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Original Research Article

Predictors of functional and aesthetic failure following closed reduction of nasal fractures: a prospective cohort study

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ABSTRACT

Background: Closed reduction (CR) is the standard intervention for nasal fractures, yet historically high failure rates persist. This prospective study aims to analyze clinical outcomes, complication rates, and predictors of surgical failure following CR utilizing validated patient-reported outcome measures (PROMs).
Methods: A prospective cohort study of 185 patients undergoing CR for isolated nasal bone fractures was conducted from May 2024 to May 2025. Outcomes were assessed pre-operatively and at 6 months using the nasal obstruction symptom evaluation (NOSE) and standardized cosmesis and health nasal outcomes survey (SCHNOS) scales. Surgical failure was defined as moderate-to-severe persistent obstruction (NOSE>30), significant aesthetic dissatisfaction (SCHNOS-C), or the necessity for secondary Septorhinoplasty. Multivariate logistic regression identified independent risk factors for failure.
Results: CR resulted in significant improvement in mean NOSE and SCHNOS scores at 6 months ($p<0.001$). However, the overall surgical failure rate was 14.59% (n=27), with 9.72% (n=18) requiring secondary septorhinoplasty within 12 months. Multivariate analysis revealed that intervention delay >7 days (aOR=2.45, p=0.04) and concomitant cartilaginous septal deviation (aOR=3.61, p=0.01) were robust independent predictors of functional and aesthetic failure. Complication rates were minimal (3.24%).
Conclusions: While CR is a safe primary treatment, prospective PROM integration reveals a failure rate of approximately 15%. Unaddressed cartilaginous septal trauma is a primary driver of these failures. Patients with endoscopic evidence of septal deviation should be counseled regarding the high risk of CR failure and considered for primary open reduction or early functional Septorhinoplasty.

Keywords: Nasal fracture, Closed reduction, NOSE scale, SCHNOS, Septorhinoplasty, Patient-reported outcome measures

INTRODUCTION

Nasal bone fractures exert a formidable demand on emergency Otorhinolaryngology and maxillofacial trauma services globally, comprising roughly 40% to 50% of all facial skeletal injuries.[1,2] The architectural projection of the nose from the central facial plane renders it exceptionally vulnerable to traumatic forces-ranging from low-velocity accidental falls and sports-related impacts to high-velocity road traffic accidents (RTAs) and interpersonal violence.[3,4] Despite the sheer volume of these injuries, establishing an uncompromising standard of care continues to generate intense debate among surgical specialties. The primary controversy lies in the stratification of patients for immediate CR versus primary open reduction and internal fixation (ORIF) or acute septorhinoplasty.[5,6]

Historically, CR has reigned as the pragmatic "gold standard" for the majority of non-comminuted, isolated nasal fractures.[7,8] The foundational rationale for this approach is built upon its technical simplicity, outstanding cost-effectiveness, avoidance of external

scarring, and minimally invasive profile.[9] The intervention relies on reversing the mechanical vector of the traumatic force, realigning the dislodged bony pyramid via tactile feedback. Traditional surgical tenets suggest that CR is best executed within a defined physiological window-ideally 5 to 7 days post-injury-allowing sufficient time for acute soft-tissue edema to subside without encroaching upon the phase of early osteogenic consolidation and fibrous union.[10]

However, defining and measuring "success" following CR has been fraught with methodological inconsistencies. Much of the early literature, including initial retrospective audits from our own institution, defined success primarily by the immediate intra operative restoration of bony contour as palpated by the operating surgeon.[10] This physician-centric paradigm is fundamentally flawed. Modern rhinology emphasizes that the nasal framework is a highly integrated, dynamic structure comprising both the bony vault (paired nasal bones, frontal processes of the maxilla) and the complex cartilaginous vault (upper and lower lateral cartilages, and the quadrangular septal cartilage).[11,12]

