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Effect of Intracuff Alkalinized Lignocaine, Plain Lignocaine and Air on Postoperative Airway Morbidity Following Endotracheal Intubation: A Randomized Comparative Study

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ABSTRACT

Background: Postoperative airway morbidity, particularly postoperative sore throat (POST), is a common complication following endotracheal intubation under general anaesthesia. Intracuff inflation with lignocaine, especially alkalinized lignocaine, has been proposed to reduce airway complications by providing continuous local anaesthesia and minimizing increases in cuff pressure.
Aim: To compare the effectiveness of intracuff alkalinized lignocaine, plain lignocaine, and air in reducing postoperative airway morbidity following endotracheal intubation.
Materials and Methods: This prospective, randomized, comparative study included 90 patients aged 18–60 years with American Society of Anesthesiologists (ASA) physical status I–III undergoing elective surgery under general anaesthesia requiring endotracheal intubation. Patients were randomly allocated into three groups (n=30 each): Group A (air-filled cuff), Group PL (2% plain lignocaine-filled cuff), and Group AL (alkalinized lignocaine-filled cuff). The primary outcome was the incidence and severity of postoperative sore throat, assessed using the Numeric Rating Scale (NRS) at 30 minutes, 1 hour, 3 hours, 8 hours, and 24 hours after extubation. Secondary outcomes included postoperative airway morbidity and cuff-related parameters. Data were analyzed using ANOVA, Chi-square test, and unpaired *t*-test, with $p<0.05$ considered statistically significant.
Results: Baseline demographic characteristics were comparable among the three groups ($p>0.05$). The Alkalinized Lignocaine group demonstrated significantly lower postoperative sore throat scores than the Plain Lignocaine and Air groups at all postoperative time points ($p<0.001$). At 8 hours after extubation, postoperative sore throat was observed in 86.67% of patients in Group A, 13.33% in Group PL, and none in Group AL. At 24 hours, sore throat persisted in 40.0% of patients in Group A, 3.33% in Group PL, and 0% in Group AL ($p=0.0005$).
Conclusion: Intracuff alkalinized lignocaine was significantly more effective than plain lignocaine and air in reducing the incidence and severity of postoperative sore throat following endotracheal intubation. Its routine use is a simple, safe, and cost-effective strategy for improving postoperative airway comfort.

Keywords*: Endotracheal intubation; postoperative sore throat; intracuff lignocaine; alkalinized lignocaine; airway morbidity; cuff inflation; general anaesthesia.*

INTRODUCTION

Postoperative airway morbidity remains one of the most common complications following endotracheal intubation under general anaesthesia. Although usually self-limiting, postoperative sore throat (POST), hoarseness of voice, dysphagia, and cough contribute significantly to patient discomfort, delay recovery, reduce patient satisfaction, and negatively

influence the overall perioperative experience. The reported incidence of POST varies widely from 20% to 70%, depending on patient characteristics, duration of intubation, endotracheal tube size, cuff pressure, airway manipulation, and anaesthetic technique [1,2].

The pathogenesis of postoperative airway morbidity is multifactorial and is primarily attributed to mucosal ischemia caused by excessive endotracheal tube cuff pressure, mechanical trauma during laryngoscopy and intubation, repeated airway manipulation, and inflammatory changes in the tracheal mucosa [3]. Nitrous oxide diffuses rapidly into air-filled cuffs, increasing intracuff pressure during anaesthesia and thereby exacerbating tracheal mucosal compression and ischemic injury. This phenomenon is considered one of the major contributors to postoperative sore throat and other airway-related complications [4].

Several preventive strategies have been investigated to reduce postoperative airway morbidity, including careful airway manipulation, monitoring cuff pressure, minimizing cuff inflation volume, use of smaller endotracheal tubes, topical corticosteroids, benzydamine hydrochloride, ketamine gargles, magnesium, lubricating gels, and intracuff inflation with liquid media instead of air [5,6]. Among these methods, filling the endotracheal tube cuff with lignocaine has attracted considerable attention because lignocaine can diffuse across the cuff membrane and provide continuous local anaesthesia to the tracheal mucosa while simultaneously preventing increases in cuff pressure associated with nitrous oxide diffusion [7].

