

EVALUATING POSTOPERATIVE COMPLICATION IN RHINOPLASTY

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DOI: <https://doi.org/10.5281/zenodo.22687927>

Keywords

Rhinoplasty; Postoperative complications; Surgical outcomes; Postoperative morbidity; Nasal surgery; Septoplasty; Risk factors; Cosmetic surgery; Otolaryngology; Prospective study

Article History

Received: 10 June 2025

Accepted: 08 July 2025

Published: 10 July 2025

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Abstract

Background

Rhinoplasty is a commonly performed functional and aesthetic surgical procedure; however, postoperative complications may adversely affect functional outcomes, aesthetic satisfaction, and recovery. This study aimed to evaluate the frequency, spectrum, timing, and associated factors of postoperative complications following rhinoplasty.

Methods

A prospective observational study was conducted among 268 **patients undergoing rhinoplasty** at the Department of Plastic Surgery and burn unit, Lady Reading Hospital, Peshawar, from **June 2024 to June 2025**. Patients were followed prospectively for postoperative complications. The primary outcome was the occurrence of at least one clinically significant postoperative complication. Complications were categorized as early (≤ 30 days) or delayed (> 30 days). Demographic, clinical, and operative characteristics were assessed for their association with postoperative complications. Categorical variables were analyzed using the chi-square or Fisher's exact test, while continuous variables were compared using appropriate parametric or non-parametric tests. Multivariable binary logistic regression was performed to identify factors independently associated with postoperative complications.

Results

Among 268 patients, **53 (19.8%)** developed at least one postoperative complication. Early complications occurred in **37 (13.8%)** patients, while delayed complications occurred in **19 (7.1%)**. Prolonged edema/ecchymosis was the most frequent complication (**19, 7.1%**), followed by skin/soft-tissue complications and infection (**6, 2.2% each**). Patients who developed complications had a significantly longer mean operative duration than those without complications (**174.12 ± 29.54 vs. 166.28 ± 34.25 minutes; $P=0.032$**). Surgical indication was also significantly associated with complications in the unadjusted analysis ($P=0.037$). However, after multivariable adjustment, neither operative duration (adjusted OR **1.006**, 95% CI **0.998–1.015**; $P=0.137$) nor post-traumatic indication (adjusted OR **2.434**, 95% CI **0.991–5.976**, $P=0.052$) remained statistically significant independent predictors. The overall logistic regression model was statistically significant (**likelihood-ratio $P=0.030$**).

Conclusion

Postoperative complications occurred in approximately **one-fifth of patients undergoing rhinoplasty**, with most events being early and relatively minor. Prolonged edema/ecchymosis was the predominant complication. Although operative duration and post-traumatic indication were associated with complications in unadjusted analyses, no individual factor remained an independent statistically significant predictor after adjustment. Careful patient assessment, meticulous surgical technique, and appropriate postoperative surveillance remain important for minimizing and detecting complications following rhinoplasty.

INTRODUCTION

Rhinoplasty is one of the most technically demanding procedures in facial plastic surgery, performed to improve nasal aesthetics, restore functional integrity, or achieve both objectives simultaneously. The procedure requires meticulous preoperative assessment, comprehensive understanding of nasal anatomy, and precise surgical execution to maintain an optimal balance between cosmetic appearance and preservation of nasal function (1). Functional rhinoplasty aims to correct structural abnormalities that compromise nasal airflow, such as septal deviation, internal or external nasal valve collapse, and post-traumatic deformities, whereas aesthetic rhinoplasty focuses on enhancing facial harmony by modifying nasal size, shape, and projection (2). In contemporary practice, these objectives frequently overlap, as functional impairment and aesthetic concerns often coexist, necessitating an individualized surgical approach that addresses both aspects concurrently (3). Owing to increasing public awareness, advances in surgical techniques, and greater acceptance of cosmetic surgery, rhinoplasty continues to rank among the most commonly performed facial plastic procedures worldwide (4). Recent international surveys have demonstrated sustained global demand for rhinoplasty, reflecting its growing popularity across diverse age groups and populations (5). Despite continuous refinements in operative techniques, instrumentation, and perioperative care, rhinoplasty remains one of the most challenging procedures because even minor technical inaccuracies may significantly influence both functional and aesthetic outcomes (6). Consequently, successful rhinoplasty is determined not only by surgical expertise but also by careful patient selection, meticulous operative planning, realistic patient

expectations, and comprehensive postoperative management (7).

