



Original Article

Effect of Intracuff Alkalinized Lignocaine, Plain Lignocaine and Air on Emergence Response, Intracuff Volume Changes And Hemodynamic Stability During Endotracheal Extubation: A Randomized Comparative Study

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ABSTRACT

Background: Endotracheal extubation is commonly associated with airway reflexes, intracuff pressure changes, and hemodynamic disturbances that may adversely affect postoperative recovery. Intracuff inflation with alkalinized lignocaine has been proposed to reduce airway irritation and provide smoother emergence compared with plain lignocaine or air.

Aim: To compare the effects of intracuff alkalinized lignocaine, plain lignocaine, and air on emergence response, intracuff volume changes, and hemodynamic stability during endotracheal extubation.

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 with endotracheal intubation. Patients were randomly allocated into three groups (n=30 each): Group AIR (air-filled cuff), Group PL (2% plain lignocaine-filled cuff), and Group AL (alkalinized lignocaine-filled cuff). The primary outcomes were the incidence of cough and postoperative restlessness during extubation and at 1, 3, 8, and 24 hours postoperatively. Secondary outcomes included intracuff inflation and deflation volumes, pulse rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure (MAP). Data were analysed using one-way ANOVA, Chi-square test, and Student's *t*-test, with $p < 0.05$ considered statistically significant.

Results: Baseline demographic characteristics were comparable among the three groups ($p > 0.05$). The incidence of cough during extubation was significantly lower in Group AL (33.33%) than in Group PL (66.67%) and Group AIR (93.33%) ($p < 0.001$). Similarly, postoperative restlessness during extubation was least frequent in Group AL (33.33%) compared with Group PL (73.33%) and Group AIR (96.67%) ($p < 0.001$). Air-filled cuffs showed a significant increase in cuff deflation volume at extubation (5.39 ± 0.34 mL) compared with plain lignocaine (4.45 ± 0.30 mL) and alkalinized lignocaine (4.37 ± 0.34 mL) ($p < 0.0001$). Patients in the AIR group also exhibited significantly higher pulse rate, systolic blood pressure, and mean arterial pressure during extubation than the lignocaine groups.

Conclusion: Intracuff alkalinized lignocaine was significantly more effective than plain lignocaine and air in reducing emergence cough, postoperative restlessness, intracuff volume changes, and hemodynamic responses during extubation. Its use represents a simple, safe, and cost-effective strategy for achieving smooth extubation and improving perioperative recovery.

INTRODUCTION

Emergence from general anaesthesia following endotracheal intubation is frequently associated with undesirable airway and cardiovascular responses, including coughing, restlessness, tachycardia, and hypertension. These responses result from stimulation of the tracheobronchial mucosa by the endotracheal tube and cuff during recovery and extubation. Although transient in healthy individuals, exaggerated emergence responses may be detrimental in patients with cardiovascular, neurosurgical, or ophthalmic disorders, where abrupt increases in blood pressure and heart rate can precipitate serious complications [1,2].

The endotracheal tube cuff plays a crucial role in maintaining an effective airway seal and preventing aspiration. Conventionally, cuffs are inflated with air; however, during anaesthesia using nitrous oxide, diffusion of nitrous oxide into the air-filled cuff increases intracuff pressure, resulting in excessive compression of the tracheal mucosa. Elevated cuff pressure impairs mucosal perfusion, produces ischemia, and contributes to airway irritation, coughing, postoperative sore throat, hoarseness, and exaggerated hemodynamic responses during extubation [3,4].

Several approaches have been proposed to attenuate extubation-related airway responses, including intravenous opioids, dexmedetomidine, lignocaine, corticosteroids, topical local anaesthetics, and careful monitoring of cuff pressure [5,6]. Among these methods, intracuff inflation with lignocaine has gained increasing attention because lignocaine gradually diffuses across the polyvinyl chloride cuff membrane, producing continuous topical anaesthesia of the tracheal mucosa while simultaneously preventing increases in cuff pressure caused by nitrous oxide diffusion [7].

Alkalinization of lignocaine with sodium bicarbonate increases the proportion of the non-ionized fraction of the drug, thereby facilitating its diffusion through the cuff membrane and enhancing its local anaesthetic effect. Previous studies have demonstrated that intracuff alkalinized lignocaine significantly reduces coughing during extubation, emergence agitation, postoperative sore throat, and hemodynamic stress responses compared with air-filled cuffs or cuffs inflated with plain lignocaine [8–10]. Additionally, liquid-filled cuffs undergo minimal volume expansion during anaesthesia, thereby maintaining more stable intracuff pressure and reducing tracheal mucosal injury.