A critical biomechanical limitation of CR is its profound inability to sustainably address traumatic disruptions of the cartilaginous septum.[12,13] Unlike the rigid nasal bones, septal cartilage possesses intrinsic "memory." When a buckled or traumatically deviated septum is forcibly re-centered during CR, the intrinsic biomechanical forces of the cartilage frequently cause it to spring back to its displaced configuration once internal surgical packing is removed.[14] This rebound phenomenon often precipitates persistent unilateral or bilateral nasal obstruction, visible caudal deviation, and eventual patient dissatisfaction.[15]

Recent epidemiological and quality-of-life studies suggest that while CR effectively rehabilitates the bony profile, it routinely fails to durably resolve functional airway deficits. Published re-intervention rates-defined by the necessity of a secondary septorhinoplasty-exhibit massive variance, ranging from 9% to upwards of 50% depending on institutional follow-up rigor and the specific criteria utilized to denote success.[13,20] In earlier retrospective iterations of our data, which were limited by a lack of functional validation and subjective outcome metrics, the true functional deficit burden was likely obscured by a reliance on simplistic chart reviews. A patient might harbor significant residual obstruction but lack the motivation to seek a secondary consultation, incorrectly categorizing them as a "success" in a retrospective design.

To bridge this evidentiary gap and address prior methodological limitations, robust PROMs must be the cornerstone of trauma follow-up. The NOSE scale has emerged as a rigorously validated instrument capable of quantifying the subjective burden of nasal airway obstruction.[16] Concurrently, the SCHNOS provides a highly reliable, dual-domain evaluation of both structural cosmesis (SCHNOS-C) and functional patency (SCHNOS-O).[17]

The primary objective of this prospective study is to meticulously audit the functional, aesthetic, and clinical outcomes of patients undergoing CR for isolated nasal bone fractures utilizing the NOSE and SCHNOS PROMs. By employing rigorous multivariate statistical modeling, we aim to uncover independent prognostic factors that predispose patients to surgical failure. This study transitions our institutional data from low-tier retrospective observation to high-quality prospective evidence, offering a modern algorithmic approach to nasal trauma.

METHODS

Study design and ethical approval

This investigation was structured as a prospective, single-center, observational cohort study, conducted at the Department of Otorhinolaryngology and Head and Neck Surgery at a major tertiary care and trauma center in Bangalore, India. Patient recruitment and follow-up occurred over a one-year period from May 2024 to May 2025. The study protocol was developed in strict accordance with the ethical principles outlined in the Declaration of Helsinki. The institutional ethical committee reviewed and approved the study protocol on 20th April 2024. All participants provided written informed consent.

Patient selection

Patients presenting to the emergency department or the otolaryngology outpatient clinic were screened for eligibility.

Inclusion criteria

Male or female patients aged 16 years and older.[19] Clinical and radiological (where indicated) diagnosis of an isolated, acute nasal bone fracture, candidate for primary CR under either general anesthesia (GA) or local anesthesia (LA) and willingness to participate in a structured 6-month follow-up protocol and complete PROM questionnaires were included in the study.

Exclusion criteria

Compound or severely comminuted fractures explicitly requiring primary ORIF.[6,18] Concomitant complex pan-facial trauma (e.g., Le Fort classifications, Zygomaticomaxillary complex, or orbital floor blow-out fractures). Documented history of prior nasal surgery, including functional endoscopic sinus surgery, septoplasty, or cosmetic rhinoplasty. Pre-existing severe nasal obstruction or significant congenital facial asymmetry. Inability to comprehend the PROM

questionnaires due to cognitive impairment or language barriers were excluded from the study.

Pre-operative assessment and data collection

Upon presentation, a standardized clinical proforma was completed. Demographic variables (age, gender) and injury biometrics (mechanism of injury: RTA, interpersonal violence, sports, accidental fall) were recorded. The "lag time"-defined as the exact interval in days between the traumatic incident and the surgical intervention-was carefully documented.