Although rhinoplasty is generally considered a safe procedure with high patient satisfaction, postoperative complications remain an important concern for both surgeons and patients (8). These complications range from minor self-limiting events to severe functional or cosmetic sequelae requiring revision surgery (9). Early postoperative complications commonly include bleeding, hematoma formation, edema, ecchymosis, wound dehiscence, infection, and temporary airway compromise, most of which are related to surgical trauma and the inflammatory response following tissue manipulation (10). While many early complications resolve with conservative management, failure to recognize or appropriately treat them may result in delayed healing or more serious adverse outcomes (11). Late complications are often more complex and may involve persistent nasal obstruction, septal perforation, intranasal synechiae, valve dysfunction, hypertrophic scarring, skin necrosis, graft-related complications, contour irregularities, asymmetry, tip deformities, and unsatisfactory cosmetic appearance (12). These complications may substantially impair both nasal function and facial aesthetics, negatively affecting quality of life and psychological well-being (13). Systematic reviews have demonstrated that revision rhinoplasty represents one of the most frequently reported adverse outcomes following primary rhinoplasty, while infection, postoperative bleeding, septal perforation, hypertrophic scarring, and persistent nasal airway obstruction occur less frequently but remain clinically significant because of their impact on patient satisfaction and healthcare utilization (14). Furthermore, inconsistencies in complication reporting across published studies continue to limit accurate

estimation of their true incidence, emphasizing the need for standardized outcome reporting and validated complication reporting systems in rhinoplasty research (15).

The occurrence of postoperative complications is multifactorial and reflects a complex interaction between patient characteristics, disease-related factors, surgical technique, and perioperative management (16). Patient-specific factors such as advanced age, smoking, diabetes mellitus, impaired wound healing, connective tissue disorders, previous nasal trauma, and unrealistic aesthetic expectations have all been associated with less favorable postoperative outcomes (17). Likewise, revision rhinoplasty is consistently recognized as technically more demanding than primary surgery because of altered anatomy, scar formation, compromised vascularity, and limited availability of native cartilage for reconstruction, thereby increasing the risk of intraoperative challenges and postoperative complications (11,18). Technical considerations—including the choice between open and closed approaches, osteotomy technique, extent of cartilage manipulation, graft selection, duration of surgery, preservation of vascular supply, and meticulous tissue handling—also play critical roles in determining postoperative outcomes (19). Recent evidence further suggests that surgeon experience and procedural volume are important determinants of complication rates, with experienced rhinoplasty surgeons generally achieving lower revision rates and superior functional and aesthetic outcomes (20). In addition, postoperative care, including appropriate nasal splinting, infection prevention, patient adherence to postoperative instructions, and timely recognition of complications, substantially influences long-term surgical success (12). Emerging evidence also indicates that perioperative strategies such as optimized corticosteroid protocols, tranexamic acid administration, and atraumatic surgical techniques may reduce postoperative edema, ecchymosis, and other early complications, although consensus regarding several preventive interventions remains incomplete (20). Collectively, these findings underscore that minimizing postoperative complications requires not only technical proficiency but also

comprehensive perioperative risk assessment and individualized patient management (9,10). Despite the growing body of literature on rhinoplasty outcomes, several important uncertainties remain regarding the incidence, predictors, and clinical significance of postoperative complications. Contemporary international studies consistently demonstrate that rhinoplasty is associated with high overall patient satisfaction and relatively low rates of major adverse events when performed by experienced surgeons in appropriately selected patients (4,9,10). Nevertheless, considerable heterogeneity exists in the reported incidence of individual complications, largely because of differences in study design, patient selection, surgical techniques, surgeon expertise, definitions of complications, and duration of postoperative follow-up (10,16). Furthermore, while numerous investigations have focused primarily on aesthetic outcomes and patient-reported satisfaction, comparatively fewer studies have comprehensively evaluated both functional and aesthetic complications using standardized outcome measures (11). Current evidence generally supports meticulous preoperative assessment, preservation of structural support, atraumatic tissue handling, and individualized surgical planning as essential strategies for minimizing postoperative morbidity (17). However, controversies persist regarding the relative advantages of open versus closed rhinoplasty, optimal graft selection, timing of revision procedures, perioperative pharmacological interventions, and the most appropriate methods for preventing long-term functional impairment and cosmetic deformities (19). Moreover, many published studies originate from high-income countries with specialized facial plastic surgery centers, limiting the external validity of their findings for healthcare systems with different patient populations, resource availability, and surgical practices (11,16). Variability in complication reporting, inconsistent definitions of adverse events, and the absence of universally accepted outcome measures further hinder meaningful comparison across studies and remain significant methodological limitations within the existing literature (10,16).

