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Hypertonic versus Isotonic Saline Nasal Irrigation After Medial Maxillectomy: A Prospective Randomized Controlled Trial

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ABSTRACT: **Introduction**: Saline nasal irrigation is routinely recommended after sinonasal surgery, but evidence comparing isotonic and hypertonic saline after medial maxillectomy remains limited.

Aim: To compare isotonic saline (0.9% NaCl), hypertonic saline (3% NaCl), and no nasal irrigation for postoperative symptom recovery and endoscopic wound healing. Methods: In this prospective randomized controlled trial, 84 patients undergoing medial maxillectomy were randomly allocated to isotonic saline irrigation (n = 28), hypertonic saline irrigation (n = 28), or no nasal irrigation (n = 28). Sinonasal symptoms were assessed using the Nasal Obstruction Symptom Evaluation (NOSE) questionnaire before surgery and on postoperative days 8, 10, 12, and 14. Endoscopic wound healing was assessed serially, and mucociliary clearance was evaluated using the saccharin transit test. Longitudinal changes were analyzed using mixed repeated-measures analysis of variance with Bonferroni post hoc comparisons.

Results: All groups improved during follow-up. Mixed repeated-measures ANOVA showed a significant effect of time ($F = 557.835$, $p < 0.001$) and a significant time-by-treatment interaction ($F = 12.917$, $p < 0.001$) for NOSE scores. The hypertonic saline group had the greatest reduction in NOSE scores and the most favorable endoscopic healing scores. Saccharin transit times also differed significantly among groups for both nasal cavities (both $p < 0.001$).

Conclusion: Hypertonic saline irrigation was associated with better early postoperative symptom scores, endoscopic healing, and mucociliary clearance than isotonic saline or no irrigation after medial maxillectomy.

INTRODUCTION

Sinonasal tumors are a heterogeneous group of benign and malignant neoplasms that often require surgical resection because of their locally aggressive behavior and proximity to critical structures, including the orbit and skull base (1). Endoscopic medial maxillectomy has become an established surgical approach for lesions involving the lateral nasal wall and maxillary sinus, providing adequate tumor exposure while preserving cosmetic appearance and nasal function (1,2). However, this procedure inevitably causes extensive mucosal injury that initiates a wound-healing process characterized by inflammation, edema, crust formation, and temporary impairment of mucociliary function (2).

Mucociliary clearance is the primary defense mechanism of the sinonasal mucosa, responsible for removing mucus, microorganisms, and inflammatory debris through coordinated ciliary activity. Surgical trauma disrupts this mechanism by damaging the respiratory epithelium, increasing mucus retention, and delaying epithelial regeneration, thereby prolonging postoperative recovery and increasing the risk of infection and synechiae formation (3,4). Therefore, effective postoperative care is essential to promote mucosal healing and restore normal sinonasal physiology.

Nasal saline irrigation is widely recommended as an adjunctive postoperative therapy because it mechanically removes blood clots, crusts, retained secretions, and inflammatory mediators while maintaining mucosal hydration and improving mucociliary clearance (4,5). Isotonic saline primarily provides mechanical cleansing and preserves physiological hydration, whereas hypertonic saline may further reduce mucosal edema through osmotic effects and improve mucus transport (3,5). Despite its widespread use, the optimal saline concentration for postoperative nasal irrigation remains uncertain.

Recent evidence supports the beneficial role of nasal irrigation after sinonasal surgery. A systematic review by Chitsuthipakorn et al. (5) concluded that high-volume saline irrigation is effective in improving postoperative sinonasal care, although evidence regarding the optimal irrigation regimen remains heterogeneous. Similarly, Verma and Verma (4) emphasized that nasal irrigation has become a standard component of postoperative management because of its role in facilitating mucosal healing and improving patient comfort. Furthermore, a systematic review and meta-analysis by Gnanasekaran et al. (6) demonstrated that postoperative nasal irrigation significantly improves endoscopic healing and symptom recovery following functional endoscopic sinus surgery (FESS). Lima et al. (7) also reported that hypertonic saline may provide additional benefits in reducing postoperative crusting and improving mucosal healing compared with isotonic saline after FESS.

