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Effectiveness of lidocaine as an endotracheal tube (ETT) cuff inflating agent: A single center experience

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Abstract
Background: Endotracheal intubation, which involves inserting a cuffed tube to secure the airway and facilitate ventilation, can lead to postoperative sore throat, a common complication that affects patient satisfaction and recovery. Traditionally, endotracheal tube (ETT) cuffs are inflated with air, but this can cause overinflation due to nitrous oxide diffusion, potentially exacerbating complications. Alternative inflation methods, such as using saline or lidocaine, have been explored to reduce these issues. Lidocaine, a local anesthetic and anti-inflammatory agent, may help by diffusing through the cuff to provide local anesthesia and minimize sore throat and other airway symptoms.
Aim of the study: This study aimed to compare lidocaine's effectiveness with air and saline as a better cuff inflating agent.
Methods: This one-year prospective study at the Department of Anesthesiology, [Name] Medical College and Hospital, [location] Bangladesh included 144 patients undergoing abdominal surgeries under general anesthesia. Patients were randomly divided into three groups: Group A with endotracheal tube (ETT) cuffs inflated with air, Group B with distilled water, and Group C with 2% lidocaine, each group containing 48 patients. Inclusion criteria included ASA 1 and ASA 2 patients aged 18-50 with surgeries lasting less than 5 hours. Exclusion criteria were difficult intubations, recent sore throat, smoking, or nasogastric tubes. Postoperative symptoms like sore throat and hoarseness were assessed at 1-3 and 22-24 hours. Data were analyzed using ANOVA and t-tests.
Result: In the study, the mean ages were similar across groups: Group A (45.83±6.88 years), Group B (44.52±7.25 years), and Group C (45.21±6.29 years). The sex ratio and body weight were comparable, with no significant differences (p>0.05). The ASA grade distribution was consistent across groups, indicating similar health statuses. Group A experienced higher sore throat incidence at 1-3 hours (62.5%) but not significantly. After 22-24 hours, Group C showed a significant decrease (4.17%, p<0.05). Group A had higher dysphasia (43.75%) and hoarseness (52.08%) initially, but Group C improved significantly by 22-24 hours, showing lower incidences (0%, p<0.05).
Conclusion: Lidocaine outperforms air and saline as an endotracheal tube (ETT) cuff inflating agent, significantly reducing postoperative sore throat, dysphagia, and hoarseness 22-24 hours after extubation. This study shows that lidocaine can enhance patient comfort and satisfaction, providing a simple, cost-effective way to improve post-surgical outcomes.

Keywords: Lidocaine, Endotracheal Tube (ETT), and cuff inflating agent

Introduction
Endotracheal intubation establishes an artificial pathway between the external environment and the patient's trachea, facilitating alveolar gas exchange and protecting the lungs from foreign substances [1]. Using cuffed endotracheal tubes is standard practice, essential for enabling positive pressure ventilation and safeguarding the airway from the aspiration of gastric contents [2]. The endotracheal tube (ETT) also plays a vital role in maintaining an open airway, facilitating ventilation, and protecting the lungs from aspiration. When inflated, the cuff of the ETT ensures a proper seal within the trachea, preventing air leaks. However, routine endotracheal intubation may cause trauma and pathological alterations, potentially resulting in postoperative sore throat symptoms [2]. Postoperative sore throat is the most frequent complication following endotracheal intubation, resulting in dissatisfaction and delays in resuming normal activities. Various factors can contribute to sore throat, and its incidence varies depending on the airway management technique [3]. In multiple studies, these devices have been associated with several issues, such as sore throat, coughing, hypertension, tachycardia, dysrhythmia, and increased intracranial and intraocular pressures [4]. The size of the endotracheal tube is a significant factor contributing to outcomes.

