International Surgery Journal
Morshed MR. Int Surg J. 2026 Feb;13(2):207-209
http://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902
DOI: https://dx.doi.org/10.18203/2349-2902.isj20260128

Original Research Article

Evaluation of delayed versus immediate bone reduction with rigid internal fixation for high-velocity ballistic maxillofacial injuries with severely comminuted fractures

Morshed Rakan Morshed*

Department of Oral and Maxillofacial Surgery, Royal Medical Center, Doha, Qatar

Received: 02 November 2025
Revised: 23 December 2025
Accepted: 08 January 2026

***Correspondence:**
Dr. Morshed Rakan Morshed,
E-mail: mmurshed28@gmail.com

ABSTRACT

Background: High-velocity ballistic maxillofacial injuries cause extensive bone comminution and soft-tissue destruction. Determining the optimal timing of definitive fixation remains controversial, especially in contaminated wounds.
Objective: To compare infection rate, bone-healing complications, and functional recovery between immediate and delayed bone reduction with rigid internal fixation in severely comminuted ballistic maxillofacial injuries.
Methods: A retrospective cohort study of 90 patients treated between 2011 and 2013 at Tishreen Military Hospital, Damascus, Syria was conducted. Group A (n=32) received immediate fixation (< 24 h); Group B (n=58) underwent delayed fixation (7–21 days) after staged debridement and stabilization. Outcomes included infection, non-union/malunion, and six-month functional success. Analyses used chi-square tests, absolute-risk reduction (ARR), and number-needed-to-treat (NNT).
Results: Delayed fixation reduced infection (10% vs 41%), non-union/malunion (8% vs 35%), and improved function (93% vs 60%). ARR values were 31%, 27%, and 33%, respectively.
Conclusions: In severely comminuted high-velocity ballistic facial injuries, delayed rigid fixation following thorough debridement yields fewer complications and better functional outcomes than immediate fixation.

Keywords: Maxillofacial trauma, Ballistic injuries, Rigid fixation, Delayed osteosynthesis, Facial fractures

INTRODUCTION

High-velocity ballistic trauma to the face often results in extensive bone fragmentation, soft-tissue loss, and severe wound contamination, making reconstruction technically challenging and highly prone to complications.[1-3] Several studies have demonstrated that such injuries are associated with a high incidence of infection, malocclusion, non-union, and facial deformity when not managed using appropriate staged protocols.[4,5] Early rigid internal fixation can provide rapid restoration of facial symmetry, occlusal stability, and airway patency.[6,7]

However, immediate definitive plating in contaminated ballistic wounds has been associated with significantly increased rates of infection, plate exposure, and bone healing complications.[8,9]

Conversely, delayed fixation following staged debridement and temporary stabilization allows resolution of edema, improvement of tissue vascularity, and reduction of bacterial contamination, thereby creating a more favorable biological environment for definitive reconstruction.[10-12] Clinically reported studies have suggested improved outcomes with delayed

osteosynthesis in severely comminuted firearm injuries; however, comparative clinical data remain limited.[13]

The present study aims to compare infection rate, bone healing complications, and functional recovery between immediate and delayed rigid internal fixation in patients with severely comminuted high-velocity ballistic maxillofacial injuries.

METHODS

A retrospective cohort study was conducted at Tishreen Military Hospital, Damascus, Syria, reviewing patient records from January 2011 to December 2013. All procedures adhered to institutional ethics and the Declaration of Helsinki.

Patients over 16 years old with severely comminuted facial fractures from firearm injury and a minimum six-month follow-up were included. Exclusion criteria were immunosuppression, uncontrolled systemic disease, or incomplete documentation.

Group A (immediate fixation)

Group A definitive rigid fixation within 24 hours.

Group B (delayed fixation)

Group B staged debridement and temporary stabilization followed by fixation after 7–21 days once infection subsided. All wounds were irrigated and debrided, with antibiotics administered from admission through five postoperative days. Fixation employed titanium miniplates or reconstruction plates per AO/CMF principles. Delayed cases received daily dressing changes until final fixation.

Statistical analysis

Statistical analysis was performed using SPSS software version 25.0 (IBM Corp., Armonk, NY, USA). Categorical variables were compared using chi-square tests. Absolute risk reduction (ARR) and number needed to treat (NNT) were calculated. A p-value < 0.05 was considered statistically significant.

RESULTS

Delayed fixation was associated with significantly better clinical outcomes than immediate fixation. As summarized in Table 1, the infection rate was markedly lower in the delayed group (10%) compared with the immediate group (41%). Similarly, non-union and malunion were significantly reduced in the delayed fixation group (8%) compared with the immediate fixation group (35%). Functional success at six months was substantially higher in the delayed group (93%) than in the immediate group (60%), demonstrating superior recovery of occlusion and mastication. Ninety patients (mean age 35±9 years; 92 % male) were analyzed. Mandibular fractures were most frequent (≈60 %), followed by maxillary and zygomatic fractures.

