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Evolution of Sports Dentistry: Transformation from Reactive Trauma Management to Preventive Performance Optimization

ABSTRACT

Sports dentistry has undergone a fundamental metamorphosis over the past decade and a half. While earlier approaches primarily focused on treating injury-related dental damage, a itegrative care concept has emerged that positions dental expertise as a oral medicine component of multidisciplinary sports medicine teams. Scientific evidence demonstrates elevated oral health risks in elite athletes compared to the general population, necessitating specialized prevention and treatment strategies. Innovative approaches aim to eliminate oral pathologies while systematically activating the performance-enhancing potential of the oral region. This contribution analyzes the developmental dynamics of modern sports dentistry and examines integration possibilities into sports medical care concepts.

Keywords: Sports dentistry, elite sports, multidisciplinary integration, prevention strategies, oral performance optimization

1. Introduction: Paradigm Shift in Sports Dental Practice

The sports dentistry landscape experienced an unprecedented transformation process during the last 15 years. Historically, the field concentrated predominantly on treating traumatically-induced orofacial injuries in conventional practice environments. Current scientific evidence demonstrates, however, that intensive athletic activity, particularly in competitive sports, is associated with significantly elevated oral health risks[1].

Representative studies of different elite and professional athletes across various disciplines reveal a considerable prevalence of oral pathologies, with athletes frequently reporting performance-relevant impairments[2]. Systematic analyses of the interactions between

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competitive sports, athlete nutrition, and oral health clarify that regular screening programs and evidence-based prevention strategies can minimize performance-limiting effects of oral diseases[3].

These findings catalysed a fundamental reorientation of sports dental practices away from purely reactive treatment approaches toward proactive, integrated care concepts that function as essential components of multidiscipline athlete care[4].

2. Historical Development: From Isolated Traumatology to Networked Medicine

2.1 Traditional versus Contemporary Treatment Philosophies

Conventional sports dental approaches were primarily restricted to treating traumatically-induced dental damage in standardized practice environments. Sports dentistry was traditionally defined as a special discipline for the prevention of oro-facial athletic trauma and associated oral diseases[5]. Although this reactive approach closed important care gaps, it captured only fragmentary aspects of the complex challenges facing modern elite athletes.

The Academy for Sports Dentistry (ASD) in North America represents this traditional orientation to this day, with primary focus on traumatology and mouthguard provision as the foundation of American sports dentistry.

Contemporary sports dental concepts, in contrast, implement comprehensive care approaches. Modern sports dentists assume responsibility for injury prevention, trauma management, oral health optimization, and performance enhancement through systematic oral medicine as part of teamwork in sports medicine[6]. Research findings on training-associated oral health effects in athletes reflect a deepened understanding of complex interdependencies between oral health and athletic performance[7].

2.2 European Innovation from 2013: Breakthrough to Systematic and Systemic Dentistry

The year 2013 marks a turning point in European sports dentistry. While North American traditions remained traumatologically oriented, Europe initiated a revolutionary breakthrough to systemically-networked dentistry that produced a new generation of specialized team dentists.

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Ralf Rangnick established pioneering standards in individualized athlete development through Red Bull Salzburg. As a pioneer, Rangnick implemented the innovative NAM Dentistry (Neurobio-anatomical-metabolic principle) with preventive and regenerative focus as a central component of team dentist care[8]. This initiative implemented conceptual dentistry in elite sports for the first time, in contrast to American thinking patterns.

Prof. Dr. Tilman Fritsch, who served as sports dentist at Red Bull Salzburg, characterizes the cooperation with Rangnick: "I came to football quite clearly through Ralf Rangnick. [...] Ralf Rangnick is a visionary and a very complex-thinking person and football teacher. He understood very early the importance of the oral cavity and its significance for the entire body"[8].

Rangnick emphasizes: "On the topic of teeth and oral health, we are firmly convinced that there is a close connection to the players' performance capacity"[9]. This conviction resulted in systematic integration of dental expertise into holistic athlete care concepts.

