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Postoperative Complications After the Surgical Management of Panfacial Fractures: A Retrospective Cohort Study

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Abstract

Introduction: Panfacial fractures represent complex maxillofacial injuries that require extensive surgical reconstruction and are associated with a substantial risk of postoperative morbidity. This study evaluated the occurrence and pattern of postoperative complications and the factors associated with their development following the surgical management of panfacial fractures.

Materials and methods: This retrospective observational cohort study was conducted at the Department of Oral and Maxillofacial Surgery of Guru Nanak Dev Dental College and Research Institute in Sunam, India. Medical records of patients who underwent surgical management of panfacial fractures between January 2018 and November 2023 were reviewed. Demographic, injury-related, operative, perioperative, and postoperative variables were analyzed. Logistic regression analysis was performed to identify the factors independently associated with postoperative complications.

Results: Among the 235 patients, 67 (28.5%) developed postoperative complications. The most frequent complications were persistent sensory disturbance in 28 (11.9%) patients, surgical site infection in 19 (8.1%) patients, and secondary surgical intervention in 23 (9.8%) patients. Patients who developed complications were older and had higher frequencies of polytrauma, traumatic brain injury, open fractures, intensive care unit admission, tracheostomy, blood transfusion, and staged reconstruction. The operative duration and time to surgery were also longer in this group. Multivariable analysis identified age >40 years (adjusted odds ratio (aOR): 2.05), open fracture (aOR: 1.88), intensive care unit admission (aOR: 1.73), tracheostomy (aOR: 2.03), operative duration >6 hours (aOR: 2.32), and surgery >7 days after trauma (aOR: 1.78) as independently associated factors.

Conclusion: Postoperative complications are common following the surgical management of panfacial fractures. The recognition of high-risk clinical and treatment-related characteristics may support individualized perioperative planning and closer postoperative surveillance.

Categories: Dentistry
Keywords: maxillofacial injuries, oral and maxillofacial surgery, panfacial fractures, postoperative complications, retrospective studies

Introduction

Panfacial fractures represent some of the most complex forms of maxillofacial trauma, involving multiple anatomical regions of the facial skeleton and frequently occurring in high-energy trauma settings. Panfacial fractures are complex facial injuries involving simultaneous fractures of the upper, middle, and lower thirds of the facial skeleton, including the frontal bone, midface, and mandible [1]. The management of these injuries is challenging because treatment must simultaneously restore facial form and occlusion, preserve orbital and functional integrity, and re-establish skeletal stability while accounting for associated systemic injuries [2]. Patients with facial trauma may also present with traumatic brain injury, cervical spine injury, ocular trauma, extensive soft tissue damage, open fractures, and other manifestations of polytrauma, which can substantially influence perioperative management and recovery [3].

In selected cases, surgical treatment commonly requires prolonged and technically demanding procedures, extensive fixation, and staged reconstruction. Consequently, postoperative morbidity remains an important concern [2,4]. Complications may include surgical site infection, wound dehiscence, hardware exposure or failure, malocclusion, facial asymmetry, persistent sensory disturbance, ocular complications, malunion or

nonunion, and the need for secondary surgical intervention [1]. The risk of these complications may be influenced by both patient- and injury-related factors, including age, injury severity, open fractures, associated traumatic brain injury, and polytrauma, as well as treatment-related factors, such as operative duration, timing of definitive surgery, intensive care requirements, tracheostomy, and staged reconstruction [1,5].

Despite advances in trauma resuscitation, fixation techniques, and reconstructive strategies, identifying patients at an increased risk of postoperative complications remains clinically relevant for perioperative planning, surveillance, counselling, and allocation of healthcare resources [3,6]. In particular, distinguishing factors that remain independently associated with complications after adjustment for coexisting injuries and treatment characteristics may provide more clinically useful information than unadjusted associations.

Therefore, this study aimed to determine the incidence and pattern of postoperative complications following the surgical management of panfacial fractures and to identify the demographic, injury-related, and treatment-related factors associated with their occurrence. The objectives of this study were to characterize the postoperative complication profile, compare patients with and without complications, and determine the independent predictors of postoperative complications using multivariable logistic regression analysis in a retrospective cohort.

