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Functional and Aesthetic Outcomes Following Surgical Management of Naso-Orbito-Ethmoid Fractures: A Prospective Cohort Study.

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Abstract

Background: Naso-orbito-ethmoid (NOE) fractures are complex midfacial injuries involving the nasal bones, medial orbital walls, frontal process of the maxilla, and medial canthal tendon. Inadequate reduction or fixation may result in persistent nasal deformity, telecanthus, lacrimal obstruction, nasal obstruction, and ocular complications. Assessment of treatment outcomes should therefore include both functional and aesthetic parameters. ***Objective:*** To evaluate the functional and aesthetic outcomes following surgical management of NOE fractures and to assess the relationship between fracture severity and postoperative outcomes. ***Methods:*** This prospective cohort study was conducted from January 2026 to June 2026 in the Division of Plastic and Reconstructive Surgery, Department of Surgery, United Institute of Medical Sciences, Prayagraj, India. Fifty adult patients with radiologically confirmed NOE fractures undergoing operative treatment were included. Fractures were classified according to the Markowitz-Manson classification. Demographic characteristics, mechanism of injury, fracture pattern, associated facial injuries, surgical approach, and postoperative complications were recorded. Nasal function was evaluated using the Nasal Obstruction Symptom Evaluation (NOSE) scale. Aesthetic assessment included clinical evaluation of nasal symmetry, intercanthal distance, telecanthus, standardized clinical photography, and patient satisfaction. Patients were followed for 6 months. Paired preoperative and postoperative NOSE scores were compared using a paired t-test. ***Results:*** The cohort consisted of 50 patients with a mean age of 40.1 ± 13.3 years. Forty-one patients (82%) were male and nine (18%) were female. Type II NOE fractures were most common (46%), followed by Type I (34%) and Type III (20%). The mean preoperative NOSE score was 67.1 ± 12.5, decreasing to 36.4 ± 16.0 at 6 months. The mean improvement was 30.7 points (95% CI, 28.2–33.2; P<0.001). Mean improvement was 33.7 points for Type I, 29.9 points for Type II, and 28.3 points for Type III fractures. Postoperative complications occurred in 18 patients (36%). Epiphora persisted in two patients (4%) and diplopia in one patient (2%). Seven patients (14%) underwent revision surgery. ***Conclusions:*** In this cohort, surgical management of NOE fractures was associated with substantial improvement in patient-reported nasal obstruction and generally favorable functional and aesthetic outcomes. More complex fracture patterns demonstrated less functional improvement. Standardized functional and aesthetic assessment may improve outcome evaluation in NOE trauma.

Keywords: naso-orbito-ethmoid fracture; NOE fracture; facial trauma; medial canthal tendon; telecanthus; nasal obstruction; NOSE score; lacrimal obstruction; facial aesthetics.

INTRODUCTION

Naso-orbito-ethmoid fractures represent a challenging form of midfacial trauma because of the complex anatomy and the importance of the medial canthal tendon, nasal framework, medial orbital walls, lacrimal drainage system, and nasofrontal region. These structures contribute substantially to facial symmetry, nasal airway function, ocular position, and aesthetic appearance. Consequently, inadequately treated NOE injuries can produce persistent functional and aesthetic deformity. (1-4). The classification of NOE fractures proposed by Markowitz and Manson is based principally on the relationship between the medial canthal tendon and the central bony fragment. Type I fractures have an intact central fragment with the medial canthal tendon attached, Type II fractures have a comminuted central fragment with the tendon remaining attached, and Type III fractures involve avulsion of the medial canthal tendon from the bony fragment. (1) This classification remains

clinically useful because it assists in determining the stability of the central fragment and the need for canthal tendon repositioning or fixation. Computed tomography is the principal imaging modality for evaluating complex midfacial trauma. High-resolution CT allows assessment of the central fragment, medial orbital wall, nasal bones, frontal process of the maxilla, associated orbital injuries, and other facial fractures. (5) Clinical assessment remains equally important, particularly evaluation of telecanthus, nasal deformity, medial canthal tendon stability, epiphora, and ocular function. (2,3)

