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A Review On Sports And Orthodontics

1Dr.Mythreyaan G, 2Dr.Prudhivirajan M, 3Dr.Jeevana Poovalingam, 4Dr.Karthikeyan, 5Dr.Saravanan.R

1House Surgeon, 2House surgeon, 3Senior Lecturer, 4Professor, 5Professor

1Thai Moogambigai Dental College and Hospital,

2Thai Moogambigai Dental College and Hospital,

3Department of Orthodontics & Dentofacial Orthopaedics, Thai Moogambigai Dental College and Hospital, Dr. M.G.R. Educational and Research Institute,

4Department of Orthodontics & Dentofacial Orthopaedics, Thai Moogambigai Dental College and Hospital, Dr. M.G.R. Educational and Research Institute,

5Department of Orthodontics & Dentofacial Orthopaedics, Thai Moogambigai Dental College and Hospital, Dr. M.G.R. Educational and Research Institute

Abstract

The intersection of sports and orthodontics represents a vital area in ensuring athlete safety, oral health, and performance optimization. Athletes undergoing orthodontic treatment are at increased risk of dental trauma, appliance damage, and soft tissue injuries, necessitating preventive strategies and customized protection. Orthodontic mouthguards particularly custom-fabricated, dual-laminate, and digitally designed variants offer superior fit, comfort, and impact absorption compared to conventional types. Advances in 3D scanning, CAD/CAM, and AI-driven fabrication now allow precise, adaptive designs suited for evolving dentition. Orthodontic treatment can further enhance airway patency, occlusal balance, and self-confidence, supporting athletic endurance and performance. Smart mouthguards integrated with sensors enable real-time monitoring of impact forces and physiological data, representing the future of personalized sports safety. A multidisciplinary collaboration among orthodontists, sports dentists, and trainers is essential to ensure comprehensive protection and continuity of orthodontic care in athletic environments.

Keywords: Orthodontics, Sports Dentistry, Mouthguards, 3D Printing, Smart Devices

Introduction

Sports and orthodontics share a critical intersection where oral health, functional performance, and injury prevention align to ensure the well-being and safety of athletes. Athletes undergoing orthodontic treatment present unique clinical considerations, as the presence of brackets, wires, or aligners not only increases susceptibility to oral trauma but can also exacerbate soft tissue injuries upon impact.[1] Participation in contact and high-intensity sports such as football, basketball, hockey, boxing, and martial

arts significantly elevates the risk of dental fractures, lacerations, and appliance breakage. Consequently, orthodontists and sports dentists emphasize a proactive, preventive approach that integrates customized protective strategies particularly the use of custom-fitted mouthguards to safeguard both dental structures and orthodontic appliances.[2] Unlike generic or boil-and-bite variants, custom mouthguards are fabricated to precisely fit an athlete's oral anatomy, accommodating orthodontic components while providing superior comfort, stability, and shock absorption. Advances in materials such as Ethylene Vinyl Acetate (EVA) and digital fabrication technologies have further enhanced the design, allowing for layered constructions that absorb and distribute impact forces efficiently.

Beyond their protective role, orthodontic interventions themselves can contribute positively to athletic performance by improving occlusal balance, chewing efficiency, airway patency, and speech clarity factors that collectively support endurance and coordination.[3] However, sports-related trauma can compromise orthodontic treatment by damaging appliances, prolonging therapy, or causing unexpected discomfort, making routine dental check-ups and appliance monitoring essential for active athletes. The collaboration between sports dentists and orthodontists is therefore indispensable, encompassing not only clinical care but also education and advocacy.[4] Through awareness programs, emergency dental kits, and training for coaches and athletes, professionals can promote compliance with safety gear and enhance preparedness for on-field injuries.[5]

Orofacial Trauma and Sports: Epidemiology and Mechanisms

Orofacial trauma represents a major clinical and public health concern in sports, encompassing a wide spectrum of dental and facial injuries that occur across both contact and non-contact disciplines. Epidemiological studies reveal that the overall prevalence of dentofacial injuries among contact sports participants ranges between 27% and 30%, with notably higher rates in basketball (up to 80.6% among professionals), rugby (37.4%), hockey (33.8%), handball (21.8%), and football (16.6%). Even in non-contact and wheeled sports such as cycling, skateboarding, and rollerblading, the incidence of orofacial trauma remains significant, with an overall prevalence of about 21.7% and dental injuries specifically affecting roughly 7.5% of athletes.[5,6,7] Most injuries approximately 55% occur during matches rather than practice sessions, highlighting the role of high-impact, competitive play.