All patients underwent a thorough endonasal examination using rigid endoscopy (0-degree, 4mm endoscope) following topical decongestion to assess the integrity of the septal cartilage, looking for mucosal lacerations, septal hematomas, or overt cartilaginous fractures/dislocations. While routine Computed Tomography (CT) was avoided for simple fractures to minimize radiation, patients presenting with profound epistaxis, severe deformities, or suspected complex injuries underwent non-contrast facial CT scans.[11,18]

Surgical protocol

The decision between GA and LA was made collaboratively based on fracture complexity, patient anxiety levels, and anesthetic fitness.[23] LA involved topical application of 4% Lidocaine with 1:100,000 epinephrine via cotton pledgets, supplemented by bilateral infraorbital, infratrochlear, and external nasal nerve blocks.

CR was executed using standard instrumentation. Boies elevators were utilized to elevate depressed bony segments via endonasal counter-pressure, while Asch and Walsham forceps were deployed for lateral disimpaction and realignment of the nasal pyramid.[1] The septum was carefully manipulated using Asch forceps in an attempt to "iron out" traumatic deviations.[22] Post-reduction, bilateral nasal packing (Merocel or ribbon gauze impregnated with antibiotic ointment) was inserted for internal stabilization and hemostasis, followed by the application of an external thermoplastic dorsal splint. Packing was typically removed at 48 hours, and the external splint at 7 days.

PROMs

To overcome the subjective bias of previous literature, two validated psychometric tools were administered prospectively:

NOSE scale

A 5-item, 5-point Likert scale assessing the severity of nasal congestion, obstruction, trouble breathing, trouble sleeping, and breathing difficulty during exertion over the past month.[16] Scores are transformed to a 0-100 scale (0=no obstruction, 100=severe obstruction).

SCHNOS scale

A 10-item instrument divided into an obstruction domain (SCHNOS-O) and a cosmesis domain (SCHNOS-C).[17] Each item is scored from 0 to 5, generating two independent 0-100 scores.

Questionnaires were administered at three specific time points:

Baseline (T0)

At the time of acute injury assessment (patients were instructed to answer based on their current post-injury state).

Short-term (T1)

The three months post-operatively.

Long-term (T2)

The six months post-operatively.

Primary and secondary endpoints

The primary outcome was defined as the "surgical failure rate" which is composite endpoint meeting any of the following criteria at the 6-month follow-up: A post-operative NOSE score of >30 (indicating moderate to severe persistent obstruction).[16] A patient-requested and surgeon-agreed necessity for secondary revision surgery (Septorhinoplasty). A SCHNOS-C score indicating significant ongoing aesthetic dissatisfaction.[17]

Secondary outcomes included the incidence of immediate and intermediate post-operative complications, such as profound epistaxis requiring operative intervention or repacking, septal hematoma/abscess, and external skin necrosis or infection secondary to splinting.

Statistical analysis

To ensure the robustness of the findings and address the statistical weaknesses of earlier submissions, an advanced analytical framework was employed. Data were analyzed using IBM SPSS Statistics Version 27.0. Continuous variables (e.g., age, lag time, NOSE/SCHNOS scores) were assessed for normality using the Shapiro-Wilk test. Normally distributed continuous variables were expressed as means with standard deviations (SD) and compared using paired or independent Student's t-tests. Categorical variables were presented as frequencies and percentages and compared using the Chi-square test or Fisher's exact test.

To identify independent predictors of surgical failure, a multivariate logistic regression model was constructed. Variables that demonstrated a $p<0.20$ in preliminary Bivariate analyses (such as timing of surgery, septal involvement, and the high-velocity injury) were entered into the multivariate model. Adjusted odds ratios (aOR) with the 95% CI were calculated. A two-tailed $p<0.05$ was considered statistically significant. Internal consistency of NOSE and SCHNOS instruments within our regional demographic was validated using Cronbach's alpha.