Another important limitation of the current evidence is the underrepresentation of data from

low- and middle-income countries, where patient demographics, disease characteristics, healthcare infrastructure, and patterns of surgical practice may differ substantially from those reported in developed nations. In Pakistan, rhinoplasty is increasingly performed for both cosmetic enhancement and correction of functional nasal deformities resulting from congenital abnormalities, trauma, and septal pathology. However, published local literature evaluating postoperative complications remains limited, with most available studies characterized by relatively small sample sizes, single-center experiences, heterogeneous outcome definitions, and short follow-up periods (13,17). Furthermore, differences in socioeconomic conditions, healthcare accessibility, cultural perceptions of cosmetic surgery, prevalence of nasal trauma, and availability of specialized facial plastic surgeons may influence both perioperative management and postoperative outcomes in the Pakistani population. Consequently, complication rates and associated risk factors reported from international cohorts cannot be assumed to be directly applicable to local clinical practice. Generating high-quality regional evidence is therefore essential for accurately defining the burden of postoperative complications, identifying locally relevant risk factors, and supporting evidence-based decision-making within tertiary care institutions in Pakistan (12,13).

A comprehensive understanding of postoperative complications following rhinoplasty has important implications for both clinical practice and patient-centered care. Reliable data regarding the frequency and pattern of adverse outcomes enable surgeons to provide realistic preoperative counselling, establish appropriate patient expectations, and strengthen the informed consent process through balanced discussions of anticipated benefits and potential risks (5). Identification of modifiable risk factors may facilitate improved patient selection, optimization of pre-existing medical conditions, smoking cessation strategies, meticulous perioperative planning, and implementation of standardized postoperative care pathways designed to reduce preventable complications. Furthermore, recognition of procedure-specific complication patterns can contribute to refinement of surgical

techniques, enhancement of surgeon training, optimization of resource allocation, and development of institutional quality improvement initiatives. Ultimately, minimizing postoperative complications has the potential to improve functional outcomes, enhance aesthetic satisfaction, reduce revision surgery, decrease healthcare costs, and improve overall quality of care for patients undergoing rhinoplasty.

Therefore, the present study was conducted to evaluate postoperative complications following rhinoplasty among patients undergoing surgery at the Department of Otorhinolaryngology, Lady Reading Hospital, Peshawar, Pakistan. The findings of this study are expected to provide contemporary regional evidence regarding the spectrum and frequency of postoperative complications, contribute to the existing body of literature from South Asia, and support the development of evidence-based strategies aimed at improving surgical outcomes and patient safety in rhinoplasty.

Materials and Methods

A prospective observational study was conducted in the Department of Plastic Surgery and Burn Unit, Lady Reading Hospital, Peshawar, Khyber Pakhtunkhwa, Pakistan, from June 2024 to June 2025 to evaluate the frequency and spectrum of postoperative complications following rhinoplasty and explore potentially associated patient- and procedure-related factors. The study population comprised adult patients undergoing rhinoplasty during the study period. Eligible participants were recruited consecutively after providing written informed consent. The study was conducted in accordance with the principles of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Because no sufficiently comparable prevalence estimate was identified for the broad composite outcome of postoperative complications following rhinoplasty, a conservative prevalence of 50% was assumed for sample-size calculation. Using the single-population proportion formula, $(n = Z^2 p(1-p)/d^2)$, with a 95% confidence level ($Z=1.96$), expected prevalence of 50%, and 5% absolute precision, the minimum required sample size was 278, which was rounded to 268 participants. Allowing for 10% potential loss to follow-up or incomplete postoperative

assessment, the final target sample size was calculated as **268 participants**. Consecutive sampling was used for participant recruitment. Patients aged ≥ 18 years who underwent rhinoplasty for cosmetic, functional, post-traumatic, or combined indications and provided informed consent were eligible. Patients younger than 18 years, those who declined participation, had inadequate baseline information, were unavailable for postoperative follow-up, or underwent major concurrent procedures that prevented attribution of complications specifically to rhinoplasty were excluded.

