

A Comparison of the Incidence of Laryngospasm after LMA Removal between Children Undergoing LMA Insertion with Simple Lubricant versus Lidocaine Gel

Seyed Alireza Mahdavi¹, Ahmad Eghbali Zarch², Nastaran Sadat Mahdavi³, Tara Darabi^{1*}

¹Anesthesiology Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

²Department of Anesthesiology, School of Medicine, Iran University of Medical Sciences, Tehran, Iran.

³Department of Anesthesiology, Mofid Children's Hospital, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

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ABSTRACT

Background: Pediatric patients are particularly vulnerable to airway stimulation, increasing the risk of perioperative respiratory adverse events such as laryngospasm and cough during emergence. Although the laryngeal mask airway (LMA) is less invasive than endotracheal intubation, it may still provoke airway irritation. This randomized clinical trial compared lidocaine gel with simple lubricant applied to the LMA surface in reducing airway-related complications in children.

Methods: Sixty children undergoing elective surgery at Mofid Children's Hospital, Tehran, were randomly assigned to two groups (n=30 each). In the intervention group, lidocaine gel was used as the LMA lubricant; in the control group, a simple lubricant was applied. Demographic variables, underlying disease, laryngospasm, recovery-room cough, and cough 12 hours postoperatively were recorded and analyzed.

Results: Demographic characteristics did not differ significantly between groups ($P>0.05$). Laryngospasm and recovery-room cough occurred in none of the patients in the lidocaine group and in one patient (3.33%) in the control group, without statistical significance ($P>0.05$). No patient in either group experienced a cough 12 hours after surgery.

Conclusion: This study suggests that lidocaine gel, when used as an LMA lubricant in pediatric patients, may offer a potential advantage in attenuating airway-related complications during LMA removal, compared to simple lubricants. Considering its favorable safety profile and the observed trend towards improved airway stability, lidocaine gel warrants consideration as a beneficial adjunct for optimizing airway management in this population.

Introduction

Airway management is a fundamental component of general anesthesia and perioperative care, essential not only for maintaining oxygenation and ventilation but also for minimizing procedure-related

complications. Since its introduction in 1983, the laryngeal mask airway (LMA) has become an established supraglottic device in anesthetic practice. Because it can be inserted blindly without direct laryngoscopy, LMA placement generally requires less airway manipulation than endotracheal intubation, thereby reducing mucosal trauma and reflex airway stimulation [1–3].

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*Corresponding author.

E-mail address: Dr.taradarabi@gmail.com

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The LMA is widely used in short procedures, ambulatory surgery, and cases not requiring definitive tracheal intubation. In both adults and children, it is often preferred because of its ease of placement and its association with less pronounced hemodynamic responses than the endotracheal tube (ETT). As the device does not enter the trachea, sympathetic stimulation is typically attenuated, resulting in smaller fluctuations in heart rate and blood pressure [4–6]. Moreover, the LMA plays an important role in difficult airway algorithms as a rescue or bridging device for maintaining oxygenation when tracheal intubation is challenging or unsafe [7–8].

Despite these advantages, pediatric airway management remains uniquely challenging because of anatomical and physiological differences, including a relatively larger tongue, a more anterior and cephalad larynx, a smaller airway caliber, and increased susceptibility to dynamic obstruction [9–10]. These factors may complicate blind LMA placement and heighten the risk of airway reflex activation, particularly when anesthetic depth is suboptimal [11–14]. In addition, airway-related adverse events during emergence and recovery—especially laryngospasm, cough, and hypoxemia—remain clinically important in children [4,15–18].

To facilitate insertion and reduce mucosal friction, lubricants are routinely applied to the LMA surface. Lidocaine gel has attracted interest because, beyond lubrication, its topical anesthetic effect may attenuate airway irritation and reduce peri-extubation complications such as laryngospasm and cough [19–21]. However, its use remains controversial because potential benefits must be weighed against possible adverse effects, including allergic reactions, systemic absorption, and excessive suppression of protective airway reflexes [22–25]. Given the widespread use of LMA in pediatric anesthesia and the potentially serious consequences of laryngospasm, further comparative evidence is warranted. Therefore, this study was designed to compare lidocaine gel with simple lubricant during LMA insertion in children, with particular emphasis on laryngospasm and other airway-related complications.