2.3 NAM Principles versus Traditional Trauma Focus

Rangnick's visionary NAM implementation differed fundamentally from conventional sports dentistry. Fritsch explains: "As a dentist, I have developed a concept over the years, NAM Dentistry (Neurobio-anatomical-metabolic principle), that translates very well to elite sports"[10]. The concept is based on three foundational pillars: "inflammation-free status, toxin-free status, and functional optimization"[10].

Traditional American approaches, as represented by the Academy for Sports Dentistry (ASD), concentrate predominantly on reactive trauma treatment and mouthguard provision. This methodology is largely limited to emergency care during competitions and considers dentistry as an isolated discipline.

The European approach of NAM Dentistry, first established by Rangnick for a team, focuses on preventive health optimization and regenerative treatment concepts. Instead of reactive injury treatment, the NAM concept aims at systematic performance enhancement through networked, multidisciplinary care of all athlete health aspects.

Fritsch explains the medical rationale: "Inflammations in the mouth also radiate into the muscles, whereby the injury risk becomes exorbitantly high without the athlete noticing anything"[8]. This insight clarifies why the NAM concept goes beyond traditional trauma treatment and considers systemic connections.

2.4 Innovation of the Team Dentist Concept

This conceptual revolution generated a completely new type of team dentist who no longer functions exclusively as a "repairer" but works as a strategic partner in performance optimization. The modern European team dentist acts:

- **Preventively:** Systematic early detection and elimination of oral risk factors
- **Regeneratively:** Promotion of natural healing and regeneration processes
- **Integratively:** Networking with other sports medical disciplines
- **Conceptually:** Development of individual, long-term care strategies

Documented NAM Implementation Successes:

Fritsch reports on measurable improvements: "We have received corresponding testimonials, for example, from the Swiss Ski Federation, which have consistently shown that athletes feel they have 'more time' – an indication of improved concentration ability. You simply have more 'working memory' in your head"[8].

Rangnick explains the practical relevance: "Here the circle naturally closes again to the playing style of RB Leipzig. Precisely our type of football thrives on making correct decisions in confined spaces"[8].

2.5 International Sports Dentistry Development

Rangnick's groundbreaking implementation of the NAM concept had far-reaching effects on international sports dentistry evolution. Fritsch describes practical successes: "Ralf Rangnick's concept of completely and uncompromisingly providing care for a club in closest networking with other medical specialties in this manner is completely new and very successful"[10].

The implementation was not without challenges. Rangnick reports on initial resistance: "At the beginning, it was initially a bit tough, as some of the players thought it wasn't necessary to go to the dentist"[9].

Fritsch adds the holistic perspective: "I believe the oral cavity is a place where there are still potentials that we partially haven't yet utilized"[9].

The European Association for Sports Dentistry consensus statement on sports dentistry integration reflects this development from isolated traumatology to networked, preventive-regenerative care[4].

3. Epidemiology: Elevated Oral Health Risks in Elite Athletes

3.1 Prevalence Distribution of Oral Pathologies

Scientific evidence clearly demonstrates that dental disease risks in elite athletes exceed those of the normal population. Systematic literature analyses on oral health in elite athletes document high pathology prevalences: dental caries 15-75%, dental erosion 36-85%, periodontal diseases 15%[3,7].

Additional studies report oral disease prevalences in elite athletes: dental caries 20-84%, dental erosion 42-59%, gingivitis 58-77%, and periodontal diseases 15-41%, caused not only by frequent sugar/carbohydrate consumption, polyunsaturated fat intake, or inadequate protein supply[3,7] but also by insufficient regenerative capacity.

3.2 Oral Inflammatory Processes as Critical Determinants

Current scientific discourse on sports dentistry and potential interactions between oral health and athlete performance is gaining increasing importance[11]. Oral inflammatory processes in elite sports require special attention as they have not only local but also systemic consequences.

Periodontitis and circulating blood cell profiles show systematic correlations that possess particular relevance in elite athletes[12]. Young German athletes (competitive and amateur athletes) generally showed signs of gingival inflammation and needed to optimize their oral health behavior[13].

Exploratory studies document connections between oral inflammatory markers and performance parameters in young elite athletes, showing that blood and performance parameters are associated with periodontal inflammatory signs[14].