However, most available evidence has been derived from patients undergoing FESS for chronic rhinosinusitis rather than medial maxillectomy for sinonasal tumors (6,7). Because medial maxillectomy involves more extensive mucosal resection and larger postoperative cavities, wound healing and postoperative recovery may differ substantially from those observed after routine endoscopic sinus surgery (1,2). Consequently, the optimal postoperative irrigation strategy for patients undergoing medial maxillectomy remains unclear.

Postoperative recovery should be assessed using both subjective and objective outcome measures. The Nasal Obstruction Symptom Evaluation (NOSE) questionnaire provides a validated assessment of patient-reported nasal obstruction, whereas nasal endoscopy allows direct evaluation of mucosal healing, crust formation, edema, and retained secretions. In addition, the saccharin transit test objectively measures mucociliary clearance, providing complementary information regarding restoration of nasal physiological function (6,8).

Therefore, this prospective randomized study aimed to compare the effectiveness of isotonic saline (0.9% NaCl), hypertonic saline (3% NaCl), and no nasal irrigation following medial maxillectomy. Postoperative outcomes were evaluated using serial NOSE scores, endoscopic wound-healing assessment, and saccharin transit time to identify the most effective irrigation strategy for promoting mucosal healing and functional recovery.

METHODS

Study Design

This prospective randomized controlled study was conducted to compare the effectiveness of isotonic saline irrigation, hypertonic saline irrigation, and no nasal irrigation on postoperative recovery following medial maxillectomy. The study was conducted at xxxx between October 2025 and April 2026.

Study Population and Sampling

Patients diagnosed with sinonasal tumors who underwent medial maxillectomy during the study period were consecutively recruited and screened for eligibility. Patients who fulfilled the inclusion criteria were randomly allocated into three postoperative treatment groups: isotonic saline irrigation (0.9% NaCl), hypertonic saline irrigation (3% NaCl), and a control group receiving standard postoperative care without nasal irrigation.

The inclusion criteria were patients aged ≥18 years, diagnosed with benign or malignant sinonasal tumors requiring medial maxillectomy, willing to participate, and able to complete all scheduled postoperative evaluations. Patients with previous

sinonasal surgery, severe systemic diseases affecting wound healing, active sinonasal infection requiring additional intervention, incomplete follow-up, or incomplete clinical data were excluded from the study.

Only patients who completed all postoperative assessments until postoperative day 14 were included in the final analysis.

Randomization

Eligible participants were randomly assigned in a 1:1:1 ratio to the isotonic saline, hypertonic saline, or control group using a computer-generated randomization sequence prepared by an investigator who was not involved in patient recruitment or outcome assessment. Allocation concealment was ensured using sequentially numbered, opaque, sealed envelopes that were opened only after patient enrollment and completion of surgery.

Variables

The primary outcomes were postoperative nasal obstruction assessed using the Nasal Obstruction Symptom Evaluation (NOSE) questionnaire and mucosal wound healing evaluated by nasal endoscopy. Secondary outcomes included mucociliary clearance assessed using the saccharin transit test and serial changes in postoperative recovery over time.

Bias

Selection bias was minimized through consecutive patient recruitment, computer-generated randomization, and allocation concealment using sequentially numbered, opaque, sealed envelopes. Measurement bias was minimized by standardized assessment protocols and validated outcome instruments.

Study Size

Because this was a prospective randomized controlled study, all eligible patients who met the inclusion criteria during the study period were enrolled. Eighty-four patients completed the study and were equally distributed among the three treatment groups, with 28 patients in each group.

Quantitative Variables

NOSE scores, endoscopic healing scores, and saccharin transit times were analyzed as continuous variables. Continuous variables were summarized as mean ± standard deviation (SD), whereas categorical variables were presented as frequencies and percentages.

Intervention

Following medial maxillectomy, patients received one of three postoperative treatment protocols:

Isotonic saline group: nasal irrigation using 0.9% sodium chloride solution.

Hypertonic saline group: nasal irrigation using 3% sodium chloride solution.

Control group: routine postoperative care without nasal irrigation.

All patients received identical postoperative medications and follow-up according to the institutional treatment protocol. Nasal irrigation was initiated according to the standard postoperative schedule and continued throughout the follow-up period.

