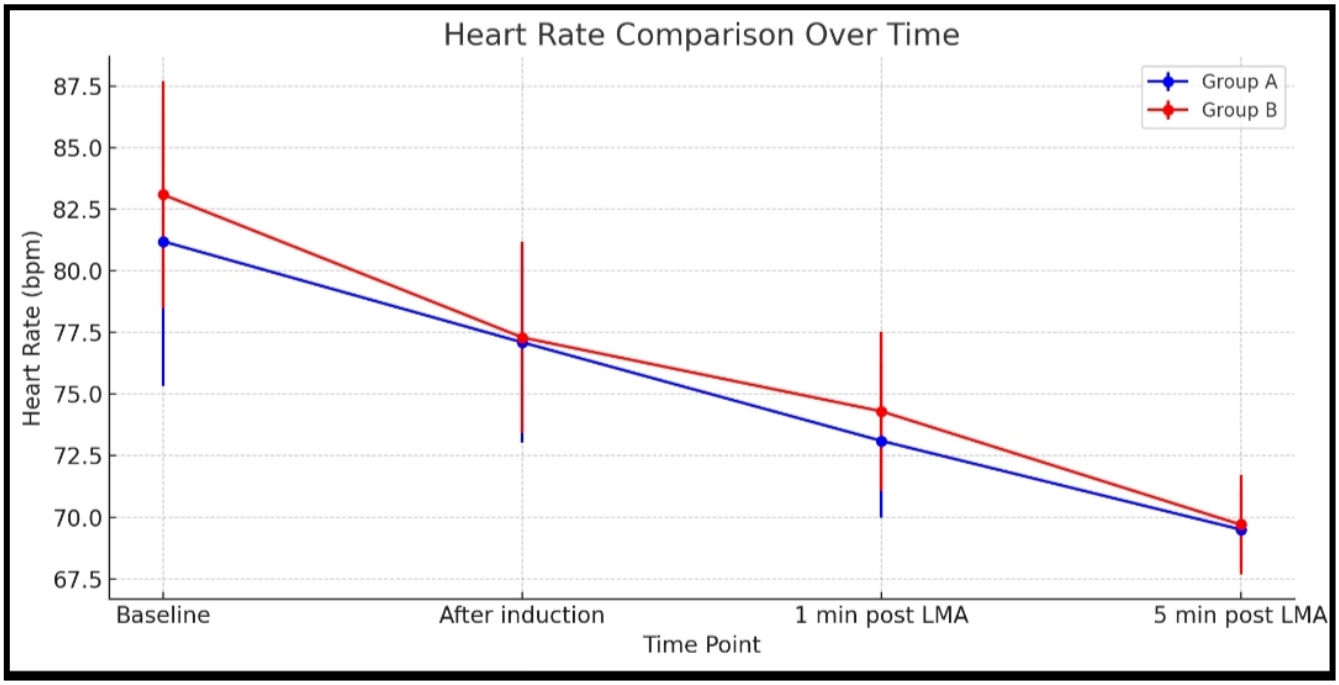

Figure [1]: Heart rate [HR] comparison over time

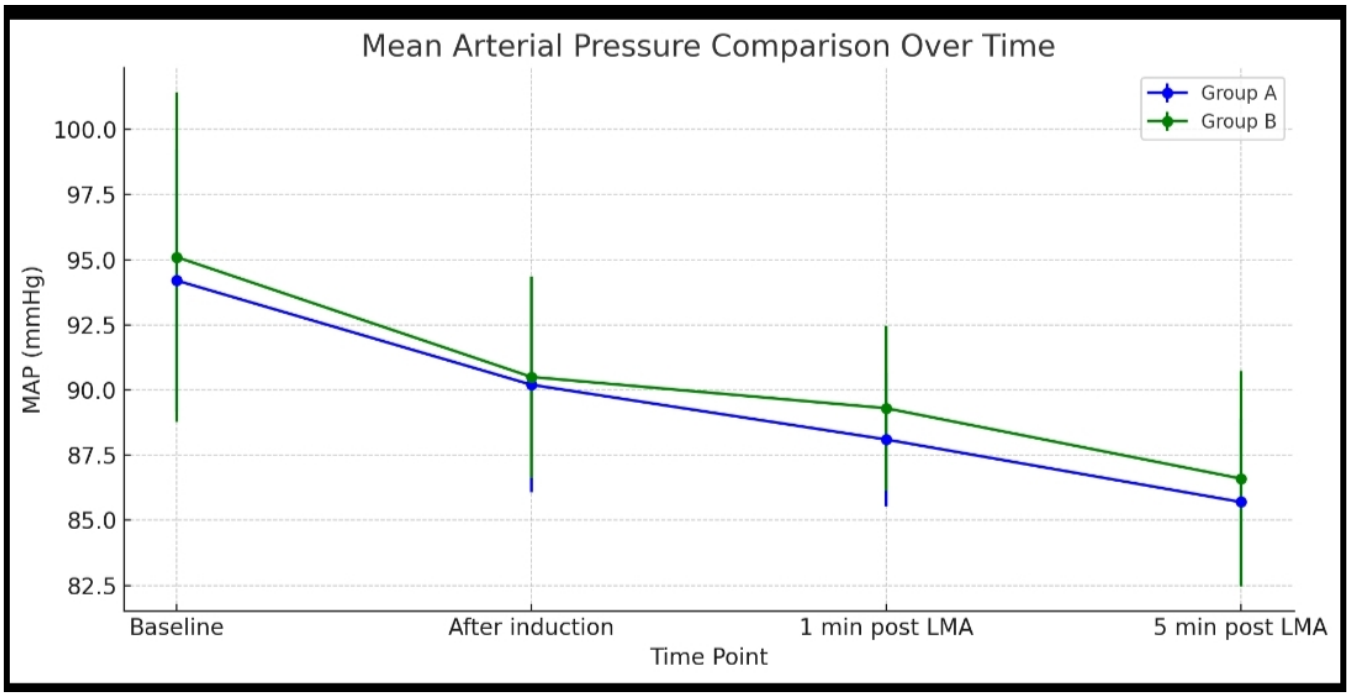

Figure [2]: mean arterial pressure [MAP] comparison over time

DISCUSSION

The use of neuromuscular blockers to facilitate LMA insertion continues to be an area of clinical interest, particularly in procedures where smooth and rapid airway management is critical. Recent studies have explored the efficacy of low-dose muscle relaxants to improve insertion conditions without inducing significant adverse effects or prolonging recovery times [12-14].

In the present study, a low dose of atracurium [0.1 mg/kg] was assessed in adult patients undergoing ophthalmic surgery, aiming to optimize LMA insertion while preserving hemodynamic stability and minimizing complications. These findings add to the growing body of evidence supporting the selective and judicious use of neuromuscular agents in short-duration surgeries where airway control must be both effective and atraumatic. This clinical trial demonstrated that administering a low dose of atracurium [0.1 mg/kg] significantly enhanced the conditions for LMA insertion in adult patients undergoing ophthalmic surgery. Specifically, the time required for successful placement was reduced, and a higher proportion of patients experienced "easy" insertion, all without significant alterations in hemodynamic parameters or increased postoperative complications.

The significant reduction in insertion time observed in the atracurium group [4.05 ± 0.53 seconds] compared to the control group [5.03 ± 0.72 seconds; $P < 0.001$] supports the findings of **Nasseri *et al.*** [11] who also reported improved LMA insertion conditions with low dose atracurium. The observed facilitation is likely due to the muscle relaxant's action on pharyngeal and jaw musculature, reducing resistance and allowing smoother placement on devices. Although the difference in ease of insertion between the two groups did not reach statistical significance [$P = 0.108$], the clinical implications are noteworthy. All patients in the atracurium group had easy insertions, whereas 20% of those in the control group required additional attempts or adjustments.

No significant differences were noted in HR or mean arterial pressure [MAP] between the two groups at any measured time point. This suggests that the administration of dexmedetomidine [1 µg/kg] prior to induction in both groups had a stabilizing effect. As a selective alpha-2 adrenergic agonist, dexmedetomidine dampens sympathetic output and mitigates cardiovascular responses to airway stimulation [15].