3.3 Performance Impact

Poor oral health demonstrably influences athletic performance capacity significantly. Overall, 32.0% of athletes reported oral health-related performance impacts: oral pain (29.9%), difficulties with normal training and competition participation (9.0%), impaired performance (5.8%), and reduced training volume (3.8%)[2].

"Untreated dental caries or periodontal diseases should not be the reason why an athlete misses a game or training session, but unfortunately it is quite common"[2].

4. Prevention Strategies and Systematic Screening

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4.1 Structured Screening Programs

Oral health screenings should be integrated into pre-seasonal athlete preparation[4]. Systematic screening programs represent a fundamental shift from traditional reactive to preventive care.

Elite athletes have high risk for poor oral health. Screening programs for oral health assessment and dental awareness creation can improve oral health in elite athletes[15]. The oral health of Dutch elite athletes was surprisingly impaired, as almost half required dental treatment[15].

These programs enable early detection of problems before they become performance-impairing complications. Regular oral health screening, integrated into general preventive healthcare for elite athletes, is necessary to ensure athletes are completely healthy during competitions[16].

4.2 Trauma Prevention through Mouthguard Technology

Custom-fitted mouthguards offer protection against orofacial trauma and possibly against concussions[4]. Mouthguard development and fitting evolved from simple protective measures to precise, sport-specific interventions.

Systematic reviews and meta-analyses confirm mouthguard effectiveness for orofacial injury and concussion prevention in sports[17]. The National Youth Sports Safety Foundation (NYSSF) estimates that players without mouthguards are 60 times more likely to damage their teeth[18].

5. Sports Nutrition Counseling: Emergent Competency Field

5.1 Sport-Specific Nutritional Risks

The sports dentist role expanded to include sport-specific nutritional counseling[3]. Continuous use of sports nutrition products was widespread, with high numbers of athletes reporting use of sports drinks during training or competition[19].

Sports drinks are often rich in sugar and carbohydrates. While this helps elite athletes maintain energy levels, oral bacteria feed on sugar and starch, releasing acids that leach minerals from tooth enamel – a process of demineralization[3],[19].

5.2 Risk Minimization Counseling

Modern sports dentists must advise athletes on how to minimize nutrition-related risks without impairing performance. Appropriately applied sports nutrition that provides performance

benefits and is connected with oral hygiene requirements is necessary for contemporary athlete health[3].

6. Educational Function for Athletes and Sports Community

6.1 Athlete Education

As members of athlete care teams, dentists trained to standards can offer sport-specific oral health counselling and encourage athletes to take responsibility for their oral health[4].

Behavior-changing suggestions for improving oral health in elite athletes show promising results[20].

Education goes beyond nutritional counseling and oral health guidance. It encompasses self-efficacy techniques aimed at athlete regeneration.

6.2 Extended Sports Community

The educational role extends to coaches, caregivers, and sports organizations. Surveys showed that only 15% would feel extremely comfortable treating dental-related sports injuries, while 95% would be open to additional dental education[18].

7. Innovative Concepts: Oral Risk Inversion and Potential Activation

7.1 Paradigm Shift: From Reactive to Proactive and Preventive

The concept of oral risk inversion and targeted utilization of oral potentials represents a fundamental paradigm shift. Instead of merely reacting to problems, the modern approach aims to understand the oral cavity as a performance optimization system.

Conscious mandibular repositioning through mouthguards or splints is intended to positively affect athletic performance[21]. This research suggests previously undiscovered oral health potentials for performance optimization.

7.2 Hormesis as Theoretical Foundation

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The revolutionary concept of oral risk inversion in NAM Dentistry finds scientific foundation in the hormesis paradigm. Hormesis describes as a biphasic dose-response relationship with low-dose stimulation and high-dose inhibition the quantitative limits of biological plasticity[22].

Hormesis is a fundamental concept with far-reaching biological and biomedical applications[23]. The most significant feature of hormetic dose-response relationships is that biological plasticity limits for adaptive processes are less than twice as high as control group responses, with most maximally 30-60% higher than control group values[22].