Materials And Methods

Study design and setting

This retrospective observational cohort study was conducted at the Department of Oral and Maxillofacial Surgery of Guru Nanak Dev Dental College and Research Institute in Sunam, India. The study was retrospective in nature and involved a review of the medical records of patients who underwent surgical management for panfacial fractures between January 2018 and November 2023. As the study involved only a retrospective review of existing patient records and did not involve any direct patient intervention, the institutional ethics committee of the college granted a waiver for the requirement of ethical approval and informed consent for the study (GNDDC/2023/142, dated December 21, 2023). Patient confidentiality was maintained throughout the study, and identifiable patient information was excluded from the analytical dataset.

Study population and patient recruitment

All potentially eligible patient records that were available during the study period were screened. Because the study was retrospective and based on previously available medical records, a formal a priori sample size calculation was not applicable. A consecutive sampling approach was used, whereby all patients who met the predefined eligibility criteria and had adequate documentation of the relevant demographic, injury-related, operative, perioperative, and postoperative variables were considered for inclusion. After screening the records of 321 patients with panfacial fractures for eligibility and completeness of the required data, 235 (73.2%) patients who underwent surgical management of panfacial fractures were included in the final analysis. The exclusion of patients because of incomplete records may have introduced selection bias if patients with incomplete documentation differed systematically from those included in the final analysis. The extent of this potential bias could not be fully established, particularly where information on the demographic characteristics or injury severity of excluded patients was unavailable. Accordingly, the findings should be interpreted in light of the possibility that the analyzed cohort may not fully represent all patients screened during the study period.

Eligibility criteria

Eligibility of study participants was summarized in Table *1*.

Eligibility of study participants
Inclusion criteria
Documented diagnosis of panfacial fracture
Diagnosis meets the study definition of panfacial trauma (fracture pattern involving the upper, middle, and lower thirds of the facial skeleton, with fractures involving multiple contiguous or non-contiguous facial regions within these three anatomical thirds)
Upper third involvement: frontal bone and frontal/orbital region
Middle third involvement: naso-orbito-ethmoid, nasal, zygomaticomaxillary, orbital, and maxillary regions
Lower third involvement: mandibular and associated dentoalveolar regions
Diagnosis established on the basis of clinical and radiological findings documented in the medical records
Underwent operative or surgical management
Sufficient medical records describing demographic characteristics, injury pattern, operative management, perioperative course, and postoperative outcomes
Minimum follow-up period of 3 months
Exclusion criteria
Incomplete records for the primary outcome or essential explanatory variables
Diagnosis does not meet the study definition of panfacial trauma
Definitive surgical management was not performed at the study center

TABLE 1: Inclusion and exclusion criteria

Data collection

Data were retrospectively extracted from institutional medical records. Demographic variables included age and sex. Injury-related variables included polytrauma, traumatic brain injury, open fracture status, and the time from trauma to definitive surgery. Operative and perioperative variables included operative duration, intensive care unit (ICU) admission, tracheostomy, blood transfusion, and staged reconstruction. These variables were analyzed in relation to the occurrence of postoperative complications, including surgical site infection, wound dehiscence, hardware exposure or failure, malocclusion, facial asymmetry, persistent sensory disturbance, diplopia or other ocular complications, malunion or nonunion, secondary surgical intervention, and other documented complications.

Exposure and treatment variables

The principal explanatory variables were demographics, injury severity, and treatment-related characteristics. Age was analyzed as a continuous and categorical variable, including a threshold of >40 years for regression analysis. Injury severity was characterized using variables such as polytrauma, traumatic brain injury, open fracture, ICU admission, and requirement for tracheostomy or blood transfusion. Treatment-related variables included the operative duration, time from trauma to first definitive surgery, and staged reconstruction. Clinically relevant demographic, injury-related, and treatment-related variables were evaluated for their association with postoperative complications.

For the regression analyses, age was categorized using a threshold of >40 years, operative duration was dichotomized at >6 hours, and time from trauma to definitive surgery was categorized at >7 days. These thresholds were used to facilitate the clinical interpretation of associations between patient characteristics, treatment-related factors, and postoperative complications. However, the categorization may result in some loss of information compared with analyzing these variables continuously, and the observed associations may be sensitive to the selected thresholds. Accordingly, the cut-offs should be interpreted as analytical categories rather than established biological or universally applicable clinical thresholds.