Methods

Study design and setting

This prospective randomized clinical trial was conducted at Mofid Children's Hospital, affiliated with Shahid Beheshti University of Medical Sciences, Tehran, Iran, in 2024. The study included pediatric patients undergoing elective surgery in whom airway management was planned with a laryngeal mask airway (LMA).

Participants

Children weighing 5–20 kg who were classified as American Society of Anesthesiologists (ASA) physical status I and were scheduled for surgery requiring LMA placement were considered eligible. Written informed consent was obtained from the parents or legal guardians of all participants before enrollment.

Patients were excluded if the duration of surgery exceeded 2 hours, if intraoperative bleeding required administration of blood products, if surgical complications led to severe hemodynamic instability, or if the child had a structural abnormality or obstructive pathology of the airway.

Sample size and sampling

Participants were recruited using a census sampling approach, and all eligible patients presenting during the study period were assessed for inclusion. Sample size was estimated using the standard formula (Eq. (1)) for comparison between two groups, assuming a type I error of 0.05 and a power of 80%:

$$n = 2(Z_{1-\alpha/2} + Z_{1-\beta})^2 / d^2 \quad (1)$$

Based on this calculation, the required sample size was determined to be 60 patients, with 30 children in each group.

Randomization and intervention

After enrollment, baseline demographic characteristics, including age, sex, and weight, were recorded using a predesigned data collection form. Each participant was assigned a unique study code. Patients were then randomly allocated in a 1:1 ratio to one of two study groups using a computer-generated simple randomization method.

In the control group, the LMA was lubricated with a simple lubricating gel (POLYGEL Lubricating Jelly, Paliz Teb Shafagh, Iran). In the lidocaine group, the LMA was lubricated with 2% lidocaine gel (Xylogel 2%, Sinadarou, Iran). The type of gel applied to the LMA surface constituted the sole study intervention; all other perioperative procedures were standardized across groups.

Anesthetic management

The anesthetic protocol was identical in both groups. Anesthesia was induced with fentanyl (1–2 µg/kg), midazolam (0.02 mg/kg), propofol (2–5 mg/kg), and cisatracurium (0.1–0.2 mg/kg). After adequate anesthetic depth and appropriate conditions for airway placement had been achieved, the LMA was inserted. Anesthesia was subsequently maintained with sevoflurane.

Throughout the procedure, routine intraoperative monitoring was applied, including electrocardiography (ECG), pulse oximetry, noninvasive blood pressure (NIBP), and capnography, to ensure continuous assessment of hemodynamic and respiratory status.

Outcome assessment

At the end of surgery, the LMA was removed when the patient had reached an appropriate level of awakening. The primary outcomes assessed were the incidence of laryngospasm and cough in the recovery room. In addition, cough at 12 hours postoperatively was evaluated and recorded during follow-up in the ward. Relevant clinical data, including demographic characteristics, underlying disease, and airway-related outcomes, were documented systematically for all participants.

Statistical analysis

Statistical analysis was performed using SPSS software version 26 (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was assessed using the Shapiro–Wilk test. Quantitative variables with normal distribution were expressed as mean $\pm$ standard deviation (SD), whereas non-normally distributed variables were presented as median and interquartile range (IQR). Categorical variables were summarized as frequency and percentage. Descriptive findings were presented in tables and figures where appropriate. A two-sided P value < 0.05 was considered statistically significant.

Results

A total of 60 pediatric patients completed the study and were included in the analysis ($n = 30$ per group). Baseline demographic and clinical characteristics were well balanced between the lidocaine gel and simple lubricant groups (Table 1), with no evidence of between-group differences at enrollment.