7.3 Oral Toxin and Inflammation Elimination

The goal of oral toxin and inflammation elimination with simultaneous dynamic function promotion (the three pillars of NAM Dentistry) is based on integration of anti-oxidative, anti-inflammatory, and cellular repair responses at all biological organization levels within biphasic dose-responses[22].

Low biological, chemical, physical, and psychological stress levels up-regulate adaptive responses that not only precondition, repair, and restore normal functions to tissues/organs but modestly overcompensate, thereby reducing background damage and improving health beyond control groups[22].

The concept of the mouth as a place of healing extends this understanding to holistic oral region consideration as a central organ system for health optimization[24].

7.4 Hormetic Sports Dentistry Approaches

Systematic addressing of oral risk factors through preventive measures, control of silent inflammation, and functional improvements enables more effective utilization of dormant athlete abilities – however, within biological plasticity limits defined by hormesis[22].

Hormetic sports dental approaches require understanding of complex interactions between physical activity and oral inflammatory markers. While moderate physical activity can have anti-inflammatory effects, intensive training leads to acute inflammatory reactions that can impair oral health[25].

8. Integration into Competition and Preparation Phases

8.1 Competition Care

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Modern sports dentistry requires differentiated approaches for competition and non-competition periods. The majority of game day work relates to dental or orofacial trauma[6].

Analyses of Olympic "polyclinic" usage by competing athletes show that oral health of athletes who visited dental clinics at the 2012 London Games was poor, with resulting significant negative impacts on well-being, training, and performance[16].

8.2 Preparation Periods: Optimization and Prevention

"We never force athletes to go to the dentist, but we encourage them to have dental evaluations/screenings, ideally in the off-season, so that any underlying dental caries or periodontal diseases can be quickly and efficiently seen and treated"[6].

Competition-free time offers opportunity for comprehensive treatments, preventive measures, and oral health optimization for upcoming seasons. Sports dental integration into broader athlete health frameworks supports improved oral health outcomes[2].

9. Future Challenges and Development Perspectives

9.1 Seasonal Challenges

Dental screenings and examinations present challenges due to demanding training and competition schedules of athletes and emphasize the importance of oral health in terms of oral medicine as part of a medical team[6].

Sports medicine evolution of the last 50 years from the "wet sponge" mentality to holistic care shows the shift to multidisciplinary teams supporting injured athletes[26].

9.2 Standardization and Protocol Development

Streamlined, universally applicable protocols must be developed that meet demanding elite athlete schedules while providing comprehensive care[6].

The European Association for Sports Dentistry consensus statement on sports dentistry integration provides important guidelines for this development[4].

10. Conclusion and Outlook

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The sports dental transformation of the last 15 years represents a remarkable evolutionary leap. From traditional practice trauma treatment, the field developed into an integrated, prevention-oriented discipline as an essential component of modern sports medicine[4,15].

Elevated risk of oral disease in elite athletes compared to the normal population requires specialized and certified approaches that go beyond traditional dental practices. Scientific evidence on oral inflammation in elite sports revolutionized our understanding of complex interactions between oral health and athletic performance[11].

Concepts for oral risk inversion and targeted utilization of oral potentials find theoretical foundations in the hormesis paradigm. Hormesis defined as an evolutionarily-based integrative health maintenance approach defines quantitative biological plasticity limits[22]. Integration of anti-oxidative, anti-inflammatory, and cellular repair responses within biphasic dose-responses opens new performance optimization possibilities – however, always within limits defined by hormesis of maximum 30-60% improvement over control values[22].

Systematic connections between oral inflammatory markers, systemic parameters, and given performance potential show that the oral cavity can represent not only a potential risk organ but also an optimization system for athletic performance[11,14].

Future developments should concentrate on further protocol standardization, deepening understanding of hormetic oral interventions, and expansion of the educational role[4,2]. Integration of hormesis principles into sports dental practice will determine the next evolutionary phase by providing scientific foundations for targeted utilization of moderate oral stressors for performance optimization – always within evolutionarily-based biological adaptability limits[22,23].

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