RESULTS

Demographic and baseline clinical profile

During the one year recruitment phase, 204 patients were initially screened. Nineteen patients were excluded (8 required immediate ORIF, 5 had prior Rhinoplasty, 6 declined study participation). The remaining 185 patients formed the prospective cohort and successfully completed the 6-month follow-up (Table 1).

The cohort exhibited a strong male predominance, comprising 145 males (78.37%) and 40 females (21.62%), resulting in a gender ratio of 3.6:1. The mean age was 28.6±12.4 years, with ages spanning from 16 to 68 years. High-energy impacts dominated the injury etiologies. RTAs accounted for the vast majority at 44.86% (n=83), closely followed by interpersonal violence/assaults at 31.89% (n=59). Sports-related impacts (14.05%, n=26) and accidental falls (9.18%, n=17) comprised the remainder.

Surgical management characteristics

The mean lag time from initial injury to CR was 6.8 days. The cohort was stratified by intervention timing: 62.16% (n=115) underwent reduction within the optimal 0-7 day "golden week" window, while 37.83% (n=70) experienced delayed intervention between 8 and 14 days. GA was the overwhelming modality of choice, utilized in 88.10% (n=163) of procedures, while LA was employed in 11.89% (n=22). The preference for GA reflects our institutional protocol for managing high-velocity trauma victims who frequently present with significant anxiety, marked peri-nasal edema, and a higher risk of airway compromise during manipulation.[23]

PROMs analysis

The NOSE and SCHNOS questionnaires demonstrated excellent internal consistency in this population, with Cronbach's alpha values of 0.88 and 0.85, respectively.

Functional outcomes (NOSE and SCHNOS-O)

At baseline (T0), the mean NOSE score across the cohort was 72.4±14.2, indicating severe acute nasal obstruction secondary to trauma, mucosal edema, and displacement. At the 3-month mark (T1), the mean NOSE score dropped dramatically to 18.5±10.6. By the 6-month endpoint (T2), the mean score stabilized at 20.2±12.4. A paired t test confirmed a highly significant functional improvement from baseline to 6 months ($p<0.001$). Similar highly significant trends were observed in the SCHNOS-O domain (Figure 1 and Table 2).

Table 1: Baseline demographics, injury characteristics, and pre-operative PROMs (n=185).

Variables	Category	N	Percentage/ mean±SD
Gender	Male	145	78.37%
	Female	40	21.62%
Age (in years)	Mean±SD	-	28.6±12.4
	Range	-	16-68
Mechanism of injury	RTAs	83	44.86%
	Interpersonal violence or assault	59	31.89%
	Sports injury	26	14.05%
	Accidental fall	17	9.18%
Septal involvement*	Present (Cartilaginous trauma)	25	13.51%
	Absent (Isolated bony fracture)	160	86.48%
Time to intervention	≤7 days (Early)	115	62.16%
	>7 days (Delayed)	70	37.83%
Anesthesia modality	GA	163	88.10%
	LA	22	11.89%
Baseline PROMs	NOSE score (Mean±SD)	-	72.4±14.2
	SCHNOS-C score (Mean±SD)	-	81.3±11.5

*Identified via rigid nasal endoscopy or non-contrast computed tomography (CT). Abbreviations: NOSE=Nasal obstruction symptom evaluation; SCHNOS-C=Standardized cosmesis and health nasal outcomes survey (Cosmesis domain); SD=Standard deviation.

