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Original Research Article

# Intracuff Installation of Lignocaine Vs Normal Saline in Prevention of Post-Operative Sore throat in Patients undergoing Surgeries in General Anesthesia with Endotracheal Tube

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**Conflict of interest: Nil**

**Abstract:**

**Background:** Endotracheal intubation during general anesthesia can lead to post-intubation complications due to tracheal mucosa damage from the endotracheal tube (ETT) cuff. High-volume low-pressure cuffs expand with minimal pressure increase until fully inflated, after which the pressure rises rapidly due to the inelasticity of the material, potentially damaging the tracheal mucosa. When lignocaine is used for cuff inflation, it diffuses to the tracheal mucosa, reducing local irritation and inflammation through its anesthetic action. Alkalinizing lignocaine enhances its diffusion rate across the ETT cuff and reduces the required dose for effective results.

**Aims and Objectives:** The study aimed to evaluate the benefits of filling the ETT cuff with 2% alkalinized lignocaine versus normal saline, focusing on preventing ETT-induced emergence phenomena and reducing post-intubation complications such as sore throat.

**Materials and Methods:** This prospective, double-blind, randomized, comparative study was conducted at Mamata Medical College in Khammam, Telangana, a tertiary hospital, from March 2023 to March 2024. Informed consent was obtained from all participants prior to enrollment. The study evaluated adult patients aged 18-60 years, classified as American Society of Anesthesiologists (ASA) physical status 1 or 2, undergoing elective surgery under general anesthesia lasting more than two hours. Patients were randomly divided into two groups using a computer-generated randomization table. Group S had their ETT cuffs filled with 0.9% normal saline, while Group L's cuffs were insufflated with 2% lignocaine alkalinized with 7.5% sodium bicarbonate in a 19:1 ratio.

**Observations and Results:** Group S initially had lower ETT cuff pressures, which rose significantly higher at extubation compared to group L ($p < 0.001$). At extubation, HR and systolic blood pressure (SBP) increases from baseline were significantly greater in group S than in group L ($p < 0.001$ and $p = 0.001$, respectively). Group L experienced less coughing and restlessness compared to group S ($p < 0.001$ and $p = 0.002$, respectively). Mean extubation and emergence times were longer in group S than in group L ($p < 0.001$).

**Conclusion:** Continuous monitoring of ETT cuff pressure is essential to keep it below the tracheal mucosa capillary occlusion pressure. Using alkalinized lignocaine for cuff inflation further reduces extubation responses and post-intubation complications.

**Keywords:** Lignocaine, Endotracheal tube, Cuff pressure, Intubation.



## Introduction

Endotracheal tube (ETT) with a cuff system is the gold standard for securing and maintaining a patent airway. While tracheal intubation is routine in general anesthesia, it comes with side effects, including local mucosal irritation and inflammation due to factors like ETT cuff pressure, volume, and duration of intubation.[1] These can lead to hemodynamic changes, sore throat, hoarseness, coughing, blood-streaked sputum, vocal cord issues, and tracheal ischemia. During emergence from anesthesia, coughing or bucking can cause hypertension, tachycardia, increased intraocular and intracranial pressures, myocardial ischemia, bronchospasm, and surgical bleeding, especially concerning in neurosurgical, ophthalmic, and vascular procedures. Post-extubation sore throat and hoarseness can significantly affect patients' anesthesia experience. Techniques to reduce these morbidities include using smaller ETTs, high-volume low-pressure cuffs, lubricant jellies, and intravenous lignocaine. ETT cuffs filled with lignocaine have also been explored as a drug delivery method.[2] Nitrous oxide (N2O) can diffuse into air-filled tracheal tube cuffs, with the

rate of diffusion proportional to its concentration gradient. High-volume low-pressure cuffs expand with minimal pressure increase until fully inflated, after which pressure rises rapidly, risking tracheal mucosa damage. This can be avoided by inflating the cuff with a liquid or a gas mixture matching the inspired gas and regularly monitoring cuff pressure. Lignocaine, which can diffuse through polyvinyl chloride ETT cuffs, can act as an anesthetic reservoir. Alkalinizing lignocaine increases its non-ionized fraction, enhancing diffusion and allowing a lower dose to be effective. Injecting alkalinized lignocaine into the ETT cuff can reduce post-intubation morbidity, improve ETT tolerance, and facilitate smooth extubation.[3] This study primarily aims to compare the efficacy of alkalinized 2% lignocaine versus normal saline in reducing post-intubation sore throat when insufflated into an ETT cuff. Secondary objectives include evaluating extubation response, incidence of restlessness, coughing, bucking, and nausea at extubation, intra-operative ETT cuff pressure, and postoperative hoarseness.

