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A Randomized, Double-Blinded Comparative Study of Pre-Operative Nebulized Dexamethasone and Intravenous Ketorolac Tromethamine for the Prevention of Post-Operative Sore Throat Following General Anesthesia

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ABSTRACT

Background: *Postoperative sore throat (POST) is a common complication following endotracheal intubation during general anesthesia, affecting approximately 30–70% of surgical patients and contributing to postoperative discomfort and reduced patient satisfaction. Airway mucosal trauma and inflammatory responses triggered by laryngoscopy and endotracheal tube placement are the primary mechanisms responsible for this condition. Although various pharmacological interventions have been proposed to mitigate POST, comparative evidence evaluating topical corticosteroids and systemic non-steroidal anti-inflammatory drugs remains limited.* ***Objective:*** *To compare the effectiveness of preoperative nebulized dexamethasone and intravenous ketorolac tromethamine in reducing the severity of postoperative sore throat among adult patients undergoing surgery under general anesthesia with endotracheal intubation.* ***Methods:*** *A prospective, randomized, double-blind clinical trial was conducted on 100 patients (ASA I–III) undergoing surgery requiring endotracheal intubation. Participants were randomly assigned to receive either preoperative nebulized dexamethasone or intravenous ketorolac tromethamine. Postoperative sore throat severity was assessed using the STAT-10 scale at 2, 4, 6, and 12 hours following extubation. Continuous variables were compared using independent t-tests, while categorical variables were analyzed using chi-square tests. Multivariable logistic regression was performed to identify predictors of moderate-to-severe POST.* ***Results:*** *Patients receiving nebulized dexamethasone demonstrated significantly lower mean sore throat scores compared with the ketorolac group at 2 hours (3.2 ± 1.1 vs. 4.6 ± 1.3), 4 hours (2.6 ± 1.0 vs. 3.9 ± 1.2), 6 hours (1.9 ± 0.9 vs. 3.1 ± 1.1), and 12 hours (1.1 ± 0.7 vs. 2.0 ± 0.8), all $p < 0.001$. Moderate-to-severe POST was significantly more frequent in the ketorolac group during early postoperative assessments. Multivariable analysis identified treatment allocation (adjusted OR = 3.06, 95% CI: 1.36–6.87) and endotracheal tube size >7.5 mm (adjusted OR = 2.20, 95% CI: 1.07–4.54) as independent predictors of clinically significant POST.* ***Conclusion:*** *Preoperative nebulized dexamethasone significantly reduces postoperative sore throat severity compared with intravenous ketorolac following endotracheal intubation. Targeted topical anti-inflammatory therapy may represent an effective strategy for improving early postoperative airway comfort and patient satisfaction.*

Keywords: *Postoperative sore throat, Dexamethasone, Ketorolac, Endotracheal intubation, General anesthesia, Airway inflammation.*

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INTRODUCTION

Postoperative sore throat (POST) is a common adverse outcome following general anesthesia with endotracheal intubation. Although usually transient and self-limiting, its clinical relevance lies in the substantial discomfort it causes in the early postoperative period and its negative influence on patient satisfaction and perceived quality of anesthesia care. Reported

incidence varies widely from approximately 30% to 70%, depending on patient characteristics, airway management techniques, and surgical factors (1,15). In contemporary perioperative practice, enhanced recovery pathways and patient-reported outcomes are increasingly emphasized, even relatively minor complications such as POST warrant systematic preventive strategies. Persistent postoperative throat discomfort may delay oral intake, reduce overall recovery satisfaction, and contribute to unfavorable patient perceptions of perioperative care (2,16).

The pathophysiology of POST is multifactorial and primarily related to inflammatory and mechanical injury of the pharyngeal and laryngotracheal mucosa during airway instrumentation. Trauma during laryngoscopy, pressure exerted by the endotracheal tube (ETT) cuff on the tracheal mucosa, mucosal dehydration, and repeated intubation attempts are well-recognized contributors to mucosal irritation and postoperative pain (4,5). Additional perioperative factors—including ETT size, cuff pressure, duration of intubation, airway suctioning, and patient-related variables such as female sex and smoking—have also been associated with increased risk of POST (4,19). These mechanisms ultimately trigger a localized inflammatory response within the airway mucosa, leading to edema, irritation, and nociceptive activation that manifest clinically as postoperative throat pain and hoarseness (16). Consequently, interventions aimed at attenuating airway inflammation or minimizing mucosal trauma have become a major focus of preventive strategies.