Alkalinization of lignocaine by adding sodium bicarbonate increases the proportion of the non-ionized form of the drug, thereby enhancing its diffusion through the polyvinyl chloride cuff membrane and improving its local anaesthetic effect [8]. Previous clinical studies have demonstrated that intracuff alkalinized lignocaine significantly reduces the incidence and severity of postoperative sore throat, cough during extubation, hoarseness of voice, and emergence-related airway reflexes compared with air-filled cuffs or cuffs inflated with plain lignocaine [8–10].

Despite encouraging evidence, variability exists among published studies regarding patient populations, anaesthetic techniques, duration of surgery, and assessment methods. Additional comparative studies are therefore required to further establish the efficacy of intracuff alkalinized lignocaine in reducing postoperative airway morbidity.

The present randomized comparative study was undertaken to evaluate the effectiveness of intracuff alkalinized lignocaine, plain lignocaine, and air in preventing postoperative airway morbidity following endotracheal intubation. The primary objective was to compare the incidence and severity of postoperative sore throat among the three groups, while secondary objectives included evaluation of dysphagia, dysphonia, hoarseness of voice, cuff inflation characteristics, and cuff leak during surgery.

MATERIALS AND METHODS

Study Design and Setting

This prospective, randomised, comparative study was conducted in the Department of Anaesthesiology after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants before enrolment.

Study Population

A total of 90 patients of either sex, aged 18–60 years, belonging to ASA physical status I, II and III, scheduled for elective abdominal, laparoscopic, diagnostic gynaecological and orthopaedic surgeries under general anaesthesia requiring endotracheal intubation were included in the study. Patients were randomly allocated into three groups of 30 patients each by the cheat method.

The study groups were:

- Group A (Air Group): Endotracheal tube cuff inflated with air.
- Group PL (Plain Lignocaine Group): Endotracheal tube cuff inflated with 2% plain lignocaine.
- Group AL (Alkalinized Lignocaine Group): Endotracheal tube cuff inflated with alkalinized lignocaine (2% lignocaine mixed with 7.5% sodium bicarbonate).

Inclusion Criteria

- Patients aged 18–60 years.
- Either sex.
- ASA physical status I–III.
- Elective abdominal, laparoscopic, diagnostic gynaecological and orthopaedic surgeries under general anaesthesia requiring oral endotracheal intubation.
- Written informed consent.

Exclusion Criteria
Patients with anticipated difficult airway, pre-existing upper respiratory tract infection or sore throat, known allergy to lignocaine, requirement for emergency surgery, or any contraindication to general anaesthesia were excluded from the study.

Anaesthetic Technique
All patients underwent routine pre-anaesthetic evaluation. In the operating room, standard monitoring including electrocardiography (ECG), non-invasive blood pressure (NIBP), pulse oximetry (SpO_2), and respiratory rate monitoring was instituted.

Patients were preoxygenated with 100% oxygen for 3 minutes. General anaesthesia was induced with intravenous propofol (2 mg/kg) followed by succinylcholine (1.5 mg/kg) to facilitate endotracheal intubation. Oral cuffed Portex endotracheal tubes of appropriate internal diameter were used. Depending on group allocation, the cuff was inflated with air, 2% plain lignocaine, or alkalinized lignocaine using the minimal occlusive volume technique.

Anaesthesia was maintained with intermittent positive-pressure ventilation using nitrous oxide (60%), oxygen (40%), and sevoflurane (1–2%). Neuromuscular blockade was maintained with vecuronium (loading dose 0.1 mg/kg followed by maintenance doses equal to 25% of the loading dose as required). Dexmedetomidine (1 µg/kg intravenously) was administered following intubation.

At the beginning of skin closure, sevoflurane was discontinued. Residual neuromuscular blockade was reversed using intravenous neostigmine (50 µg/kg) and glycopyrrolate (8 µg/kg). After patients regained adequate spontaneous respiration and responded to verbal commands, the trachea was extubated. Postoperative analgesia was provided with intravenous diclofenac (1.5 mg/kg).

Outcome Assessment
The primary outcomes were the incidence and severity of postoperative sore throat. Severity was assessed using the Numeric Rating Score (NRS), where 0 indicated no sore throat, scores of 1–3 indicated mild sore throat, 4–6 indicated moderate sore throat, and 7–10 indicated severe sore throat. Patients were evaluated at 30 minutes, 1 hour, 3 hours, 8 hours, and 24 hours after extubation.

The secondary outcomes included postoperative airway morbidity such as dysphagia, dysphonia, and hoarseness of voice. Minimal occlusive cuff inflation volume, cuff deflation volume at extubation, and the presence of cuff leak during surgery were also recorded. Whenever a cuff leak was detected at 30, 60, or 90 minutes after intubation, an additional 1 mL of the assigned cuff inflation medium was instilled.