Common injury types include dental trauma such as avulsion, luxation, and crown fractures; soft tissue lacerations and contusions involving the lips, cheeks, and mucosa; temporomandibular joint (TMJ) injuries like dislocation and disc compression; and skeletal fractures of the mandible or zygomatic bone, particularly in sports involving high-velocity collisions or contact with equipment. [6,7]The predominant mechanisms of injury involve direct impacts from other players, balls, sticks, or sporting gear, as well as falls and accidental collisions that generate significant blunt force trauma.[8] Moreover, underlying dental and skeletal anomalies such as malocclusion and increased overjet (greater than 4–6 mm) substantially heighten both the likelihood and severity of trauma, particularly affecting maxillary incisors that lack adequate lip protection.[9] Class II Division 1 malocclusion and incompetent lip closure further exacerbate vulnerability to frontal dental injuries. Orthodontic intervention aimed at early correction of excessive overjet and improvement of lip coverage can thus play a preventive role in reducing susceptibility to dental trauma among at-risk athletes.[10]

Figure 1: Orofacial Trauma and Orthodontics

Orthodontic Considerations in Athletes

Orthodontic management in athletes demands a specialized and carefully coordinated approach that integrates comprehensive assessment, personalized treatment planning, and proactive injury prevention strategies to safeguard oral health while maintaining peak sports performance.[11] A thorough pre-treatment evaluation, including a detailed medical and dental history, is essential to identify systemic conditions, previous facial trauma, or medication use that may influence healing or injury risk. Risk assessment must consider the athlete's primary sport, as high-contact activities such as boxing, hockey, football, and martial arts carry a greater likelihood of orofacial trauma compared to non-contact sports like swimming or running. Baseline records, including occlusal analysis and documentation of malocclusion or increased overjet, allow orthodontists to identify individuals at elevated risk and implement preventive measures accordingly.[12]

Fixed orthodontic appliances, while effective for alignment, pose challenges in sports settings due to the risk of soft tissue lacerations from brackets and wires upon impact and difficulties in fitting protective mouthguards over moving teeth. Removable and clear aligner therapies provide alternative advantages, being smooth, comfortable, and less likely to cause soft tissue injury, while allowing removal during high-contact sports so athletes can wear standard mouthguards; however, frequent removal or loss of aligners can disrupt treatment progress, and wearing aligners without external protection may still leave teeth vulnerable to trauma.[13] Ideally, orthodontic treatment should begin during an athlete's off-season to minimize interference with performance and reduce the risk of irritation or appliance-related discomfort during competition.[14] When trauma occurs during orthodontic care, immediate management includes assessing the extent of injury, stabilizing loose brackets or wires, treating soft tissue damage, and ensuring proper documentation and radiographic evaluation, often requiring collaboration between orthodontists, general dentists, and sports trainers. Regular follow-ups reinforce preventive practices, ensure appliance integrity, and facilitate prompt intervention if injuries arise.[15]

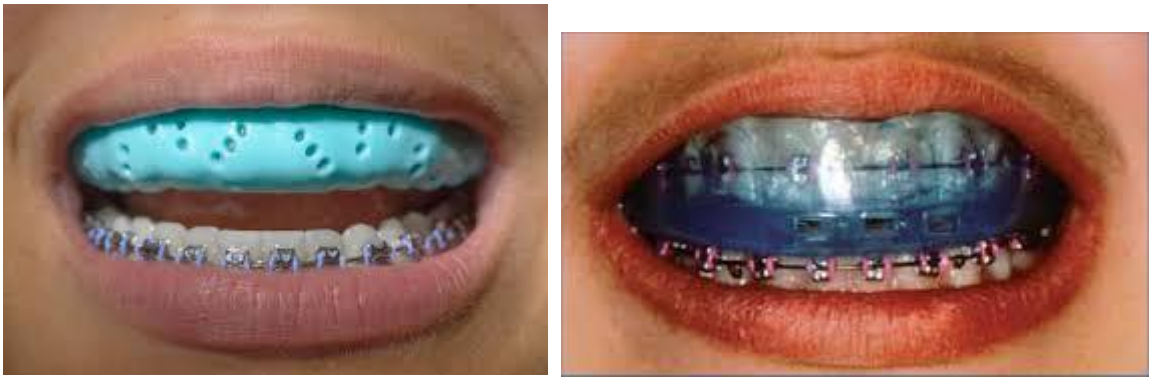

Figure 2: Mouthguards in Orthodontics

Mouthguards in Orthodontics

Orthodontic mouthguards play an essential role in safeguarding athletes' teeth, soft tissues, and orthodontic appliances during sports activities, offering a critical balance between protection, comfort, and adaptability throughout orthodontic treatment. Depending on their design and fabrication process, mouthguards are classified into three primary types—stock, boil-and-bite, and custom-fabricated each differing in fit, comfort, and protective efficacy. Stock mouthguards, which are pre-formed and inexpensive, provide the least protection and poorest fit, often feeling bulky and uncomfortable, especially when worn over braces.[16] Boil-and-bite mouthguards, made of thermoplastic materials that soften in hot water and are molded to the user's teeth, offer a moderately improved fit but often fail to adapt well over orthodontic appliances and may deform as tooth positions change during treatment. In contrast, custom-fabricated mouthguards crafted from precise dental impressions or 3D intraoral scans represent the gold standard in orofacial protection for orthodontic patients, ensuring superior comfort, retention, and shock absorption.[17]

