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PRIMARY AND EMERGENCY MANAGEMENT OF DENTAL AND FACIAL TRAUMA: OUTCOMES OF EARLY RESTORATIVE INTERVENTIONS IN MAXILLOFACIAL INJURIES; A SYSTEMATIC REVIEW

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Abstract

Background: Dental and facial trauma present to emergency services and require rapid decisions on stabilization, timing of definitive repair, and restorative strategies. Delays may increase infection risk, worsen functional outcomes, and complicate reduction due to edema or early fibrosis. **Objective:** To synthesize evidence on the outcomes of early (primary, emergency) restorative or definitive interventions for dental and maxillofacial injuries, focusing on timing-dependent outcomes and early restorative approaches. **Methods:** A PRISMA-informed systematic review was conducted using PubMed Central full-text articles. We included original clinical studies evaluating timing or early restorative strategies for mandibular, midface, orbital, nasal, and dental trauma (fixation timing, early reduction windows, replantation timing, fragment reattachment strategies). Outcomes included complications (infection, malunion, nonunion, reoperation), function (occlusion, ocular motility, diplopia), symmetry, accuracy measures, and restorative retention. **Results:** Ten original studies met inclusion criteria (prospective audits, retrospective cohorts, and clinical cohort studies). In mandibular fractures, shorter time-to-surgery was associated with reduced infection risk in some cohorts, while large multicenter data suggested comparable complication rates with semi-elective pathways when patients were selected appropriately. For zygomaticomaxillary complex (ZMC) fractures, surgery within a defined early window was associated with improved intraoperative symmetry measures. In orbital injuries, most symptoms improved early, and only a subset required surgery after short-term observation. In dental trauma, extra-alveolar time strongly influenced survival of replanted teeth, and early fragment reattachment strategies achieved acceptable short-term and longer-term retention in selected cases. **Conclusion:** In injury types, evidence supports structured

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emergency pathways that prioritize early stabilization and timely definitive care, particularly within practical early windows, while allowing selected semi-elective approaches without compromising outcomes in low-risk mandibular fractures. Dental restorative outcomes are strongly time-sensitive for avulsions and are favorable for fragment reattachment when protocols and case selection are appropriate.

Keywords: Dental Trauma; Maxillofacial Injuries; Emergency Management; Early Intervention; Mandibular Fracture; Zygomaticomaxillary Complex Fracture.

INTRODUCTION

Dental and facial trauma are common emergency presentations with potential for airway compromise, hemorrhage, infection, long-term functional limitation (occlusion, mastication, speech, vision), and major esthetic impact. Early management principles typically include immediate stabilization, infection prevention, pain control, and timely definitive repair when indicated. In mandibular fractures, the relationship between delay to fixation and complications remains debated, and systematic reviews have highlighted heterogeneity in definitions of early versus delayed repair and inconsistency in complication reporting (Stone et al. 2018).

For dentoalveolar trauma, early immobilization and appropriate splint selection, duration influence periodontal and pulpal outcomes; reviews emphasize matching splint rigidity and immobilization time to injury pattern (de Andrade Veras et al. 2017). Avulsion injuries are particularly time-sensitive because periodontal ligament viability declines with extra-alveolar time and inadequate storage, affecting long-term survival. Recent clinical guidance and expert consensus continue to emphasize rapid management steps (Huang et al. 2024).

In midface trauma, early recognition of red flags and careful timing of surgical repair are central to outcome optimization, but practice varies (Patel et al. 2021). Sequencing and timing of interventions in complex fractures can affect complication rates and final symmetry (Ramakrishnan et al. 2020). Soft-tissue facial injuries add another time dimension: earlier closure and coordinated definitive care may reduce infection and improve healing, depending on contamination and complexity (Hamzah et al. 2024).

Given the clinical importance of early decision-making in emergency and definitive phases, this review focuses on outcomes of early restorative interventions in maxillofacial injuries, spanning fracture fixation timing, early reduction windows, dental replantation timing, and fragment reattachment strategies.

METHODS

This systematic review followed PRISMA principles (protocol-driven eligibility criteria, transparent selection, and structured synthesis). We limited evidence to full-text articles available in PubMed Central to ensure verifiability.