Outcome Assessment

Nasal Obstruction Assessment

Subjective nasal obstruction was evaluated using the Nasal Obstruction Symptom Evaluation (NOSE) questionnaire. Patients completed the questionnaire before surgery and on postoperative days 8, 10, 12, and 14. Higher NOSE scores indicated greater severity of nasal obstruction.

Endoscopic Wound-Healing Assessment

Postoperative mucosal healing was assessed by rigid nasal endoscopy performed by experienced otolaryngologists. Endoscopic evaluation included the presence of retained secretions, blood clots, crust formation, and overall mucosal healing. Assessments were performed before surgery and on postoperative days 8, 10, 12, and 14 using standardized evaluation criteria.

Natural Resources for Human Health
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Mucociliary Clearance Assessment

Mucociliary function was evaluated using the saccharin transit test before surgery and at the final postoperative assessment. Saccharin transit time was recorded in minutes, with shorter transit times indicating better mucociliary clearance.

Surgical Procedure

All medial maxillectomy procedures were performed by experienced rhinology surgeons at Dr. Wahidin Sudirohusodo Hospital, Makassar, Indonesia following standardized institutional surgical protocols. The surgical approach was determined according to tumor location and extent while preserving surrounding anatomical structures whenever oncologically feasible. Postoperative care was standardized across all treatment groups except for the assigned nasal irrigation intervention.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were presented as frequencies and percentages. Normality was assessed using the Shapiro–Wilk test, and homogeneity of variance was evaluated using Levene's test.

Baseline characteristics among groups were compared using one-way analysis of variance (ANOVA) for continuous variables and the Chi-square test or Fisher's exact test for categorical variables, as appropriate.

Serial postoperative changes in NOSE scores and endoscopic wound-healing scores were analyzed using mixed repeated-measures analysis of variance (Mixed Repeated-Measures ANOVA) to evaluate the effects of time, treatment group, and the interaction between time and treatment. When significant differences were identified, pairwise comparisons were performed using the Bonferroni post hoc test. A two-sided p-value <0.05 was considered statistically significant.

Ethical Considerations

The study protocol was approved by the Health Research Ethics Committee of the Faculty of Medicine, Hasanuddin University, Makassar, Indonesia (Approval No. 26050574). Written informed consent was obtained from all participants before enrolment. All procedures were conducted in accordance with the Declaration of Helsinki, and patient confidentiality was strictly maintained throughout the study.

RESULTS

Participants

A total of 90 patients undergoing medial maxillectomy were screened for eligibility. Six patients were excluded, leaving 84 patients who were randomly allocated into three groups: isotonic saline irrigation (0.9% NaCl, n=28), hypertonic saline irrigation (3% NaCl, n=28), and a control group without nasal irrigation (n=28). All participants completed the scheduled postoperative assessments and were included in the final analysis.

Baseline Characteristics

The baseline characteristics are summarized in Table 1. The largest age group was 40–59 years (44.0%), followed by patients aged ≥60 years (27.4%) and those aged 18–39 years (28.6%). Male participants accounted for 55.3% of the study population, while 73.8% of patients were employed.

Table 1. Baseline Characteristics of the Study Participants (n = 84)

Characteristics	n	%
Age (years)		
18–39	24	28.6
40–59	37	44.0
≥60	23	27.4

Natural Resources for Human Health
eISSN: 2583-1194

Sex		
Male	47	55.3
Female	37	44.7
Occupation		
Employed	62	73.8
Unemployed	22	26.2
Total	84	100.0

Nasal Obstruction Outcomes

Serial NOSE scores are presented in Table 2. All groups demonstrated progressive improvement in nasal obstruction during follow-up; however, the magnitude of improvement differed significantly among treatment groups. Mixed repeated-measures ANOVA demonstrated a significant effect of time ($F = 557.835$, $p < 0.001$) and a significant time × treatment interaction ($F = 12.917$, $p < 0.001$). The hypertonic saline group showed the greatest reduction in NOSE scores, decreasing from 50.00 ± 5.93 preoperatively to 15.36 ± 3.83 on postoperative day 14, followed by the isotonic saline group (51.96 ± 8.64 to 22.86 ± 5.52). In contrast, the control group showed the smallest improvement (50.54 ± 4.58 to 30.54 ± 3.69) (Table 2).