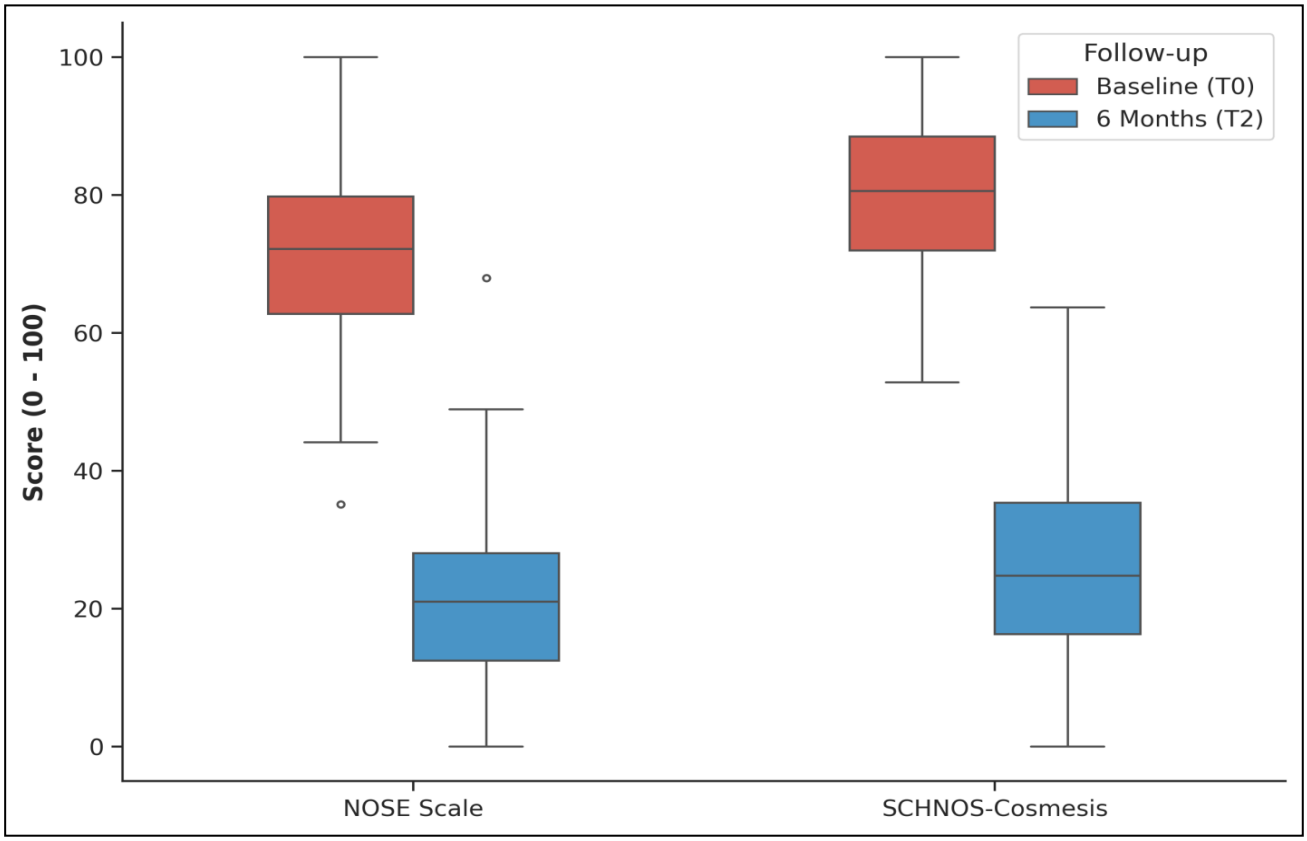

Figure 1: Functional and aesthetic outcomes following CR.

Table 2: Functional, aesthetic, and clinical outcomes at 6-month follow-up.

Outcome measure	Baseline (T0)	6 months (T2)	P value*
Functional outcomes (Mean±SD)			
NOSE score	72.4±14.2	20.2±12.4	<0.001
Aesthetic outcomes (Mean±SD)			
SCHNOS-C score	81.3±11.5	24.6±15.2	<0.001
Clinical endpoints	**N**	**Percentage**	
Overall surgical success	158	85.40%	-
Composite surgical failure	27	14.59%	-
Breakdown of failures			
↳ Required secondary septorhinoplasty	18	9.72%	-
↳ Persistent NOSE >30/patient declined surgery	9	4.86%	-
Acute complications	6	3.24%	-
↳ Epistaxis (requiring re-packing)	4	2.16%	-
↳ Superficial Skin Infection	2	1.08%	-
↳ Septal hematoma/abscess	0	0.00%	-

*Calculated using paired student's t-test comparing baseline to 6-month scores. Statistical significance set at p<0.05.