Outcome measures

The primary outcome was the occurrence of at least one documented postoperative complication following the surgical management of panfacial fractures during the available follow-up period. The outcome was coded dichotomously as complication present or absent. Complications were identified retrospectively from the clinical notes, postoperative assessments, diagnostic findings, and records of additional interventions

available in the medical records. Specific outcomes included surgical site infection, wound dehiscence, hardware exposure or failure, malocclusion, facial asymmetry, persistent sensory disturbance, diplopia or other ocular complications, malunion or nonunion, and unplanned secondary surgical intervention. Surgical site infection and wound dehiscence were identified from documented clinical diagnoses and descriptions of wound findings. Malocclusion and facial asymmetry were identified from documented postoperative clinical assessments. Sensory disturbances and ocular complications were identified from recorded postoperative symptoms and clinical findings, while hardware complications and malunion or nonunion were identified from documented clinical and radiological findings, where available. Unplanned secondary surgical intervention was identified from records documenting additional surgery for a postoperative complication. Individual complications were not mutually exclusive, as a patient could experience more than one complication during follow-up.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, New York, United States). Continuous variables were assessed for normality using the Shapiro-Wilk test and summarized as mean±standard deviation. Categorical variables were summarized as frequencies and percentages. For comparisons between patients with and without postoperative complications, continuous variables were analyzed using the independent-samples t-test. Categorical variables were compared using the chi-squared test. The effect sizes were reported using Cohen's d for continuous comparisons and Cramér's V for categorical comparisons. Univariate logistic regression analysis was initially performed to evaluate the association between individual demographic, injury-related, and treatment-related variables and postoperative complications. Candidate variables for the multivariable logistic regression model were identified using a two-stage approach. First, variables with a univariable association at $p<0.20$ were considered for inclusion. Second, clinical relevance and the availability of complete data were considered when determining the final set of candidate variables. The $p<0.20$ threshold was used as a screening criterion rather than as evidence of an independent association. The final multivariable model was used to estimate adjusted associations between the selected variables and the occurrence of postoperative complications. Associations were expressed as odds ratios (ORs) with 95% confidence intervals (CIs), and adjusted odds ratios (aORs) with 95% CIs were reported for the multivariable analysis. All statistical tests were two-sided, and a $p<0.05$ was considered statistically significant.

Results

A total of 235 patients with surgically managed panfacial fractures were included in this analysis. The mean age was 36.8±13.2 years, and 185 (78.7%) patients were male. Road traffic accidents were the predominant mechanism of injury, accounting for 154 (65.5%) cases. Traumatic brain injury was present in 69 (29.4%) patients, whereas polytrauma and open fractures were reported in 91 (38.7%) and 48 (20.4%) patients, respectively. Orbital and maxillary fractures were the most frequent fracture components, occurring in 201 (85.5%) and 208 (88.5%) patients, respectively (Table 2, Figure 1, Figure 2).

Variable		Overall (N=235)
Age (years), mean±SD	Overall	36.8±13.2
	Male	37.5±13.1
	Female	34.2±13.4
Sex, n (%)	Male	185 (78.7%)
	Female	50 (21.3%)
Age group, n (%)	≤20 years	28 (11.9%)
	21-30 years	67 (28.5%)
	31-40 years	65 (27.7%)
	41-50 years	38 (16.2%)
	>50 years	37 (15.7%)
Mean follow-up period	Overall	5.08±3.82

TABLE 2: Demographic and baseline characteristics of the study population (N=235)

Data are presented as mean±standard deviation (SD) for continuous variables and as frequency and percentage for categorical variables.

