Original Article

Effect of Simulated Mouth Breathing on Emergence Agitation After Nasal Surgeries

Saad Rasool[1], Muhammad Hussan Farooq[2] and Sana Mustafa[3]

ABSTRACT

Objective: To evaluate the effectiveness of preoperative simulated mouth-breathing training in reducing the severity and incidence of emergence agitation among adult patients undergoing nasal surgery under general anesthesia

Study Design: Randomized controlled trial study

Place and Duration of Study: This study was conducted at the Department of Anesthesiology and Pain Medicine, Shifa International Hospital, Islamabad, from 1st October 2025 till 31st March 2026.

Methodology: The trial included 180 adults aged 18–65 years with ASA physical status I–II undergoing sinonasal surgery with nasal packing. Ninety patients received simulated mouth-breathing training at three preoperative time points and 90 received standard preoperative care. Richmond Agitation-Sedation Scale (RASS) scores were recorded at extubation and 15 and 30 minutes later.

Results: Mean RASS scores were lower with mouth-breathing training at extubation (1.02±0.85 vs 1.32±0.99), 15 minutes (0.99±0.99 vs 1.37±1.15), and 30 minutes (0.66±0.77 vs 1.04±0.95). The overall mixed-model treatment effect was −0.36 RASS points (95% CI −0.56 to −0.15; p<0.001), with no treatment-by-time interaction (p=0.845). EA at 15 and 30 minutes was less frequent in the intervention group. However, the proportion experiencing at least one EA episode during the full 30-minute period was 51.1% versus 61.1% (RR 0.84, 95% CI 0.64–1.09; p=0.176).

Conclusion: Preoperative simulated mouth-breathing training reduced the severity of emergence agitation and the repeated probability of agitation during early recovery. It did not significantly reduce the proportion of patients who experienced at least one EA episode.

Key Words: emergence agitation; mouth breathing; sinonasal surgery; RASS; preoperative education.

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INTRODUCTION

During recovery from general anaesthesia, some adults develop a short period of restlessness, disorientation, or non-purposeful movement.[1] This is commonly described as emergence agitation (EA).[2] Reported rates vary considerably because studies use different populations, observation windows, and diagnostic thresholds.[3] Although often brief, EA can disrupt recovery and may result in self-injury, removal of lines or tubes, bleeding, greater staff workload, and other postoperative problems.[4] The issue is especially relevant in nasal and other ENT procedures.[5] Several factors may contribute, including pain, younger age, smoking, airway instrumentation, and volatile anesthesia.[6] Nasal packing adds another feature that is specific to these operations: the patient wakes unable to breathe normally through the nose and must immediately switch to oral breathing. While still emerging from anaesthesia, that unfamiliar sensation may be interpreted as obstruction or suffocation.[7,8]

Preventive strategies therefore span more than one approach. Dexmedetomidine, butorphanol, propofol-based total intravenous anaesthesia, and deep extubation have all been studied as ways of reducing EA.[9] Non-pharmacological methods are attractive for a different reason: they do not add sedative or haemodynamic effects. Previous studies have explored nasal compression, nasal splinting, and preoperative familiarization with mouth breathing.[10,11]

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METHODOLOGY

This randomized controlled trial was conducted in the Department of Anaesthesiology and Pain Medicine, Shifa International Hospital, Islamabad from 1st October 2025 till 31st March 2026. A total of 180 patients were enrolled using non-probability consecutive sampling and randomly allocated into two equal groups through the lottery method. Group A comprised 90 patients who received preoperative simulated mouth-breathing training, while Group B included 90 patients who received standard preoperative care. Patients aged 18–65 years, of either sex, with American Society of Anesthesiologists (ASA) physical status I or II, who were scheduled to undergo sinonasal surgery under general anesthesia with planned postoperative nasal packing, were included. Eligible surgical procedures included septoplasty, septorhinoplasty, turbinate reduction, and functional endoscopic sinus surgery (FESS). Patients with pre-existing psychiatric or neurological disorders, those receiving psychotropic medications, and patients unable to understand Urdu, Pashto, Punjabi, or English were excluded. Patients with ASA physical status III or higher, those undergoing procedures without postoperative nasal packing, and individuals who declined informed consent were also excluded.