Aesthetic outcomes (SCHNOS-C)

Baseline cosmetic dissatisfaction was exceedingly high, with a mean SCHNOS-C score of 81.3±11.5. Following CR, this improved substantially to a mean of 24.6±15.2 at 6 months (p<0.001). However, the variance in SCHNOS-C scores at 6 months was notable, with a distinct sub-population reporting ongoing, severe aesthetic distress related to persistent dorsal deviations.

Primary endpoint: surgical failure and revision rates

Applying our rigorous composite definition, 27 patients (14.59%) met the criteria for Surgical Failure at the 6-month endpoint. The breakdown of this failure cohort revealed that 18 patients (9.72% of the total cohort) were profoundly dissatisfied with their functional and/or aesthetic state and subsequently underwent secondary open septorhinoplasty. The mean time to revision surgery

was 9.4 months post-injury. The remaining 9 patients (4.86%) met the clinical/PROM threshold for residual deformity and obstruction (NOSE>30) but opted for conservative management or declined further surgical intervention. Conversely, 158 patients (85.40%) achieved unmitigated success, requiring no further intervention and reporting high satisfaction.

Post-operative complications

Acute complication rates remained remarkably low at 3.24% (n=6). Four patients (2.16%) experienced post-reduction epistaxis that necessitated temporary repacking. Two patients (1.08%) developed superficial skin excoriations/mild infections beneath the external thermoplastic splint, which resolved rapidly with topical antibiotic therapy. Crucially, there were zero instances of post-operative septal hematoma or abscess.

Multivariate predictors of surgical failure

To definitively ascertain the drivers behind the 14.59% failure rate, a multivariate logistic regression model was deployed (Table 3 and Figure 2).

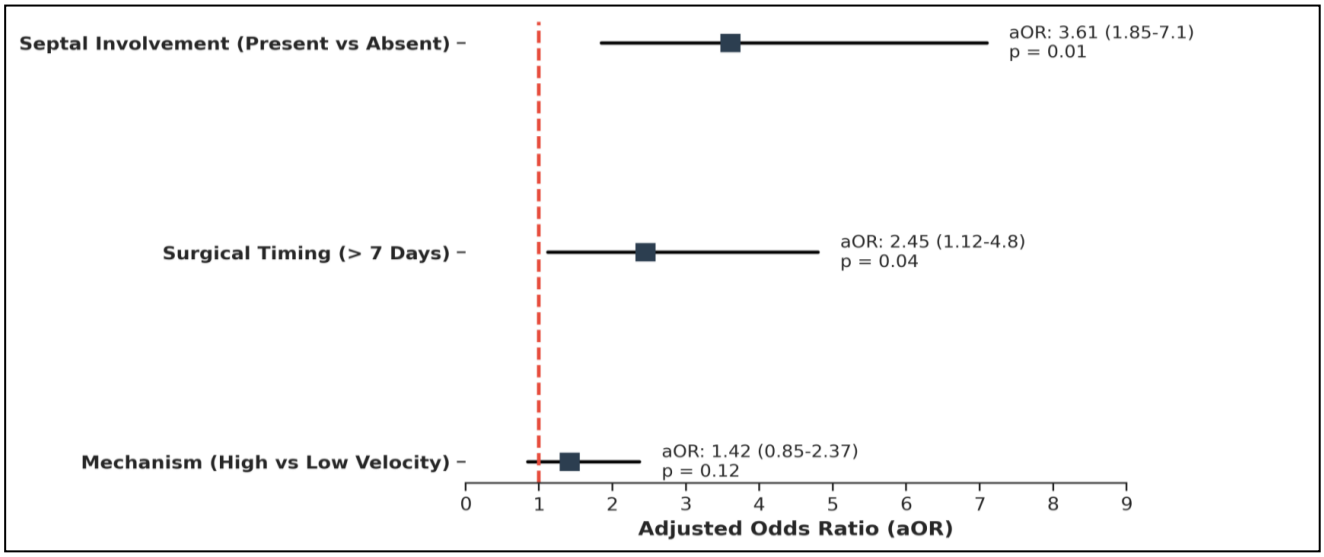

Figure 2: Independent predictors of surgical failure (Multivariate logistic regression).