**Need of the study**

Current techniques to mitigate post-intubation complications, such as using smaller ETTs, high-volume low-pressure cuffs, and various lubricants, offer some relief but are not universally effective. The use of lignocaine, particularly in its alkalinized form, presents a promising alternative due to its ability to diffuse through the ETT cuff material and provide local anesthesia to the tracheal mucosa. This potential to act as an anesthetic reservoir can reduce post-intubation sore throat, improve ETT tolerance, and ensure a smoother extubation process.[4]

Comparing the efficacy of alkalinized 2% lignocaine against normal saline when used in ETT cuffs can provide valuable insights into better clinical practices. By evaluating both the primary outcome of reduced postoperative sore throat and secondary outcomes such as extubation response, restlessness, coughing, bucking, nausea, and hoarseness, this study aims to establish a more effective and patient-friendly approach to managing airway-related morbidities in surgical patients. Thus, this research is crucial for enhancing patient care and comfort in the postoperative period.[5]

**Aim and objectives**

To compare the efficacy of alkalinized 2% lignocaine and normal saline, in reducing the incidence of post-intubation sore throat, when insufflated into an ETT cuff

Material and methods

This prospective, double-blind, randomized, comparative study was conducted at Mamata Medical College in Khammam, Telangana, a tertiary hospital, from March 2023 to March 2024. Informed consent was obtained from all participants prior to enrollment. The study evaluated adult patients aged 18-60 years, classified as American Society of Anesthesiologists (ASA) physical status 1 or 2, undergoing elective surgery under general anesthesia lasting more than two hours. Patients were randomly divided into two groups using a computer-generated randomization table. Group S had their ETT cuffs filled with 0.9% normal saline, while Group L's cuffs were insufflated with 2% lignocaine alkalinized with 7.5% sodium bicarbonate in a 19:1 ratio. The volume of the study agent was determined based on the need to achieve an adequate ETT cuff seal and prevent air leaks during positive pressure ventilation. The media used for cuff inflation was prepared by an anesthesiologist not involved in the study, while the primary investigator, who monitored intraoperative and postoperative variables, was blinded to the agent used. The study agents were colorless liquids, eliminating observational bias.

Exclusion criteria included pregnant women, smokers, patients with known drug allergies, or a history of respiratory disease, as well as those undergoing head and neck surgeries, those with anticipated/unanticipated difficult airways, and patients not extubated at the end of surgery. General anesthesia induction involved propofol, fentanyl, and muscle relaxant atracurium bromide, with the airway secured using a cuffed ETT of appropriate size. ETT cuff pressure was continuously monitored by connecting the pilot balloon to an agent-filled transducer through extension tubing, ensuring pressure remained below 30 cm H2O (or 22 mmHg). Anesthesia maintenance included sevoflurane, oxygen, and N2O, with fentanyl administered at one microgram per kilogram of body weight per hour for analgesia. Hemodynamic parameters such as heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) were recorded every 30 minutes and at extubation. Restlessness, bucking, and extubation responses were noted at extubation, with extubation response measured as a percentage increase in HR and MAP from the pre-extubation baseline.

Restlessness or agitation was assessed using the Riker Sedation Agitation Scale, and bucking was evaluated on a four-point scale. Emergence time was defined as the interval from discontinuing anesthetic agents to following verbal commands, and extubation time was the interval from stopping anesthetic agents to tracheal extubation. Post-intubation morbidities were evaluated at extubation

and at 4, 8, 16, and 24 hours postoperatively. Sore throat, coughing, hoarseness, and nausea were graded on respective scales, with sore throat and coughing rated from 0 (no symptoms) to 3 (severe), hoarseness from 0 (none) to 3 (severe), and nausea scored as 1 (yes) or 0 (no).

**Result**

The distribution of patients in the two study groups was similar concerning age, gender, ASA physical status, and the type and duration of surgery. In both groups, the majority of surgeries lasted between 120 to 160 minutes.