Data Collection: Following institutional ethical approval, eligible patients were assessed according to the predefined inclusion and exclusion criteria. Written informed consent was obtained before enrollment. Participants were randomly allocated in a 1:1 ratio to the intervention or control group using the lottery method. Both groups received routine preoperative counseling regarding anesthesia, surgical procedures, and perioperative care. In addition to standard counseling, patients in Group A underwent simulated mouth-breathing training at three predefined intervals: during the pre-anesthesia assessment clinic visit, on the night before surgery, and during transfer to the operating room. During each training session, nasal airflow was temporarily obstructed using a swimmer's nasal clip, and patients were instructed to breathe through the mouth to become familiar with the sensation of nasal obstruction. Patients in Group B received standard preoperative care without simulated nasal obstruction or mouth-breathing training. A standardized general anesthesia protocol was followed for all participants. Routine intraoperative monitoring included electrocardiography, non-invasive blood pressure measurement, and pulse oximetry. Anesthesia was induced using intravenous midazolam 1.5 mg, nalbuphine 0.1 mg/kg, atracurium 0.6 mg/kg, and propofol 2 mg/kg, followed by endotracheal intubation. Anesthesia was maintained using sevoflurane at approximately 1.8% volume, with supplemental atracurium 0.1 mg/kg administered as required. Intravenous paracetamol was administered for perioperative analgesia at a dose of 1 g in patients weighing more than 50 kg and 15 mg/kg in those weighing less than 50 kg. At the completion of surgery, neuromuscular blockade was reversed using neostigmine and glycopyrrolate under train-of-four monitoring. Endotracheal extubation was performed after fulfillment of predefined clinical recovery criteria.

Assessment of Emergence Agitation: Emergence agitation was assessed using the Richmond Agitation-Sedation Scale (RASS). Scores were recorded immediately after extubation and subsequently at 15 and 30 minutes during early postoperative recovery. The primary outcome was the severity of emergence agitation, assessed through RASS scores across the three measurement intervals. Emergence agitation was operationally defined as a RASS score of $\geq+2$. Secondary outcomes included the proportion of patients developing emergence agitation at each assessment, the proportion experiencing at least one episode of agitation during the 30-minute observation period, the requirement for clinical intervention, and the duration of stay in the post-anesthesia care unit (PACU).

Statistical Analysis: Data were analyzed using Python version 3.13 with the pandas, SciPy, and statsmodels libraries. Continuous variables with approximately symmetric distributions were expressed as mean ± standard deviation, while skewed variables were presented as median with interquartile range (IQR). Between-group comparisons of normally distributed continuous variables were performed using the independent-samples t-test, whereas the Mann–Whitney U test was applied to skewed variables. Repeated binary emergence-agitation outcomes were analyzed using generalized estimating equations (GEE) with a modified Poisson model and robust standard errors. Treatment effects were expressed as risk ratios with 95% confidence intervals. The proportion of patients experiencing at least one agitation episode during the 30-minute observation period was analyzed separately at the patient level. All statistical tests were two-sided, and a p-value ≤ 0.05 was considered statistically significant.

RESULTS

All 180 randomized patients were included in the final analysis, with 90 patients in each group. RASS data were complete at all three assessment times. Age, sex, BMI, ASA physical status, and overall comorbidity burden were similar between groups. FESS was more frequent in the control group (62.2% vs 45.6%; Pearson chi-square p=0.025). Surgery duration also tended to be longer in controls, with a median of 140.5 minutes (IQR 91.0-165.8) compared with 123.0 minutes (IQR 80.3-143.8) in the intervention group (Mann-Whitney U p=0.057; standardized mean difference approximately 0.32) (Table 1).

RASS scores were lower in the mouth-breathing group at each scheduled assessment. At extubation the mean score was 1.02±0.85 compared with 1.32±0.99 in controls. The difference remained present at 15 minutes and 30 minutes. In the random-intercept mixed model, the average treatment effect across the three assessments was −0.36 RASS points (95% CI −0.56 to −0.15; p<0.001) (Table 2, Fig 1).

The primary finding was robust to alternative analysis. Gaussian GEE gave an almost identical treatment estimate (mean difference −0.36, 95% CI −0.56 to −0.15; p<0.001). When RASS was treated as an ordinal outcome, the odds of occupying a higher RASS category were also lower with training (OR 0.49, 95% CI 0.33–0.74; p<0.001). Adjustment for FESS and duration of surgery produced a similar mixed-model effect (adjusted mean difference −0.32, 95% CI −0.52 to −0.11; p=0.003).

EA defined as RASS ≥+2 occurred less often in the intervention group at each time point. The difference was not statistically significant at extubation, but was significant at 15 and 30 minutes. When EA was summarized as whether a patient experienced at least one episode during the entire observation period, 46/90 (51.1%) intervention patients and 55/90 (61.1%) controls met the definition (RR 0.84, 95% CI 0.64–1.09; p=0.176) (Table 3, Fig 2).