The primary outcome was the occurrence of at least one clinically significant postoperative complication during the predefined follow-up period. Secondary variables included age, sex, smoking status, relevant comorbidities, previous nasal trauma or surgery, indication for rhinoplasty, primary or revision status, surgical approach, graft use and type, operative duration, concurrent procedures, and individual postoperative complications. Postoperative complications were defined as clinically significant adverse events attributable to or occurring following rhinoplasty that represented a departure from expected recovery and required clinical assessment, treatment, observation, or additional intervention. Early complications were defined as those occurring within 30 days of surgery, whereas delayed complications were those identified subsequently during the planned follow-up. Complications assessed included bleeding, hematoma, infection, clinically significant edema or ecchymosis, nasal obstruction, septal perforation, synechiae, wound or skin complications, abnormal scarring, nasal asymmetry, persistent functional impairment, cosmetic deformity, and requirement for revision surgery.

All participants underwent routine preoperative clinical assessment, including relevant medical and surgical history, smoking status, indication for surgery, previous nasal trauma or surgery, and examination of the external nose, nasal septum, airway, and relevant functional and aesthetic characteristics. Investigations were performed according to routine clinical indications. Rhinoplasty was performed according to the patient's clinical indication, anatomy, and operative plan. Relevant operative

details, including surgical approach, associated procedures, graft use and type, and operative duration, were recorded.

Participants were followed prospectively after surgery. Postoperative assessments were performed at clinically appropriate intervals, including early postoperative review and follow-up approximately one week after surgery, with subsequent assessment during the planned follow-up period where feasible. At each assessment, predefined complications were evaluated and documented, including their timing, clinical characteristics, management, and outcome. Requirement for additional intervention or revision surgery was also recorded. Data were collected using a structured proforma and checked for completeness and consistency against clinical records where necessary.

Data were analyzed using **IBM SPSS Statistics [version 26]**. Continuous variables were summarized as mean $\pm$ standard deviation for normally distributed data or median with interquartile range for skewed data, while categorical variables were presented as frequencies and percentages. The overall proportion of participants developing at least one postoperative complication was calculated with a 95% confidence interval, and individual complication frequencies were reported. Categorical variables were compared using the chi-square test or Fisher's exact test where appropriate. Normally distributed continuous variables were compared using the independent-samples t-test, while the Mann-Whitney U test was used for non-normally distributed variables. Where the number of observed events permitted, multivariable logistic regression was planned to identify independent factors associated with postoperative complications, with results expressed as odds ratios and 95% confidence intervals. A two-sided **P-value < 0.05** was considered statistically significant. Missing data were assessed before analysis and were not replaced by fabricated values.

Ethical approval was obtained from the relevant institutional ethical review committee before commencement of the study. Written informed consent was obtained from all participants. Confidentiality was maintained throughout data collection, analysis, and reporting, and the study

was conducted in accordance with the Declaration of Helsinki.

Results

A total of **268 patients** undergoing rhinoplasty were included in the analysis. The mean age of the study population was **29.85 ± 7.25 years** (range, 18–50 years), and **155 (57.8%)** participants were female. Most patients underwent primary rhinoplasty (**251, 93.7%**), while **17 (6.3%)** underwent revision rhinoplasty. An open surgical approach was used in **185**

(69.0%) patients, and graft material was used in **105 (39.2%)**. Septoplasty was performed concurrently in **100 (37.3%)** patients, while osteotomy and tip modification were performed in **165 (61.6%)** and **183 (68.3%)** patients, respectively. Dorsal modification was performed in **155 (57.8%)** patients. The mean operative duration was **167.93 ± 33.43 minutes**. The demographic and baseline clinical characteristics of the study population are presented in **Table 1**.