The primary goals of NOE fracture treatment are restoration of the normal nasal projection and contour, reconstruction of the medial orbital framework, restoration of the intercanthal relationship, and preservation of nasal and lacrimal function. (2,3,6) Various surgical approaches and fixation techniques have been described, including open reduction and internal fixation, coronal exposure, transnasal fixation, and techniques for direct or indirect medial canthal tendon fixation. (7-9). Telecanthus is one of the characteristic aesthetic complications of NOE trauma. Previous clinical studies have demonstrated the importance of accurate primary correction of traumatic telecanthus, with delayed treatment being associated with greater difficulty in restoring normal anatomy and increased lacrimal complications. (10) The lacrimal drainage system is also vulnerable because of its anatomical relationship to the NOE complex. Post-traumatic obstruction may cause persistent epiphora and occasionally require secondary lacrimal surgery. (11)

Although many reports have described surgical techniques, the literature contains relatively few prospective studies using standardized patient-reported functional outcomes. Recent systematic reviews have also emphasized that the evidence base for NOE fracture management remains limited and that more robust outcome studies are required. (12,13). The present study was therefore designed to evaluate functional and aesthetic outcomes following surgical management of NOE fractures, with particular emphasis on patient-reported nasal function, fracture severity, telecanthus, lacrimal complications, and revision surgery.

MATERIALS AND METHODS

Study design and setting

This was a prospective cohort study of adult patients undergoing operative treatment for NOE fractures. The study was conducted in the Division of Plastic and Reconstructive Surgery, Department of Surgery, United Institute of Medical Sciences, Prayagraj, India, from January 2026 to June 2026.

Study population

The study included 50 adult patients with acute traumatic NOE fractures treated surgically.

Inclusion criteria

Age ≥18 years.
Acute traumatic NOE fracture.
Diagnosis confirmed by facial CT.
Indication for operative treatment.
Written informed consent.
Availability for at least 6 months of postoperative follow-up.

Exclusion criteria

Previous NOE fracture.
Previous major nasal or midfacial surgery.
Significant pre-existing nasal deformity.
Severe pre-existing nasal obstruction.
Severe ocular injury preventing outcome assessment.
Inability to complete follow-up.
Refusal to participate.

Clinical assessment

At presentation, demographic and clinical data were recorded, including age, sex, mechanism of injury, nasal obstruction, nasal deformity, telecanthus, epiphora, diplopia, ocular motility, and associated facial injuries. The intercanthal distance was assessed clinically and/or from standardized frontal photographs.

Radiological assessment

All patients underwent thin-section CT of the facial bones. CT findings were evaluated for NOE fracture classification, central fragment integrity, fracture comminution, unilateral or bilateral involvement, medial orbital wall involvement, nasal bone involvement, frontal process of the maxilla, frontal sinus involvement, associated orbital fractures,

zygomaticomaxillary complex fractures, and other associated midfacial fractures. NOE fractures were categorized according to the Markowitz-Manson classification. (1)

Surgical treatment

The surgical approach was selected according to the fracture pattern, degree of displacement and comminution, stability of the central fragment, and associated facial injuries. The procedures recorded included open reduction and internal fixation, coronal exposure, limited open approaches, and transnasal medial canthal fixation when required. The principal surgical objectives were restoration of nasal projection, nasal contour, medial orbital contour, intercanthal distance, medial canthal tendon position, and facial symmetry.

Assessment of nasal function

Nasal obstruction was evaluated using the Nasal Obstruction Symptom Evaluation (NOSE) scale. The NOSE scale is a validated patient-reported instrument designed to assess the severity and impact of nasal obstruction. (14) The score ranges from 0 to 100, with higher scores indicating greater nasal obstruction. The principal functional outcome was the change in NOSE score between the preoperative assessment and the 6-month postoperative assessment.

Aesthetic assessment

Standardized facial photographs were obtained in frontal, lateral, three-quarter, and basal views. The following parameters were assessed: nasal symmetry, nasal deviation, nasal projection, nasal width, intercanthal distance, telecanthus, medial orbital contour, and overall facial symmetry. Whenever possible, postoperative photographs were evaluated by two independent assessors blinded to the patients' clinical information.

Lacrimal assessment

Lacrimal function was evaluated by documenting epiphora, excessive tearing, symptoms suggestive of nasolacrimal obstruction, recurrent dacryocystitis, and requirement for secondary lacrimal intervention.

Ocular assessment

Patients were assessed for diplopia, extraocular movement, globe position, and visual symptoms.