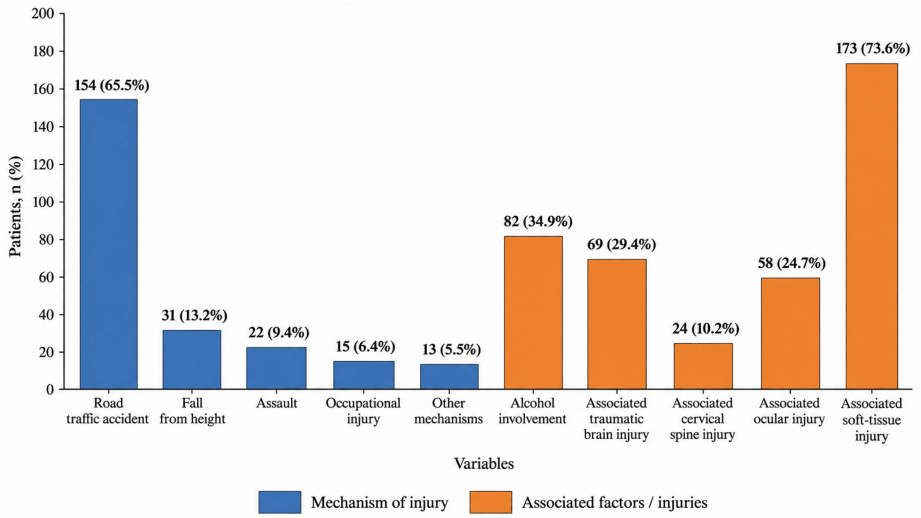


FIGURE 1: Distribution of patients according to the mechanism of injury, with road traffic accidents representing the predominant cause of panfacial trauma (n=235)

Graph generated from GraphPad Prism version 10 (GraphPad Software, San Diego, California, United States).

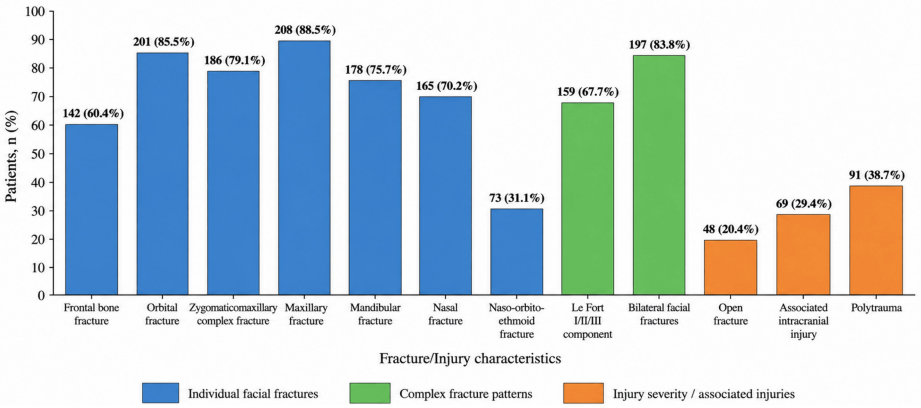


FIGURE 2: Distribution of patients according to the anatomical fracture components and major indicators of injury severity (n=235)

Graph generated from GraphPad Prism version 10 (GraphPad Software, San Diego, California, United States).

The mean time from injury to definitive surgery was 6.4±4.8 days, and the mean operative duration was 6.7±2.1 hours. ICU admission, tracheostomy, and blood transfusion were required in 82 (34.9%), 47 (20%), and 98 (41.7%) patients, respectively. Staged reconstruction was performed in 61 (26%) patients (Figure *3*).

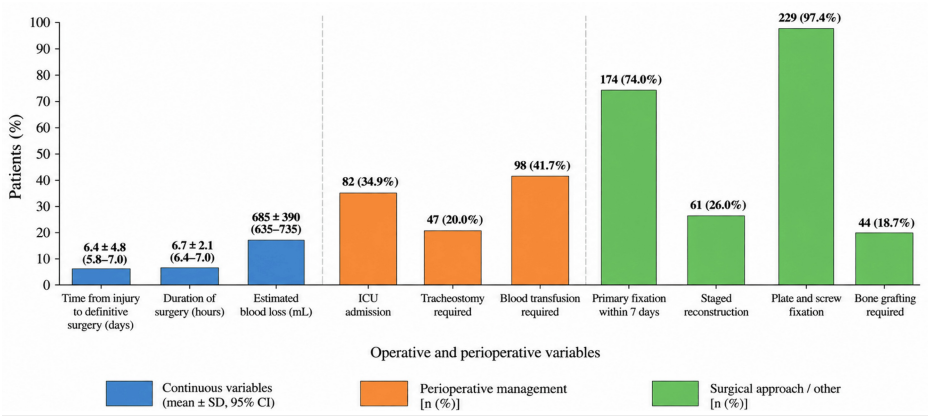


FIGURE 3: Distribution of patients according to operative duration, time from injury to definitive surgery, estimated blood loss, intensive care unit admission, tracheostomy, blood transfusion, timing of fixation, staged reconstruction, plate-and-screw fixation, and bone grafting (n=235)

Graph generated from GraphPad Prism version 10 (GraphPad Software, San Diego, California, United States).