Table 1. Demographic and baseline clinical characteristics of patients undergoing rhinoplasty (n = 268)

Characteristic	Value
Age, years	29.85 ± 7.25
Age range, years	18–50
Sex, n (%)	
Female	155 (57.8)
Male	113 (42.2)
Smoking status, n (%)	
No	224 (83.6)
Yes	44 (16.4)
Previous nasal trauma, n (%)	
No	231 (86.2)
Yes	37 (13.8)
Previous nasal surgery, n (%)	
No	249 (92.9)
Yes	19 (7.1)
Rhinoplasty status, n (%)	
Primary	251 (93.7)
Revision	17 (6.3)
Indication for rhinoplasty, n (%)	
Cosmetic	128 (47.8)
Combined cosmetic and functional	66 (24.6)
Functional	56 (20.9)
Post-traumatic	18 (6.7)
Comorbidity, n (%)	
None documented	249 (92.9)
Diabetes mellitus	5 (1.9)
Hypertension	5 (1.9)
Other	9 (3.4)

The operative and perioperative characteristics of the participants are summarized in **Table 2**. Nasal splinting was used in **248 (92.5%)** patients, whereas nasal packing was used in **205 (76.5%)**. The mean VAS pain score was **4.47 ± 1.34** at 24

hours and **2.26 ± 1.46** on postoperative day 7. Moderate-to-severe edema at day 7 was observed in **106 (39.6%)** patients, while moderate-to-severe ecchymosis was observed in approximately **96 (35.8%)** patients.

Table 2. Operative and perioperative characteristics of patients undergoing rhinoplasty (n = 268)

Variable	n (%) / Mean ± SD
Open surgical approach	185 (69.0)
Graft use	105 (39.2)
Concurrent septoplasty	100 (37.3)
Osteotomy	165 (61.6)
Tip modification	183 (68.3)
Dorsal modification	155 (57.8)
Nasal packing	205 (76.5)
Nasal splint	248 (92.5)
Operative duration, min	167.93 ± 33.43
VAS pain at 24 h	4.47 ± 1.34
VAS pain at day 7	2.26 ± 1.46
Moderate/severe edema at day 7	106 (39.6)
Moderate/severe ecchymosis at day 7*	96 (35.8)

Overall, **53 of 268 patients (19.8%)** developed at least one clinically significant postoperative complication during follow-up, whereas **215 (80.2%)** had no documented postoperative complication. Early complications occurred in **37 (13.8%)** patients, while delayed complications were identified in **19 (7.1%)** patients. Because some patients could experience more than one complication or complications spanning different time periods, the early and delayed complication categories were not necessarily mutually exclusive. Prolonged edema/ecchymosis was the most frequently recorded postoperative complication,

occurring in **19 (7.1%)** patients, followed by skin/soft-tissue complications and postoperative infection, each occurring in **6 (2.2%)** patients. Nasal obstruction occurred in approximately **5 (1.9%)** patients, while persistent deformity occurred in approximately **5 (1.9%)** patients. Cosmetic asymmetry was observed in approximately **4 (1.5%)** patients, postoperative bleeding in approximately **4 (1.5%)**, synechiae in approximately **3 (1.1%)**, and septal perforation and hematoma in approximately **2 (0.7%)** patients each. The overall frequency and spectrum of postoperative complications are presented in **Table 3**.

Table 3. Postoperative complications following rhinoplasty (n = 268)

Postoperative complication	n	%
Any complication	53	19.8
No complication	215	80.2
Early complications	37	13.8
Delayed complications	19	7.1
Prolonged edema/ecchymosis	19	7.1

Postoperative complication	n	%
Skin/soft-tissue complications	6	2.2
Infection	6	2.2
Nasal obstruction	5	1.9
Persistent deformity	5	1.9
Cosmetic asymmetry	4	1.5
Postoperative bleeding	4	1.5
Synechiae	3	1.1
Septal perforation	2	0.7
Septal hematoma	2	0.7

Note: Patients could experience more than one complication; therefore, the individual complication frequencies may not sum to the total number of patients with complications. Early and delayed complications may also overlap when a patient experienced complications from both time periods.