Table No. 1: Baseline demographic and perioperative characteristics

Characteristic	Mouth-breathing training (n=90)	Control (n=90)	p-value
Age, years	34.5 ± 12.4	35.6 ± 12.3	0.571
Male sex, n (%)	60 (66.7)	56 (62.2)	0.533
BMI, kg/m²	26.5 ± 5.3	26.8 ± 4.9	0.705
ASA II, n (%)	44 (48.9)	49 (54.4)	0.456
Any recorded comorbidity, n (%)	45 (50.0)	47 (52.2)	0.766
FESS included, n (%)	41 (45.6)	56 (62.2)	0.025
Septoplasty included, n (%)	67 (74.4)	72 (80.0)	0.374
Turbinate reduction, n (%)	60 (66.7)	57 (63.3)	0.639
Duration of surgery, min, median (IQR)	123.0 (80.3-143.8)	140.5 (91.0-165.8)	0.057

Table No. 2: RASS scores and treatment effects

Assessment	Mouth-breathing training	Control	Mean difference (95% CI)	Hedges g	p-value
Extubation	1.02 ± 0.85	1.32 ± 0.99	−0.30 (−0.58 to −0.02)	−0.32	0.035
15 minutes	0.99 ± 0.99	1.37 ± 1.15	−0.38 (−0.66 to −0.10)	−0.35	0.008
30 minutes	0.66 ± 0.77	1.04 ± 0.95	−0.39 (−0.67 to −0.11)	−0.45	0.006
Overall mixed-model effect	—	—	−0.36 (−0.56 to −0.15)	—	<0.001

Table No. 3: Emergence agitation, intervention requirement and PACU duration

Outcome	Mouth-breathing training	Control	Effect estimate (95% CI)	p-value
EA at extubation	27/90 (30.0%)	38/90 (42.2%)	RR 0.71 (0.48–1.06)	0.088
EA at 15 minutes	21/90 (23.3%)	36/90 (40.0%)	RR 0.58 (0.37–0.92)	0.016
EA at 30 minutes	14/90 (15.6%)	26/90 (28.9%)	RR 0.54 (0.30–0.96)	0.031
Any EA, 0–30 min	46/90 (51.1%)	55/90 (61.1%)	RR 0.84 (0.64–1.09)	0.176
Recorded intervention	6/90 (6.7%)	14/90 (15.6%)	RR 0.43 (0.17–1.07)	0.058
PACU duration, min, median (IQR)	35 (30–40)	35 (35–40)	—	0.142

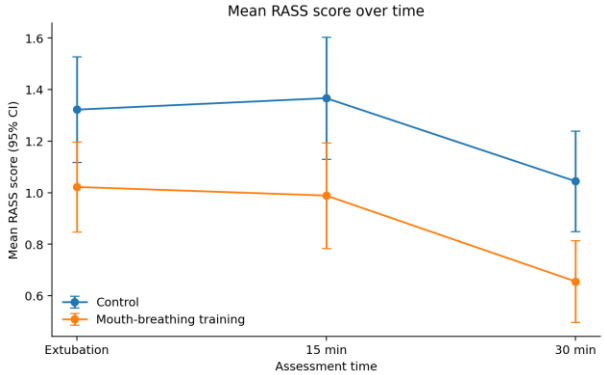


Figure No. 1: Mean RASS score at extubation, 15 minutes, and 30 minutes. Error bars represent 95% confidence intervals.

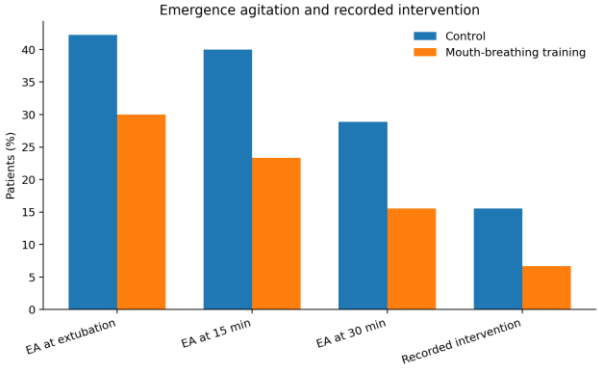


Figure No. 2: Proportion of patients meeting RASS ≥+2 at each assessment and proportion with a recorded intervention.

