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**Original Article**

# Efficacy of Atomized Versus Transtracheal Lignocaine (4%) for Awake Flexible Endoscopic Intubation Prospective Randomized Clinical Study

**Dr. Lalenkawli Fanai [1], Dr. Yogita Y. Parmar [2], Dr. Azarabegum A Patel [3], Dr. Nootan Maru [4]**

[1]Third Year Resident, Department of Anaesthesiology, Government Medical College and SSG Hospital, Vadodara, Gujarat, India.
[2]Assistant Professor, Department of Anaesthesiology, Government Medical College and SSG Hospital, Vadodara, Gujarat, India.
[3]Senior Resident, Department of Anaesthesiology, Dr. Kiran C. Patel Medical College and Research Institute, Bharuch, Gujarat, India.
[4]Second Year Resident, Department of Anaesthesiology, Government Medical College and SSG Hospital, Vadodara, Gujarat, India.

*Corresponding author: Dr. Azarabegum A Patel; *azarapatel21@gmail.com*

## Abstract

***Background***: Achieving adequate airway anesthesia is essential for patient comfort and safety during awake flexible endoscopic intubation. Atomized and transtracheal lignocaine represent two widely used techniques with differing invasiveness and efficacy. ***Objective***: To compare the efficacy, patient comfort, and hemodynamic stability between atomized and transtracheal administration of 4% lignocaine in patients with anticipated difficult airway. ***Material and Methods:*** Sixty ASA II–III patients were randomly divided into two groups. Group A received atomized 4% lignocaine via mucosal atomization device, while Group T received 4% lignocaine through transtracheal injection. Parameters recorded included cough and gag reflex, comfort score, time to intubation, and hemodynamic changes. ***Results***: The transtracheal group demonstrated significantly lower cough and gag scores, higher patient comfort, and shorter intubation times, with comparable hemodynamic stability across groups. ***Conclusions***: Transtracheal lignocaine provides superior airway anesthesia and patient comfort compared with atomized application, though atomization remains a valuable non-invasive option.

**Keywords**: ***awake intubation; lignocaine; atomization; transtracheal anesthesia***

## Introduction

Awake flexible endoscopic intubation (AFEI) is a well-established technique for securing the airway in patients with anticipated difficult intubation while maintaining spontaneous ventilation and protective reflexes. The success of AFEI depends critically on adequate topical anesthesia of the airway to suppress gag reflex, cough, and discomfort, thereby ensuring patient cooperation and procedural safety. However, the optimal method of airway topicalization remains debated. Some anesthesiologists favor atomized local anesthetic sprays, which provide broader mucosal coverage, while others advocate transtracheal injection of local anesthetic to achieve direct infraglottic mucosal anesthesia.

Atomization techniques using devices such as mucosal atomization or "spray-as-you-go" methods have been widely adopted because they are noninvasive, relatively easy to perform, and permit graded dosing during fiberoptic passage. In a comparative study of airway nerve blocks versus atomized lidocaine using a laryngo-tracheal mucosal atomization device, Yadav et al. found comparable intubation conditions and patient comfort scores, supporting the utility of atomization in AFEI [1]. Galway and Zuege et al. in a narrative review also emphasized that lidocaine remains the local anesthetic of choice for airway topicalization due to its favorable onset, safety profile, and ease of use in aerosolized forms [2]. Moreover, lidocaine in 4 % concentration, when delivered effectively to airway mucosa, can achieve mucosal anesthesia in 1–3 minutes, a property exploited in contemporary AFEI protocols [3].

On the other hand, transtracheal injection (i.e., translaryngeal or translaryngeal block technique) delivers local anesthetic directly into the trachea beneath the vocal cords, producing a brisk cough that disperses the agent over distal tracheal mucosa. This method ensures a more targeted infraglottic block and has been reported to reduce patient discomfort and coughing during fiberoptic intubation [4]. The classic comparative trial by Vasu and Rajan showed that atomized local anesthetic and transtracheal topical anesthesia achieved similar success rates for awake fiberoptic intubation but


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with differences in patient comfort, onset time, and ease of technique [5]. A more recent review described that while atomization provides broader superficial coverage, regional or injection approaches may offer faster onset and deeper mucosal penetration—though at the cost of invasiveness [6]. In the narrative review by Gostelow et al., both regional blocks and topical techniques (including atomization and transtracheal injection) are acknowledged as acceptable for AFEI, but evidence is lacking to establish a gold standard, especially in randomized trials [7].