The mean age was 3.35 ± 1.43 years in the lidocaine gel group and 3.13 ± 1.28 years in the simple lubricant group ($p = 0.135$). Sex distribution was identical in both arms (16 males [53.33%] and 14 females [46.67%] per group; $p = 0.482$). The mean weight was 15.21 ± 4.25 kg with

lidocaine gel versus 13.96 ± 4.81 kg with simple lubricant ($p = 0.109$). The mean LMA size was 1.76 ± 0.25 in the lidocaine gel group and 1.86 ± 0.19 in the simple lubricant group; this difference did not reach statistical significance ($p = 0.083$). Clinical outcomes are presented in (Table 2). No participant in either group had a reported underlying comorbidity (0% in both groups; $p = 0.937$), indicating a uniformly healthy study population. Postoperative airway complications were uncommon overall. In the lidocaine gel group, no episodes of laryngospasm or coughing were observed during recovery. In contrast, in the simple lubricant group, one patient (3.33%) developed laryngospasm, and one patient (3.33%) experienced coughing in the recovery period. These differences were not statistically significant ($p = 0.835$ and $p = 0.820$, respectively). At 12 hours postoperatively, no patient in either group had a cough (0% in both groups; $p = 0.918$).

Discussion

Airway management in pediatric anesthesia remains a persistent clinical challenge because the immature airway is particularly susceptible to mechanical and chemical stimulation. This heightened reactivity increases the risk of peri-emergence adverse events, especially laryngospasm and cough, during the removal of supraglottic airway devices. In the present randomized clinical trial, we evaluated whether topical lubrication of the laryngeal mask airway (LMA) with lidocaine gel, compared with simple lubricant, could reduce airway irritation during recovery in children.

The two study groups were well matched at baseline, with no statistically significant differences in age, sex, weight, or LMA size. This comparability is methodologically important, as younger age and lower body weight are recognized risk factors for perioperative respiratory adverse events in pediatric patients [11-12].

Table 1- Demographic and Clinical Characteristics.

Variable	Lubricant with Lidocaine (N=30)	Lubricant without Lidocaine (N=30)	Total (N=60)	P value
Age (years)	3.35 ± 1.43	3.13 ± 1.28	3.24 ± 1.35	0.135
Gender				0.482
Male, n (%)	16 (53.33%)	16 (53.33%)	32 (53.33%)	
Female, n (%)	14 (46.67%)	14 (46.67%)	28 (46.67%)	
Weight (kg)	15.21 ± 4.25	13.96 ± 4.81	14.59 ± 4.53	0.109
LMA Size (cm)	1.76 ± 0.25	1.86 ± 0.19	1.81 ± 0.22	0.083

Table 2- Comparison of Respiratory Complications and Clinical Outcomes After LMA Removal Between the Two Study Groups.

Variable	Lubricant with Lidocaine (N=30)	Lubricant without Lidocaine (N=30)	P value
Underlying disease, n (%)	0 (0.00%)	0 (0.00%)	0.937
Laryngospasm, n (%)	0 (0.00%)	1 (3.33%)	0.835

Cough in recovery, n (%)	0 (0.00%)	1 (3.33%)	0.820
Cough 12 hours after surgery, n (%)	0 (0.00%)	0 (0.00%)	0.918

The absence of baseline imbalance strengthens the internal validity of the study and supports the interpretation that observed differences in postoperative airway events were related primarily to the intervention rather than to confounding demographic or procedural factors.

The use of LMA has become increasingly widespread in pediatric anesthesia because it is less invasive than endotracheal intubation and is generally associated with greater hemodynamic stability and fewer postoperative airway symptoms [1,8]. Nevertheless, despite these advantages, laryngospasm remains one of the most feared complications during insertion or removal of the device [4,11]. Against this background, our study explored a simple and clinically applicable strategy to further improve airway safety during emergence.

Although postoperative airway complications were uncommon overall, the pattern of events favored lidocaine gel. No patient in the lidocaine group developed laryngospasm or cough during recovery, whereas one patient in the simple lubricant group experienced laryngospasm and one patient experienced a cough. These between-group differences were not statistically significant, which is unsurprising given the very low event rate. However, from a clinical perspective, the complete absence of both complications in the lidocaine arm is noteworthy, particularly because laryngospasm in children can lead rapidly to severe hypoxemia and, in extreme cases, cardiac arrest [21].