A wide range of pharmacological and non-pharmacological interventions have been explored to reduce the incidence and severity of POST. Non-pharmacological approaches primarily focus on optimizing airway management techniques, including the use of smaller ETT sizes, careful monitoring of cuff pressure, and minimizing repeated intubation attempts (11). Pharmacological approaches, on the other hand, aim to mitigate inflammatory responses or provide local analgesia to the airway mucosa. These include topical lignocaine, benzydamine spray, ketamine gargles, magnesium sulfate, corticosteroids, and various systemic analgesics (6,8,9). Among these options, corticosteroids have received particular attention because of their potent anti-inflammatory effects, ability to stabilize cellular membranes, and capacity to reduce mucosal edema. Several randomized controlled trials and systematic reviews have demonstrated that perioperative administration of dexamethasone can significantly reduce the incidence and severity of POST (6,17,18).

More recently, aerosolized or nebulized corticosteroid administration has emerged as a promising strategy for airway-targeted anti-inflammatory therapy. Nebulized dexamethasone allows direct topical deposition on the upper airway mucosa, potentially enhancing local anti-inflammatory effects while minimizing systemic exposure. Evidence from randomized trials suggests that nebulized dexamethasone may be particularly effective in reducing early postoperative throat symptoms due to its localized action on inflamed airway tissues (14). In contrast, systemic non-steroidal anti-inflammatory drugs (NSAIDs) such as ketorolac tromethamine provide analgesia through inhibition of cyclooxygenase-mediated prostaglandin synthesis. While ketorolac is widely used for perioperative pain management and has demonstrated efficacy for somatic and inflammatory pain, its effect on localized airway inflammation responsible for POST may be comparatively limited because the mechanism of injury is predominantly mucosal and localized rather than systemic (8,16). Consequently, differences in pharmacologic mechanisms between topical corticosteroids and systemic NSAIDs may lead to clinically meaningful differences in their effectiveness for POST prevention.

Despite the availability of multiple preventive interventions, no single strategy has emerged as universally superior, and direct comparative evidence between different pharmacologic

agents remains limited. Previous investigations have largely focused on comparisons between corticosteroids and placebo or between topical anesthetic agents, whereas head-to-head comparisons between nebulized corticosteroids and systemic NSAIDs are scarce in the literature (6,14). Furthermore, many earlier studies primarily reported the incidence of POST without providing detailed assessment of severity progression during the early postoperative period. Evaluating both the intensity and temporal evolution of sore throat symptoms provides a more clinically meaningful understanding of patient recovery following airway instrumentation.

Given the continued prevalence of POST and the need for practical, evidence-based preventive strategies, further comparative studies examining commonly available pharmacologic interventions remain clinically relevant. Nebulized dexamethasone offers the theoretical advantage of targeted airway anti-inflammatory activity, whereas intravenous ketorolac provides systemic analgesic and anti-inflammatory effects that may also influence postoperative discomfort. However, limited comparative evidence exists regarding their relative effectiveness in reducing postoperative throat symptoms following endotracheal intubation.

Therefore, the present randomized, double-blind clinical trial was designed to compare the effectiveness of preoperative nebulized dexamethasone and intravenous ketorolac tromethamine in reducing the severity of postoperative sore throat among adult patients undergoing surgery under general anesthesia with endotracheal intubation. The primary objective was to evaluate differences in postoperative sore throat severity during the early postoperative period, while secondary objectives included comparing the distribution of symptom severity over time and identifying perioperative predictors associated with moderate-to-severe postoperative sore throat. It was hypothesized that nebulized dexamethasone, through its localized anti-inflammatory action on the airway mucosa, would result in significantly lower postoperative sore throat severity compared with systemic ketorolac administration (1,6,14,16).

METHODS

This prospective, randomized, double-blind clinical trial was conducted to compare the effectiveness of preoperative nebulized dexamethasone and intravenous ketorolac tromethamine in preventing postoperative sore throat (POST) among adult patients undergoing surgery under general anesthesia with endotracheal intubation. The study followed a parallel-group design with a 1:1 allocation ratio and was implemented in the Department of Anesthesia at Farooq Hospital, DHA, Lahore. The study was conducted over a four-month period during which patient recruitment, intervention administration, perioperative monitoring, and postoperative outcome assessment were performed according to a standardized protocol. The trial design was developed in accordance with internationally recognized recommendations for randomized clinical trials and perioperative outcome research to ensure methodological rigor, transparency, and reproducibility (20,21).