Statistical Analysis
Data were analysed using standard statistical methods. Quantitative variables including age, weight, heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure were expressed as mean ± standard deviation, whereas qualitative variables such as postoperative sore throat, cough, and restlessness were expressed as frequencies and percentages. Intergroup comparisons were performed using the unpaired *t*-test, Chi-square test, and one-way analysis of variance (ANOVA), as appropriate. A p-value >0.05 was considered not significant, $p<0.05$ statistically significant, and $p<0.01$ highly significant.

RESULTS & OBSERVATIONS
A total of 90 patients were included in the study and randomly allocated into three equal groups: Group A (Air), Group PL (Plain Lignocaine), and Group AL (Alkalinized Lignocaine), with 30 patients in each group. The demographic profile of the study population was comparable among the three groups, with no statistically significant differences in age, body weight, or sex distribution (p>0.05), indicating that the groups were well matched for baseline characteristics.

Table 1. Demographic characteristics of the study population

Variable	Group A (n=30)	Group PL (n=30)	Group AL (n=30)	P-value
Age (years)	36.1 ± 11.9	33.1 ± 12.14	33.5 ± 11.8	0.57
Weight (kg)	57.2 ± 3.54	56.8 ± 3.83	57.9 ± 3.71	0.46
Male/Female	22/8	15/15	16/14	NS

The severity of postoperative sore throat was evaluated using the Numeric Rating Scale (NRS) at 30 minutes, 1 hour, 3 hours, 8 hours, and 24 hours following extubation. The mean NRS score was highest in the Air group at all postoperative intervals, followed by the Plain Lignocaine group, whereas the Alkalinized Lignocaine group demonstrated the lowest

scores throughout the observation period. The reduction in postoperative sore throat severity was statistically highly significant in the Alkalinized Lignocaine group compared with the other two groups ($p<0.001$).

Table 2. Numeric Rating Score (NRS) of postoperative sore throat

Postoperative interval	Group A	Group PL	Group AL	P-value
30 minutes	4.40 ± 0.62	2.10 ± 0.30	1.06 ± 0.25	<0.001
1 hour	3.70 ± 0.69	1.33 ± 0.48	0.46 ± 0.50	<0.001
3 hours	2.83 ± 1.08	0.60 ± 0.50	0.00 ± 0.00	<0.001
8 hours	1.80 ± 1.12	0.13 ± 0.34	0.00 ± 0.00	<0.001
24 hours	1.00 ± 0.98	0.03 ± 0.18	0.00 ± 0.00	<0.001

The incidence of postoperative sore throat decreased progressively in all three groups during the postoperative period. However, patients in the Air group consistently exhibited a significantly higher incidence of sore throat than those in the Plain Lignocaine and Alkalinized Lignocaine groups. At 8 hours after extubation, postoperative sore throat was present in 86.67% of patients in Group A compared with 13.33% in Group PL, whereas none of the patients in Group AL experienced sore throat. At 24 hours, sore throat persisted in 40% of patients in Group A and 3.33% of patients in Group PL, while no patient in Group AL reported postoperative sore throat.

