

The Triple Role of Individual Mouthguard in Athlete Health

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Abstract: Prevention of oral pathologies, traumatic events and gnathological disorders is a cornerstone of modern dentistry. Oral health may limit athletes ability, both during training and competitions. Careful analysis indicates that the athletes' health can be at risk in a wide range of sports disciplines. Role of sport dentist is crucial, and a dental specialist should be included in the team that follows the athlete. In addition, it is crucial to alert the whole sporting world to the importance of using individual mouthguards. The custom-made mouthguard, is an effective device helping to avoid dental trauma. Additionally it can provide the transmission of such substances as chlorhexidine, fluorine and casein to control the ecological variation of the oral cavity induced by the sport itself. It also offers a psychological support and better occlusal stability, which have a positive impact on sports performance. Thus an individual mouthguard should be adopted in all disciplines and sports categories where there is a potential risk of dental injuries. But it should be designed and manufactured by specialized dentists and dental technicians.

1 INTRODUCTION

Sports-related dentistry focuses on the study, review, prevention and treatment of oral diseases and focuses on maintaining athlete's dental health and disseminating new knowledge within the sports medicine community.

Sports dentistry can be considered as a pre-eminent area of dentistry, since oral health can limit the skills of athletes, both professionals and non-professionals, during training and competitions.

The clinical and scientific work carried out over the years by sport dentist has shown that athletes are affected by various pathologies, including traumas, caries, erosions, gnathological disorders, and many variations occur in oral cavity, such as in salivary pH, salivary flow, microbial load and S-IgA levels.

2 DISCUSSION

In this work a great attention was then given to the use of individual mouthguard and its triple role: the well-known protective function against dental traumas; reservoir for substances, such as chlorhexidine, fluoride and casein to prevent oral pathologies; for athlete's performance by controlling

and stabilizing the occlusion through mandibular repositioning and postural improvement.

In order to achieve the athlete's health it is necessary that Sport Dentistry is placed as an integral part of a fundamental multi-factorial framework, in which one can include different professional health specialists, such as: general practitioner, pediatrician, psychologist, allergist, speech therapist, otolaryngologist, physiatrist, physiotherapist and non-health specialists, such as: instructors and coaches of various sports.

The active Italian population is composed of 35 million 593 thousand individuals who practice one or more sports or some physical activity in their free time. (ISTAT, 2017)

Between 6 and 10 years of age the 59.7% of children are sporty and regularly practice sport.

Oral health is a fundamental element of general health and well-being. The quality of life of the sportsman (Needleman et al., 2017) is also related to the social context and physical activity. Traumas, gnathological disorders, alterations and / or oral diseases, such as tooth decay, erosions, dental discolorations, periodontal disease and respiratory infections represent main problems in sport activity directly related to the conditions treated by dentistry.

A review of the literature on the connection between physical activity and oral health shows that athletes' oral situation seems to be at risk in a wide range of sports disciplines. (Needleman et al., 2015; Escartin et al., 2000) Needleman et al. report an incidence of caries between 15 - 75%, dental erosions between 36 - 85%, periodontal diseases 15% among the athletes (Needleman et al., 2015; Ashley et al. 2015).

Gay Escoda et al (Gay Escoda et al., 2011) in a study conducted on footballers of Cf Barcelona, describe plaque indices of 2.3 and DMFT of 5.7 and those are bad values because the score should be equal or proximus to 0 in a healthy mouth. Poor attention to oral health is also demonstrated by young players characterized by a greater plaque index, increased dental discoloration, increased frequency of spoiled habits (atypical swallowing, onychophagia), and lower frequency of daily brushing compared to subjects who did not practice any type of sport activity. (D'Ercole et al., 2013)

Particular exposure to the onset of extrinsic dental discolorations is reported in swimmers, with varying incidence in reported by different authors (D'Ercole et al, 11.76%, Escartin et al, 60.2%) (D'Ercole et al., 2016; Escartin et al., 2000) This may be attributed to a difference in: pH of pool water, salivary pH, hours of pool training, disinfectants used in swimming pools, eating habits.