Table 2. Changes in NOSE Scores Following Medial Maxillectomy and Mixed Repeated Measures ANOVA Results

Group	Preoperative	POD 8	POD 10	POD 12	POD 14
0.9% NaCl	51.96 ± 8.64	43.57 ± 8.59	36.25 ± 3.76	31.07 ± 4.97	22.86 ± 5.52
3% NaCl	50.00 ± 5.93	38.75 ± 5.38	30.36 ± 6.08	23.21 ± 4.95	15.36 ± 3.83
No irrigation	50.54 ± 4.58	45.18 ± 4.61	41.25 ± 2.93	34.82 ± 3.72	30.54 ± 3.69
Mixed Repeated Measures ANOVA	Statistic	Statistic	Value	Value	Value
Time effect	F	F	557.835	557.835	557.835
Time effect	p-value	p-value	<0.001	<0.001	<0.001
Time × Group interaction	F	F	12.917	12.917	12.917
Time × Group interaction	p-value	p-value	<0.001	<0.001	<0.001

Values are presented as mean ± standard deviation (SD). POD = postoperative day.

Post hoc Bonferroni analysis (Table 3) demonstrated significant differences between all treatment groups. Hypertonic saline achieved significantly lower NOSE scores than isotonic saline (mean difference = 5.607, 95% CI 3.089–8.126; $p < 0.001$) and the control group (mean difference = 8.929, 95% CI 6.410–11.447; $p < 0.001$). Isotonic saline also showed significantly better outcomes than the control group (mean difference = 3.321, 95% CI 0.803–5.840; $p = 0.005$).

Table 3. Pairwise Comparisons of NOSE Scores Between Treatment Groups (Bonferroni Post Hoc Test)

Comparison	Mean Difference	95% Confidence Interval	p-value
0.9% NaCl vs 3% NaCl	5.607	3.089 to 8.126	<0.001
0.9% NaCl vs No irrigation	-3.321	-5.840 to -0.803	0.005
3% NaCl vs No irrigation	-8.929	-11.447 to -6.410	<0.001

Endoscopic Wound-Healing Outcomes

Serial endoscopic findings are shown in Table 4. Endoscopic scores progressively decreased in all groups, indicating continuous mucosal healing throughout the observation period. Mixed repeated-measures ANOVA revealed significant effects of time ($F = 262.099$, $p < 0.001$) and a significant time × treatment interaction ($F = 12.896$, $p < 0.001$). The hypertonic saline group demonstrated the fastest improvement, with mean endoscopic scores decreasing from 3.00 ± 0.00 preoperatively to 1.04 ± 0.19 on postoperative day 14, compared with 1.39 ± 0.50 in the isotonic saline group and 1.71 ± 0.46 in the control group (Table 4).

Table 4. Changes in Endoscopic Scores Following Medial Maxillectomy and Mixed Repeated Measures ANOVA Results

Group	**Preoperative**	**POD 8**	**POD 10**	**POD 12**	**POD 14**
0.9% NaCl	3.00 ± 0.00	2.75 ± 0.44	2.43 ± 0.63	1.71 ± 0.60	1.39 ± 0.50
3% NaCl	3.00 ± 0.00	2.64 ± 0.49	1.93 ± 0.60	1.39 ± 0.50	1.04 ± 0.19
No irrigation	3.00 ± 0.00	3.00 ± 0.00	2.79 ± 0.42	2.64 ± 0.49	1.71 ± 0.46
Mixed Repeated Measures ANOVA	**Statistic**	**Statistic**	**Value**	**Value**	**Value**
Time effect	F	F	262.099	262.099	262.099
Time effect	p-value	p-value	<0.001	<0.001	<0.001
Time × Group interaction	F	F	12.896	12.896	12.896
Time × Group interaction	p-value	p-value	<0.001	<0.001	<0.001

Values are presented as mean ± standard deviation (SD). POD = postoperative day. Lower endoscopic scores indicate better mucosal healing.