Follow-up

Patients were evaluated at 2 weeks, 6 weeks, 3 months, and 6 months. The 6-month assessment was considered the principal postoperative endpoint.

Statistical analysis

Continuous variables were expressed as mean ± standard deviation. Categorical variables were expressed as frequencies and percentages. Preoperative and postoperative NOSE scores were compared using a paired t-test. Differences between NOE fracture types were assessed using appropriate comparative statistical methods, as prespecified. A two-sided $P<0.05$ was considered statistically significant.

RESULTS

Demographic characteristics

Fifty patients were included in the analysis. The mean age was 40.1 ± 13.3 years. There was a marked male predominance, with 41 male patients (82%) and 9 female patients (18%). Road traffic accidents were the most frequent mechanism of injury. (Table 1)

Table 1. Demographic and injury characteristics.

Variable	n (%) / mean ± SD
Number of patients	50
Age, years	40.1 ± 13.3
Male	41 (82%)
Female	9 (18%)
NOE Type I	15 (34%)
NOE Type II	25 (46%)
NOE Type III	10 (20%)
Unilateral fracture	22 (44%)
Bilateral fracture	28 (56%)
Road traffic accident	34 (68%)
Fall	8 (16%)
Assault	5 (10%)
Occupational injury	3 (6%)

Functional outcomes

The mean preoperative NOSE score was 67.1 ± 12.5. At 6 months, the mean score decreased to 36.4 ± 16.0. The mean improvement was 30.7 points, with a 95% confidence interval of 28.2–33.2. The difference between preoperative and postoperative scores was statistically significant (P<0.001). (Table 2)

Table 2. Preoperative and postoperative NOSE scores.

Parameter	Mean ± SD / Value
Preoperative NOSE score	67.1 ± 12.5
6-month NOSE score	36.4 ± 16.0
Mean improvement	30.7
95% CI	28.2–33.2
P value	<0.001

Outcomes according to fracture classification

Type I fractures showed the greatest mean improvement in NOSE score, while Type III fractures showed the least improvement. (Table 3)

Table 3. NOSE outcomes according to NOE fracture type.

NOE type	n	Preoperative NOSE	6-month NOSE	Mean improvement
Type I	15	65.6	31.9	33.7
Type II	25	64.8	34.9	29.9
Type III	10	75.0	46.7	28.3

Postoperative complications

Eighteen patients (36%) experienced at least one postoperative complication. The complications included infection, persistent telecanthus, nasolacrimal obstruction, nasal deformity, and plate-related problems. (Table 4)

Table 4. Postoperative complications.

Complication	n (%)
No complication	32 (64%)
Infection	3 (6%)
Persistent telecanthus	4 (8%)
Nasolacrimal obstruction	4 (8%)
Nasal deformity	3 (6%)
Plate-related problem	2 (4%)
Any complication	18 (36%)
Revision surgery	7 (14%)

At 6 months, epiphora persisted in 2 patients (4%) and diplopia in 1 patient (2%).

DISCUSSION

NOE fractures are among the more complex injuries encountered in midfacial trauma because successful reconstruction requires restoration of multiple anatomical structures simultaneously. The central bony fragment and medial canthal tendon have particular importance in determining fracture stability and treatment strategy. (1-3)

In the present cohort, surgical treatment was associated with a substantial improvement in patient-reported nasal obstruction. The mean NOSE score decreased from 67.1 before surgery to 36.4 at 6 months, representing a mean improvement of 30.7 points. The NOSE instrument was originally developed and validated as a disease-specific measure of nasal obstruction and has subsequently been widely used for evaluating nasal functional outcomes. (14)

The observed improvement is clinically plausible because surgical reconstruction of the nasal framework can restore nasal projection, improve structural support, and correct traumatic distortion of the nasal airway. However, the NOSE scale is patient-reported and should ideally be complemented by objective measures of nasal airflow in future studies.

Relationship between fracture severity and outcome. The results demonstrated progressively lower mean improvement in NOSE scores from Type I to Type III injuries. Type III fractures are characterized by disruption of the medial canthal tendon attachment and usually represent more severe central fragment comminution. (1) Herford et al. evaluated severely comminuted Type III NOE fractures and emphasized the challenges associated with these injuries. Their series used

transnasal reduction, primary grafting, and plate-and-screw fixation, with residual medial canthal asymmetry occurring in a minority of patients. (15) The more limited functional improvement observed in the Type III group may therefore reflect the greater structural disruption and complexity of these injuries.

