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Return to Play After Maxillofacial Fractures in Professional Athletes

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Abstract

Background. Maxillofacial fractures in professional sports traditionally dictate 8-12 weeks of recovery. Evolving rehabilitation approaches and materials engineering prompt a re-evaluation of these protocols to safely reduce athletic absence.

Aim. To synthesize literature on optimizing return-to-play (RTP) timelines for maxillofacial injuries and propose clinical and radiological criteria for a safe return, emphasizing zygomaticomaxillary complex (ZMC) fractures.

Material and methods. A narrative review of 36 peer-reviewed articles was conducted, focusing on RTP timelines, epidemiology, combat sports, protective gear (masks and mouthguards), clinical management, and bone healing biology.

Results. Early RTP (under 6 weeks) is feasible for selected athletes utilizing mandatory protective masks and strictly graded physical activity. Conversely, high-impact and combat sports require a strict minimum 3-month recovery. Custom polycarbonate masks and intraoral mouthguards effectively mitigate secondary injury risks.

Conclusions. RTP can be safely accelerated through rigid internal fixation and advanced protective wear. However, this mandates rigorous multidisciplinary monitoring, individualized risk assessment, and informed consent.

Keywords: maxillofacial fractures, return-to-play, combat sports, protective masks, sports medicine, rehabilitation

1. Introduction

Maxillofacial fractures constitute a complex clinical challenge in the athletic population. The anatomy of the face serves as a protective structure for sensory organs and is highly susceptible to trauma during physical competition. In professional sports, prolonged recovery periods create a conflict between the biological requirements of hard tissue healing and professional pressures, including contractual obligations and athletic ambitions [5].

Historically, sports medicine relied on general maxillofacial surgery guidelines, which recommended a period of 8 to 12 weeks for facial bone fractures to achieve adequate radiological union before facing potential secondary impacts [33, 34]. Contemporary epidemiological data reveal that the incidence of maxillofacial injuries in certain sports remains substantial, particularly in ice hockey, soccer, and combat sports [6, 11]. This sustained injury rate has prompted the exploration of more individualized rehabilitation protocols. Advancements in protective masks designed via CAD/CAM technology and 3D printing [17], along with the widespread application of open reduction and internal fixation (ORIF), provide new mechanisms for load distribution and protection [25].

The divergence between conservative surgical timeframes and the operational demands of professional sports creates a need for synthesized clinical Return-to-Play (RTP) pathways [3]. The objective is to facilitate an earlier return while minimizing the risks of refracture, diplopia, or facial asymmetry. This issue is uniquely challenging in maximum-contact disciplines, such as boxing and mixed martial arts (MMA), where the head is a legal target [10, 14].

Research Objective

The primary research objective of this narrative review is to evaluate the scientific literature regarding optimal return-to-play (RTP) timelines following maxillofacial fractures in professional athletes, specifically analyzing the conditions under which an early return (under 6 weeks) might be considered safely applicable.

Key Review Questions

1. Is an early return to professional team sports (under 6 weeks) achievable and safe after a stable maxillofacial fracture when utilizing rigid fixation and customized protective masks?

2. Does the literature support the necessity of a minimum 3-month convalescence period for combat sports (boxing, MMA) due to unavoidable head impacts?
3. How does the application of rigid plate stabilization (ORIF) alter the functional timeline for mechanical loading compared to the timeline of natural radiological bone union?

2. Research materials and methods

2.1. Participants

The analysis summarizes data from 36 selected peer-reviewed publications. The populations within these source studies included professional and amateur athletes, as well as patients treated in emergency and maxillofacial surgery departments for sports-related trauma. The cumulative sample sizes across these studies range from small case series to large database analyses encompassing thousands of craniofacial injuries [1, 10, 11].

2.2. Procedure / Test protocol / Skill test trial / Measure / Instruments

This study is structured as a comprehensive narrative review. The selected literature was categorized into specific analytical domains: (1) Time to return to sport in professionals, (2) Epidemiology and trends, (3) Combat sports, (4) Protective masks, (5) Mouthguards, (6) Clinical management, (7) Nasal fractures, and (8) Biology of facial bone healing. Relevant data regarding rehabilitation timelines, relative risk estimates, injury specificity, and protective equipment properties were systematically extracted and synthesized to address the key review questions.