**ETT Cuff Pressure:** The initial pressure (T-0) in mmHg needed to "seal" the trachea and prevent air leaks during positive pressure ventilation was higher in Group L compared to Group S. However, there was a significant reduction in pressure in the alkalinized group after 90 minutes. Conversely, the cuff pressure in Group S increased gradually over time. By the end of the study (T-End), the cuff pressure in Group S was significantly higher than in Group L ($p < 0.001$).

In both groups, cuff pressure was consistently maintained below the critical tracheal perfusion pressure.

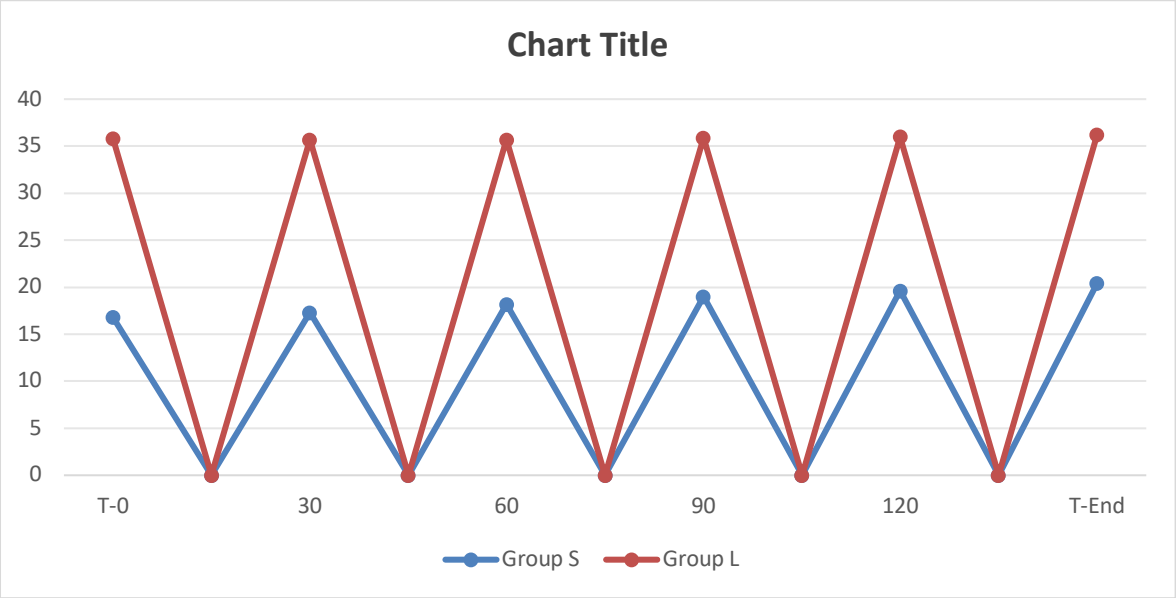


**Figure 1: Mean ETT cuff pressor at different time interval in both the study group**

**Extubation response:** The extubation response was measured as a percentage increase in heart rate (HR) and blood pressure from baseline. At extubation, there was a significant increase in HR ($p < 0.001$) and systolic blood pressure (SBP) ($p = 0.001$) in Group S. The changes in diastolic blood pressure (DBP) ($p = 0.242$) and mean arterial pressure (MAP) ($p = 0.738$) were comparable between the two groups.

**Table 2: Extubation Response (% increase from baseline) in both the study group**

| Extubation response/emergence phenomenon (% increase from baseline) | Group S | Group L | P value |
|---|---|---|---|
| Heart Rate | 15.76±5.45 | 7.59±3.84 | <0.001** |
| Systolic Blood Pressure | 12.02±3.11 | 10.26±2.64 | 0.001** |
| Diastolic Blood Pressure | 8.75±4.03 | 7.91±3.72 | 0.242 |
| Mean Arterial Pressure | 9.30±3.65 | 9.11±2.57 | 0.738 |

The study revealed that 80% of the subjects did not experience bucking at extubation, with 73.3% in Group S and 86.7% in Group L. However, the difference between the two groups was not statistically significant ($p = 0.189$).

**Restlessness or Level of Agitation:**

Restlessness was evaluated using the Ricker Sedation-Agitation Scale. Each patient's highest agitation score was recorded. Most subjects in both groups were calm and followed commands (score = 4). None of the subjects exhibited dangerous agitation (score = 7). In Group S, 6.7% showed emergence agitation (score ≥ 5), and this difference between the groups was significant ($p = 0.002$).