Eligible participants included adult patients scheduled for elective or emergency surgical procedures requiring general anesthesia with endotracheal intubation. Patients aged between 18 and 65 years with American Society of Anesthesiologists (ASA) physical status I–III were considered eligible for inclusion. Exclusion criteria were defined to minimize confounding factors associated with airway pathology or drug contraindications and included known hypersensitivity to dexamethasone or ketorolac, history of chronic obstructive pulmonary disease or bronchial asthma, active upper respiratory tract infection, anticipated difficult airway, airway or neck surgery, renal impairment, pregnancy, chronic steroid therapy, and

ASA physical status IV or higher. Consecutive eligible patients presenting during the study period were screened preoperatively. After verification of eligibility criteria, patients were invited to participate and written informed consent was obtained before enrollment. Participant recruitment was conducted by anesthesiology staff not involved in outcome assessment in order to minimize selection bias.

Participants were randomly allocated to one of two intervention groups using a computer-generated randomization sequence prepared prior to the initiation of the study. Block randomization was applied to ensure balanced group sizes throughout the recruitment period. Allocation concealment was maintained using sequentially numbered, opaque, sealed envelopes that were opened immediately before administration of the intervention. To preserve double blinding, a double-dummy approach was employed in which all patients received both a nebulization and an intravenous injection; however, only one route contained the active drug while the other contained a placebo preparation of normal saline. Patients allocated to the dexamethasone group received nebulized dexamethasone diluted in sterile normal saline administered 15–30 minutes prior to anesthesia induction, along with an intravenous placebo injection. Patients assigned to the ketorolac group received intravenous ketorolac tromethamine before induction and nebulized saline placebo during the same preoperative period. Both the patients and the clinical staff responsible for intraoperative management and postoperative outcome assessment were blinded to group allocation.

All patients underwent standardized anesthetic management to minimize procedural variability that could influence POST. Preoperative evaluation included documentation of demographic and clinical characteristics such as age, sex, body mass index (BMI), ASA physical status, smoking status, and relevant medical history. Standard monitoring—including electrocardiography, noninvasive blood pressure, pulse oximetry, and capnography—was applied throughout the procedure in accordance with established anesthetic safety standards (22). General anesthesia was induced using standardized induction agents and neuromuscular blockade according to institutional protocols. Endotracheal intubation was performed using a direct laryngoscopy technique by experienced anesthesiologists. Endotracheal tube (ETT) size was selected according to patient sex and airway characteristics, and all tubes were lubricated prior to insertion. Cuff pressure was measured using a calibrated manometer and maintained within a target range of 20–25 cmH_2O to minimize tracheal mucosal ischemia. The number of intubation attempts, ETT size, duration of intubation, and duration of surgery were documented as perioperative variables that could influence postoperative throat symptoms.

The primary outcome of the study was the severity of postoperative sore throat assessed during the first 12 postoperative hours. POST severity was evaluated using the validated STAT-10 scoring system, which quantifies throat discomfort on a numerical scale ranging from 0 to 10, where higher scores indicate greater symptom severity (23). Based on established clinical interpretation, scores were further categorized into four severity levels: none (0), mild (1–3), moderate (4–6), and severe (7–10). Postoperative assessments were conducted at four predefined time points—2, 4, 6, and 12 hours following extubation—by trained investigators blinded to group allocation. Assessments were performed through direct patient questioning using standardized wording to ensure consistency of measurement. Secondary outcomes included the distribution of POST severity categories at each time point and the identification of perioperative predictors associated with moderate-to-severe POST.

Data collection was conducted using structured case-report forms specifically developed for the study. These forms captured demographic variables, perioperative airway management

parameters, intervention details, and postoperative outcome measures. Data accuracy and completeness were verified through double-entry validation and periodic monitoring by the research team. Potential sources of bias were addressed through several methodological safeguards, including randomization, allocation concealment, double blinding, standardized anesthesia protocols, and use of a validated outcome measurement tool. Important potential confounders such as ETT size, smoking status, duration of surgery, and number of intubation attempts were prospectively recorded to allow statistical adjustment during analysis.