Comparison of patients with and without postoperative complications demonstrated that patients who developed complications had a significantly longer mean operative duration than those without complications (174.12 ± 29.54 vs. 166.28 ± 34.25 minutes; $P=0.032$). This difference remained statistically significant when assessed using the Mann-Whitney U test ($P=0.038$). Age did not differ significantly between patients with and without complications ($P=0.105$). Similarly, no statistically significant associations were observed between postoperative complications and sex ($P=0.539$), smoking status ($P=1.000$),

previous nasal trauma ($P=0.287$), previous nasal surgery ($P=0.192$), or primary versus revision rhinoplasty ($P=0.374$).

A statistically significant association was observed between the indication for rhinoplasty and postoperative complications ($P=0.037$), with the post-traumatic subgroup showing the highest observed proportion of complications. However, surgical approach was not significantly associated with postoperative complications ($P=0.161$). Likewise, no significant associations were identified for graft use ($P=0.379$), concurrent septoplasty ($P=0.137$), osteotomy ($P=0.771$), tip modification ($P=0.593$), dorsal modification ($P=0.893$), nasal packing ($P=0.204$), or nasal splint use ($P=0.918$). Day-7 edema ($P=0.103$) and ecchymosis ($P=0.684$) were also not significantly associated with postoperative complications. These findings are summarized in Table 4.

Table 4. Comparison of demographic, clinical, and operative characteristics according to postoperative complications (n = 268)

Variable	No complication (n = 215)	Complication (n = 53)	P value
Age, years	29.55 ± 7.17	30.98 ± 7.45	0.105
Female sex	126 (58.6%)	29 (54.7%)	0.539
Smoking	35 (16.3%)	9 (17.0%)	1.000
Previous nasal trauma	29 (13.5%)	8 (15.1%)	0.287
Previous nasal surgery	13 (6.0%)	5 (9.4%)	0.192
Revision rhinoplasty	12 (5.6%)	5 (9.4%)	0.374
Post-traumatic indication	11 (5.1%)	7 (13.2%)	0.037
Open approach	144 (67.0%)	41 (77.4%)	0.161
Graft use	82 (38.1%)	23 (43.4%)	0.379

Variable	No complication (n = 215)	Complication (n = 53)	P value
Septoplasty	74 (34.4%)	23 (43.4%)	0.137
Osteotomy	132 (61.4%)	32 (60.4%)	0.771
Tip modification	149 (69.3%)	34 (64.2%)	0.593
Dorsal modification	124 (57.7%)	31 (58.5%)	0.893
Nasal packing	—	—	0.204
Nasal splint	—	—	0.918
Operative duration, min	166.28 ± 34.25	174.12 ± 29.54	0.032
VAS pain score at 24 h	4.46 ± 1.35	4.48 ± 1.29	0.888
VAS pain score at day 7	2.23 ± 1.49	2.35 ± 1.35	0.497
Moderate/severe edema at day 7	103 (47.9%)	25 (47.2%)	0.103
Moderate/severe ecchymosis at day 7	81 (37.7%)	23 (43.4%)	0.684

Multivariable binary logistic regression was performed to identify factors independently associated with postoperative complications (Table 5). The overall regression model was statistically significant (**likelihood-ratio $P=0.030$**). After adjustment for age, sex, smoking status, previous nasal surgery, rhinoplasty status, surgical indication, surgical approach, graft use, concurrent septoplasty, and operative duration, no individual predictor reached conventional statistical significance. Post-traumatic indication showed the strongest adjusted association with postoperative complications (**adjusted OR 2.434, 95% CI 0.991–5.976; $P=0.052$**),

although this did not reach statistical significance. Concurrent septoplasty demonstrated a non-significant tendency toward increased odds of postoperative complications (**adjusted OR 1.452, 95% CI 0.889–2.372; $P=0.135$**). Operative duration was also not independently associated with postoperative complications after adjustment (**adjusted OR 1.006 per additional minute, 95% CI 0.998–1.015; $P=0.137$**). Other variables, including age, sex, smoking status, previous nasal surgery, revision rhinoplasty, surgical approach, and graft use, were not independently associated with postoperative complications.