Postoperative complications occurred in 67 (28.5%) patients. Persistent sensory disturbance was the most frequent complication, occurring in 28 (11.9%) patients, followed by surgical site infection in 19 (8.1%), secondary surgical intervention in 23 (9.8%), malocclusion in 16 (6.8%), and diplopia or other ocular complications in 15 (6.4%) (Figure *4*).

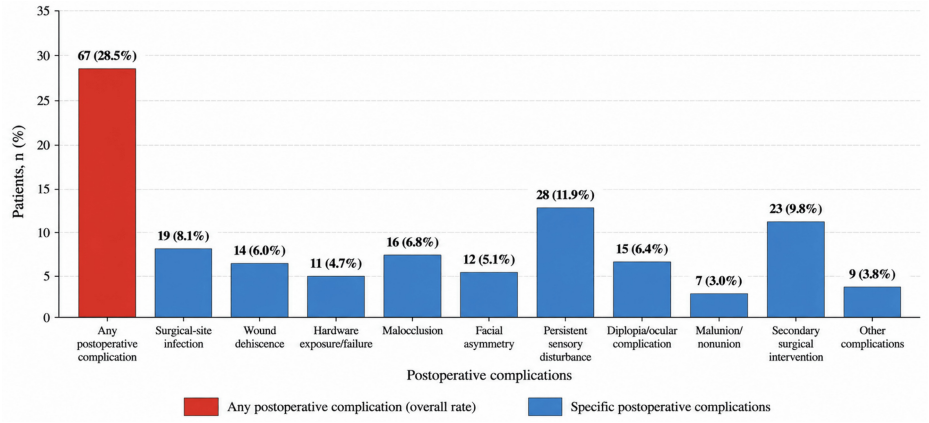


FIGURE 4: Distribution of the documented postoperative complications following surgical treatment, including sensory, infectious, wound, occlusal, ocular, skeletal, hardware-related, and other complications (n=235)

Individual complications were not mutually exclusive because a patient could experience more than one complication.

Graph generated from GraphPad Prism version 10 (GraphPad Software, San Diego, California, United States).

Patients with postoperative complications were older than those without complications (40.1±14.3 vs. 35.5±12.5 years; p=0.014). Polytrauma, traumatic brain injury, open fracture, ICU admission, tracheostomy, blood transfusion, and staged reconstruction were significantly more frequent in patients who developed complications. Surgery duration was also significantly longer in the complication group (7.9±2.3 vs. 6.2±1.8 hours; p<0.001), as was time to surgery (7.9±6.0 vs. 5.8±4.0 days; p=0.004) (Table *3*).

Variable	No complication (n=168)	Complication (n=67)	Test statistic (df)	P-value	Effect size
Age (years), mean±SD	35.5±12.5	40.1±14.3	t=2.47 (233)	0.014*	d=0.36
Male sex, n (%)	136 (81%)	49 (73.1%)	χ^2=1.77 (1)	0.183	V=0.09
Polytrauma, n (%)	57 (33.9%)	34 (50.7%)	χ^2=5.71 (1)	0.015*	V=0.16
Traumatic brain injury, n (%)	41 (24.4%)	28 (41.8%)	χ^2=7.00 (1)	0.008*	V=0.17
Open fracture, n (%)	27 (16.1%)	21 (31.3%)	χ^2=7.06 (1)	0.008*	V=0.17
Intensive care unit admission, n (%)	48 (28.6%)	34 (50.7%)	χ^2=10.45 (1)	0.001*	V=0.21
Tracheostomy, n (%)	25 (14.9%)	22 (32.8%)	χ^2=9.36 (1)	0.002*	V=0.20
Blood transfusion, n (%)	59 (35.1%)	39 (58.2%)	χ^2=10.57 (1)	0.001*	V=0.21
Staged reconstruction, n (%)	35 (20.8%)	26 (38.8%)	χ^2=8.08 (1)	0.004*	V=0.19
Surgery duration (hours), mean±SD	6.2±1.8	7.9±2.3	t=5.83 (233)	<0.001*	d=0.83
Time to surgery (days), mean±SD	5.8±4.0	7.9±6.0	t=2.89 (233)	0.004*	d=0.43

TABLE 3: Comparison of demographic, injury-related, and treatment-related characteristics according to postoperative complications

Continuous variables are presented as mean±standard deviation (SD) and were compared using the independent-samples t-test; categorical variables are presented as frequency and percentage and were compared using the chi-squared test; Cohen's d was used as the effect size for continuous variables and Cramér's V for categorical variables.