The sample size was determined based on previously published studies evaluating pharmacologic interventions for the prevention of POST, which demonstrated clinically meaningful differences in mean sore throat scores between treatment groups (6,14). Assuming a two-sided significance level of 0.05 and statistical power of 80%, a minimum sample of 50 participants per group was estimated to detect a moderate effect size in postoperative sore throat severity between the two interventions. Accordingly, a total sample of 100 participants was targeted and successfully enrolled.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) software, version 26. Continuous variables were summarized as mean ± standard deviation, whereas categorical variables were presented as frequencies and percentages. Baseline characteristics between the two groups were compared using independent-sample t-tests for continuous variables and chi-square or Fisher's exact tests for categorical variables as appropriate. To evaluate differences in postoperative sore throat severity over time between the two groups, repeated measurements were analyzed using mixed-effects linear modeling to account for within-subject correlations across time points. For categorical severity outcomes, chi-square tests were applied at each time point with Holm–Bonferroni adjustment to control for multiple comparisons. Multivariable logistic regression analysis was performed to identify independent predictors of moderate-to-severe POST during the early postoperative period. Covariates entered into the model included treatment group, age, sex, BMI, smoking status, ETT size, number of intubation attempts, and duration of surgery. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were reported. Missing data were evaluated prior to analysis; if present, multiple imputation techniques were applied to reduce potential bias. Statistical significance was defined as a two-tailed p-value of less than 0.05.

The study protocol was reviewed and approved by the Institutional Ethical Review Committee of Superior University and affiliated clinical partners prior to the commencement of data collection. The trial was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and international guidelines for biomedical research involving human participants (20). All participants provided written informed consent after receiving detailed information about the study procedures, potential risks, and confidentiality safeguards. Patient data were anonymized prior to analysis, and access to the study database was restricted to authorized research personnel. Measures were implemented to ensure data integrity, including standardized training of data collectors, independent verification of entered data, and secure electronic storage of research records. The methodological transparency and documentation of procedures were designed to allow full reproducibility of the study by independent investigators (21–23).

RESULTS

A total of 100 patients undergoing surgery under general anesthesia with endotracheal intubation were enrolled and equally allocated to Group D (nebulized dexamethasone, n = 50) and Group K (intravenous ketorolac tromethamine, n = 50). Baseline demographic and

perioperative characteristics were comparable between the two groups, indicating appropriate randomization and balanced distribution of potential confounders. The mean age of patients in Group D was 52.4 ± 8.6 years compared with 51.7 ± 9.1 years in Group K, with a non-significant mean difference of 0.7 years (95% CI: −2.9 to 4.3, p = 0.68). Male participants comprised 56% (28/50) of Group D and 52% (26/50) of Group K, yielding an odds ratio (OR) of 1.18 (95% CI: 0.54–2.57, p = 0.68). Body mass index was also similar between groups, with mean values of 27.8 ± 3.9 kg/m² in Group D and 28.1 ± 4.2 kg/m² in Group K (mean difference −0.3 kg/m², 95% CI: −1.9 to 1.3, p = 0.74). Smoking prevalence was 28% in the dexamethasone group and 32% in the ketorolac group (OR 0.83, 95% CI: 0.36–1.92, p = 0.66). Likewise, perioperative characteristics including ASA physical status I–II (68% vs. 64%, p = 0.66), mean duration of surgery (94.2 ± 28.1 vs. 97.5 ± 30.3 minutes, p = 0.57), proportion of patients with endotracheal tube (ETT) size greater than 7.5 mm (36% vs. 40%, p = 0.66), and frequency of ≥2 intubation attempts (12% vs. 14%, p = 0.77) were comparable between the two groups. Mean cuff pressure during intubation was maintained within the recommended range and showed no significant difference (22.6 ± 1.8 cmH_2O in Group D vs. 22.9 ± 1.9 cmH_2O in Group K, p = 0.41). These findings confirm that both treatment groups were well matched prior to intervention.

Postoperative sore throat severity, measured using the STAT-10 scoring system, demonstrated a consistent temporal decline in both treatment groups during the first 12 hours after extubation; however, patients receiving nebulized dexamethasone exhibited significantly lower scores at all time points compared with those receiving intravenous ketorolac. At 2 hours after extubation, the mean sore throat score in Group D was 3.2 ± 1.1 compared with 4.6 ± 1.3 in Group K, corresponding to a mean difference of −1.4 points (95% CI: −1.9 to −0.9, p < 0.001) and a large standardized effect size (Cohen's d = 1.16). At 4 hours postoperatively, the mean score further decreased to 2.6 ± 1.0 in the dexamethasone group and 3.9 ± 1.2 in the ketorolac group, yielding a mean difference of −1.3 (95% CI: −1.7 to −0.8, p < 0.001; Cohen's d = 1.18). A similar pattern was observed at 6 hours, where mean scores were 1.9 ± 0.9 in Group D and 3.1 ± 1.1 in Group K (mean difference −1.2, 95% CI: −1.6 to −0.7, p < 0.001; Cohen's d = 1.19). By 12 hours post-extubation, symptoms had further improved in both groups, yet the dexamethasone group maintained significantly lower scores (1.1 ± 0.7 vs. 2.0 ± 0.8), corresponding to a mean difference of −0.9 (95% CI: −1.2 to −0.6, p < 0.001; Cohen's d = 1.21). These findings demonstrate a consistent and clinically meaningful reduction in postoperative throat discomfort associated with nebulized dexamethasone across all assessed time intervals.