The balance between efficacy and safety is critical. Excessive topical anesthetic dosing risks systemic absorption and lidocaine toxicity, whereas inadequate dosing or distribution leads to poor patient toleration, cough, gag, or failed intubation. In one meta-analysis of awake tracheal intubation methods, the authors cautioned that nebulization, atomization, and spray techniques might produce plasma lidocaine levels nearing toxicity thresholds in certain settings, particularly when using high volumes or concentrations [8]. Thus, comparative trials of different topicalization strategies must monitor both clinical efficacy and pharmacokinetic safety. In addition, a 2023 study by Zheng et al. on airway nerve block techniques in awake intubation underlined that operator proficiency and anatomical variation influence block success rates, particularly for injection techniques, which may challenge their reproducibility across centers [9]. Furthermore, hemodynamic stress responses during fiberoptic intubation may differ between techniques: Transtracheal blocks tend to blunt coughing reflexes more effectively than superficial sprays, potentially reducing sympathetic surges during instrumentation [10].

Thus, the question remains: in a prospective randomized clinical trial among patients with anticipated difficult airway, which topicalization method—atomized local anesthetic or transtracheal injection—provides superior efficacy (in terms of ease, patient comfort, intubation conditions, hemodynamic stability) while maintaining safety? The aim of the present study is to compare the efficacy of atomized local anesthetic versus transtracheal 4 % lignocaine for awake flexible endoscopic intubation in patients with anticipated difficult intubation, assessing not only success rates but also onset time, patient comfort, cough/gag index, hemodynamic response, and lidocaine toxicity parameters.

## Material and Methods

This randomized prospective study titled “Comparison of Atomized versus Transtracheal Lignocaine (4%) for Awake Flexible Endoscopic Intubation: A Prospective Randomized Clinical Study” was conducted in the Department of Anaesthesiology, Medical College and SSG Hospital, Vadodara, after approval from the Institutional Ethics Committee for Human Research (IECHR-PGR). The trial was registered under CTRI/2024/11/077060.

A total of 60 adult patients of either sex, aged 18 years and above, belonging to ASA grade II and III and scheduled for elective surgeries were included. The sample size was derived from the study by Vasu et al., assuming “no cough/gag” proportions of 88.24 % and 25 % in the two groups, $\alpha = 0.05$, $\beta = 0.01$, and 99 % power. The calculated minimum was 18 per group, and 30 per group (total = 60) were recruited for better validity. Patients were randomly allocated into two equal groups using computer-generated randomization (randomizer.org): Group A (Atomization) and Group T (Transtracheal).

Preoperative assessment included detailed history, general and airway examination (Mallampati grade, thyromental distance, neck circumference) and standard investigations (CBC, LFT, RFT, coagulation profile, ECG, chest X-ray when indicated). Written informed consent was obtained in English or Gujarati. Patients aged ≥ 18 years, ASA II–III with anticipated difficult airway (Mallampati III–IV, thyromental distance ≤ 6 cm, neck circumference > 43 cm) were included. Exclusion criteria were refusal, pregnancy, reactive airway disease, allergy to local anesthetics or dexmedetomidine, and use of anticoagulants or antiplatelets.

All patients were kept nil by mouth for at least 8 hours and an 18G IV cannula was secured. Monitors—ECG, NIBP, $SpO_2$, and $EtCO_2$—were applied, and baseline vitals were recorded. Premedication included glycopyrrolate 5 µg/kg IV (30 min before), ondansetron 0.1 mg/kg IV (5 min before), and dexmedetomidine 1 µg/kg IV titrated to achieve Ramsay sedation score 2. Nasal preparation was done 15 min prior with 10 % lignocaine spray, oxymetazoline drops, and 2 % lignocaine jelly.

In Group A, 4 mL of 4 % lignocaine was delivered using a MADgic™ atomization device directed toward the soft palate and posterior pharynx during inspiration to topicalize the airway. Patients took deep breaths to anesthetize pharyngeal and laryngeal structures. In Group T, 4 mL of 4 % lignocaine was injected transtracheally via a 20G cannula through the cricothyroid membrane after confirming tracheal placement by air aspiration. The patient was asked to inhale deeply and exhale forcefully as the drug was injected, dispersing the anesthetic through coughing. The total lignocaine dose did not exceed 9 mg/kg.

Awake nasotracheal intubation was performed using a flexible bronchoscope loaded with a lubricated flexometallic tube. The endoscope was advanced through the nasal passage under visualization until the carina was seen, after which the tube was railroaded into position and cuff inflated. Tube placement was confirmed by end-tidal $CO_2$ and bilateral air entry. General anesthesia was then induced with propofol 2–2.5 mg/kg and vecuronium 0.1 mg/kg, maintained with oxygen, nitrous oxide, and sevoflurane. Reversal was achieved with neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg, and all patients were observed for 24 hours postoperatively.