DISCUSSION

The present randomized controlled trial evaluated the effectiveness of preoperative simulated mouth-breathing training in reducing emergence agitation among adult patients undergoing sinonasal surgery under general anesthesia. The findings demonstrated that patients receiving simulated mouth-breathing training had significantly lower Richmond Agitation-Sedation Scale (RASS) scores during the first 30 minutes following extubation compared with those receiving standard preoperative care. The overall treatment effect was significant, indicating that preoperative familiarization with mouth breathing may reduce the severity of emergence agitation. However, although the frequency of agitation was lower at individual postoperative assessments, the proportion of patients experiencing at least one episode during the observation period did not differ significantly between the groups. This pattern is compatible with the earlier randomized study by Xu et al[10], which combined nasal splinting with mouth-breathing training and reported emergence delirium in 16.3% of the intervention group compared with 35.6% of controls after endoscopic sinus surgery. The absolute rates are not directly transferable because the intervention and agitation scale were different. Even so, the direction of effect is similar. Kumari and Agrawal[11] also reported benefit from preoperative external nasal compression, and a network meta-analysis of 17 randomized trials involving 2,122 patients found that both pharmacological and non-pharmacological strategies can reduce EA after nasal surgery.[12] The common thread across these approaches may be preparation for the sensation of postoperative nasal blockage.

The cumulative frequency of EA in our cohort was high, but this should be interpreted alongside the way the outcome was measured. Adult studies report widely different rates depending on the scale, threshold, and duration of observation, while nasal and ENT procedures are consistently represented among higher-risk groups.[3-8] Kim et al. reported 22.2% after nasal surgery using a lower threshold of RASS $\geq$+1 and identified younger age, recent smoking, sevoflurane, postoperative pain, and airway or urinary devices as risk factors.[13] We used RASS $\geq$+2 but observed patients on three occasions over 30 minutes. A cumulative endpoint that counts an episode at any of those assessments will naturally be higher than a single-time-point estimate. Pharmacological prophylaxis remains an important comparator. Dexmedetomidine has been studied extensively in nasal surgery: one randomized trial reduced agitation from 52% to 28% with intraoperative infusion, and a 2025 meta-analysis of nine trials also found a protective effect.[14] Preoperative intranasal dexmedetomidine has shown similar benefit in adult ENT surgery.[15] Butorphanol has also reduced EA after FESS, although delayed spontaneous breathing, verbal response, and extubation were reported.[16] These options may produce stronger binary effects than a behavioral intervention, but they also introduce drug-related consequences. Simulated mouth-breathing training is better viewed as an additional low-risk measure, not as a substitute for pharmacological treatment when that is otherwise indicated. The background anaesthetic technique is another relevant factor. Propofol-based total intravenous anaesthesia has produced less emergence agitation than volatile maintenance after nasal surgery[17], a finding supported by meta-analysis.[18] Deep extubation has also been associated with less EA than awake extubation in a recent randomized trial.[19] Our protocol used sevoflurane in both groups. This standardization strengthens the internal group comparison, but it may also have raised the overall frequency of agitation and limits direct extrapolation to pathways based on TIVA or different extubation strategies. An important practical implication of the study is the feasibility of implementing simulated mouth-breathing training in routine preoperative care. The intervention required only a swimmer's nasal clip, brief instructional sessions, and patient cooperation. It was administered at three preoperative time points without additional pharmacological treatment. In resource-limited healthcare settings, including many hospitals in Pakistan, inexpensive interventions that improve the quality of postoperative recovery may be particularly valuable. Preoperative education can be integrated into anesthesia assessment and nursing counseling without requiring specialized equipment or major changes to surgical protocols.

This study had several limitations. First, it was conducted at a single tertiary-care hospital with a sample size of 180 patients, which may limit the generalizability of the findings to other healthcare settings and surgical populations. Second, the study included only adults with ASA physical status I–II undergoing sinonasal surgery with postoperative nasal packing; therefore, the findings may not be applicable to patients with more severe systemic diseases or those undergoing procedures without nasal packing. Third, although randomization was performed, functional endoscopic sinus surgery was more frequent in the control group, and surgical duration tended to be longer, potentially influencing postoperative agitation despite statistical adjustment. Fourth, emergence agitation was assessed using the Richmond Agitation-Sedation Scale, which measures agitation and sedation but does not specifically distinguish emergence delirium from agitation caused by pain, anxiety, or respiratory discomfort. Larger multicenter randomized trials with standardized assessments of pain, anxiety, postoperative complications, and longer follow-up are recommended to confirm these findings.

CONCLUSION

Preoperative simulated mouth-breathing training was associated with lower RASS scores during the first 30 minutes after sinonasal surgery and with less agitation across repeated assessments. It did not demonstrate a

statistically significant reduction in the proportion of patients who experienced at least one RASS ≥+2 episode. As a brief, low-cost intervention without additional drug exposure, it may be a useful adjunct for improving the quality of emergence after nasal surgery.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Saad Rasool, Muhammad Hussan Farooq
Drafting or Revising Critically:	Saad Rasool, Sana Mustafa
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

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