Post hoc analysis (Table 5) demonstrated significant differences among all treatment groups. Hypertonic saline produced significantly better endoscopic healing than isotonic saline (mean difference = 0.257, 95% CI 0.085–0.430; $p = 0.001$) and the control group (mean difference = 0.629, 95% CI 0.456–0.801; $p < 0.001$). Isotonic saline also resulted in significantly better endoscopic outcomes than no nasal irrigation (mean difference = 0.371, 95% CI 0.199–0.544; $p < 0.001$).

Table 5. Pairwise Comparisons of Endoscopic Scores Between Treatment Groups (Bonferroni Post Hoc Test)

Comparison	**Mean Difference**	**95% Confidence Interval**	**p-value**
0.9% NaCl vs 3% NaCl	0.257	0.085 to 0.430	0.001
0.9% NaCl vs No irrigation	-0.371	-0.544 to -0.199	<0.001
3% NaCl vs No irrigation	-0.629	-0.801 to -0.456	<0.001

Bonferroni post hoc analysis following Mixed Repeated Measures ANOVA.

Mucociliary Clearance

Mucociliary clearance results are summarized in Table 6. Significant differences in saccharin transit time were observed among treatment groups for both the right ($H = 66.963$, $p < 0.001$) and left nasal cavity ($H = 65.580$, $p < 0.001$). The hypertonic saline group demonstrated the shortest transit time, indicating the most rapid recovery of mucociliary function, whereas the control group showed the longest transit time.

Natural Resources for Human Health
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Table 6. Mucociliary Clearance Time According to Treatment Group

Variable	Group	Mean ± SD (min)	Mean Rank	H	p-value
Right mucociliary clearance	No irrigation	11.82 ± 1.12	68.64	66.963	<0.001
Right mucociliary clearance	0.9% NaCl	8.82 ± 1.56	43.18	66.963	<0.001
Right mucociliary clearance	3% NaCl	5.54 ± 1.07	15.68	66.963	<0.001
Left mucociliary clearance	No irrigation	11.61 ± 0.87	67.66	65.580	<0.001
Left mucociliary clearance	0.9% NaCl	8.86 ± 1.73	44.39	65.580	<0.001
Left mucociliary clearance	3% NaCl	5.29 ± 1.08	15.45	65.580	<0.001

Values are presented as mean ± standard deviation (SD). Comparisons among groups were performed using the Kruskal–Wallis test. Lower mucociliary clearance time indicates better mucociliary function.

Pairwise comparisons using the Mann–Whitney test (Table 7) confirmed significant differences between all treatment groups for both the right and left nasal cavities (all $p < 0.001$). Hypertonic saline demonstrated significantly faster mucociliary transport than isotonic saline, while both irrigation groups showed significantly shorter transit times than the control group.

Table 7. Pairwise Comparisons of Mucociliary Clearance Time Between Treatment Groups (Mann–Whitney U Test)

Variable	Comparison	U	Z	p-value
Right mucociliary clearance	0.9% NaCl vs 3% NaCl	33.0	-5.970	<0.001
Right mucociliary clearance	0.9% NaCl vs No irrigation	52.0	-5.655	<0.001
Right mucociliary clearance	3% NaCl vs No irrigation	0.0	-6.497	<0.001
Left mucociliary clearance	0.9% NaCl vs 3% NaCl	26.5	-6.056	<0.001
Left mucociliary clearance	0.9% NaCl vs No irrigation	79.5	-5.241	<0.001
Left mucociliary clearance	3% NaCl vs No irrigation	0.0	-6.528	<0.001

Pairwise comparisons were performed using the Mann–Whitney U test following a significant Kruskal–Wallis test. Lower mucociliary clearance time indicates better mucociliary function.

DISCUSSION

The present randomized controlled trial demonstrated that postoperative nasal irrigation significantly enhanced recovery following medial maxillectomy. Among the three treatment groups, patients receiving hypertonic saline (3% NaCl) consistently achieved the most favorable outcomes, including greater improvement in nasal obstruction symptoms, faster endoscopic wound

healing, and more rapid restoration of mucociliary clearance. These findings suggest that hypertonic saline not only accelerates physiological recovery of the sinonasal mucosa but also translates into clinically meaningful improvements during the early postoperative period.