*p<0.05 was considered statistically significant.

On univariate logistic regression, age >40 years (OR: 2.65; 95% CI: 1.46-4.82; p=0.001), polytrauma (OR: 2.01; 95% CI: 1.12-3.61; p=0.019), traumatic brain injury (OR: 2.22; 95% CI: 1.22-4.05; p=0.009), open fracture (OR: 2.38; 95% CI: 1.23-4.61; p=0.010), ICU admission (OR: 2.58; 95% CI: 1.45-4.59; p=0.001), tracheostomy (OR: 2.80; 95% CI: 1.43-5.49; p=0.003), operative duration >6 hours (OR: 2.59; 95% CI: 1.40-4.79; p=0.002), surgery >7 days after trauma (OR: 2.56; 95% CI: 1.32-4.97; p=0.005), and staged reconstruction (OR: 2.40; 95% CI: 1.29-4.46; p=0.006) were significantly associated with postoperative complications (Table *4*).

Potential risk factor	Complications in exposed n/N (%)	Complications in unexposed n/N (%)	OR (95% CI)	P-value
Age >40 years	32/75 (42.7%)	35/160 (21.9%)	2.65 (1.46-4.82)	0.001*
Polytrauma	34/91 (37.4%)	33/144 (22.9%)	2.01 (1.12-3.61)	0.019*
Traumatic brain injury	28/69 (40.6%)	39/166 (23.5%)	2.22 (1.22-4.05)	0.009*
Open fracture	21/48 (43.8%)	46/187 (24.6%)	2.38 (1.23-4.61)	0.010*
Intensive care unit admission	34/82 (41.5%)	33/153 (21.6%)	2.58 (1.45-4.59)	0.001*
Tracheostomy	22/47 (46.8%)	45/188 (23.9%)	2.80 (1.43-5.49)	0.003*
Blood transfusion	39/98 (39.8%)	28/137 (20.4%)	2.58 (1.43-4.64)	0.002*
Surgery >6 hours	47/127 (37%)	20/108 (18.5%)	2.59 (1.40-4.79)	0.002*
Surgery >7 days after trauma	24/54 (44.4%)	43/181 (23.8%)	2.56 (1.32-4.97)	0.005*
Staged reconstruction	26/61 (42.6%)	41/174 (23.6%)	2.40 (1.29-4.46)	0.006*

TABLE 4: Univariate logistic regression analysis of factors associated with postoperative complications

Data are presented as the number of patients with complications and without complications, with percentages calculated within the respective exposure categories. Associations were evaluated using univariate logistic regression and are presented as odds ratios (ORs) with 95% confidence intervals (CIs).

*p<0.05 was considered statistically significant.

In the multivariable logistic regression model, age >40 years (aOR: 2.05; 95% CI: 1.16-3.63; p=0.014), open fracture (aOR: 1.88; 95% CI: 1.04-3.41; p=0.037), ICU admission (aOR: 1.73; 95% CI: 1.00-3.00; p=0.049), tracheostomy (aOR: 2.03; 95% CI: 1.11-3.72; p=0.022), operative duration >6 hours (aOR: 2.32; 95% CI: 1.34-4.02; p=0.003), and surgery >7 days after trauma (aOR: 1.78; 95% CI: 1.01-3.15; p=0.046) remained independently associated with postoperative complications (Table *5*). Polytrauma, traumatic brain injury, blood transfusion, and staged reconstruction were not independently significant in the adjusted model.