2.3. Data collection and analysis / Statistical analysis

2.3.1. Statistical Software

As this study is a narrative review, no primary dataset was generated, and therefore no proprietary statistical software was utilized for de novo inferential statistical calculations. All numerical data, including frequencies, means, and relative risk estimates, were extracted directly from the peer-reviewed source literature.

2.3.2. AI

Artificial intelligence (AI) tools were utilized for two specific, clearly delimited purposes in this study. First, AI-assisted text analysis was applied to the extracted literature to support the identification of recurring thematic patterns and to help organize the reviewed evidence into coherent conceptual categories (e.g., etiology, pathophysiology, epidemiology, diagnostics, and prevention). Second, AI was used to refine the academic English of the manuscript, ensuring clarity, terminological consistency, and adherence to scientific writing standards.

It is important to emphasize that all AI tools were used strictly as assistive instruments under continuous human supervision. The selection of sources, critical appraisal of the included studies, interpretation of results, and formulation of all conclusions were performed exclusively by the human authors, who are responsible for the scientific content of this review. The AI tools served primarily to enhance efficiency in literature organization, thematic synthesis, and linguistic refinement, and did not replace expert human judgment at any stage of the analytical or interpretive process. The authors have reviewed, verified, and approved all content in its final form and take full responsibility for the integrity and accuracy of the work.

2.3.3. Statistical Methods

Data from the selected publications were synthesized qualitatively. Extracted numerical parameters included reported times to resume training (measured in days or weeks), surgical intervention rates (expressed as percentages), and risk estimates for protective equipment (such as relative risk or odds ratios). Evidence was contextualized by noting the varying study designs, ranging from systematic reviews and meta-analyses to retrospective cohorts and observational case reports, allowing for a weighted narrative synthesis of the findings without formal statistical pooling.

3. Research results

3.1. Time to return to sport in professionals

The concept of accelerated RTP balances patient safety against athletic demands. A systematic review by Ansari et al. (2019) [1] investigated this paradigm, analyzing early return (< 6 weeks) protocols. Based on their synthesis, which included two notable retrospective studies (n=278), returning to play at approximately 7 weeks yielded a low refracture rate [1]. However, the authors explicitly emphasized the limitations of the available evidence, stressing the necessity for individualized approaches, careful discipline gradation, rigorous use of protective masks, and obtaining informed consent [1].

An accelerated protocol was documented by Hada et al. (2019) [2] in a cohort of elite rugby players. Following surgical treatment of facial fractures, athletes were permitted to begin jogging at an average of 9.9 days, participate in specific training at 10.8 days, and resume full physical contact at 18.3 days [2]. The study reported no refractures, highlighting the mechanical durability of titanium micro-osteosynthesis (ORIF) in a monitored environment [2].

Fowell and Earl (2013) [3] proposed criteria for a safe return after 3 weeks based on a prospective series of 20 athletes (with 17 of the 20 successfully returning to competition in that timeframe). They emphasized the importance of a risk-benefit analysis, clear communication with the athlete regarding inherent micro-risks, and the strict absence of neurological or ophthalmological deficits prior to clearance [3]. Conversely, Roccia et al. (2008) [4] recommended a slightly more conservative baseline of ≥40 days for general sports. Their multicenter analysis noted a 93.5% operative rate, primarily addressing displaced midface and mandibular fractures [4]. Bojino et al. (2020) [5] proposed a 4-step graded return protocol, emphasizing the distinction between amateurs and professionals; they noted that contract pressure often drives the demand for "fast-track" procedures in professional settings [5].

3.2. Epidemiology and trends of maxillofacial fractures in sports

Puolakkainen et al. (2022) [6] tracked injury trends in Finland over nearly 30 years, observing a sustained frequency of maxillofacial fractures, predominantly driven by ice hockey and soccer. Within their cohort, 46.5% of injuries required open reduction and internal fixation [6].