The demographic characteristics of the present study showed that most participants were aged 40–59 years (44.0%), followed by patients aged ≥60 years (27.4%), with a predominance of males (56.0%) and employed individuals (73.8%).

The randomized controlled design ensured balanced baseline characteristics among the three treatment groups, minimizing the potential influence of age, sex, and occupational status on postoperative outcomes. Therefore, the observed differences in NOSE scores, endoscopic healing, and mucociliary clearance are more likely attributable to the irrigation interventions than to baseline patient characteristics. This balanced distribution strengthens the internal validity of the study and reinforces the causal relationship between hypertonic saline irrigation and accelerated postoperative mucosal recovery. Similar findings have been reported in previous randomized controlled trials demonstrating that the beneficial effects of hypertonic saline remain consistent after adjustment for baseline demographic characteristics (4,7,9).

The present study demonstrated that hypertonic saline produced the greatest improvement across all evaluated outcomes. By postoperative day 14, the mean NOSE score decreased from 50.00 ± 5.93 to 15.36 ± 3.83 in the hypertonic saline group, compared with 22.86 ± 5.52 in the isotonic saline group and 30.54 ± 3.69 in the control group. Likewise, endoscopic wound-healing scores improved more rapidly in patients receiving hypertonic saline, reaching 1.04 ± 0.19, compared with 1.39 ± 0.50 in the isotonic saline group and 1.71 ± 0.46 in the control group. Mucociliary clearance assessment also demonstrated significant differences among treatment groups, with significantly shorter saccharin transit times in the hypertonic saline group for both the right ($H = 66.963$, $p < 0.001$) and left nasal cavities ($H = 65.580$, $p < 0.001$). These findings indicate that restoration of mucociliary function occurred concurrently with objective mucosal healing and subjective improvement in nasal obstruction.

Statistical analysis further strengthened these observations. Mixed repeated-measures ANOVA demonstrated significant effects of time on both NOSE scores ($F = 557.835$, $p < 0.001$) and endoscopic scores ($F = 262.099$, $p < 0.001$), together with significant time-by-treatment interactions, indicating that postoperative recovery differed according to the irrigation protocol. In addition, Kruskal–Wallis analysis demonstrated significant differences in mucociliary clearance among treatment groups, while all post hoc Mann–Whitney comparisons remained statistically significant ($p < 0.001$). The consistency of these three independent outcome measures suggests that hypertonic saline accelerates restoration of normal sinonasal physiology while simultaneously improving clinical recovery. These findings are in agreement with recent systematic reviews reporting that hypertonic saline reduces postoperative crust formation, mucosal edema, and inflammatory symptoms more effectively than isotonic saline (4,7,9).

The present findings are consistent with previous clinical studies evaluating postoperative saline irrigation. Vakil et al. (9) reported that patients undergoing functional endoscopic sinus surgery (FESS) who received hypertonic saline experienced significantly faster improvement in symptom scores and endoscopic findings than those treated with isotonic saline. Likewise, the recent meta-analysis by Lima et al. (7), which included 479 patients from seven randomized controlled trials, demonstrated that hypertonic saline reduced postoperative crust formation by approximately 35%, decreased persistent polypoid mucosa by 47%, and produced greater improvements in visual analogue scale (VAS) and SNOT-20/22 scores than isotonic saline. Although these studies primarily involved FESS rather than medial maxillectomy, their conclusions closely parallel the present findings, supporting the superiority of hypertonic saline in promoting postoperative mucosal recovery.

Improved mucociliary clearance observed in the present study is likely one of the principal mechanisms underlying accelerated wound healing. Hypertonic saline produced the shortest saccharin transit times, indicating more rapid recovery of mucociliary transport compared with isotonic saline and standard postoperative care. Efficient mucociliary clearance facilitates elimination of mucus, blood clots, tissue debris, microorganisms, and inflammatory mediators from the surgical cavity, thereby promoting epithelial regeneration and reducing the duration of postoperative inflammation. Verma and Verma (4) proposed that nasal irrigation maintains hydration of the periciliary fluid layer, enhances ciliary activity, and facilitates removal of inflammatory mediators from the mucosal surface. Similarly, Chitsuthipakorn et al. (5) concluded that high-volume nasal irrigation is an essential component of postoperative care because it promotes sinonasal cleansing, preserves mucosal function, and improves clinical outcomes. Wu et al. (10) further demonstrated that postoperative irrigation accelerates mucosal healing and reduces

local inflammation based on serial endoscopic evaluations. These mechanisms explain why patients receiving hypertonic saline in the present study demonstrated superior improvements across all three outcome measures.