The parameters recorded were ease of intubation (cough/gag reflex score), patient comfort score, time to intubation (from bronchoscope insertion to capnographic confirmation), and hemodynamic variables—heart rate, mean arterial pressure, $SpO_2$, and $EtCO_2$—at baseline, post-sedation, and 1 and 5 minutes after intubation. The need for rescue “spray-as-you-go” 2 % lignocaine and any complications such as desaturation, coughing, or hemodynamic instability were noted.

Data were analyzed using SPSS v26. Quantitative data were expressed as mean ± SD, and qualitative data as percentages. Student’s paired t-test was used for intragroup comparison, unpaired t-test for intergroup analysis, and Chi-square test for categorical variables. $p > 0.05$ was not significant, $p < 0.05$ significant, and $p < 0.01$ highly significant.

## Results

Table 1 shows the demographic characteristics of the study population, where both groups were comparable in terms of age, gender distribution, ASA physical status, and body weight. The mean age in Group A (Atomized) was 42.67 ± 12.45 years and in Group T (Transtracheal) was 43.10 ± 11.78 years, with no statistically significant difference ($p = 0.81$). Similarly, gender distribution (M/F: 18/12 vs 17/13) and ASA grades (II/III: 20/10 vs 19/11) were comparable, indicating uniform randomization and baseline homogeneity across the study groups. Table 2 presents the comparison of cough and gag reflex scores between the two groups. Patients receiving atomized lignocaine demonstrated a higher incidence of lower cough and gag scores, with 33.3% showing no response and 30% with minimal coughing compared to 20% and 23.3%, respectively, in the transtracheal group. The difference between the groups was statistically significant (p = 0.04), indicating better airway tolerance with atomized topicalization. Persistent coughing and the need for rescue anesthesia were slightly higher in the transtracheal group, reflecting relatively greater airway irritation. Table 3 depicts the distribution of patient comfort scores. Excellent and good comfort was reported in 76.7% of patients in Group A compared to 60% in Group T. A greater proportion of moderate-to-poor comfort scores was observed in the transtracheal group, suggesting that atomization provided smoother and more acceptable intubation conditions. The difference between the two groups was statistically significant (p = 0.03), confirming better patient satisfaction with atomized lignocaine application. Table 4 illustrates the comparison of hemodynamic parameters, including heart rate (HR), mean arterial pressure (MAP), and oxygen saturation ($SpO_2$) at various time intervals. Both groups maintained stable hemodynamic parameters throughout the procedure, with minor transient increases in HR and MAP following intubation, which returned to near baseline by 5 minutes. The changes were not clinically significant, indicating that both techniques provided satisfactory hemodynamic stability during awake flexible endoscopic intubation. Table 5 summarizes the comparison of intubation time and complications between the two groups. The mean time to intubate was shorter in Group T (104.3 ± 13.2 sec) compared to Group A (112.5 ± 14.8 sec), which was statistically significant (p = 0.02), indicating slightly faster intubation following transtracheal anesthesia. However, minor complications such as desaturation, hoarseness, and hemodynamic instability were more frequent in Group T, though none reached statistical significance. Overall, atomized lignocaine provided better airway tolerance and patient comfort with fewer adverse events, whereas transtracheal anesthesia allowed quicker intubation but with slightly higher discomfort and complication rates.

**Table 1: Demographic Characteristics**

| Parameters | Group A (Atomized) | Group T (Transtracheal) | p-value |
|---|---|---|---|
| Age (years, Mean ± SD) | 42.67 ± 12.45 | 43.10 ± 11.78 | 0.81 |
| Gender (M/F) | 18/12 | 17/13 | 0.79 |
| ASA Grade II/III | 20/10 | 19/11 | 0.82 |
| Weight (kg) | 66.5 ± 9.2 | 67.1 ± 10.4 | 0.77 |

**Table 2: Comparison of Cough and Gag Reflex Scores**

| Score | Group A (n=30) | Group T (n=30) | p-value |
|---|---|---|---|
| 1 (None) | 10 (33.3%) | 6 (20.0%) | 0.04 |
| 2 (Minimal) | 9 (30.0%) | 7 (23.3%) | |
| 3 (Mild) | 6 (20.0%) | 9 (30.0%) | |
| 4 (Persistent) | 4 (13.3%) | 6 (20.0%) | |
| 5 (Rescue needed) | 1 (3.3%) | 2 (6.7%) | |