Despite encouraging evidence, limited studies have simultaneously compared emergence response, intracuff volume changes, and hemodynamic stability using air, plain lignocaine, and alkalinized lignocaine as cuff inflation media. Therefore, the present randomized comparative study was undertaken to evaluate the effects of intracuff alkalinized lignocaine, plain lignocaine, and air on cough, postoperative restlessness, intracuff volume changes, and peri-extubation hemodynamic responses in patients undergoing elective surgery under general anaesthesia.

MATERIALS AND METHODS

Study Design and Setting

This prospective, randomized, 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 American Society of Anesthesiologists (ASA) physical status I, II, and III, undergoing 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 equal groups of 30 patients each using the cheat method.

Study Groups

Group AIR: Endotracheal tube cuff inflated with air.

Group PL: Endotracheal tube cuff inflated with 2% plain lignocaine.

Group AL: Endotracheal tube cuff inflated with alkalinized lignocaine prepared by mixing 4 mL of 2% plain lignocaine with 2 mL of 7.5% sodium bicarbonate.

Inclusion Criteria

- Age 18–60 years
- Either sex
- ASA physical status I–III
- Body weight 45–85 kg
- Elective surgery under general anaesthesia requiring endotracheal intubation

Exclusion Criteria

- ASA IV and V
- Age <18 years or >60 years
- Body weight <45 kg or >85 kg
- Pregnancy
- Cardiovascular, respiratory, diabetic, or neurological diseases
- Allergy to local anaesthetics
- Anticipated difficult airway
- Risk of aspiration
- Previous tracheal or laryngeal surgery
- Patient refusal

Anaesthetic Technique

All patients underwent routine preoperative assessment. Standard monitoring including ECG, non-invasive blood pressure, pulse oximetry, and respiratory rate was instituted.

Premedication consisted of intravenous glycopyrrolate (4 µg/kg), ondansetron (80 µg/kg), and midazolam (20 µg/kg). Anaesthesia was induced using propofol (2 mg/kg) and succinylcholine (1.5 mg/kg). Oral cuffed Portex endotracheal tubes of appropriate size were used. The cuff was inflated according to group allocation using the minimal occlusive volume technique.

Anaesthesia was maintained with nitrous oxide (60%), oxygen (40%), sevoflurane (1–2%), vecuronium, and dexmedetomidine (1 µg/kg). Neuromuscular blockade was reversed using neostigmine and glycopyrrolate. Patients were extubated after meeting standard extubation criteria.

Outcome Measures

Primary Outcomes

- Incidence of cough during extubation and at 1, 3, 8, and 24 hours
- Incidence of postoperative restlessness during extubation and at 1, 3, 8, and 24 hours

Secondary Outcomes

- Intracuff inflation volume
- Intracuff deflation volume
- Pulse rate
- Systolic blood pressure
- Diastolic blood pressure
- Mean arterial pressure at extubation
- Variation in mean arterial pressure during the peri-extubation period

Statistical Analysis

Quantitative variables were expressed as mean ± standard deviation, while qualitative variables were expressed as frequencies and percentages. Intergroup comparisons were performed using Student's unpaired t-test, Chi-square test, and one-way ANOVA. A p-value <0.05 was considered statistically significant and p<0.01 highly significant.

RESULTS AND OBSERVATIONS

A total of 90 patients completed the study and were equally distributed among the three study groups. Baseline demographic characteristics were comparable with no statistically significant differences between groups.

Table 1. Demographic characteristics

Variable	AIR	PL	AL	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 incidence of cough was highest in the AIR group throughout the observation period and lowest in the AL group. A significant reduction in cough was observed with intracuff alkalinized lignocaine during extubation and at one hour after extubation.

Table 2. Incidence of cough

Time	AIR	PL	AL	AIR vs PL	AIR vs AL	AL vs PL
During extubation	28 (93.33%)	20 (66.67%)	10 (33.33%)	0.009	<0.001	0.009
1 hour	19 (63.3%)	9 (30%)	6 (20%)	0.009	0.0006	0.37
3 hours	7 (23.3%)	6 (20%)	3 (10%)	0.648	0.13	0.278
8 hours	4 (13.33%)	3 (10%)	0	0.687	0.038	0.07
24 hours	3 (10%)	2 (6.67%)	0	0.64	0.07	0.15

Postoperative restlessness followed a similar trend, with the highest incidence in the AIR group and the lowest incidence in the AL group.