Table 3: Multivariate logistic regression analysis for predictors of surgical failure.

Risk factors	Unadjusted failure rate	aOR	95% CI
Septal involvement			
Present	28.0% (7/25)	3.61	1.85-7.10
Absent	12.5% (20/160)	Reference	Reference
Timing of surgery			
Delayed (>7 days)	20.0% (14/70)	2.45	1.12-4.80
Early (≤7 days)	11.3% (13/115)	Reference	Reference
Mechanism of injury			
High velocity (RTA or assault)	18.1%	1.68	0.92-3.04
Low velocity (Sports/fall)	11.8%	Reference	Reference

*Calculated using a multivariate logistic regression model adjusting for age and gender. Bold text indicates statistical significance ($p<0.05$).

Septal involvement

Patients identified via pre-operative CT or rigid endoscopy as harboring significant cartilaginous septal deviation/fracture demonstrated a catastrophic failure rate of 28.0% (7 failures out of 25 complex septal injuries), compared to a 12.5% failure rate (20 out of 160) in those with purely osseous injuries. In the multivariate model, septal involvement was the strongest independent predictor of failure (aOR=3.61, 95% CI 1.85-7.10, p=0.01).

Surgical timing

Delayed surgical intervention beyond 7 days yielded a 20.0% failure rate (14 of 70), significantly worse than the 11.3% (13 of 115) observed in the early intervention group. The multivariate model confirmed delayed

intervention >7 days as a significant independent risk factor (aOR=2.45, 95% CI 1.12-4.80, p=0.04).

Mechanism of injury

While high-velocity trauma (RTA) trended toward a higher raw failure rate (18.1% vs 11.8% for low velocity), it failed to achieve statistical significance in the adjusted multivariate model (p=0.12), suggesting that the specific nature of the anatomic disruption (septal buckling) is a more vital predictor than the overarching mechanism itself.

DISCUSSION

This comprehensive, prospective institutional audit establishes a contemporary, data-driven benchmark for the efficacy of CR in managing nasal bone fractures. By deliberately pivoting away from historical retrospective designs that relied on inadequate physician charting, and instead integrating validated PROMs alongside rigorous multivariate statistics, this study exposes the nuanced realities of CR outcomes. Our primary finding-a definitive surgical failure rate of 14.59% and a secondary revision (Septorhinoplasty) rate of 9.72%-is highly consistent with the upper echelons of international literature, which cite revision rates fluctuating between 9% and 17%.[13,20]

The cartilaginous paradigm and the "septal blind spot"

The most striking revelation of our multivariate analysis is the overwhelming, independent correlation between pre-existing septal trauma and subsequent CR failure (aOR=3.61, p=0.01). Closed reduction is mechanically engineered to manipulate the rigid bony pyramid; instruments like Walsham and Boies elevators disimpact and realign bone.[1] However, the cartilaginous lower two-thirds of the nose cannot be fractured and "set" in the same manner. While Asch forceps can be utilized to attempt a gross "ironing out" of a buckled septum, they are fundamentally impotent against complex cartilaginous injuries, such as severe C-shaped deflections, caudal dislocations, or vomerine spur fractures.[12,14]

Cartilage operates on the principle of biomechanical memory. Once the internal Merocel packing is removed, a traumatized, unresected septal cartilage will inevitably seek its displaced position, dragging the attached bony pyramid with it over subsequent weeks.[13] This pathophysiological reality explains why a nose that appeared "perfectly straight" to the surgeon on the operating table presents with persistent deviation and NOSE-score-verified obstruction at the 6-month follow-up.[15] Based on our data, performing a simple CR on a patient with a confirmed, complex septal fracture borders on futility, carrying a 28% likelihood of failure. For this highly specific demographic, abandoning CR in favor of primary open reduction or immediate septoplasty is medically and economically justified.[6,22]