Ruslin et al. (2016) [7] demonstrated a correlation between specific sports and fracture morphology. Zygomatic bone fractures were most prevalent among cyclists and soccer players, while soccer also presented a notable frequency of isolated coronoid process fractures [7]. Rugby, characterized by lateral body collisions, showed a predisposition for mandibular angle fractures [7]. Viozzi (2017) [8] indicated that sports account for 3% to 29% of all facial injuries presenting to surgical emergency departments, with fractures comprising 10% to 42% of these cases. Gilardi et al. (2023) [9] analyzed ice hockey trauma, finding the face to be the most frequently injured region (31.3% of all injuries), primarily resulting from direct player-to-player contact or puck impacts [9].

3.3. Combat sports

Combat sports require a distinct clinical approach due to the intentional nature of head strikes. An analysis of the National Electronic Injury Surveillance System (NEISS) from 2014–2023 by Mehra et al. (2026) [10] identified that among reported craniofacial injuries across various combat sports, boxing accounted for the highest proportion of facial fractures, constituting 13.2% of the craniofacial trauma recorded [10]. Hojjat et al. (2016) [11] reported that fractures constituted 36.9% of all facial injuries evaluated among boxers in emergency settings.

Jones et al. (2023) [12] found that in professional Mixed Martial Arts (MMA), facial trauma accounted for 15.8% of injuries, with fractures specifically representing 3.6%. Chang et al. (2024) [13] compared visual organ trauma between the two sports, noting that the design of MMA gloves contributed to a higher rate of orbital blow-out incarcerations (17.6% of severe eye injuries) compared to boxing (3.1%) [13]. Studies by Karpman et al. (2016) [14] and a meta-analysis by Huang et al. (2026) [15] further document the consistent risk of facial bone trauma in MMA (approximately 10.9%) [14, 15]. Due to the inability to utilize protective masks during competition, the literature uniformly recommends a minimum 3-month convalescence period for combat athletes to allow for adequate mineral saturation of the secondary callus [1, 4].

3.4. Protective masks

External force dispersion systems play a critical role in facilitating early RTP. Antunes et al. (2018) [16] documented a 3-week return for a soccer player utilizing a thermoformable mask made of ethylene-vinyl acetate (EVA). They identified key requirements for such masks: low weight, flexibility in the impact zone, and uncompromised peripheral vision [16].

Orabona et al. (2019) [17] utilized in-house 3D printing and CBCT scans to produce polycarbonate masks for isolated zygomatic arch fractures treated without fixation. This rapid prototyping method yielded personalized masks at a low cost of approximately 5 euros and required roughly 90 minutes of production time [17]. Aung et al. (2021) [18] evaluated the physical properties of 3D-printed masks made from perforated ABS and knitted fabric cushioning. Their testing confirmed that this composition offers favorable air permeability, flexural strength, and shock absorption capability, providing a mechanical barrier that shields healing bone trabeculae [18].

3.5. Mouthguards

A systematic review and meta-analysis by Knapik et al. (2019) [19] demonstrated the efficacy of mouthguards in reducing the risk of overall orofacial injuries. Their analysis indicated a substantial protective effect, estimating that athletes who do not wear mouthguards face an approximately 2.3 times higher risk of orofacial injuries compared to users (RR ~2.3) [19]. However, both their 2019 study and an earlier 2007 review [20] emphasize that there is a lack of credible evidence to suggest mouthguards provide systemic protection against concussions [19, 20].

Fernandes et al. (2019) [21] similarly demonstrated a lower prevalence of dentoalveolar trauma among athletes utilizing mouthguards. Current guidelines issued by the International Association of Dental Traumatology (IADT) and the Academy for Sports Dentistry (ASD) in 2024 strongly recommend custom-made, multi-layer guards over universal (stock) or boil-and-bite variants [22]. Roberts (2023) [23] highlighted ongoing materials research and the potential for integrating biomechanical sensors, while Tuna and Ozel (2014) [24] discussed how mouthguards help dissipate upward forces directed at the skull base [23, 24].