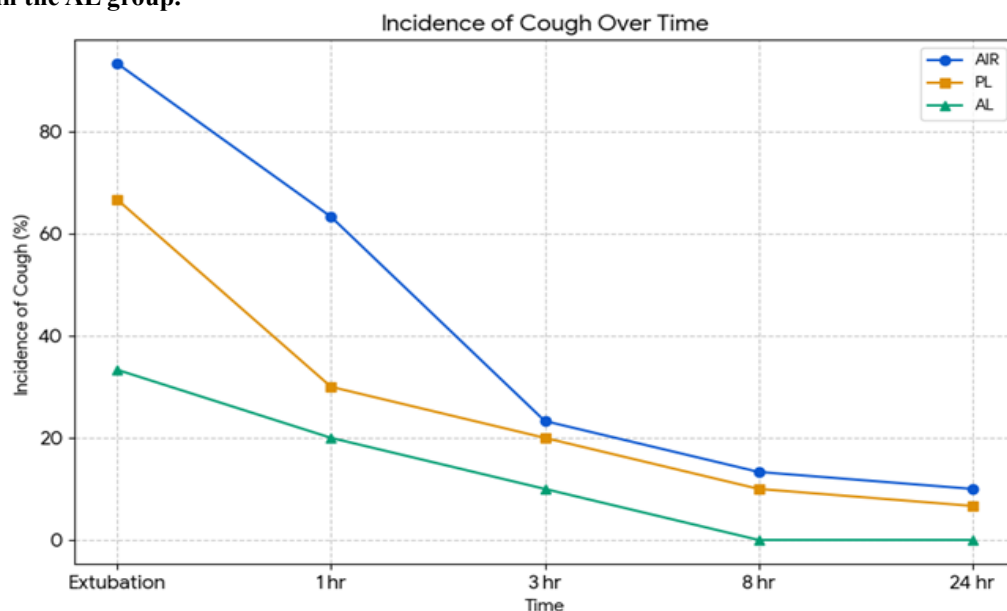


Table 3. Incidence of restlessness

Time	AIR	PL	AL	AIR vs PL	AIR vs AL	AL vs PL
During extubation	29 (96.67%)	22 (73.33%)	10 (33.33%)	0.01	<0.001	0.001
1 hour	18 (60%)	14 (46.67%)	4 (13.33%)	0.30	0.0003	0.007
3 hours	6 (20%)	5 (16.67%)	2 (6.67%)	0.738	0.128	0.228
8 hours	3 (10%)	1 (3.33%)	0	0.30	0.07	0.313
24 hours	2 (6.67%)	0	0	0.15	0.15	NA

Compared with the liquid-filled cuffs, intracuff air demonstrated a significant increase in cuff volume at extubation, whereas both lignocaine groups showed a reduction in cuff volume.

Table 4. Inflation and deflation cuff volume (mL)

Variable	AIR	PL	AL	AIR vs PL	AIR vs AL	AL vs PL
Inflation volume	4.76±0.31	4.86±0.29	5.03±0.22	0.20	0.0003	0.013
Deflation volume	5.39±0.34	4.45±0.30	4.37±0.34	<0.0001	<0.0001	0.33

Patients in the AIR group demonstrated significantly greater hemodynamic responses during extubation compared with the lignocaine groups.