These custom devices are designed to accommodate brackets, wires, and ongoing tooth movement, providing an individualized, secure fit despite the dynamic changes associated with active orthodontic therapy. Design modifications in orthodontic mouthguards include buffer zones around brackets, increased material thickness, and specialized features such as brace bumpers and flexible ortho-channels to contour around appliances.[18] Material selection is equally vital: soft, dual-laminate Ethylene Vinyl Acetate (EVA) is most commonly used, combining a cushioned inner layer for comfort with a firm outer shell that effectively distributes impact forces. Recent advancements in digital fabrication technologies, including 3D scanning and additive manufacturing, have revolutionized mouthguard production, enabling faster fabrication, precise adaptation, and easy replacement as the dentition evolves during treatment. Regular reassessment and periodic replacement are essential to maintain fit and protection during active tooth movement.[19]

From a biomechanical standpoint, orthodontic mouthguards function through force distribution and energy absorption, effectively dispersing impact forces over a larger surface area to minimize tooth avulsion, fracture, or bracket dislodgement, while soft, resilient materials absorb kinetic energy to reduce transmitted forces. Additionally, their smooth, well-adapted surfaces protect against soft tissue injuries such as lip and cheek lacerations, which are otherwise common in athletes with braces.[20,21]

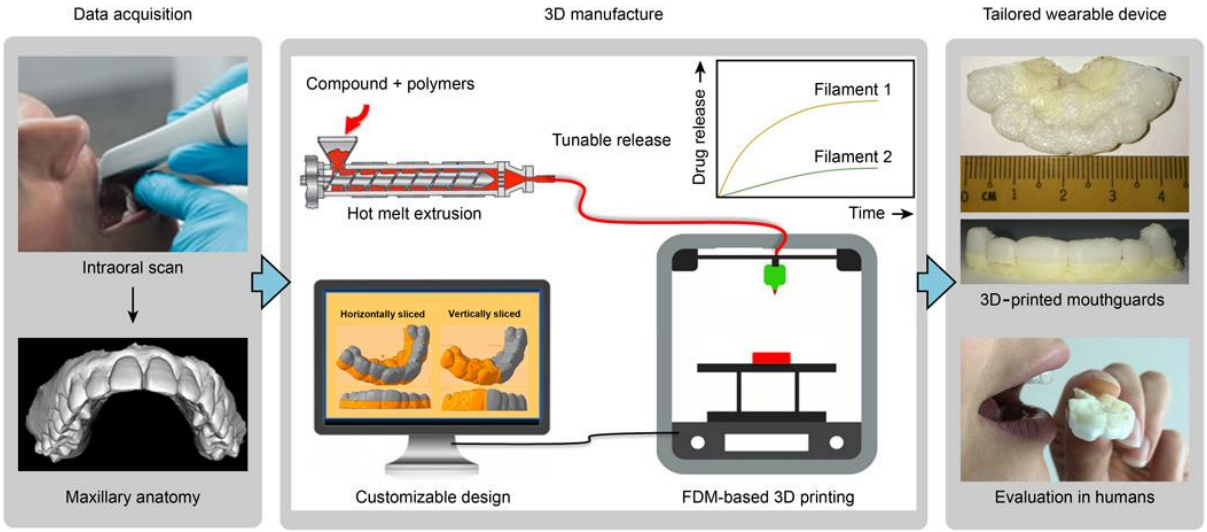

Figure 3: 3D printing and CAD/CAM for Mouthguard

Orthodontic Considerations in Sports Performance and Safety

Orthodontic appliances significantly influence athletes' speech, breathing, performance, and psychological well-being, while also presenting unique challenges in mouthguard compliance and emergency management during sports activities.[22] Fixed appliances and aligners can initially affect articulation particularly in producing sibilant and fricative sounds though speech adaptation typically occurs within weeks. Orthodontic correction can enhance breathing efficiency by improving jaw alignment and arch form, thus promoting nasal airflow, reducing mouth breathing, and indirectly contributing to improved endurance, airway patency, and athletic performance.[23] Certain appliances, such as palatal expanders or functional devices, are intentionally designed to optimize airway space, offering potential benefits in sleep quality and stamina.

On a psychological level, the visibility of braces may temporarily affect self-esteem and body image, especially for athletes frequently in the public eye or media, leading many to prefer aesthetic options such as clear aligners or ceramic brackets. However, successful orthodontic treatment often enhances confidence, communication, and overall psychological resilience[24]. Despite the proven protective role of mouthguards, athletes undergoing orthodontic treatment often face compliance challenges due to discomfort, speech interference, or poor fit. [25]

Conclusion

In conclusion, the synergy between orthodontic treatment and sports safety highlights the importance of advanced, personalized protection systems for athletes. The integration of AI-driven 3D printing and CAD/CAM technology enables precise, custom-fitted mouthguards that adapt to dynamic orthodontic changes. Emerging smart mouthguards with embedded sensors enhance impact monitoring and athletic performance tracking. Future innovations combining clear aligner systems with 3D-printable polymers promise dual functionality offering both orthodontic correction and superior protective capability.

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