3.6. Clinical management, surgical treatment, and imaging

A Cochrane review by Nasser et al. (2013) [25] evaluated treatments for mandibular fractures, comparing closed reduction with open reduction and internal fixation (ORIF). ORIF facilitates the immediate mechanical restoration of the mandibular arch, allowing for earlier nutritional progression and the prevention of muscle atrophy [25]. Nevertheless, Meara (2023) [26] highlighted that temporary elastic occlusal guidance and physiotherapy remain essential for restoring functional occlusion [26].

For sideline management, Usman (2022) [27] outlined critical red flags indicating the need for immediate removal from play, including diplopia in extreme gaze positions, palpebral crepitus (subcutaneous emphysema), and infraorbital nerve (V2) entrapment [27]. For diagnostic imaging, the American College of Radiology (ACR) 2022 guidelines establish non-contrast maxillofacial computed tomography (CT) with 3D reconstruction as the gold standard, noting that traditional radiography is generally insufficient [28].

3.7. Nasal fractures

Patel et al. (2017) [29] estimated that isolated nasal bone and septal injuries represent approximately 60% of all maxillofacial sports trauma. Following proper acute care, they suggest athletes may return to play within days if utilizing a polycarbonate mask, which should be worn for 6 weeks [29]. Marston et al. (2017) [30] emphasized the importance of identifying acute nasal septal hematomas to prevent cartilage lysis and subsequent saddle nose deformities [30].

An epidemiological study by Manninen et al. (2023) [31] of 599 patients noted that psychological concerns regarding permanent disfigurement strongly influence the preference for surgical management in nasal fractures. Renkonen et al. (2016) [32] demonstrated the efficacy of closed reduction under local anesthesia in a cohort of 483 patients, identifying an optimal therapeutic window of approximately 10 days post-injury, after which early callus formation hinders closed manipulation [32].

3.8. Biology of facial bone healing

Rever et al. (1991) [33] demonstrated in animal models that facial bones heal primarily via secondary union, with a robust bone matrix forming around the 8-week mark [33]. Kawai et al. (1997) [34] assessed radiological union in human mandibles, noting that signs of union appear at 1-2 months in younger populations and 2-3 months in adults, with over 85% showing full radiological union by 3 months [34].

Yu et al. (2020) [35] utilized serial CT scans to track the precise radiological phases of fracture evolution. Zhang et al. (2012) [36] described the underlying mechanisms, detailing the inflammatory, soft callus, hard callus, and prolonged remodeling phases driven by chemical and mechanical stimuli [36]. The capacity for early return to sport prior to 8-12 weeks relies mechanically on modern titanium miniplate systems (ORIF), which transfer functional loads across the fracture gap during the biological healing phase [1, 2, 4].

4. Discussion

The clinical management of maxillofacial injuries in professional athletes requires reconciling the biological timeline of bone healing with occupational demands. Epidemiological data highlight a consistent volume of facial trauma across multiple sports [6, 11]. While fundamental biological studies confirm that mineralized bone union requires approximately 12 weeks to peak structurally [33, 34], the clinical approach in sports medicine increasingly focuses on functional restoration supported by hardware.

The evidence suggesting the feasibility of early RTP (e.g., Ansari 2019, Hada 2019) is largely derived from retrospective analyses and case series [1, 2]. This indicates a relatively low level of evidence; therefore, generalized recommendations must be made with caution. The utilization of ORIF acts as an internal load-bearing scaffold, while custom 3D-printed polycarbonate masks serve as an external protective barrier [17, 18]. Together, these modalities bypass the biological timeline of primary tissue weakness by deflecting kinetic forces away from the healing osteotomy sites.

However, applying this accelerated timeline to combat sports is medically contraindicated. Statistics from Karpman (2016) [14], Jones (2023) [12], and Huang (2026) [15] illustrate that the face intentionally absorbs severe impact forces in these disciplines. Attempting to accelerate the return of combat athletes prior to the 3-month mark risks severe complications, including refracture and neurological trauma, as the skull remains structurally compromised [1, 10].