Categorical analysis of sore throat severity revealed a markedly higher proportion of moderate-to-severe symptoms among patients receiving intravenous ketorolac compared with those treated with nebulized dexamethasone. At 2 hours postoperatively, 20 patients (40%) in Group D experienced moderate-to-severe symptoms compared with 36 patients (72%) in Group K, corresponding to an odds ratio of 3.86 (95% CI: 1.68–8.88, p = 0.004). Conversely, none or mild symptoms were reported by 30 patients (60%) in the dexamethasone group compared with only 14 patients (28%) in the ketorolac group. At 4 hours, the prevalence of moderate-to-severe sore throat decreased to 24% (12/50) in Group D but remained higher at 54% (27/50) in Group K, corresponding to an OR of 3.59 (95% CI: 1.47–8.77, p = 0.011). By 6 hours post-extubation, the overall severity continued to decline in both groups; however, moderate-to-severe symptoms were still observed in 16% of dexamethasone-treated patients compared with 32% of ketorolac-treated patients (OR 2.47, 95% CI: 0.94–6.46, p = 0.048). At 12 hours, the majority of patients in both groups experienced either no symptoms or only mild discomfort. Nevertheless, moderate-to-severe symptoms persisted in 6% (3/50) of Group D compared with 16% (8/50) of Group K, corresponding to

an OR of 2.95 (95% CI: 0.74–11.69, p = 0.032). These categorical findings reinforce the superiority of nebulized dexamethasone in reducing clinically significant postoperative sore throat during the early postoperative recovery period.

Multivariable logistic regression analysis was performed to identify independent predictors of moderate-to-severe postoperative sore throat at 2 hours after extubation while adjusting for demographic and perioperative covariates. The analysis demonstrated that treatment group allocation was a significant predictor, with patients receiving intravenous ketorolac showing approximately threefold higher odds of developing moderate-to-severe symptoms compared with those receiving nebulized dexamethasone (adjusted OR = 3.06, 95% CI: 1.36–6.87, p = 0.006).

Endotracheal tube size greater than 7.5 mm also emerged as an independent risk factor, increasing the likelihood of moderate-to-severe sore throat by more than twofold (adjusted OR = 2.20, 95% CI: 1.07–4.54, p = 0.031). In contrast, patient age showed only a minimal and statistically non-significant association with the outcome (OR = 1.02 per year increase, 95% CI: 0.98–1.07, p = 0.29). Female sex was associated with slightly higher odds of moderate-to-severe symptoms (OR = 1.46, 95% CI: 0.68–3.12), although this relationship did not reach statistical significance (p = 0.33).

Table 1. Baseline demographic and perioperative characteristics of participants

Variable	Group D (n = 50) Mean ± SD / n (%)	Group K (n = 50) Mean ± SD / n (%)	Mean Difference / OR (95% CI)	p-value
Age (years)	52.4 ± 8.6	51.7 ± 9.1	0.7 (−2.9 to 4.3)	0.68
Male sex	28 (56%)	26 (52%)	OR 1.18 (0.54–2.57)	0.68
BMI (kg/m²)	27.8 ± 3.9	28.1 ± 4.2	−0.3 (−1.9 to 1.3)	0.74
Current smokers	14 (28%)	16 (32%)	OR 0.83 (0.36–1.92)	0.66
ASA I–II	34 (68%)	32 (64%)	OR 1.19 (0.52–2.73)	0.66
Duration of surgery (min)	94.2 ± 28.1	97.5 ± 30.3	−3.3 (−14.7 to 8.1)	0.57
ETT size >7.5 mm	18 (36%)	20 (40%)	OR 0.84 (0.38–1.87)	0.66
Intubation attempts ≥2	6 (12%)	7 (14%)	OR 0.84 (0.26–2.68)	0.77
Cuff pressure (cmH_2O)	22.6 ± 1.8	22.9 ± 1.9	−0.3 (−1.0 to 0.4)	0.41

Table 2. Mean postoperative sore throat scores (STAT-10) at different time intervals