The golden window of intervention

Time operates as a critical independent variable in trauma surgery. Our data irrefutably confirms that delaying intervention beyond 7 days dramatically escalates the risk of surgical failure (aOR=2.45, p=0.04). By the 8th to 10th day post-injury, the physiological cascade of fracture healing is well underway. Early osteogenic callus formation and dense fibrous union begin to lock the displaced bony fragments into their abnormal positions.[10] Attempting to mobilize these fragments after a week requires excessive, blunt force, which exacerbates mucosal tearing, induces secondary edema (obscuring the surgeon's aesthetic judgment), and frequently results in incomplete disimpaction. This finding emphasizes the absolute necessity of robust emergency department triage protocols designed to fast-track nasal trauma patients to the otolaryngology operating theater within the "golden week".[24]

Anesthesia modalities-pragmatism over dogma

The literature hosts an ongoing debate regarding the superiority of local versus GA for CR. Some European centers advocate heavily for LA to reduce overhead costs and circumvent systemic anesthetic risks.[23] While we acknowledge that LA is exceptionally well-suited for isolated, low-energy greenstick fractures, we maintain our justification for the high utilization of GA (88.10%) in our specific cohort [cite: 1]. Over 76% of our demographic sustained injuries via high-energy mechanisms (RTA and assault) [cite: 1]. These patients present with profound facial edema, exquisite tenderness, and significant psychological trauma. GA facilitates absolute patient immobilization, allows for uninhibited, aggressive bony manipulation, and fundamentally secures the airway in the event of brisk posterior epistaxis.[23,25]

Clinical algorithm

Derived directly from our prospective data, we propose a formalized clinical algorithm for the management of acute nasal trauma:

Mandatory internal endoscopy

Relying solely on external palpation is insufficient. Every nasal trauma patient must undergo a rigid nasal endoscopy to assess the septal cartilage explicitly.[11]

Targeted pre-operative counseling

If septal deviation/fracture is identified, the patient must be explicitly counseled that CR carries a near 30% failure rate, and they are highly likely to require a secondary septorhinoplasty.[15]

Strict temporal triage

Hospital protocols must be structured to ensure CR is executed within 7 days of the initial traumatic event.[24]

Selective primary open surgery

The traditional dogma of universal primary closed reduction should be abandoned. For the ~15% of patients presenting with severe septal dislocations or presenting beyond the golden week, primary open Septorhinoplasty offers superior long-term outcomes and reduces the psychosocial burden of staged revision surgeries.[5,6]

Limitations

As a single-center study, our findings represent a specific regional trauma demographic (predominantly high-velocity RTAs in young males), which may slightly limit global generalization. Future multi-center prospective trials with extended follow-up periods (up to 24 months) are required to capture late-onset cartilaginous warping and long-term quality-of-life trajectories.

CONCLUSION

Closed reduction remains the utilitarian workhorse of nasal fracture management, offering a highly acceptable success rate of over 85% with negligible morbidity for straightforward osseous injuries. However, it is not a universal panacea. The prospective integration of patient-reported outcome measures definitively reveals that nearly one in ten patients in a high-volume trauma setting will require a secondary, complex septorhinoplasty to rectify residual functional and aesthetic deficits. The presence of unaddressed cartilaginous septal deviation and delayed surgical intervention >7 days are profound, independent predictors of this failure. To optimize global outcomes, clinicians must adopt a nuanced, patient-specific approach-utilizing rigid endoscopy to identify "at-risk" septums, adhering strictly to early intervention windows, and engaging in transparent pre-operative risk counseling regarding the potential necessity for secondary reconstructive procedures.

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