No difference has been found on the incidence of the different pathologies among the athletes of the developed countries as compared to the athletes from developing Countries. Poor oral health is common in all professional athletes. This could affect athletic performance: 28-40% of athletes are concerned that their oral health has an impact on their lives and 5-18% of athletes have the impression that this has effect also on sports performance. (Needleman et al., 2015; Ashley et al., 2015) The oral cavity has a resident microbial population with a characteristic composition that exists, in the majority of cases, in harmony with the host; it is very individual and includes protozoa, fungi, bacteria and viruses.

The environment in the oral cavity is not uniform and the conditions vary throughout life in relation to lifestyle, hygiene habits, eating habits, possible administration of drugs and not least with the carrying out of sports activities. (Spinas, 2009).

Nutrition, weekly attendance and hours of training, climatic conditions and psychophysical stress conditions may have repercussions on the oral health of athletes, since they determine important changes in oral ecosystem. (Spinas, 2009)

Several authors have reported that an intense physical exercise causes a reduction of salivary flow, decreases the production of secretory immunoglobulin S-IgA, and consequent decrease in the host defenses and therefore increased susceptibility to pathologies as infections of the first respiratory tract. (D'Ercole et al., 2016; Spinas, 2009; Laing et al., 1993; Giuca et al., 2014).

The negative effects of the lowering of S-IgA, linked to a lower salivary flow rate compared to the beginning of competitions, remain during the whole training day. (Nieman et al., 2002) The decrease of S-IgA occurs after a short exercise completed in maximum effort, and the low levels remain even if there is a 5 minute pause between one exercise and another, because there is a general decrease in salivary flow rate. (Ozcelik et al., 2006)

D'Ercole et al (D'Ercole et al., 2013) showed that the young soccer players analyzed had a statistically superior salivary microbial load, related to cariogenic strains such as *S. mutans*, *Lactobacillus* spp., if compared to general population, both before and after training. In post-training there was also a statistically significant decrease in S-IgA concentration. Young players seem to run a greater risk in developing oral diseases than sedentary individuals, because of poor attention to their oral health and by the effects of microbiological and immunological alterations that occur during training.

D'Ercole and Tripodi (D'Ercole and Tripodi, 2013) showed that in young swimmers training for 2 hours a day for 5 days a week, the presence of pathogenic strains such as *S. mutans*, *S. sanguis*, *L. fermentum* and *A. gerenseriae* increases in a statistically significant way after training. Furthermore, average bacterial load values were significantly higher in swimmers than in sedentary populations. Training time is the period characterized by a more intense salivary function and physiological response, such as the decrease in S-IgA production and therefore can be considered an open window for exposure to diseases of the oral cavity.

However, swimming at a competitive level involves higher average values of S-IgA, both before and after training, compared to non-agonist swimmers. In addition, agonist swimmers has in their oral cavity in addition to cariogenic microorganisms, such as *S. mutans* and *S. sobrinus*, an high percentage also protective bacteria, such as *S. sanguinis*, which in this case is associated with a lower incidence of active caries, compared to non-agonist swimmers. (D'Ercole et al., 2016)

Dental traumas are frequent events in some sports and can be linked to multiple situations and these

events reflect on the quality of athlete's life, imposing attention not only to immediate treatment, but also to the resolution of sequelae that could manifest themselves in the future, with a consequent health and economic commitment.

Dento-alveolar traumatic lesions are very frequent events in both deciduous and permanent dentition. On average, it is calculated that 3 subjects every 10 suffer an oral injury (Andreasen and Andreasen, 1990) and at least one of these subjects supposes it can be caused by sporting activity. (Glendor, 2009)

Pre-adolescent age groups in permanent dentition (8-12 years) and subjects in the age group 1-3 years in deciduous dentition are above all particularly exposed to such lesions.