Smaller tubes are associated with lower rates of sore throat. The most commonly used endotracheal tubes feature high-volume, low-pressure cuffs typically made of Polyvinyl Chloride (Portex). Research indicates that using high-volume, pre-formed cuffs made from non-irritating materials can reduce the severity of tracheal injuries [2]. Although there are several approaches, none have been effective in preventing sore throats and other symptoms of intubation. Traditionally, the ETT cuff is inflated with air. However, using air has been associated with significant complications due to the diffusion of nitrous oxide from the bloodstream into the cuff, leading to overinflation and increased cuff pressure [5]. Various alternative substances for cuff inflation have been explored to mitigate these complications, including saline, alkalinized lidocaine, and a mixture of air with other agents. Among these, lidocaine has gained considerable attention due to its dual role as a local anaesthetic and an anti-inflammatory agent [6], and studies have shown that lidocaine can reduce the occurrence of postoperative airway symptoms [7]. Lidocaine, developed in the early 20th century, was approved for human use in 1948 by the US Food and Drug Administration and was used for postoperative analgesic and antihyperalgesic effects [8, 9]. Lidocaine exhibits anti-nociceptive, antihyperalgesic, and anti-inflammatory properties. Rather than a direct local anesthetic action, these effects likely account for its prolonged impact even hours after an infusion has ended [10-14]. Lidocaine applied inside an ETT cuff gradually diffuses through the cuff membrane [15]. Diffusion of lidocaine across the endotracheal tube cuff may allow it to store local anesthesia, providing subsequent anesthesia to the underlying tracheal mucosa and preventing the diffusion of nitrous oxide into the cuff [16]. It has been hypothesized that the lidocaine diffusion across the cuff will produce topical anaesthesia on the trachea, thus preventing sore throat [17]. This study aimed to compare lidocaine's effectiveness with air and saline as a better cuff inflating agent.

Methodology & Materials

This prospective study was conducted at the Department of Anaesthesiology in [Name] Medical College and Hospital, [Location], Bangladesh, spanning a period of one year from [start] to [end]. A total of 144 cases were included and randomly assigned to three groups, each containing 48 patients, using a card sampling method.

The groups were designated as follows:

- **Group A:** Endotracheal tube cuff filled with air.
- **Group B:** Endotracheal tube cuff filled with distilled water.
- **Group C:** Endotracheal tube cuff filled with 2% lidocaine.

Inclusion criteria

- Patients classified as ASA 1 and ASA 2.
- Age between 18 and 50 years.
- Surgical procedures with a duration of less than 5 hours.

Exclusion criteria

- Cases requiring more than one attempt at intubation or deemed difficult.
- Patients with a history of sore throat in the last 6 weeks, smokers, and tobacco chewers.
- Patients with nasogastric tubes in-situ.

A sterile endotracheal tube (Rusch; 7.5 mm for women, 8.0 mm for men) with high volume and low-pressure cuffs was utilized for all participants in this study. The patients included were classified as ASA grade I or II and were undergoing general endotracheal anesthesia for abdominal surgeries lasting less than 90 minutes. A standardized anesthetic protocol was followed throughout the study. Anesthesia induction involved administration of 3-6 mg/kg of thiopental sodium followed by 1.5 mg/kg of succinylcholine for intubation. Before intubation, patients were ventilated with 100% oxygen via facemask. Maintenance anesthesia included a mixture of 35% oxygen and 65% nitrous oxide, halothane, opioid analgesics, and vecuronium as a muscle relaxant. At the end of the surgery, muscle relaxation was reversed using neostigmine and atropine. In the lidocaine group, the endotracheal tube cuffs were prefilled with 8 ml of 2% lidocaine 90 minutes prior to intubation to facilitate lidocaine diffusion across the cuff. All cuffs were depressurized to sub-atmospheric pressure before intubation. Following intubation, the cuffs were inflated with air, distilled water, or lidocaine solution to achieve an appropriate seal, ensuring that the lidocaine dose did not exceed 5 mg/kg to prevent local anesthetic toxicity in case of cuff rupture.

Postoperatively, patients were directly queried regarding symptoms such as sore throat, cough, difficulty swallowing, and hoarseness. A verbal rating scale was employed to assess the presence and severity of sore throat in all three groups at two intervals: 1-3 hours postoperatively and 22-24 hours postoperatively. Data were meticulously recorded on a specially designed data sheet after obtaining informed consent from each participant. Statistical analysis of the findings was performed using ANOVA followed by Fischer's PLSD for intra-group comparisons, and unpaired t-tests for between-group comparisons. Results were presented as Mean±SD, with significance set at $p<0.05$, and were summarized in both tabular and graphical formats using the Statistical Package for Social Sciences (SPSS, Version 26).