**Cough:**

In Group L, 86.7% of subjects did not cough, compared to 40% in Group S. In Group L, 6.7% reported mild or moderate cough, whereas in Group S, 40% had mild and 20% had moderate cough. No subjects in either group experienced a severe

cough. This difference was highly significant ($p < 0.001$).

**Sore Throat**

A comparative assessment of sore throat between the groups was conducted at various time intervals. Immediately after extubation (0 hours), none of the patients in Group L reported a sore throat. Four hours post-extubation, only 6.7% of subjects in Group L had a mild sore throat. No patients in Group L complained of a sore throat at the 8th, 16th, and 24th hours post-extubation. The differences between the two groups were highly significant at all-time intervals.

**Hoarseness:**

At extubation, 36% of subjects in Group S and 48% in Group L did not experience hoarseness. The incidence of mild hoarseness was 26.7% in Group S and 13.3% in Group L, which was suggestively significant ($p = 0.057$). No subjects in either group experienced severe hoarseness (a gross change in the quality of voice perceived by others).

**Nausea:**

In Group S, 20% of subjects and 13.3% in Group L complained of nausea. The difference was statistically insignificant.

The mean extubation time was 12.40±1.72 minutes in group S and 10.80±0.94 minutes in group L.

Emergence time of 10.731.45 minutes in group S was higher than 8.27 0.86 minutes in group L. The difference in both extubation and emergence time between the two groups was highly significant ($p<0.001$).

**Table 3: Distribution of study subjects as per sorethroat score at different time interval in both the group**

| Sore throat (score) | At extubation | 4th hour | 8th hour | 16th hour | 24th hour |
|---|---|---|---|---|---|
| Group S (n=60) | | | | | |
| 0 | 32(53.3%) | 36(60%) | 48(80%) | 52(86.7%) | 52(86.7%) |
| 1 | 4(6.7%) | 8(13.3%) | 8(13.3%) | 8(13.3%) | 8(13.3%) |
| 2 | 20(33.3%) | 16(26.7%) | 4(6.7%) | Nil | Nil |
| 3 | 4(6.7%) | Nil | Nil | Nil | Nil |
| Group L (n=60) | | | | | |
| 0 | 60(100%) | 56(93.3%) | 60(100%) | 60(100%) | 60(100%) |
| 1 | Nil | 4(6.7%) | Nil | Nil | Nil |
| 2 | Nil | Nil | Nil | Nil | Nil |
| 3 | Nil | Nil | Nil | Nil | Nil |
| P value | <0.001** | <0.001** | <0.001** | 0.006* | 0.006* |

**Discussion**

Airway management is a crucial aspect of anesthetic practice and critical care medicine. Endotracheal intubation remains the gold standard for securing the airway, being a simple, rapid, safe, and non-surgical technique. In the current healthcare environment, performance metrics are constantly scrutinized, necessitating a review of hospital procedures for their impact on patient outcomes. Emergence from general anesthesia often involves complications such as coughing, bucking, restlessness, nausea, and vomiting. Increased ETT cuff pressure, especially with the use of N2O, can cause tracheal mucosal injury, leading to post-extubation sore throat and hoarseness. Although endotracheal intubation is a longstanding practice in airway management and included in most protocols, many fail to address the risk of excessive ETT cuff pressure.

During anesthesia with N2O, the ETT cuff pressure rises over time because N2O diffuses into the cuff faster than it diffuses out, due to the partial pressure gradient across the polyvinyl chloride cuff membrane. When the ETT cuff pressure surpasses the capillary perfusion pressure, tracheal mucosal erosion can occur. Hyperinflation of the ETT cuff can be prevented by using a liquid instead of air. Alkalinization of lignocaine increases its diffusion rate through the cuff wall, allowing a lower dose to achieve the same effect. Besides its anesthetic properties, lignocaine also has analgesic and anti-inflammatory effects. Navarro et al.[6] measured plasma lignocaine concentrations after ETT cuff inflation with alkalinized lignocaine, showing detectable serum levels, which supports the theory that the ETT cuff can serve as a controlled release reservoir for lignocaine to adjacent tracheal tissue.

In our study, extubation showed a significant increase in HR ($p <0.001$) and SBP ($p=0.001$) in group S compared to group L. Soares et al [7]. Also found improved hemodynamic stability during extubation in groups with alkalinized lidocaine-filled cuffs compared to air or saline-filled cuffs. This finding is particularly beneficial for patients with coronary artery disease, where tachycardia could compromise myocardial perfusion.