Predictor	Reference category	β	SE	Wald χ^2	aOR (95% CI)	P-value	VIF	Tolerance
Age >40 years	Age ≤40 years	0.72	0.29	6.16	2.05 (1.16-3.63)	0.014*	1.28	0.78
Polytrauma	No polytrauma	0.48	0.27	3.16	1.62 (0.95-2.76)	0.077	2.14	0.47
Traumatic brain injury	No traumatic brain injury	0.51	0.28	3.32	1.67 (0.97-2.87)	0.064	1.96	0.51
Open fracture	Closed fracture	0.63	0.3	4.41	1.88 (1.04-3.41)	0.037*	1.32	0.76
Intensive care unit admission	No intensive care unit admission	0.55	0.28	3.86	1.73 (1.00-3.00)	0.049*	2.31	0.43
Tracheostomy	No tracheostomy	0.71	0.31	5.25	2.03 (1.11-3.72)	0.022*	1.87	0.53
Blood transfusion	No blood transfusion	0.47	0.26	3.27	1.60 (0.96-2.67)	0.071	2.05	0.49
Surgery duration >6 hours	Surgery ≤6 hours	0.84	0.28	9.00	2.32 (1.34-4.02)	0.003*	1.41	0.71
Surgery >7 days after trauma	Surgery ≤7 days after trauma	0.58	0.29	4.00	1.78 (1.01-3.15)	0.046*	1.35	0.74
Staged reconstruction	Primary fixation	0.39	0.27	2.09	1.48 (0.87-2.51)	0.145	1.62	0.62

TABLE 5: Multivariable logistic regression analysis of factors independently associated with postoperative complications

Multivariable logistic regression was used to determine factors independently associated with postoperative complications. Results are presented as regression coefficients (β), standard errors (SEs), adjusted odds ratios (aORs), and 95% confidence intervals (CIs).

*p<0.05 was considered statistically significant.

Model summary: Model χ^2 (10 df)=40.0 (p<0.001); −2 log likelihood=240.9; Cox-Snell R^2=0.16; Nagelkerke R^2=0.22; Hosmer-Lemeshow χ^2 (8 df)=8.5 (p>0.05); AUC=0.75 (95% CI: 0.68-0.82).

Discussion

Panfacial fractures represent a particularly complex form of maxillofacial trauma because multiple facial regions are disrupted simultaneously, often resulting in the loss of reliable anatomical landmarks and coexisting systemic injuries [1]. In the present study, postoperative complications constituted an important component of morbidity after surgical management. This observation is consistent with previous studies showing considerable variability in complications following panfacial fracture treatment [5,7]. A recent meta-analysis by Jeong et al. [5] demonstrated substantial heterogeneity in the reported complication rates, with malocclusion, infection, enophthalmos, asymmetry, and other functional and esthetic complications among the commonly reported outcomes.

Road traffic accidents were the predominant mechanism of injury in our study, consistent with previous literature, in which high-energy road trauma remains an important cause of extensive maxillofacial injuries. A retrospective study of maxillofacial trauma identified road traffic accidents as the most common cause [8]. The extensive involvement of multiple facial regions in our cohort further reflects the high-energy nature of these injuries. Such fractures are technically challenging because restoration requires the simultaneous re-establishment of facial height, width, projection, orbital architecture, and occlusion. Ali and Lettieri [4] emphasized that successful panfacial reconstruction depends on restoring the occlusal relationship and progressively re-establishing the spatial relationships of the facial buttresses.

Persistent sensory disturbance was the most frequent postoperative complication observed in our study. This may result from direct nerve injury caused by fracture displacement, compression, or traction during surgical manipulation and postoperative tissue changes. Similar sensory complications have been described in the literature [9]. The occurrence of malocclusion and ocular complications is also clinically important because they can result in persistent functional and esthetic impairment. Previous systematic evidence has identified malocclusion, enophthalmos, infection, and facial asymmetry as important complications following panfacial fracture treatment [5].

Older age was independently associated with postoperative complications in this study. This association may reflect age-related differences in physiological reserve, tissue healing, and tolerance to prolonged and complex surgical procedures [10]. However, systemic comorbidities were not assessed in the present study; therefore, their potential contribution to the observed association cannot be determined. Although age-specific evidence of panfacial trauma remains limited, this finding supports a more careful perioperative assessment of older patients. Open fractures are also independently associated with complications, which is biologically plausible because communication with the oral or external environment increases

contamination and is frequently accompanied by soft tissue disruption [11]. Consequently, meticulous wound management, appropriate antimicrobial treatment, and stable fixation are particularly important in these injuries.

ICU admission and tracheostomy were independently associated with postoperative complications in the adjusted model. However, these associations should not be interpreted as evidence of direct causation. Both variables may serve as proxies for greater overall trauma severity, airway compromise, neurological injury, or associated systemic injuries. Although the regression model adjusted for selected demographic, injury-related, and treatment-related variables, a validated global injury-severity score was not included. Consequently, residual confounding by the overall severity of trauma cannot be excluded. These findings should therefore be interpreted as associations with postoperative complications rather than as evidence that ICU admission or tracheostomy directly increases complication risk. Panfacial trauma commonly occurs with traumatic brain injury and other systemic injuries, requiring a multidisciplinary approach in which stabilization of life-threatening conditions precedes definitive facial reconstruction [6,12].