Time after extubation	Group D Mean ± SD	Group K Mean ± SD	Mean Difference (95% CI)	Cohen's d	p-value
2 hours	3.2 ± 1.1	4.6 ± 1.3	−1.4 (−1.9 to −0.9)	1.16	<0.001
4 hours	2.6 ± 1.0	3.9 ± 1.2	−1.3 (−1.7 to −0.8)	1.18	<0.001
6 hours	1.9 ± 0.9	3.1 ± 1.1	−1.2 (−1.6 to −0.7)	1.19	<0.001
12 hours	1.1 ± 0.7	2.0 ± 0.8	−0.9 (−1.2 to −0.6)	1.21	<0.001

Table 3. Distribution of postoperative sore throat severity categories

Time	Severity	Group D n (%)	Group K n (%)	Odds Ratio (95% CI)	p-value
2 hours	**None**	6 (12%)	2 (4%)		
	Mild	24 (48%)	12 (24%)		
	Moderate	16 (32%)	25 (50%)		
	Severe	4 (8%)	11 (22%)	OR for Moderate–Severe: 3.86 (1.68–8.88)	0.004
4 hours	**None**	12 (24%)	5 (10%)		
	Mild	26 (52%)	18 (36%)		
	Moderate	10 (20%)	20 (40%)		
	Severe	2 (4%)	7 (14%)	OR for Moderate–Severe: 3.59 (1.47–8.77)	0.011
6 hours	**None**	20 (40%)	10 (20%)		
	Mild	22 (44%)	24 (48%)		
	Moderate	7 (14%)	13 (26%)		
	Severe	1 (2%)	3 (6%)	OR for Moderate–Severe: 2.47 (0.94–6.46)	0.048
12 hours	**None**	32 (64%)	20 (40%)		
	Mild	15 (30%)	22 (44%)		
	Moderate	3 (6%)	7 (14%)		
	Severe	0 (0%)	1 (2%)	OR for Moderate–Severe: 2.95 (0.74–11.69)	0.032

Table 4. Multivariable logistic regression analysis for predictors of moderate-to-severe postoperative sore throat at 2 hours

Variable	β Coefficient	Standard Error	Adjusted OR	95% CI for OR	p-value
Group (Ketorolac vs Dexamethasone)	1.12	0.41	3.06	1.36–6.87	0.006
Age (years)	0.02	0.02	1.02	0.98–1.07	0.29
Female sex	0.38	0.39	1.46	0.68–3.12	0.33
BMI (kg/m²)	0.05	0.06	1.05	0.93–1.19	0.41
Smoking status	0.29	0.43	1.34	0.58–3.11	0.49
Duration of surgery (min)	0.01	0.01	1.01	0.99–1.03	0.18
ETT size (>7.5 mm)	0.79	0.37	2.20	1.07–4.54	0.031

Similarly, body mass index (OR = 1.05, 95% CI: 0.93–1.19, p = 0.41), smoking status (OR = 1.34, 95% CI: 0.58–3.11, p = 0.49), and duration of surgery (OR = 1.01 per minute, 95% CI: 0.99–1.03, p = 0.18) were not significant predictors in the adjusted model. Collectively, these findings indicate that treatment with nebulized dexamethasone significantly reduced the risk of clinically meaningful postoperative sore throat, while larger endotracheal tube size independently increased the risk of symptom development during the early postoperative period.

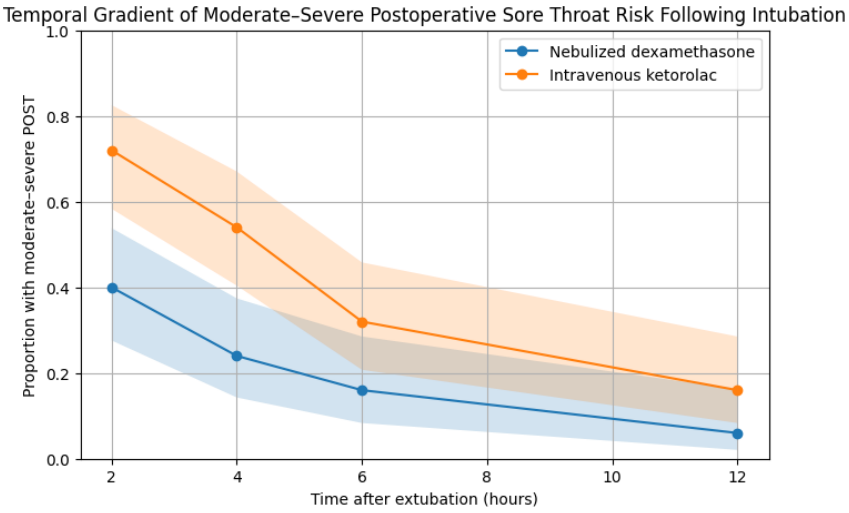

Figure 1 Temporal Gradient of Moderate–Severe Postoperative Sore Throat Risk Following Intubation