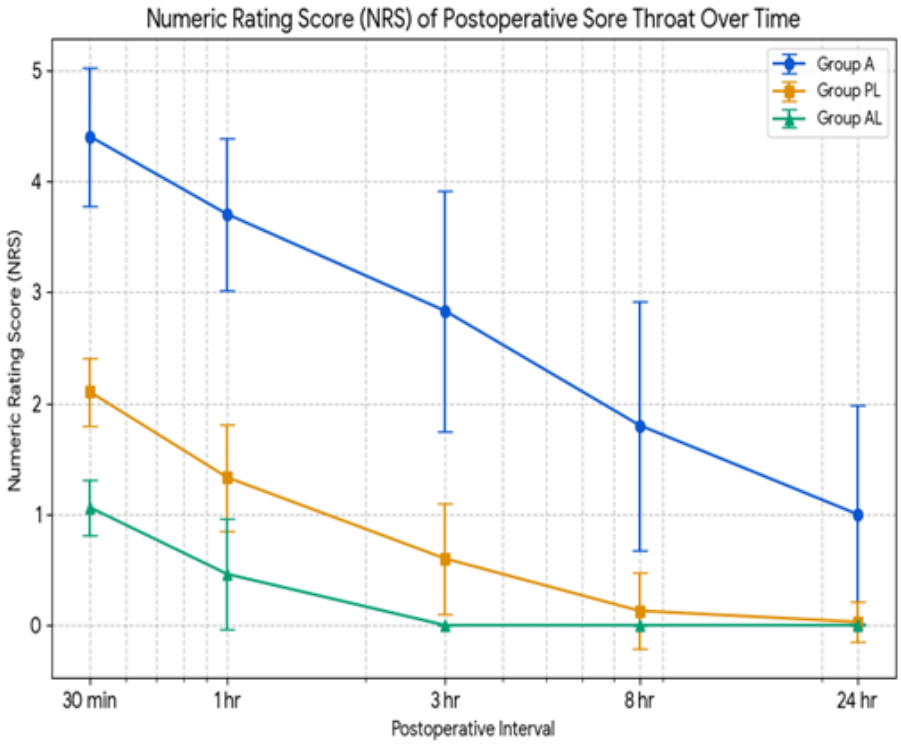
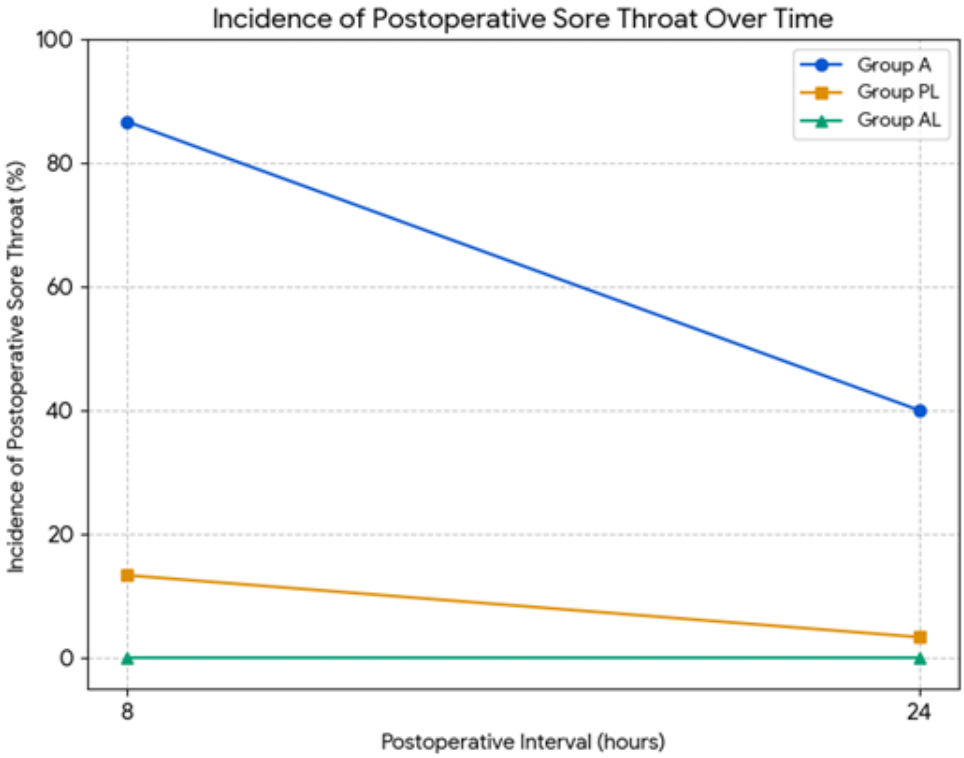


Table 3. Incidence of postoperative sore throat

Postoperative interval	Group A (n=30)	Group PL (n=30)	Group AL (n=30)	P-value
8 hours	26 (86.67%)	4 (13.33%)	0 (0%)	<0.001
24 hours	12 (40.00%)	1 (3.33%)	0 (0%)	0.0005



DISCUSSION

The present randomized comparative study demonstrated that intracuff alkalinized lignocaine significantly reduced both the incidence and severity of postoperative airway morbidity compared with plain lignocaine and air. Patients whose endotracheal tube cuffs were inflated with alkalinized lignocaine experienced consistently lower postoperative sore throat scores throughout the 24-hour observation period, confirming the superiority of this technique in minimizing tracheal irritation following endotracheal intubation.