Eligibility criteria

Inclusion: Original clinical studies (randomized, prospective observational, retrospective cohort, clinical audit) available in PMC; patients with dental trauma and, or maxillofacial

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injuries (mandible, ZMC, orbital fractures, nasal fractures, dental avulsion, crown fractures); evaluation of timing (early vs delayed) and, or early restorative strategy (early fixation window, early reduction, immediate replantation, single-visit and multi-visit reattachment); reported clinical outcomes (complications, function, esthetics, symmetry, retention, survival).

Exclusion: case reports, series without analytic outcomes, non-traumatic conditions, purely technical papers without patient outcomes, and non-PMC full text.

Information sources and search approach

We searched PMC via targeted keyword combinations reflecting: “mandible fracture delay fixation,” “emergency vs elective mandible fracture management,” “zygomaticomaxillary complex fracture timing,” “orbital floor fracture observation surgery,” “tooth avulsion extra-alveolar time survival,” and “fragment reattachment cohort.” We also reviewed reference lists of relevant PMC review papers to identify eligible original studies.

Study selection and data extraction

Two-step selection was applied: title, abstract screening for relevance to timing, early restorative outcomes; full-text assessment against inclusion criteria. Extracted data included study design, setting, sample size, injury type, and definition of early intervention, comparator, intervention details, follow-up period, and outcomes.

Risk of bias assessment

Given mixed designs, we used domain-based appraisal aligned with observational study limitations (selection bias, confounding, outcome ascertainment, and completeness of follow-up). We prioritized outcomes with objective definitions (infection requiring antibiotics, surgery, malunion, nonunion, quantified symmetry, volume measures, survival, retention outcomes).

Synthesis

Due to heterogeneity in injuries, timing definitions, and outcome measures, meta-analysis was not performed. Results were synthesized narratively and summarized in two tables (study characteristics and main findings).

RESULTS

Study Selection and Overview

Ten original PMC studies were included in three outcome domains: mandibular fracture timing and pathway design; midface, orbital, nasal trauma timing and accuracy outcomes; and dental trauma restorative timing, strategies (avulsion survival, fragment reattachment). Key included cohorts ranged from small clinical cohorts (n=20) to multicenter prospective audits (n>700).

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Table 1: Characteristics of included original studies (PMC full text)

Study (year)	Design, setting	Population (n)	Injury type	"Early" definition, exposure	Main outcomes
Gazal et al. (2015)	Retrospective cohort; single center	91	Mandibular fractures	Delay from injury to treatment	Infection, complications vs waiting time
Lander et al. (2022)	Retrospective analysis; large database	Large administrative cohort	Mandibular fracture (ORIF)	Time to repair (>6 days)	Malunion, nonunion predictors
Hughes et al. (2022)	Prospective multicenter audit (49 UK centers)	717 (semi-elective 68; emergency 649)	Mandible fractures	Emergency vs semi-elective pathway; time-to-fixation	Complications, readmission; LOS
Kang et al. (2021)	Retrospective; pediatric cohort	Noted cohort	Pediatric nasal fractures	Early (<7 days) vs delayed	Post-reduction outcomes
Amrith et al. (2010)	Clinical observational study	82	Blowout orbital fractures	Time course of symptom recovery	Diplopia, motility limitation resolution
Soliman et al. (2023)	Retrospective cohort	307	Isolated orbital floor fractures	Observation vs later surgery	Proportion requiring surgery; timing
Ebeling, Sakkas et al. (2025)	Retrospective cohort; single center	62 (1-point 42; multi-point 20)	ZMC fractures	Timing window (3–7 days) + fixation strategy	Intraoperative accuracy, symmetry measures
Roskamp et al. (2023)	Retrospective cohort	62 teeth	Tooth avulsion (replantation)	Extra-alveolar time (>60 min)	Tooth survival; hazard ratios
Liu et al. (2024)	Cohort study (two groups)	20 patients; 22 teeth	Complicated crown-root fractures	Single-visit immediate vs multi-visit	Pain, fatigue, periodontal indices, detachment
Sung et al. (2025)	Retrospective cohort	75	Anterior crown fractures	Fragment reattachment outcomes over time	Retention rates; prognostic factors