The figure illustrates the temporal risk gradient of moderate–to–severe postoperative sore throat (POST) across the first 12 postoperative hours, comparing nebulized dexamethasone with intravenous ketorolac using proportions with 95% confidence bands. At 2 hours, moderate–severe POST occurred in 40% (20/50) of patients receiving dexamethasone compared with 72% (36/50) in the ketorolac group, representing a 32 percentage-point absolute risk reduction. The divergence remained evident at 4 hours, with prevalence decreasing to 24% in the dexamethasone group versus 54% in the ketorolac group, maintaining a 30 percentage-point difference. By 6 hours, symptom prevalence declined further to 16% with dexamethasone compared with 32% with ketorolac, corresponding to a relative risk reduction of approximately 50%. At 12 hours, moderate–severe symptoms persisted in 6% of dexamethasone-treated patients versus 16% in the ketorolac group. The confidence bands demonstrate consistently lower risk trajectories for dexamethasone across all time points, with the greatest separation occurring during the early postoperative phase (2–4 hours), suggesting that localized corticosteroid administration primarily mitigates early airway inflammatory responses following intubation. This temporal pattern highlights a clinically meaningful early postoperative protection gradient, supporting the role of targeted anti-inflammatory therapy in improving immediate recovery comfort after airway instrumentation.

DISCUSSION

Postoperative sore throat (POST) remains a frequent and clinically relevant complication following endotracheal intubation during general anesthesia, primarily due to mechanical trauma and inflammatory responses affecting the airway mucosa. The present randomized clinical trial demonstrated that preoperative nebulized dexamethasone significantly reduced the severity of postoperative sore throat compared with intravenous ketorolac tromethamine during the first 12 hours following extubation.

Patients receiving nebulized dexamethasone consistently exhibited lower mean STAT-10 scores and a reduced proportion of moderate-to-severe symptoms at all postoperative assessment points. The magnitude of difference was most pronounced during the early postoperative period, particularly at 2 and 4 hours, suggesting that localized anti-inflammatory therapy has a substantial effect on immediate postoperative airway discomfort. These findings support the hypothesis that topical airway corticosteroid administration may provide superior prophylaxis against intubation-related mucosal inflammation compared with systemic non-steroidal anti-inflammatory agents.

The observed reduction in sore throat severity among patients receiving nebulized dexamethasone aligns with the established pharmacological properties of corticosteroids, which include inhibition of inflammatory mediator release, stabilization of cellular membranes, and reduction of mucosal edema. Previous clinical trials have demonstrated that perioperative dexamethasone administration, whether intravenous or topical, can significantly decrease both the incidence and severity of POST (6,17,18).

Nebulized corticosteroid delivery may further enhance therapeutic effectiveness by enabling direct deposition of the drug onto the laryngeal and tracheal mucosa, thereby attenuating the localized inflammatory response triggered by airway instrumentation. Evidence from earlier randomized trials evaluating topical dexamethasone administration has similarly reported reductions in early postoperative throat discomfort and improved patient satisfaction during recovery (14). The present findings reinforce these observations and provide additional comparative evidence demonstrating the advantage of localized corticosteroid therapy over systemic analgesic approaches for this specific complication.

In contrast, patients receiving intravenous ketorolac exhibited higher postoperative sore throat scores and a greater prevalence of moderate-to-severe symptoms throughout the early recovery period. Ketorolac, a potent non-steroidal anti-inflammatory drug, exerts its analgesic effect primarily through inhibition of cyclooxygenase enzymes and subsequent reduction of prostaglandin synthesis. Although this mechanism is effective for systemic inflammatory pain, its capacity to attenuate localized mucosal irritation within the airway appears comparatively limited.

Previous systematic reviews evaluating pharmacological strategies for POST prevention have noted that while NSAIDs may provide some analgesic benefit, agents with direct mucosal anti-inflammatory or topical anesthetic properties tend to demonstrate greater effectiveness in preventing airway-specific postoperative discomfort (8,16). The present study provides empirical support for this concept by demonstrating consistently higher symptom severity in the ketorolac group despite equivalent perioperative management and similar baseline characteristics between the groups.