Result

The study included 144 patients, divided equally into three groups (Group A, Group B, and Group C), each comprising 48 patients. Table 1 provides the demographic characteristics of the study population. The mean age of the patients was comparable across the three groups: Group A (45.83±6.88 years), Group B (44.52±7.25 years), and Group C (45.21±6.29 years), with no statistically significant difference ($p>0.05$). The sex ratio (Male: Female) varied among the groups: Group A (1:3), Group B (1:2), and Group C (1:1), but this difference was also not statistically significant ($p>0.05$). The mean body weight was similar across the groups: Group A (72.35±16.0 kg), Group B (73.25±16.51 kg), and Group C (72.11±17.85 kg), with no significant differences observed ($p>0.05$). Figure 1 illustrates the percentage-wise comparison of the study groups based on the American Society of Anesthesiologists (ASA) grade. The distribution of ASA grades was similar among the groups, indicating a comparable baseline health status across the participants. Table 2 compares the incidence of sore throat among the study groups at two different time points. After 1-3 hours, Group A reported a

higher incidence of sore throat (62.5%) compared to Group B (39.58%) and Group C (27.08%), although this difference was not statistically significant (p>0.05). However, after 22-24 hours, the incidence of sore throat significantly decreased in Group C (4.17%) compared to Group A (43.75%) and Group B (20.83%), with a significant P-value of <0.05. Table 3 shows the comparison of dysphasia among the study groups. After 1-3 hours, Group A reported the highest incidence of dysphasia (43.75%), followed by Group B and Group C (Both 25.00%), with a statistically significant difference (p<0.05). After 22-24 hours, the incidence of dysphasia was significantly lower in Group C (0.00%) compared to Group A (20.83%) and Group B (20.83%), with a significant P-value of < 0.05. Table 4 details the comparison of hoarseness among the study groups. After 1-3 hours, Group A had the highest incidence of hoarseness (52.08%), followed by Group B (35.42%) and Group C (25.00%), with a statistically significant difference (P<0.05). After 22-24 hours, the incidence of hoarseness significantly decreased in Group C (0.00%) compared to Group A (43.75%) and Group B (20.83%), with a significant P-value of < 0.05.

Table 1: Demographical characteristics of the study population

Characteristics	Group A (N=48)	Group B (N=48)	Group C (N=48)	P-value
Age in years (Mean±SD)	45.83±6.88	44.52±7.25	45.21±6.29	>0.05
Sex ratio (Male: Female)	1:3	1:2	1:1	>0.05
Body weight in kg (Mean±SD)	72.35±16.0	73.25±16.51	72.11±17.85	>0.05

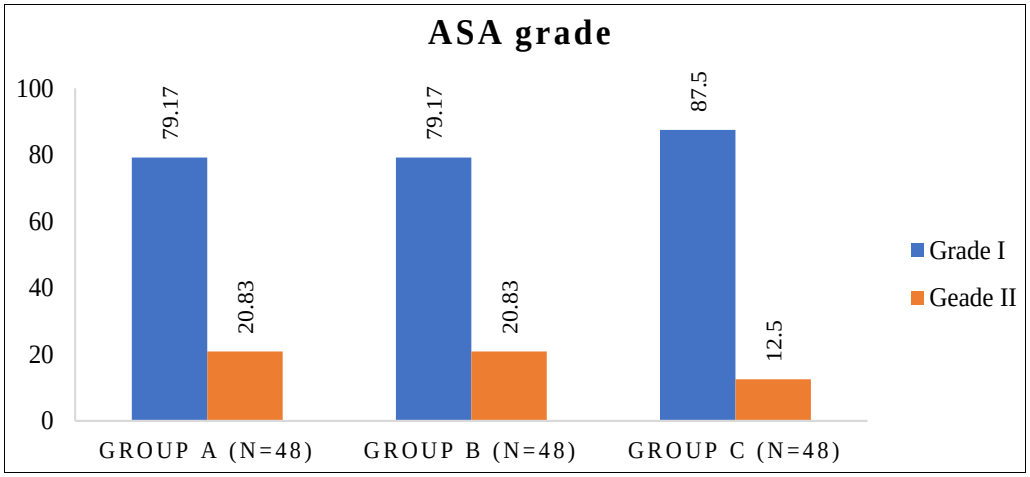

Fig 1: Percentage wise comparison of study groups based on ASA grade

Table 2: Comparison of study groups based on sore throat

Sore throat	Group A (N=48)		Group B (N=48)		Group C (N=48)		P-value
	N	%	N	%	N	%	
After 1-3 hours	30	62.5	19	39.58	13	27.08	>0.05
After 22-24 hours	21	43.75	10	20.83	2	4.17	<0.05