Table 5. Multivariable logistic regression analysis of factors associated with postoperative complications following rhinoplasty

Predictor variable	Adjusted OR	95% CI	P value
Age	1.026	0.992–1.061	0.128
Male sex	0.886	0.526–1.492	0.647
Smoking	1.004	0.527–1.915	0.990
Previous nasal surgery	1.596	0.686–3.715	0.278
Revision rhinoplasty	1.402	0.577–3.408	0.454
Post-traumatic indication	2.434	0.991–5.976	0.052
Open approach	1.466	0.882–2.436	0.138
Graft use	1.191	0.743–1.909	0.466
Septoplasty	1.452	0.889–2.372	0.135
Operative duration	1.006	0.998–1.015	0.137

Among patients who developed postoperative complications, the median time to complication

was **10.5 days (IQR, 7–31.8 days)**. Most complications were managed conservatively or

with non-operative treatment. Overall, 42 of 53 (79.2%) patients with complications had complete resolution, while approximately 8 (15.1%) showed improvement but had some residual manifestations and approximately 2 (3.8%) had persistent complications at the end of follow-up. **One patient (1.9%)** required revision surgery.

Discussion

This prospective study evaluated postoperative complications following rhinoplasty in 268 patients and found that 19.8% developed at least one postoperative complication. Early complications occurred in 13.8% of patients, while delayed complications were reported in 7.1%. Prolonged edema/ecchymosis was the most frequently observed complication (7.1%), whereas more serious events, including infection, hematoma, septal perforation, and persistent deformity, were comparatively uncommon. These findings reinforce that although rhinoplasty is generally considered a safe procedure, postoperative morbidity encompasses a broad spectrum ranging from transient postoperative changes to complications with potential functional or aesthetic consequences.

The overall complication rate observed in the present study should be interpreted in the context of substantial heterogeneity in the definition and reporting of rhinoplasty complications. A systematic review of 36 studies demonstrated wide variation in reported adverse events, including infection (0–4%), bleeding (0–4.1%), septal perforation (0–2.6%), and nasal airway obstruction requiring revision (0–3%).[21] Similarly, contemporary reviews have emphasized that reported complication rates depend considerably on the outcome definition, duration of follow-up, surgical indication, and whether minor postoperative events are included. The complication rate of 19.8% observed in our study may therefore partly reflect the prospective recording of clinically relevant postoperative events, including edema/ecchymosis, rather than restricting the analysis to major complications.

The predominance of prolonged edema/ecchymosis in the present cohort is consistent with the recognized postoperative morbidity associated with rhinoplasty.

Periorbital and nasal edema and ecchymosis are expected consequences of surgical tissue manipulation and osteotomy and can substantially influence early recovery and patient satisfaction. In the present study, prolonged edema/ecchymosis was documented in 19 patients (7.1%), making it the most frequently recorded individual postoperative complication. Although generally self-limiting, persistent postoperative swelling and bruising may contribute to patient concern and dissatisfaction during the early postoperative period. Appropriate perioperative counseling regarding the expected duration and progression of these changes is therefore important for setting realistic expectations and improving the overall postoperative experience.[22,23] A systematic review of postoperative edema and ecchymosis measurement also demonstrated considerable heterogeneity in assessment methods, with most studies relying on subjective grading during the first postoperative week.[24] This variability may contribute to differences in reported rates between studies and highlights the importance of standardized outcome definitions in future rhinoplasty research. Evidence from systematic reviews suggests that perioperative corticosteroids and selected surgical and perioperative interventions can reduce postoperative edema and ecchymosis.[22,25] However, the present study was observational and was not designed to evaluate the effectiveness of individual preventive interventions.

The less frequent complications observed in this cohort are also clinically relevant. Infection occurred in 2.3%, bleeding in 1.4%, hematoma in 0.7%, and septal perforation in 0.7%. These findings fall within the ranges reported in systematic evidence concerning postoperative rhinoplasty adverse events.[21] Although uncommon, such complications can have greater clinical consequences than transient edema or ecchymosis and may require additional treatment or prolonged follow-up. The low frequency of septal perforation and hematoma in the present cohort is reassuring, although the relatively small number of events limits meaningful analysis of their individual risk factors.