In this study, both HR and MAP demonstrated gradual declines over time, which is consistent with the known pharmacodynamic profile of dexmedetomidine [16]. Its inclusion likely minimized hemodynamic variability during LMA insertion, thus isolating the effect of atracurium on insertion quality [17].

Dexmedetomidine has a rapid distribution phase [approximately 6 minutes] and a terminal half-life of around 2 hours [18].

When administered as a slow intravenous bolus over 10 minutes—as was done in this study—it achieves adequate plasma levels quickly. These properties make it ideal for short procedures such as ophthalmic operations. The sedative and sympatholytic effects likely peaked at the time of LMA placement, which helped maintain cardiovascular stability and reduce the confounding impact of airway stimulation [19].

Postoperative sore throat was less frequent in the atracurium group [2 cases vs. 5 in the control group], although the difference was not statistically significant. This trend may be attributed to smoother LMA placement facilitated by muscle relaxation, which reduces mechanical trauma to the pharyngeal mucosa [20, 21].

The results, aligning with previous studies such as **Yoshino *et al.*** [10], showed that the addition of low-dose neuromuscular blockers improved LMA insertion conditions.

On the other hand, findings by **Chen *et al.*** [9] have raised concerns about using muscle relaxants due to potential delays in recovery and additional cost. However, clinical scenarios requiring a rapid and minimally traumatic airway approach — such as in ophthalmic surgery where even minor patient movement can interfere — using a low-dose relaxant appears justified and beneficial.

Limitations: This study is limited by the relatively small sample size [n = 40], which may have restricted the statistical power to detect significant differences in secondary endpoints, such as postoperative sore throat. Additionally, the study did not include recovery time measurements or neuromuscular monitoring, which could have offered further insight into the postoperative impact of low dose atracurium.

Conclusion: This study demonstrates that low-dose atracurium [0.1 mg/kg] can significantly facilitate LMA insertion in adult patients undergoing ophthalmic surgery, offering faster placement with minimal complications. Hemodynamic parameters remained stable throughout, likely aided by the pre-induction use of dexmedetomidine, which provided a uniform sympatholytic effect across both groups. Together, these findings highlight the clinical value of combining dexmedetomidine with low-dose neuromuscular blockade to achieve smoother airway management without compromising cardiovascular stability or recovery.

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