Table 2: Main findings: outcomes of early restorative interventions

Injury group	Study	Comparison, timing factor	Key findings
Mandible fractures	Gazal et al. (2015)	Shorter vs longer wait to surgery	Authors concluded that reducing waiting time decreased infection risk in mandibular fracture management.
Mandible fractures	Lander et al. (2022)	Repair delay threshold (>6 days)	Delay beyond an early window was associated with higher odds of malunion, nonunion in adjusted models.
Mandible fractures	Hughes et al. (2022)	Emergency admission vs semi-elective pathway	Semi-elective had longer injury-to-fixation (median 127h vs 43h) but similar complication, readmission rates; LOS shorter in semi-elective group.

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Nasal fractures (peds)	Kang et al. (2021)	<7 days vs >7 days	Delayed treatment (>7 days) was associated with worse outcomes compared with early reduction.
Orbital blowout	Amrith et al. (2010)	Symptom evolution post-injury	Most symptoms (diplopia, motility limitation) resolved within 7 days; longer symptom duration correlated with worse diplopia, motility limitation.
Orbital floor fractures	Soliman et al. (2023)	Observation vs surgery after short delay	Only 9.8% required surgery; those cases typically declared within 2–4 days of observation.
ZMC fractures	Ebeling, Sakkas et al. (2025)	1-point vs multi-point fixation + early timing	Multi-point fixation improved intraoperative accuracy; surgery within 3–7 days was a favorable factor for improved intraorbital volume symmetry.
Tooth avulsion	Roskamp et al. (2023)	Extra-alveolar time >60 min	Extra-alveolar time >60 minutes significantly increased hazard of failure (HR reported 12.5).
Crown-root fractures	Liu et al. (2024)	Immediate single-visit vs multi-visit	Both achieved satisfactory esthetics at 1 year; multi-visit had shorter operative duration, less pain and slightly better early periodontal health but may increase risk of fragment detachment.
Crown fractures	Sung et al. (2025)	Long-term retention after reattachment	Estimated retention declined over time (75% at 5 years); complicated fractures had lower retention than uncomplicated; age and extent affected outcomes.

In included mandibular fracture studies, timing interacted with both complication biology (infection, malunion risk) and system-level pathway design. In a single-center cohort (n=91), reducing waiting time was linked to decreased infection risk in mandibular fractures (Gazal et al. 2015). In contrast, large multicenter data comparing emergency admission to semi-elective admission pathways found that although time from injury to fixation was longer in the semi-elective group (median 127 vs 43 hours), complication and readmission rates were similar, and semi-elective care reduced length of stay (Hughes et al. 2022). A database-based analysis supported that longer delays (beyond approximately 6 days) were associated with higher odds of malunion, nonunion, highlighting that “how long is too long” likely depends on fracture pattern, patient risk factors, and whether interim stabilization (bridle wiring) is performed (Lander et al. 2022). Collectively, these data suggest that early fixation is beneficial when clinically feasible, but selected patients may be safely managed in semi-elective pathways without compromising outcomes, provided stabilization, follow-up, and risk stratification are robust.

For pediatric nasal fractures, early reduction (within 7 days) produced better outcomes than delayed reduction, consistent with the concept that increasing edema, callus formation, and early fibrosis complicate late manipulation (Kang et al. 2021). In orbital injuries, two complementary patterns emerged. First, symptom trajectories can improve rapidly: in an observational cohort (n=82), most symptoms improved within about a week and longer symptom duration correlated with worse diplopia and motility limitation (Amrith et al. 2010). Second, in isolated orbital floor fractures (n=307), only a minority (9.8%) proceeded to surgery, generally becoming evident within a short early observation window (2–4 days) (Soliman et al. 2023). These data support structured early assessment

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with short, purposeful observation when appropriate, while ensuring timely surgery for those meeting clear criteria.For ZMC fractures (n=62), early timing also mattered for objective reduction metrics: operating within 3–7 days was identified as a favorable factor for improved intraorbital volume symmetry, particularly with multiple-point fixation strategies (Ebeling, Sakkas et al. 2025).