A prolonged operative duration was independently associated with postoperative complications. Longer procedures may reflect greater fracture complexity, extensive tissue injury, increased surgical manipulation, and greater physiological stress [5,13,14]. The complexity of reconstruction and absence of reliable anatomical landmarks are recognized challenges in facial trauma [1]. Therefore, the present findings support detailed preoperative imaging, surgical planning, appropriate fixation sequencing, and multidisciplinary coordination to minimize unnecessary operative delays.

Delayed definitive surgery is independently associated with postoperative complications. This finding should be interpreted cautiously because delay may reflect the severity of associated injuries rather than the effect of the delayed surgery itself. A systematic review by Ramakrishnan et al. [15] suggested that early repair generally facilitates reduction and fixation, although definitive facial surgery may be delayed in patients with life-threatening injuries. Thus, the clinical objective should be timely definitive reconstruction once the patient is adequately stabilized, rather than indiscriminate early intervention.

The use of a composite binary outcome, defined as the occurrence of any postoperative complication, facilitated the analysis of factors associated with overall postoperative morbidity. However, this approach combined complications with differing clinical significance, ranging from sensory disturbances and wound complications to malunion or nonunion and unplanned secondary surgery. Consequently, the composite outcome does not distinguish the severity, functional consequences, or treatment requirements associated with individual complications. The observed associations should therefore be interpreted as relating to the overall occurrence of documented complications rather than to the severity or risk of any specific complication. Future studies should consider prespecified severity classifications and separate analyses of clinically important complications when sample sizes permit.

The multivariable logistic regression analysis should be interpreted cautiously because 67 patients experienced postoperative complications while 10 predictors were included in the model, corresponding to approximately 6.7 outcome events per predictor. This relatively limited number of events raises the possibility of overfitting, potentially resulting in unstable adjusted estimates and reduced generalizability. Furthermore, several predictors, including polytrauma, traumatic brain injury, ICU admission, tracheostomy, and blood transfusion, may be interrelated markers of injury severity. Their simultaneous inclusion may increase model complexity and affect the precision of the estimated associations. Accordingly, the multivariable findings should be considered exploratory rather than definitive evidence of independent associations. Future studies with larger samples and sufficient outcome events should evaluate model stability, assess collinearity, and consider parsimonious modelling strategies.

Surgery more than seven days after trauma was independently associated with postoperative complications in the multivariable analysis. However, this association requires cautious interpretation. In panfacial trauma, delayed definitive treatment may be necessary because of associated life-threatening injuries, neurological status, soft tissue conditions, or the need for systemic stabilization. Therefore, the observed association may partly reflect confounding by injury severity and clinical complexity rather than an adverse effect of surgical delay itself. As the retrospective study did not fully account for all factors influencing the timing of surgery, a causal relationship cannot be established.

Clinically, these findings support early multidisciplinary risk assessment and individualized perioperative planning, particularly for older patients, open fractures, severe associated injuries, airway requirements, or anticipated prolonged surgery. These patients may benefit from closer postoperative surveillance for infectious, sensory, occlusal, ocular, and hardware-related complications. The principal limitations of this study include its retrospective design, dependence on the completeness of the medical records, potential residual confounding, and limited generalizability to other institutions and healthcare settings. Therefore, the identified associations should not be interpreted as causal. Nevertheless, these findings provide clinically relevant information for risk stratification and perioperative management of patients undergoing surgical treatment for facial fractures.

Conclusions

Postoperative complications were common following the surgical management of panfacial fractures, occurring in 28.5% of patients in this single-center retrospective cohort. Older age, open fractures, ICU admission, tracheostomy, prolonged operative duration, and delayed surgery were independently associated with postoperative complications. These findings should be interpreted as associations rather than validated predictive factors, as the study was not designed to develop or validate a clinical prediction model. Furthermore, several identified factors may reflect underlying injury severity and clinical complexity, and residual confounding cannot be excluded. Larger prospective multicenter studies incorporating standardized injury-severity assessments are warranted to confirm these associations and evaluate their clinical applicability.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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