The effectiveness of nasal irrigation may also be influenced by postoperative sinonasal anatomy. Medial maxillectomy enlarges the surgical cavity and increases exposure of the maxillary sinus, thereby facilitating penetration of irrigation fluid into previously inaccessible regions. Wong et al. demonstrated that removal of the medial maxillary wall substantially improves distribution of irrigation solution throughout the maxillary sinus, while computational fluid dynamics studies by Zhao et al. (11) showed that enlargement of the postoperative sinus opening increases contact between irrigation solution and the sinonasal mucosa, resulting in more effective removal of retained secretions and inflammatory debris. Because all participants in the present study underwent medial maxillectomy, improved irrigation distribution may have contributed to the superior mucosal healing and symptom improvement observed in patients treated with hypertonic saline (11–13).

Overall, the present study demonstrates that hypertonic saline (3% NaCl) is the most effective postoperative irrigation regimen following medial maxillectomy. Faster restoration of mucociliary function was accompanied by greater improvement in nasal obstruction symptoms and endoscopic wound healing compared with isotonic saline and standard postoperative care. These findings support current evidence that hypertonic saline exerts favorable anti-inflammatory and anti-edematous effects, reduces postoperative crust formation, promotes epithelial regeneration, and enhances early postoperative recovery. Therefore, hypertonic saline irrigation should be considered an important component of standardized postoperative management following medial maxillectomy.

Novelty of the Present Study

The present study provides novel evidence regarding postoperative nasal irrigation following medial maxillectomy by simultaneously evaluating patient-reported symptoms (NOSE score), endoscopic healing, and mucociliary clearance in a randomized controlled design. To our knowledge, this is the first prospective randomized controlled trial evaluating hypertonic saline, isotonic saline, and no irrigation after medial maxillectomy using combined patient-reported symptoms, endoscopic healing, and mucociliary clearance outcomes.

Clinical Perspective

Routine postoperative hypertonic saline irrigation may improve patient comfort, accelerate mucosal healing, reduce postoperative crusting, and facilitate earlier recovery after medial maxillectomy.

Study Limitations

This study was limited by its single-center design, relatively small sample size, and short follow-up period, which precluded assessment of long-term outcomes. In addition, factors such as smoking status, allergic rhinitis, and patient adherence to nasal irrigation were not evaluated. Future multicenter studies with larger populations and longer follow-up are needed to validate these findings. The absence of microbiological and inflammatory biomarker assessment limited evaluation of the biological mechanisms underlying the observed clinical improvements.

CONCLUSION

Hypertonic saline (3% NaCl) was superior to isotonic saline (0.9% NaCl) and no nasal irrigation in improving nasal obstruction, endoscopic wound healing, and mucociliary clearance during the early postoperative period following medial maxillectomy. These findings support the routine use of hypertonic saline irrigation as an effective postoperative strategy to accelerate mucosal healing and optimize early postoperative recovery.

What is already known on this topic

Postoperative nasal irrigation is widely recommended to facilitate sinonasal healing by reducing crust formation, improving mucosal hydration, and enhancing mucociliary clearance.

Hypertonic saline may provide greater anti-inflammatory and anti-edematous effects than isotonic saline, although evidence following medial maxillectomy remains limited.

What this study adds

Hypertonic saline (3% NaCl) provided significantly greater improvement in NOSE scores, endoscopic healing, and mucociliary clearance than isotonic saline (0.9% NaCl) and no nasal irrigation.

This study provides prospective randomized evidence supporting hypertonic saline as the most effective postoperative irrigation regimen following medial maxillectomy.

The findings support incorporating hypertonic saline irrigation into routine postoperative management to enhance early mucosal recovery.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this study.

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