Table 3: Comparison of study groups based on dysphasia

Dysphasia	Group A (N=48)		Group B (N=48)		Group C (N=48)		P-value
	N	%	N	%	N	%	
After 1-3 hours	21	43.75	12	25.00	12	25.00	<0.05
After 22-24 hours	10	20.83	10	20.83	0	0	<0.05

Table 4: Comparison of study groups based on hoarseness

Hoarseness	Group A (N=48)		Group B (N=48)		Group C (N=48)		P-value
	N	%	N	%	N	%	
After 1-3 hours	25	52.08	17	35.42	12	25	<0.05
After 22-24 hours	21	43.75	10	20.83	0	0	<0.05

Discussion

Endotracheal intubation is essential for managing patients during surgery, mechanical ventilation, and emergencies, with the ETT cuff ensuring an effective seal to prevent air leaks and aspiration. However, cuff inflation can cause complications, including tracheal mucosal injury, sore throat, hoarseness, and more severe issues like tracheal stenosis and tracheoesophageal fistula [5, 18]. This can be due to trauma and nerve damage to the throat structures [19-21]. Various factors can affect these symptoms, including the patient's sex and gender, the size and pressure of the endotracheal tube cuff, the length of intubation, the patient's position, and the experience level of the anesthesiologist.

Postoperative sore throat is a common and bothersome complication affecting over 50% of patients recovering from general anesthesia. Various approaches have been employed to mitigate this issue [22]. The primary objective of this study was to evaluate the effectiveness of lidocaine as an endotracheal tube (ETT) cuff inflating agent compared to air and saline in reducing postoperative sore throat, dysphagia, and hoarseness. Our findings indicate that lidocaine significantly reduces the incidence and severity of these