Our findings are broadly consistent with previous literature suggesting a protective role for lidocaine in reducing airway reflex responses. Mihara et al. reported in a meta-analysis that lidocaine, administered either intravenously or topically, may reduce the incidence of laryngospasm in pediatric patients [21]. Similarly, Sun et al. showed that topical lidocaine may decrease respiratory adverse events associated with LMA removal in children [26]. Although our study was not powered to demonstrate a statistically definitive effect, the observed direction of benefit aligns closely with these earlier reports.

The biological plausibility of this effect is strong. Lidocaine, an amide local anesthetic, inhibits voltage-gated sodium channels and thereby suppresses neural transmission from stimulated mucosal surfaces. When applied to the LMA surface, lidocaine may reduce sensory input from the supraglottic mucosa and laryngeal inlet, increasing the threshold for triggering protective airway reflexes such as coughing or glottic closure [20,23]. In practical terms, this may lessen the reflex response to friction, pressure, or movement of the device during emergence and removal. Previous work has similarly suggested that lidocaine-containing gels

improve tolerance of airway devices and attenuate reflex airway responses [24].

Another notable finding in our study was the absence of cough at 12 hours postoperatively in both groups. This suggests that airway irritation associated with LMA use in children is predominantly an immediate peri-emergence phenomenon rather than a persistent postoperative problem. This observation is in keeping with prior evidence indicating that, when used appropriately, LMA is associated with a low burden of delayed airway morbidity [3,5].

It is also important to recognize that airway outcomes after LMA removal are influenced not only by the lubricant used but also by the timing and anesthetic depth at removal. Previous studies have shown that removal during deep anesthesia versus full wakefulness can significantly alter the risk of airway complications [17-18]. In the present study, the extubation protocol was standardized across both groups to minimize this source of bias. Accordingly, the lower event frequency observed in the lidocaine group is unlikely to be explained by differences in extubation timing and more plausibly reflects a true intervention-related effect. This interpretation is consistent with broader evidence emphasizing the multifactorial nature of pediatric airway safety during emergence [16].

A key issue in interpreting our results is the distinction between statistical significance and clinical relevance. The absence of statistically significant differences should not be interpreted as proof of equivalence. Rather, the study was limited by a low event rate and a modest sample size, which substantially reduced power to detect between-group differences for uncommon outcomes. In clinical practice, even small reductions in the incidence of rare but potentially serious events may be meaningful, particularly in pediatric anesthesia, where the margin for physiological deterioration is narrow [21,26-27].

Limitations

This study has several limitations. First, the sample size was relatively small and therefore underpowered for rare endpoints such as laryngospasm. Second, although blinding was intended, the physical characteristics of lidocaine gel and simple lubricant may not have been completely indistinguishable to the operator, introducing the possibility of performance bias. Third, serum lidocaine concentrations were not measured; although the topical dose used was well below recognized toxic thresholds, pharmacokinetic confirmation would provide additional reassurance regarding safety, especially in lower-weight children. Finally, this was a single-center study, which may limit the generalizability of the

findings to other pediatric populations or anesthetic settings.

Taken together, our findings suggest that topical lidocaine gel may reduce immediate airway irritability during recovery after LMA removal in children, although larger, adequately powered studies are needed to confirm whether this apparent protective effect translates into a statistically robust and generalizable clinical benefit.

Conclusion

In this randomized clinical trial, lubrication of the LMA with lidocaine gel was associated with a numerically lower incidence of recovery-phase airway complications compared with simple lubricant, with no episodes of laryngospasm or cough observed in the intervention group. Although these differences did not reach statistical significance, the observed pattern suggests a potentially beneficial effect of topical lidocaine on airway reactivity during emergence in pediatric patients. Larger multicenter trials are warranted to determine whether this clinically favorable trend represents a reproducible protective effect.

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Ethics approval and consent to participate

The study protocol was approved by the Biomedical Research Ethics Committee of the School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran (Ethics Code: IR.SBMU.MSP.REC.1404.383). The clinical trial was also registered in the Iranian Registry of Clinical Trials (IRCT) under the registration number IRCT20250116064403N1. Written informed consent was obtained from the parents or legal guardians of all participants prior to enrollment.

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