Regarding general protective equipment, reviews by Knapik (2007, 2019) [19, 20] clarify a vital distinction: mouthguards significantly reduce the risk of localized dentoalveolar trauma but lack evidence for providing systemic protection against concussions. Therefore, while mouthguards are highly effective for orofacial protection [21], they do not mitigate neurological impact risks.

Proposed Clinical and Radiological Criteria for Return-to-Play Following Zygomaticomaxillary Complex (ZMC) Fractures

A specific gap identified in the literature involves standardized RTP criteria for complex midface injuries. Based on the synthesis of clinical principles discussed in the reviewed literature (drawing upon guidelines proposed by Fowell [3], Roccia [4], and Usman [27]), the following theoretical clinical-radiological criteria are proposed. *These represent an expert synthesis and recommendation rather than prospectively validated clinical rules, and should be interpreted as a framework for physician decision-making.*

1. **Ophthalmological and Neurological (Clinical):**
    1. Absence of diplopia in all fields of gaze, confirmed via formal ophthalmological testing.
    2. Absence of restrictive ophthalmoplegia or clinically significant enophthalmos.
    3. Satisfactory recovery or stable management of infraorbital nerve (V2) paresthesia.

2. **Stomatognathic (Clinical):**
    1. Restoration of the patient's baseline dental occlusion.
    2. Adequate and pain-free maximal incisal opening (typically >40 mm, though this should account for individual pre-trauma anatomical variability), without mechanical impingement from the zygomatic arch.

3. **Physical (Clinical):**
    1. Resolution of acute visual-field-limiting edema.
    2. Absence of pain upon palpation over the fracture sites and during simulated functional loading.

4. **Radiological (High-Resolution CT):**
    1. Anatomical restoration of the midfacial buttresses.
    2. Confirmation of stable hardware placement without evidence of screw pull-out.
    3. Adequate reconstruction of the orbital floor to prevent herniation of periorbital contents.

Meeting these synthetic criteria may reasonably inform a physician's decision to permit a graded return to contact activities, always necessitating close supervision and individualized risk assessment [3, 5].

5. Conclusions

1. **Feasibility of Early Return:** Permitting a professional athlete to return to sports following surgical treatment of maxillofacial fractures before the traditional 8–12 weeks of biological union is documented in the literature as feasible for certain non-combat sports [1, 2]. This relies on the mechanical support of titanium fixations (ORIF) and shock-absorbing masks. However, this conclusion is based primarily on lower-level evidence (retrospective studies and case series) and requires strict individualization and informed consent [1, 3].

2. **Categorization of Disciplines:** For combat sports (boxing, MMA), early RTP remains contraindicated. The physiological period required for complete callus remodeling (minimum 12 weeks) must be respected to prevent severe secondary structural and neurological trauma [10, 11, 14].

3. **Protective Materials:** Rapid prototyping and 3D modeling of custom masks facilitate accelerated convalescence by providing necessary protection without severely compromising vision [17]. Similarly, custom-made intraoral mouthguards are strongly recommended for their proven efficacy in reducing dentoalveolar injuries, though they do not prevent concussions [19, 21].

4. **Clinical Frameworks:** Formulating structured RTP criteria, such as the proposed theoretical framework for ZMC fractures, can assist sports medicine physicians. Transparent communication regarding the limitations of medical hardware and biological healing timelines is essential to counter commercial pressures in professional sports [3, 4, 5].

Disclosure

The authors report no inappropriate organizational affiliations.

Supplementary Materials

No additional materials are directly attached; inquiries should be directed to the corresponding author.

Author Contributions

Conceptualization: SP, KS, AM
Methodology: SP
Software: SP
Check: KS, AM
Formal analysis: SP
Investigation: AM
Resources: SP, KS
Data curation: SP
Writing - rough preparation: SP
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Supervision: AM
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Conflicts of Interest

The authors declare a complete absence of any financial or intellectual conflicts of interest.

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