common postoperative complications, which can considerably enhance patient comfort and satisfaction following intubation. The demographic characteristics of the study population, including age, sex ratio, and body weight, were comparable across all three groups (Group A: air, Group B: saline, and Group C: lidocaine), with no significant differences observed (p>0.05). This homogeneity ensures that the outcomes observed can be attributed to the intervention rather than demographic variables. The incidence of sore throat was significantly lower in the lidocaine group compared to the air and saline groups. At 1-3 hours post-extubation, sore throat was reported by 62.5% of patients in Group A, 39.58% in Group B, and 27.08% in Group C (p>0.05). This trend was more pronounced at 22-24 hours post-extubation, with 43.75% in Group A, 20.83% in Group B, and only 4.17% in Group C reporting a sore throat (p<0.05). These findings align with previous studies that have demonstrated the efficacy of lidocaine in reducing postoperative sore throat. For instance, a study by Estebe found that lidocaine significantly reduced the incidence of postoperative sore throat compared to saline and air when used as an ETT cuff inflating agent [18]. Dysphagia was also significantly reduced in the lidocaine group. At 1-3 hours post-extubation, 43.75% of patients in Group A, 25% in Group B, and 25% in Group C reported dysphagia (p<0.05). At 22-24 hours post-extubation, the incidence dropped to 20.83% in Group A, 20.83% in Group B, and 0% in Group C (p<0.05). The absence of dysphagia in the lidocaine group at 22-24 hours post-extubation suggests a notable protective effect of lidocaine on the laryngeal mucosa. This outcome corroborates the findings of Thomas and Beevi (2007), who reported a significant reduction in dysphagia with the use of lidocaine for ETT cuff inflation [23]. The incidence of hoarseness followed a similar pattern, with a significant reduction in the lidocaine group. At 1-3 hours post-extubation, hoarseness was reported by 52.08% of patients in Group A, 35.42% in Group B, and 25% in Group C (p<0.05). At 22-24 hours post-extubation, the incidence of hoarseness was 43.75% in Group A, 20.83% in Group B, and 0% in Group C (p< 0.05). These results are consistent with the study conducted by Navarro *et al*., which demonstrated that lidocaine as an ETT cuff inflating agent significantly reduces the incidence of postoperative hoarseness compared to air and saline [6]. A study by Fagan *et al*. supports our findings, indicating that using lidocaine for ETT cuff inflation reduces post-extubation coughing compared to saline or air [24]. Studies by Lam *et al*. demonstrated that both alkalinized and non-alkalinized intracuff lidocaine can help prevent and alleviate postoperative sore throat and postintubation-related epiglottitis [25]. George and his team evaluated the impact of lignocaine administered via the endotracheal tube (ETT) versus intravenous lignocaine on the extubation response in patients undergoing craniotomy with skull pins. Instilling 1 mg/kg of lignocaine into the ETT did not mitigate the airway and hemodynamic responses during anesthesia emergence. Additionally, administering the same dose intravenously 10 minutes before extubation was unlikely to prevent coughing. These findings align with the results of this study [26]. In a study by Husson *et al*., lidocaine, air, and normal saline were compared, revealing no statistically significant differences among the groups [27]. In contrast, Bennet *et al*. found significant differences between the air and saline groups concerning hoarseness and sore throat [28]. Additionally, Soltani *et al*. conducted research in 1999 on various methods of lidocaine application and their impact on postoperative cough and sore throat. Their findings indicated that intracuff lidocaine was more effective in preventing postoperative sore throat [29]. Seegobin, VanHasselt, and Stanley examined the impact of N_2O on the pressure within endotracheal air-filled cuffs. Their research revealed that N_2O permeated through the thin-walled cuff, increasing cuff pressure beyond the initial level and compromising mucosal blood flow. This blood flow is crucial for minimizing tracheal morbidity related to intubation. They also noted that some damage to the tracheal mucosa was unavoidable due to the interaction between the cuff material and the tracheal wall. This over-expansion of the cuff during anesthesia can significantly contribute to tracheal or laryngeal injury and may also be a factor in postoperative sore throat in intubated patients. Patel *et al*. found that cuffs inflated with room air exhibited a more rapid and higher pressure increase than those inflated with saline [29, 30]. The results indicate that using lidocaine as an endotracheal tube (ETT) cuff inflating agent significantly reduces the incidence of postoperative sore throat, dysphasia, and hoarseness, particularly after 22-24 hours, compared to traditional methods. Group C, which utilized lidocaine, consistently showed the lowest incidence of these complications, suggesting its effectiveness in improving patient outcomes post-intubation. The findings of this study have significant clinical implications. Postoperative sore throat, dysphagia, and hoarseness are common and distressing complications following tracheal intubation. These complications can lead to patient discomfort, prolonged recovery times, and increased healthcare costs. By using lidocaine as an ETT cuff inflating agent, healthcare providers can reduce the incidence and severity of these complications, thereby enhancing patient comfort and overall satisfaction. Furthermore, the use of lidocaine is a simple, cost-effective intervention that can be easily incorporated into routine clinical practice.

Limitations of the study

The limitations of this study include a relatively small sample size of 144 patients, which may not fully represent the broader patient population and could limit the generalizability of the findings. The study was conducted at a single center, which may introduce site-specific biases. The study only included patients undergoing general anesthesia for abdominal surgeries lasting less than 90 minutes, limiting its applicability to other surgeries or more prolonged procedures. Furthermore, the subjective nature of assessing sore throat, dysphagia, and hoarseness could lead to variability in reporting. Lastly, the potential risk of local anesthetic toxicity from lidocaine was mitigated but not eliminated.

Conclusion and recommendations

In conclusion, our study demonstrates that lidocaine is a superior endotracheal tube (ETT) cuff inflating agent compared to air and saline. Lidocaine significantly reduces postoperative sore throat, dysphagia, and hoarseness, particularly evident 22-24 hours after extubation. The incidence of these complications was markedly lower in the lidocaine group, highlighting its efficacy in mitigating common postoperative discomforts associated with intubation. These findings suggest that incorporating lidocaine into routine clinical practice for ETT cuff inflation can enhance patient comfort and satisfaction, offering a

simple and cost-effective solution to improve post-surgical outcomes.

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