We defined emergence time as the interval from turning off the anesthetic agent to the patient obeying commands, and extubation time as the time from turning off the anesthetic agent to the

removal of the tracheal tube by the anesthesiologist. Both times were shorter in the alkalinized lignocaine group compared to the normal saline group ($p<0.01$). This contrasts with Ahmady et al. [8], who found increased emergence and extubation times in the lignocaine group. They extubated their patients when they performed purposeful movements, which might have prolonged extubation time in the lignocaine group despite better tube tolerance. Tracheal intubation with ETT, cuff inflation, and resulting hyperinflation stimulate the rapidly adapting stretch receptors in the tracheal mucosa, causing cough during extubation (ETT-induced cough). Our study found that cough on emergence was significantly more prevalent in group S ($p<0.001$), with 20% of subjects experiencing persistent coughs lasting more than five seconds. Our findings were similar to those of Navarro et al. [6] and Jaichandran et al [9]. but differed from Wetzel et al [10]., who did not find any benefit of intracuff non-alkalinized lignocaine over saline in reducing emergence coughing among smokers in procedures lasting less than 1.5 hours. Estebe et al. [11] confirmed increased ETT tolerance in lignocaine groups, which was not proportional to the degree of alkalinization, suggesting that any degree of alkalinized lignocaine in ETT cuffs would result in better outcomes in longer surgeries.

Although most patients in our study were calm in both groups, 26.7% were restless at extubation in group S ($p=0.002$). The incidence of bucking and nausea was comparable in both groups, aligning with previous studies by Rao et al [12] and Estebe et al [11].

Tracheal wall ischemia occurs when the pressure from the hyper inflated cuff exceeds the tracheal capillary perfusion pressure, potentially leading to sore throat, hoarseness, and dysphagia. We continuously monitored the ETT cuff pressure, keeping it below 30 cm of $H_2O$ at all times in both groups. Cuff pressure was higher in group S at extubation ($p<0.001$), correlating with a significantly higher incidence of sore throat in group S. Even 24 hours post-extubation, 13.3% of patients in group S still had a mild sore throat. Altintas et al. demonstrated the efficacy of 10% lignocaine over saline in reducing post-extubation sore throat, while Porter et al [13] found no difference between 2% plain lignocaine and saline.

Our study found a suggestive significance concerning hoarseness at extubation ($p=0.05$). The incidence of hoarseness in the study by Combes et al [14] was similar in the air and saline groups, despite higher cuff pressures in the air-filled group, suggesting hoarseness might not be associated with cuffed tracheal tubes but rather with the presence of the tracheal tube between the vocal cords or trauma during intubation or extubation.

In this prospective, randomized, double-blind study, we evaluated the efficacy of alkalinized 2% lignocaine over 0.9% normal saline in reducing post-intubation complications. A total of 120 patients were randomly assigned to two groups. Following proper protocols, we observed a significant decrease in hemodynamic disturbances, restlessness, and coughing at emergence from general anesthesia with the ETT cuff inflated with alkalinized 2% lignocaine. This benefit extended to the postoperative period, with a reduced incidence of sore throat and hoarseness. Additionally, intra-cuff lignocaine prevented a significant rise in ETT cuff pressure during surgery.

Our study had some limitations. We did not measure the pH of the alkalinized lignocaine 2% used for inflating the ETT cuff, nor did we measure plasma lignocaine concentrations during the study.

## Conclusion

The present study highlights the benefits of using alkalinized 2% lignocaine over normal saline as an insufflating agent for endotracheal tube (ETT) cuffs. Our findings show that alkalinized lignocaine 2% is more effective in maintaining stable hemodynamic parameters at extubation and in reducing the incidence and severity of coughing, restlessness, and bucking. Additionally, it appears to offer better outcomes in terms of reducing post-operative nausea, hoarseness, and sore throat. This could be particularly advantageous for patients undergoing neurosurgery, ophthalmic procedures, those with pre-existing ischemic heart conditions, and for surgeries of extended duration.

Based on these results, we advocate for the use of alkalinized 2% lignocaine as the preferred agent for filling tracheal tube cuffs in such scenarios, rather than using air or saline. We also recommend incorporating regular ETT cuff pressure monitoring into standard practice. Maintaining cuff pressure below the critical tracheal perfusion pressure throughout the duration of intubation can help prevent tracheal mucosal ischemia and mitigate associated complications.

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