The demographic characteristics of the three study groups were comparable with respect to age, body weight, and sex distribution, indicating successful randomization and minimizing the possibility of confounding variables affecting the study outcomes. Similar baseline comparability has been reported in previous randomized controlled trials evaluating different cuff inflation media [8,9].

Postoperative sore throat remains one of the most frequent complaints after general anaesthesia with endotracheal intubation. The mechanism involves mucosal ischemia secondary to cuff pressure, epithelial injury during intubation, inflammatory mediator release, and increased intracuff pressure resulting from nitrous oxide diffusion into air-filled cuffs [3,4]. In the present study, patients in the Air group consistently exhibited the highest Numeric Rating Scale (NRS) scores at all postoperative intervals. In contrast, the Plain Lignocaine group demonstrated a significant reduction in sore throat severity, while the Alkalinized Lignocaine group showed the greatest benefit, with negligible symptoms after the first few postoperative hours.

These findings are consistent with the landmark study by Estebe et al. [8], who demonstrated that alkalinized intracuff lignocaine diffuses readily through the cuff membrane, producing topical anaesthesia of the tracheal mucosa while simultaneously preventing increases in cuff pressure. Their study reported a marked reduction in postoperative sore throat, coughing during emergence, and tracheal irritation, findings comparable to those observed in the present investigation.

Navarro and Baughman [7] first demonstrated that lignocaine could diffuse across the endotracheal tube cuff and produce local anaesthesia of the tracheal mucosa. Subsequent studies confirmed that alkalinization substantially enhances the diffusion of the non-ionized fraction of lignocaine, thereby improving its clinical effectiveness. The superior results observed in the present study with alkalinized lignocaine support this pharmacological principle.

The progressive decline in postoperative sore throat observed in all groups reflects the self-limiting nature of mucosal inflammation after extubation. Nevertheless, the rate of recovery was significantly faster in the Alkalinized Lignocaine group. By 24 hours, no patient in this group experienced postoperative sore throat, whereas persistent symptoms remained in 40% of patients receiving air-filled cuffs and in a small proportion of patients receiving plain lignocaine.

These observations closely resemble those reported by Huang et al. [9], who found significant reductions in postoperative sore throat and hoarseness when alkalinized lignocaine was used for cuff inflation.

The lower incidence of airway morbidity with alkalinized lignocaine can be attributed to multiple mechanisms. Besides providing sustained local anaesthesia through diffusion across the cuff membrane, the liquid-filled cuff acts as a barrier against nitrous oxide diffusion, thereby maintaining relatively stable intracuff pressure and preventing excessive compression of the tracheal mucosa [4,8]. In contrast, air-filled cuffs are prone to progressive pressure increases during prolonged anaesthesia, resulting in impaired mucosal perfusion and postoperative discomfort.

Although plain lignocaine also reduced postoperative sore throat compared with air, its efficacy was inferior to alkalinized lignocaine. This difference is likely explained by the lower proportion of non-ionized lignocaine available for diffusion through the cuff membrane, leading to delayed and less effective local anaesthesia [7,8]. Similar findings have been reported in several randomized clinical trials comparing plain and alkalinized lignocaine for intracuff inflation [9,10].

The present study has several strengths, including its prospective randomized design, uniform anaesthetic protocol, standardized assessment of postoperative sore throat using the Numeric Rating Scale, and comparable baseline characteristics among study groups. However, certain limitations should be acknowledged. The sample size was relatively small and derived from a single institution, which may limit the generalizability of the findings. Intracuff pressure was not continuously monitored throughout surgery, and postoperative patient satisfaction and long-term airway outcomes were not evaluated. Future multicentre randomized trials with larger sample sizes and continuous cuff pressure monitoring would further validate these findings.

Overall, the findings of the present study provide strong evidence that intracuff alkalinized lignocaine is a simple, inexpensive, and effective technique for reducing postoperative airway morbidity following endotracheal intubation. Its routine use may improve patient comfort, reduce postoperative airway complications, and enhance the quality of recovery after general anaesthesia.

CONCLUSION

Intracuff alkalinized lignocaine was significantly more effective than plain lignocaine and air in reducing the incidence and severity of postoperative sore throat following endotracheal intubation. Patients in the alkalinized lignocaine group experienced minimal postoperative airway morbidity and faster resolution of symptoms. Intracuff alkalinized lignocaine is a simple, safe, and cost-effective technique that can be routinely used to improve postoperative airway comfort in patients undergoing general anaesthesia with endotracheal intubation.

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