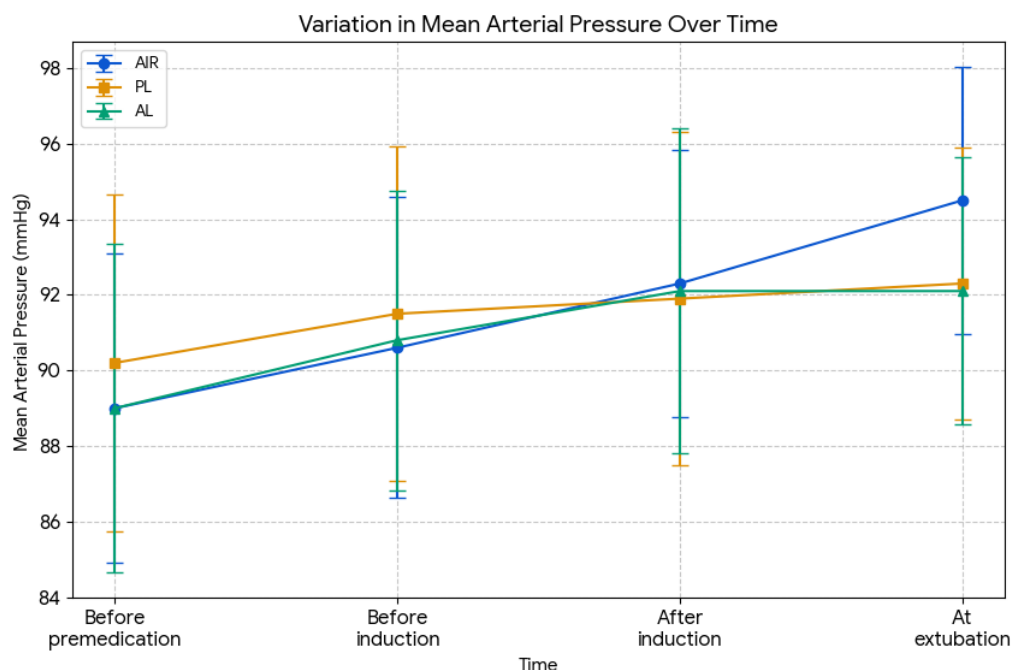
Table 5. Hemodynamic variables at extubation

Variable	AIR	PL	AL	AIR vs PL	AIR vs AL	AL vs PL
Pulse (/min)	85.7±3.7	82.9±3.05	82.8±3.54	0.002	0.003	0.90
SBP (mmHg)	124.4±2.84	120.4±3.83	121.7±3.26	<0.0001	0.001	0.16
DBP (mmHg)	79.4±4.0	78.2±3.65	77.3±3.94	0.22	0.04	0.35
MAP (mmHg)	94.5±3.53	92.3±3.59	92.1±3.54	0.02	0.01	0.82

The mean arterial pressure increased during extubation in all three groups, with the greatest increase observed in the AIR group.

Table 6. Variation in mean arterial pressure

Time	AIR	PL	AL	P value
Before premedication	89.0±4.08	90.2±4.47	89.0±4.34	0.48
Before induction	90.6±3.98	91.5±4.42	90.8±3.96	0.65
After induction	92.3±3.52	91.9±4.41	92.1±4.30	0.90
At extubation	94.5±3.53	92.3±3.59	92.1±3.54	0.02



DISCUSSION

The present randomized comparative study demonstrated that intracuff alkalinized lignocaine significantly attenuated emergence responses, minimized intracuff volume changes, and improved hemodynamic stability during extubation compared with plain lignocaine and air. Patients in the alkalinized lignocaine group experienced substantially lower incidences of cough and postoperative restlessness, while maintaining more stable cuff characteristics and cardiovascular parameters throughout the peri-extubation period.

Baseline demographic characteristics were comparable among the three groups, indicating adequate randomization and reducing the likelihood of selection bias. Similar demographic homogeneity has been reported in previous randomized controlled studies evaluating different cuff inflation media [8,9].

Cough during extubation remains one of the most common airway reflexes encountered during recovery from general anaesthesia. It results from mechanical stimulation of tracheal mucosal receptors by the endotracheal tube and cuff, leading to sympathetic activation and marked cardiovascular responses [2]. In the present study, cough was most frequent in the Air group and least frequent in the Alkalinized Lignocaine group throughout the postoperative observation period. The marked reduction in cough observed with alkalinized lignocaine is consistent with the findings of Estebe et al. [8], who demonstrated that alkalinized intracuff lignocaine effectively suppresses tracheal reflexes by providing continuous local anaesthesia through diffusion across the cuff membrane.

Postoperative restlessness showed a similar pattern, with significantly fewer patients experiencing agitation in the alkalinized lignocaine group. Reduction of airway irritation during emergence likely contributed to smoother extubation and improved patient comfort. These findings are in agreement with Huang et al. [9], who reported lower emergence agitation and improved recovery characteristics when alkalinized lignocaine was used for cuff inflation.

An important finding of the present study was the significant difference in intracuff volume changes among the three groups. Air-filled cuffs demonstrated a substantial increase in cuff volume at extubation, whereas both lignocaine groups showed a slight reduction in cuff volume. These observations are explained by diffusion of nitrous oxide into air-filled cuffs during anaesthesia, producing progressive increases in intracuff pressure and volume. Liquid-filled cuffs largely prevent this phenomenon because nitrous oxide has minimal diffusion into liquids [3,4]. Consequently, stable cuff pressure reduces tracheal mucosal ischemia and minimizes airway irritation.