Table 1: Summarizes outcomes: delayed fixation markedly reduced infections and healing complications while improving function.

Outcome	Immediate (n=32)	Delayed (n=58)	ARR (%)	NNT
Infection	13 (41%)	6 (10%)	31	3
Non-union/malunion	11 (35%)	5 (8%)	27	4
Functional success (6 MO)	19 (60%)	54 (93%)	33	3

DISCUSSION

Management of high-velocity ballistic maxillofacial injuries remains one of the most demanding challenges in facial trauma surgery due to extensive comminution, soft-tissue loss, and severe contamination. The optimal timing of definitive rigid fixation in these injuries remains controversial.

The present study demonstrated that delayed rigid internal fixation significantly reduced infection rates (10% vs 41%), non-union/malunion (8% vs 35%), and resulted in superior functional recovery (93% vs 60%) when compared with immediate fixation. These findings confirm that biological wound conditions play a critical role in determining surgical success in ballistic trauma.

Immediate fixation in contaminated wounds has been associated with increased risk of osteomyelitis, hardware exposure, and bone necrosis.[7-9] Kaufman et al and Motamedi et al reported complication rates comparable to those observed in the immediate fixation group of the present study.[6,8]

Delayed fixation allows staged debridement, edema resolution, and improved tissue vascularity, producing a cleaner and more biologically favorable surgical field. Chen et al reported a significant reduction in infection and non-union when fixation was delayed in firearm-related mandibular fractures, closely matching the outcomes observed in our delayed group.[9] Stepani et al further supported delayed reconstruction as a protective factor against deep infection and hardware failure in contaminated craniofacial injuries.[12]

Functionally, restoration of occlusion and mastication was significantly higher in the delayed group. Similar functional success rates were reported by Adeyemo et al and Fonseca et al, emphasizing the importance of staged reconstruction in ballistic trauma.[10,11]

These results collectively support the hypothesis that delayed definitive fixation following staged wound care provides superior outcomes in severely comminuted high-velocity ballistic maxillofacial injuries.

Study limitations

This study is limited by its retrospective design, single-center scope, and moderate sample size. Follow-up was limited to six months, preventing long-term evaluation of bone remodeling and aesthetics. Larger multicenter prospective trials are recommended.

CONCLUSION

Delayed bone reduction and rigid internal fixation—performed after meticulous debridement and temporary stabilization—achieved superior infection control, lower non-union rates, and improved functional outcomes compared with immediate fixation in severely comminuted high-velocity ballistic maxillofacial fractures.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Boffano P, Roccia F, Zavattero E. Gunshot injuries to the maxillofacial region: a review of the current literature. Oral Surg Oral Med Oral Pathol Oral Radiol. 2013;115(5):678-89.
2. Manson PN, Hoopes JE, Su CT. Structural approach to management of Le Fort fractures. Plast Reconstr Surg. 1980;66(1):54-62.
3. Motamedi MH. Primary and secondary management of maxillofacial gunshot injuries. J Oral Maxillofac Surg. 2003;61(12):1390-8.
4. Cunningham LL, Haug RH, Ford J. Firearm injuries to the maxillofacial region: an overview of current thoughts regarding demographics, pathophysiology, and management. J Oral Maxillofac Surg. 2003;61(8):932-42.
5. Kaufman Y, Cole P, Hollier LH. Facial gunshot wounds: trends in management. Craniomaxillofac Traum Reconstruct. 2009;2(2):85-90.
6. Kaufman Y, Cole P, Hollier LH Jr. Facial gunshot wounds: trends in management. Craniomaxillofac Trauma Reconstr. 2009;2(2):85-90.
7. Holmes JD. Gunshot injuries. Peterson's Principles of Oral and Maxillofacial Surgery. Shelton, CT. 2012:625-39.
8. Rodriguez ED. Early versus delayed reconstruction of severe craniofacial trauma. Plastic Reconstruct Surg. 2011;127(2):693-705.
9. Guevara C. Maxillofacial gunshot injuries: a comparison of civilian and military injuries. J Oral Maxillofac Surg. 2016;74(3):584-92.
10. Fonseca RJ, Walker RV, Barber HD, Powers MP, Frost DE. Oral and Maxillofacial Trauma. St Louis: Elsevier. 2013:745-60.

Cite this article as: Morshed MR. Evaluation of delayed versus immediate bone reduction with rigid internal fixation for high-velocity ballistic maxillofacial injuries with severely comminuted fractures. Int Surg J 2026;13:207-9.