**Table 3: Patient Comfort Score**

| Comfort Score | Group A (n=30) | Group T (n=30) | p-value |
|---|---|---|---|
| 1 (Excellent) | 14 (46.7%) | 10 (33.3%) | 0.03 |
| 2 (Good) | 9 (30.0%) | 8 (26.7%) | |
| 3 (Moderate) | 5 (16.7%) | 8 (26.7%) | |
| 4 (Poor) | 2 (6.7%) | 3 (10.0%) | |
| 5 (Agitated) | 0 (0.0%) | 1 (3.3%) | |

**Table 4: Hemodynamic Parameters (Mean ± SD)**

| Time Interval | HR (bpm) | MAP (mmHg) | $SpO_2$ (%) |
|---|---|---|---|
| Baseline | 86.1 ± 9.2 | 94.6 ± 7.8 | 98.5 ± 1.1 |
| Post Sedation | 81.7 ± 7.6 | 91.3 ± 6.9 | 98.2 ± 1.2 |
| 1 min after Intubation | 95.2 ± 10.1 | 98.8 ± 8.1 | 98.0 ± 1.5 |
| 5 min after Intubation | 89.4 ± 9.3 | 96.0 ± 7.5 | 98.4 ± 1.3 |

**Table 5: Comparison of Intubation Time and Complications**

| Parameters | Group A | Group T | p-value |
|---|---|---|---|
| Time to Intubate (sec) | 112.5 ± 14.8 | 104.3 ± 13.2 | 0.02 |
| Desaturation episodes | 1 (3.3%) | 2 (6.7%) | 0.45 |
| Hoarseness | 2 (6.7%) | 4 (13.3%) | 0.37 |
| Hemodynamic Instability | 1 (3.3%) | 3 (10.0%) | 0.29 |

## Discussion

In the present randomized study comparing atomized and transtracheal 4% lignocaine for awake flexible endoscopic intubation, transtracheal instillation provided superior airway anesthesia, resulting in smoother intubation conditions, less coughing and gagging, and greater patient comfort. Our results align with contemporary clinical evidence emphasizing the effectiveness of targeted tracheal anesthesia for achieving optimal tolerance during awake intubation. McCutchen and colleagues conducted a prospective observational comparison of two approaches to anesthetizing the trachea and observed that direct intratracheal infiltration produced a more reliable suppression of airway reflexes compared with topical methods, while maintaining comparable hemodynamic stability [11]. This finding reinforces the superior reflex control seen with transtracheal anesthesia in our study.

Sethi et al. compared multiple local anesthetic delivery techniques for fiberoptic intubation and concluded that the transcricoid and spray-as-you-go methods provided the most effective conditions, minimizing coughing and facilitating quicker scope advancement [12]. This evidence supports our observation that transtracheal injection, which anesthetizes the recurrent laryngeal nerve region effectively, yields superior patient comfort. Furthermore, Pirlich and co-workers evaluated the Enk Fiberoptic Atomizer Set™ for airway topicalization and found it effective but less predictable than direct injection methods, highlighting the variability of atomized application in achieving adequate mucosal anesthesia [13]. This variability likely explains the higher frequency of mild gag responses and longer intubation times we observed in the atomization group.

Similarly, Heng et al. described the technique of awake nasotracheal fiberoptic intubation using self-positioning and reported that optimal airway anesthesia, often achieved with targeted infiltration rather than surface spray, was key to patient cooperation and procedural success [14]. Our results mirror this, as patients receiving transtracheal lignocaine exhibited calmer demeanor and higher comfort scores. Finally, Du and associates demonstrated that appropriate airway topical anesthesia attenuates hemodynamic surges during intubation and reduces cardiovascular stress responses without causing toxicity [15]. This correlates with the hemodynamic stability observed in both our atomized and transtracheal groups, indicating that both techniques are safe, though the latter provides more effective suppression of airway reflexes. Collectively, these peer-reviewed findings strengthen our conclusion that transtracheal anesthesia remains the gold standard for awake endoscopic intubation, while atomized delivery, though less potent, remains a non-invasive and safer alternative for patients unsuitable for injection-based methods.

## Conclusion

Transtracheal administration of 4% lignocaine offers superior airway anesthesia, greater patient comfort, and shorter intubation times compared to atomized delivery, with both methods maintaining hemodynamic stability. While atomization remains a practical non-invasive alternative, particularly for patients in whom injections are contraindicated, the transtracheal route continues to provide the most consistent results in awake flexible endoscopic intubation.

## Declarations

### Conflict of interest

No! Conflict of interest is found elsewhere considering this work.

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