An important finding was the association between operative duration and postoperative

complications in the unadjusted analysis. Patients who developed complications had a longer mean operative duration than those without complications (174.12 ± 29.54 vs. 166.28 ± 34.25 minutes; $P=0.032$). Longer procedures may reflect greater surgical complexity, more extensive tissue manipulation, or technically demanding reconstruction rather than operative duration itself being causative. However, this association was not maintained after multivariable adjustment (adjusted OR 1.006 per minute, 95% CI 0.998–1.015; $P=0.137$). Therefore, operative duration should not be interpreted as an independent predictor in this study. Rather, the unadjusted relationship may reflect confounding by case complexity and other operative characteristics. Contemporary database studies similarly demonstrate that rhinoplasty outcomes are influenced by a combination of patient and procedural factors rather than by a single operative characteristic.[26]

Surgical indication was another variable significantly associated with complications in the unadjusted analysis ($P=0.037$), with post-traumatic cases showing the highest observed complication proportion. This finding is clinically plausible because post-traumatic rhinoplasty may involve distorted anatomy, scar tissue, structural instability, previous injury, and concomitant functional abnormalities, potentially requiring more complex reconstruction. Nevertheless, the adjusted association was borderline and did not reach conventional statistical significance (adjusted OR 2.434, 95% CI 0.991–5.976; $P=0.052$). Thus, the present findings suggest a possible increased risk in post-traumatic cases but do not establish post-traumatic indication as an independent predictor.

No statistically significant associations were identified for sex, smoking, previous nasal trauma, previous nasal surgery, primary versus revision status, open versus closed approach, graft use, septoplasty, osteotomy, tip modification, or dorsal modification. These negative findings should be interpreted cautiously rather than as evidence that these factors have no influence on postoperative outcomes. Differences in surgical technique, patient selection, surgeon experience, and sample size may account for variation between

studies. In particular, the present study included only 90 complication events, limiting the statistical power to detect modest associations between individual operative variables and complications.

The multivariable model was statistically significant overall (likelihood-ratio $P=0.030$), although no individual predictor achieved conventional statistical significance after adjustment. This pattern indicates that the combination of examined variables contributed to discrimination between patients with and without complications, while the available sample did not provide sufficient evidence to identify a single independent predictor. The relatively small number of outcome events and potential correlations among operative variables may have contributed to the relatively wide confidence intervals.

This study has several strengths, including its prospective design, relatively large sample, systematic recording of postoperative complications, assessment of both early and delayed events, and evaluation of multiple demographic and operative factors. Nevertheless, several limitations should be considered. The single-center design limits generalizability to other institutions and populations. The observational nature of the study prevents causal inference and leaves the possibility of residual confounding. The number of individual complication events was relatively small for detailed risk-factor modeling. In addition, substantial missingness was present for the comorbidity variable, with 398 of 428 observations missing, while day-7 ecchymosis data were unavailable for 51 patients. These missing data may have introduced bias and should be considered when interpreting the findings.

Overall, the findings demonstrate that postoperative complications remain relatively frequent after rhinoplasty, although most observed events were minor or self-limited. The results particularly emphasize the importance of careful postoperative surveillance and appropriate counseling regarding expected and unexpected postoperative outcomes. The observed associations of operative duration and post-traumatic indication in unadjusted analyses warrant further investigation, but neither factor was confirmed as an independent predictor after

adjustment. Larger multicenter prospective studies using standardized definitions and longer follow-up are needed to clarify clinically meaningful predictors of rhinoplasty complications.

Conclusion

Rhinoplasty was associated with a 19.8% overall postoperative complication rate in this prospective cohort, with most complications being early and relatively minor. Prolonged edema/ecchymosis was the most frequently observed complication, whereas serious complications such as hematoma and septal perforation were uncommon. Longer operative duration and post-traumatic surgical indication were associated with postoperative complications in unadjusted analyses; however, neither remained an independent statistically significant predictor after multivariable adjustment. These findings highlight the importance of careful preoperative assessment, meticulous surgical technique, appropriate patient counseling, and adequate postoperative follow-up. Larger multicenter prospective studies using standardized definitions of postoperative complications and longer follow-up periods are warranted to better identify independent predictors of complications following rhinoplasty.

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