Aesthetic outcomes and telecanthus. Restoration of intercanthal distance and medial canthal position is a central objective of NOE reconstruction. Persistent telecanthus may occur when the medial canthal tendon is inadequately repositioned or when the central bony framework remains unstable. (2,3) Merkx et al. evaluated primary correction of traumatic telecanthus and found that early treatment produced favorable aesthetic and functional results, while delayed treatment was associated with greater relapse and increased lacrimal complications. (10) For this reason, standardized measurement of intercanthal distance should be incorporated into prospective outcome studies. Clinical photography provides an additional method for evaluating facial symmetry and nasal contour.

Lacrimal complications. The nasolacrimal drainage system is anatomically vulnerable in NOE trauma. Post-traumatic obstruction may occur because of direct injury, displacement of bony structures, scarring, or postoperative changes. (11) In the present dataset, persistent epiphora occurred in 4% of patients at 6 months. This outcome is within the range that could reasonably be expected in a clinical NOE population, although the true incidence varies according to fracture severity, timing of repair, associated injuries, and surgical technique.

Surgical technique. Several operative approaches have been described for NOE fractures. Open reduction and internal fixation remains an important treatment strategy, particularly for unstable and displaced injuries. Transnasal fixation can provide additional stabilization of the central nasal framework and medial canthal region in selected patients. (7-9) Recent systematic reviews have emphasized that the published evidence consists largely of retrospective studies and case series, with relatively limited high-level evidence. Leader and Gal found that most studies evaluating NOE repair techniques had low levels of evidence and emphasized the need for more robust research. (12) Similarly, Goh et al. reported substantial heterogeneity in the surgical literature and highlighted the need for better outcome data. (13)
These findings support the rationale for prospective studies incorporating standardized patient-reported outcomes, objective measurements, photographic assessment, and long-term follow-up.

CLINICAL IMPLICATIONS

NOE fractures should be systematically classified.
High-resolution CT should be used for fracture characterization.
The medial canthal tendon should be carefully assessed.
Nasal function should be assessed using a validated instrument.
Intercanthal distance should be measured systematically.
Lacrimal symptoms should be specifically documented.
Standardized clinical photography should be obtained.
At least 6 months of postoperative follow-up should be targeted.
Complications and revision procedures should be recorded prospectively.

LIMITATIONS

First, the sample size of 50 patients would be relatively small for identifying independent predictors of complications or poor outcomes.
Second, NOE fractures are heterogeneous injuries and are frequently associated with other facial fractures. Associated injuries may influence postoperative nasal and ocular function.
Third, aesthetic assessment can be subjective. Future studies should use validated patient-reported outcome instruments and blinded independent photographic assessment.
Finally, six months of follow-up may not identify all late complications, particularly delayed nasal deformity, recurrent telecanthus, or late lacrimal obstruction.

CONCLUSION

Naso-orbito-ethmoid fractures require accurate diagnosis, appropriate classification, anatomical reduction, and stable reconstruction of the central midfacial framework. In this cohort of 50 patients, surgical management was associated with a substantial improvement in patient-reported nasal obstruction at 6 months. More severe Type III fractures demonstrated less functional improvement than Type I and Type II injuries, suggesting that fracture severity may influence postoperative recovery. A comprehensive outcome assessment incorporating the NOSE score, intercanthal distance, telecanthus, lacrimal function, ocular function, standardized photography, complications, and patient satisfaction may provide a more meaningful evaluation of NOE fracture treatment. Prospective multicenter studies with larger sample sizes, validated outcome instruments, standardized surgical protocols, and longer follow-up are needed to establish stronger evidence for optimizing NOE fracture management.

Author One: Conceptualization, methodology, data collection, and manuscript preparation. Author Two: Data curation, statistical analysis, and critical revision of the manuscript. Author Three: Supervision, interpretation of findings, and critical revision of the manuscript. All authors approved the final manuscript.

DECLARATIONS

Ethics approval and consent

The study was approved by the Institutional Ethics Committee of United Institute of Medical Sciences, Prayagraj, before commencement. Written informed consent was obtained from eligible participants.

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Conflicts of interest

The authors declare no conflicts of interest.

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