The hemodynamic responses observed during extubation further support the beneficial effects of intracuff lignocaine. Patients receiving air-filled cuffs exhibited significantly higher pulse rate, systolic blood pressure, and mean arterial pressure compared with both lignocaine groups. Although all patients demonstrated transient increases in mean arterial pressure during extubation, the magnitude of this response was significantly attenuated with intracuff lignocaine, particularly alkalized lignocaine. These findings are clinically relevant because exaggerated cardiovascular responses during extubation may increase the risk of myocardial ischemia, cerebrovascular events, and postoperative bleeding in susceptible patients [1,5].

The superior performance of alkalized lignocaine compared with plain lignocaine is attributable to enhanced diffusion of the non-ionized form of lignocaine through the polyvinyl chloride cuff membrane following alkalization with sodium bicarbonate. This results in earlier onset and more effective topical anaesthesia of the tracheal mucosa throughout surgery [7,8]. Similar pharmacological advantages have been demonstrated in previous experimental and clinical investigations comparing alkalized and non-alkalized lignocaine [8–10].

The strengths of the present study include its prospective randomized design, standardized anaesthetic technique, uniform postoperative assessment, and comprehensive evaluation of airway, cuff, and hemodynamic outcomes. However, certain limitations should be acknowledged. The study was conducted at a single centre with a relatively modest sample size, limiting the generalizability of the findings. Continuous intracuff pressure monitoring was not performed, and plasma lignocaine concentrations were not measured. Future multicentre studies with larger sample sizes and continuous cuff pressure monitoring may provide additional evidence regarding the long-term benefits and safety of intracuff alkalized lignocaine.

Overall, the findings of the present study indicate that intracuff alkalized lignocaine provides smoother emergence from anaesthesia by reducing cough, postoperative restlessness, intracuff volume changes, and cardiovascular responses during extubation. This inexpensive and easily applicable technique may enhance perioperative safety and improve the quality of recovery following endotracheal intubation.

CONCLUSION

Intracuff alkalized lignocaine was superior to plain lignocaine and air in attenuating emergence responses following endotracheal extubation. It significantly reduced the incidence of cough and postoperative restlessness, minimized intracuff volume changes, and provided greater hemodynamic stability during extubation. Intracuff alkalized lignocaine is a simple, safe, and cost-effective technique that can be routinely used to facilitate smooth extubation and improve perioperative patient outcomes.

REFERENCES

1. Bidwai AV, Bidwai VA, Rogers CR, Stanley TH. Blood pressure and pulse rate responses to endotracheal extubation with and without prior lidocaine. **Anesthesiology**. 1979;51(2):171–173.
2. Minogue SC, Ralph J, Lampa MJ. Laryngotracheal topical lidocaine reduces coughing on emergence from general anaesthesia. **Anesth Analg**. 2004;99(4):1253–1257.
3. Seegobin RD, van Hasselt GL. Endotracheal cuff pressure and tracheal mucosal blood flow. **Br Med J**. 1984;288:965–968.
4. Combes X, Schauvliege F, Peyrouset O, et al. Intracuff pressure and postoperative sore throat. **Anesthesiology**. 2001;95(5):1120–1124.
5. Kovac AL. Controlling the hemodynamic response to laryngoscopy and endotracheal intubation. **J Clin Anesth**. 1996;8(1):63–79.
6. Guler G, Akin A, Tosun Z, et al. Single-dose dexmedetomidine attenuates airway and circulatory reflexes during extubation. **Acta Anaesthesiol Scand**. 2005;49(8):1088–1091.
7. Navarro LH, Baughman VL. Lidocaine in the endotracheal tube cuff reduces coughing and postoperative sore throat. **J Clin Anesth**. 1997;9(5):394–397.
8. Estebe JP, Dollo G, Le Corre P, et al. Alkalized intracuff lidocaine reduces emergence phenomena and postoperative airway morbidity. **Anesth Analg**. 2002;94(1):227–230.
9. Huang CJ, Tsai MC, Chen CT, Cheng CR, Wu KH, Wei TT. Intracuff alkalized lidocaine decreases postoperative sore throat, cough, and hoarseness. **Can J Anaesth**. 1999;46(7):697–700.
10. Estebe JP, Gentili M, Le Corre P, et al. Alkalized lidocaine in the endotracheal tube cuff improves emergence and reduces airway complications. **Anesth Analg**. 2004;99(5):1536–1541.