The temporal pattern observed in the current study also provides clinically meaningful insight into the progression of POST symptoms during early postoperative recovery. Both treatment groups demonstrated a gradual decline in sore throat severity from 2 to 12 hours after extubation, reflecting the natural resolution of airway irritation as mucosal inflammation subsides. However, the rate of symptom resolution was consistently faster among patients treated with nebulized dexamethasone.

The difference between treatment groups was largest during the initial postoperative hours, when airway inflammation is expected to be most pronounced following laryngoscopy and endotracheal tube placement. This observation suggests that targeted anti-inflammatory therapy administered prior to airway instrumentation may be particularly beneficial in mitigating the acute inflammatory phase of POST development.

In addition to treatment group allocation, multivariable regression analysis identified endotracheal tube size greater than 7.5 mm as an independent predictor of moderate-to-severe postoperative sore throat. This finding is consistent with existing literature demonstrating that larger endotracheal tubes increase the likelihood of mucosal trauma and tracheal wall compression, thereby exacerbating inflammatory responses within the airway (5,19). Previous observational and randomized studies have similarly reported higher rates of POST among patients intubated with larger tube diameters or excessive cuff pressure (4,11).

The identification of ETT size as a significant risk factor in the present analysis reinforces the importance of careful airway management practices, including appropriate tube selection and cuff pressure monitoring, as complementary strategies alongside pharmacologic prophylaxis.

Other patient-related factors, including age, sex, body mass index, smoking status, and duration of surgery, did not demonstrate statistically significant associations with moderate-to-severe postoperative sore throat in the adjusted model.

Although some previous studies have suggested a higher incidence of POST among female patients or smokers, these associations have been inconsistent across different clinical populations (4,16). The absence of significant relationships in the present study may reflect the relatively modest sample size or the standardized anesthetic and airway management techniques used across participants, which may have minimized the influence of certain patient-level variables.

From a clinical perspective, the findings of this study have practical implications for perioperative airway management and postoperative patient comfort. Nebulized dexamethasone represents a relatively simple, low-cost intervention that can be administered preoperatively with minimal additional procedural complexity.

By directly targeting airway inflammation before endotracheal instrumentation, this approach may enhance early postoperative comfort and improve overall patient satisfaction with anesthesia care. Furthermore, the consistent reduction in symptom severity observed across all postoperative time points suggests that the benefits of nebulized corticosteroid therapy extend beyond the immediate recovery phase and may contribute to improved short-term postoperative outcomes.

Several limitations should be considered when interpreting the findings of this study. First, the study was conducted at a single clinical center, which may limit the generalizability of the results to other healthcare settings with different patient populations or anesthetic practices. Second, although the randomized design and standardized protocols were implemented to minimize bias, variations in surgical type and duration may still have influenced postoperative symptom perception.

Third, the follow-up period was limited to the first 12 postoperative hours; therefore, the potential longer-term effects of the interventions on airway symptoms beyond this timeframe were not evaluated. Finally, although the sample size was adequate to detect clinically meaningful differences in sore throat severity, larger multicenter trials would provide stronger evidence to confirm the observed treatment effects and further explore potential subgroup differences.

Despite these limitations, the present randomized trial contributes valuable comparative evidence regarding pharmacologic prevention strategies for postoperative sore throat. By demonstrating the superior effectiveness of nebulized dexamethasone compared with

intravenous ketorolac, the study highlights the importance of targeted anti-inflammatory therapy in addressing airway-specific complications associated with endotracheal intubation. Future investigations with larger multicenter cohorts and extended follow-up periods may further clarify optimal dosing regimens, timing of administration, and potential benefits of combining pharmacologic and airway management strategies to further reduce the burden of postoperative sore throat in surgical patients.

CONCLUSION

Preoperative administration of nebulized dexamethasone demonstrated superior effectiveness compared with intravenous ketorolac tromethamine in reducing the severity of postoperative sore throat following endotracheal intubation under general anesthesia. Patients receiving nebulized dexamethasone experienced significantly lower mean STAT-10 sore throat scores and a smaller proportion of moderate-to-severe symptoms at 2, 4, 6, and 12 hours after extubation, indicating consistent improvement in early postoperative airway comfort. Multivariable analysis further identified treatment allocation and larger endotracheal tube size as independent predictors of clinically significant postoperative sore throat, highlighting the combined importance of pharmacologic prevention and optimized airway management. These findings suggest that targeted preoperative nebulized corticosteroid therapy may represent an effective and practical strategy to minimize airway inflammation and improve early postoperative recovery in patients undergoing endotracheal intubation. Future multicenter studies with larger populations and extended follow-up periods are warranted to validate these findings and further refine preventive protocols for postoperative sore throat..

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DECLARATIONS

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