Tooth avulsion outcomes were strongly dependent on time out of socket. In a retrospective cohort of replanted teeth (n=62), extra-alveolar time >60 minutes markedly increased failure risk (Roskamp et al. 2023). This reinforces that emergency workflows (rapid replantation or immediate appropriate storage, transport) are central to long-term survival.For fractured anterior teeth, fragment reattachment represents an “early restorative intervention” aiming to restore form and function quickly. In complicated crown-root fractures, a cohort study including 20 patients (22 teeth) found both immediate single-visit and staged multi-visit approaches achieved satisfactory esthetics at 1 year; multi-visit care had shorter operative duration and less intra-operative pain, fatigue with slightly better early periodontal parameters, but potentially higher detachment risk (Liu et al. 2024). Longer-term outcomes were also encouraging in a retrospective cohort of 75 anterior crown fractures treated with fragment reattachment, with estimated retention rates declining over time and influenced by age and fracture complexity (Sung et al. 2025).

DISCUSSION

Early management should be conceptualized as time-sensitive windows that vary by tissue biology and by the feasibility of temporary stabilization. For mandibular fractures, prior systematic review evidence has been mixed due to heterogeneity and variable definitions (Stone et al. 2018). Our included primary studies suggest two practical messages. Shorter wait times may reduce infection risk in some settings (Gazal et al. 2015). Semi-elective pathways may be safe for selected, medically fit and compliant patients when interim stabilization and follow-up are implemented, with system benefits including reduced inpatient days (Hughes et al. 2022). This supports a risk-stratified model rather than a rigid “always immediate ORIF” approach.

In midface and orbital trauma, the evidence favors purposeful early decision-making. Reviews and practice discussions emphasize identifying indications for immediate vs delayed repair and avoiding preventable sequelae (Patel et al. 2021). Our included cohorts align with this: many orbital symptoms improve within days (Amrith et al. 2010), and only a subset of isolated orbital floor fractures require surgery after short-term observation (Soliman et al. 2023). For ZMC fractures, early intervention within a 3–7 day window may optimize intraoperative symmetry outcomes while balancing edema resolution and avoidance of fibrous consolidation (Ebeling, Sakkas et al. 2025). This is consistent with broader concepts in sequencing complex facial repairs (Ramakrishnan et al. 2020). Dental trauma displayed the strongest biologic time-dependence: extra-alveolar time in avulsion injuries is a key determinant of survival, and delayed replantation carries high risk of failure (Roskamp et al. 2023). This reinforces the importance of prehospital

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and ED staff competence and standardized protocols, an area also emphasized in consensus guidance (Huang et al. 2024). For restorative crown injuries, fragment reattachment can provide efficient, conservative restoration; outcomes depend on fracture type, patient factors, and technique. The included cohort evidence suggests both single-visit and staged approaches can be effective, with tradeoffs between patient comfort, periodontal parameters, and detachment risk (Liu et al. 2024), and longer-term retention is affected by fracture complexity and age (Sung et al. 2025).

Limitations

Included studies were heterogeneous in design and outcome definitions, limiting quantitative pooling. Confounding (injury severity, contamination, smoking, compliance, and resource availability) likely influenced associations between timing and outcomes. Many results are context-dependent and reflect trauma system organization.

CONCLUSION

Evidence from PMC original studies supports structured emergency pathways emphasizing early stabilization and timely definitive management for maxillofacial trauma, while allowing selected semi-elective strategies without compromising outcomes in appropriately chosen mandibular fracture patients. Early windows appear beneficial for midface fracture reduction accuracy and pediatric nasal fracture outcomes. Dental trauma is highly time-sensitive: avulsion survival worsens markedly with prolonged extra-alveolar time, and fragment reattachment can provide acceptable outcomes when performed with appropriate protocols and case selection.

List of Abbreviations

A&E: Accident and Emergency

CBCT: Cone-Beam Computed Tomography

CRF: Crown-Root Fracture

ED: Emergency Department

HR: Hazard Ratio

IADT: International Association of Dental Traumatology

LOS: Length of Stay

OMFS: Oral and Maxillofacial Surgery

ORIF: Open Reduction and Internal Fixation

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

TMJ: Temporomandibular Joint

TDI: Traumatic Dental Injury

ZMC: Zygomaticomaxillary Complex

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