The traumas occurred during the sport practice oscillate around a percentage of 25-30% of the total at charge of dentition. They are more frequent between 8 and 21 years of age. Their frequency decreases with increasing age of the subjects. (Dursun et al., 2015)

In a study conducted by our group at the Department of Medical, Oral and Biotechnological Sciences of the University of Chieti-Pescara, 234 athletes between the ages of 6 and 13, 348 with an age equal to or greater than 14 years, (a total of 582 athletes) practicing different sports with a high risk of trauma were evaluated with questionnaires and clinical examinations

In mixed dentition is observed as there is a high prevalence of traumas (43.60%) in the sample, while in permanent dentition the percentage of traumas decreases (36.20%).

The athletes were also evaluated according to the use of the mouthguard. A low use of mouthguards (5.13%) was shown for the sub-group in mixed dentition, which increases (15.50%) in permanent dentition.

In particular, the use of mouthguards was motivated by the previous traumatic experience in 90% of the subjects examined. Dividing athletes by discipline practiced, it was seen that in the sports played by subjects with a lower average age, the percentage of use of the mouthguard is almost nil. As the average age increases, this percentage increases but in all sports there were high prevalences of dento-alveolar traumatism (11.11% - 54.50%).

Mouthguard or oral protector is a resilient device inserted into the oral cavity to reduce traumas involving the oromaxillofacial region, in particular the teeth and periodontal tissues, during physical activity. (Sethi et al., 2016) Sport mouthguards are designed to protect intraoral and soft lips and tissues from tears, teeth from fractures and avulsions and

jaws from fractures and dislocations. (Gould et al., 2016)

In Italy, around one million mouthguards are purchased almost exclusively at sports stores. These are not custom-made and often of "one size fit all" types.

The Italian Society of Sports Odontostomatology (SIOS) has for years actively promoted the use of individual mouthguards. The individual mouthguard is a product made in dental laboratory on dentist prescription. It must be protective, adapt to the oral structures, retentive, minimally interfering with the phonation and breathing, with an adequate thickness in critical areas, comfortable, space-saving, odorless and tasteless.

The individual mouthguards have all these features and are made from proven and certified materials. Depending on the type of sport, different thicknesses are used: up to 6mm thick in contact sports.

For the realization of an individual mouthguard that meets all the ideal characteristics, specific training is required for both the dentist and the dental technician.

In some countries the use of the mouthguard is made mandatory for young and senior athletes during competitions, and it is estimated that, in countries where it is not mandatory, only 4-6% of athletes use the mouthguard. (D'Ercole and Tripodi, 2017)

The Italian Ministry of Health has intervened on the issue (sport and traumas) spreading the guidelines for the prevention and clinical management of traumas and recognizing mouthguard as the best method of prevention for dental traumas giving importance to social and public health aspects linked to dental traumatology, especially in subjects in the developmental age. The use of the oral protector is necessary, as well as in contact sports even in sports that use tools, ball, since these responsible for 74% of maxillofacial injuries. The loss of a tooth or worse the fracture of the maxillary bones can prevent the athlete from competing for long periods, therefore, it is necessary that professional athletes do not underestimate these aspects.

The material indicated today as the most suitable for the production of dental protections is ethylene vinyl acetate (EVA) known for its characteristics of high flexibility, elasticity and certified biocompatibility. Even when using proper material, mouthguard should be properly designed and manufactured.

Worn and jagged edges may cause injury to oral mucosa, such as hyperkeratosis, erythema and ulceration. From these continuous solutions, caused

by oral mouthguards, there could be a diffusion in the bloodstream of all the microorganisms present in the oral cavity, with consequent opportunistic infections at the systemic level (eg: endocarditis, pericarditis, pneumonia, asthma, etc.). (Glass et al., 2009; Barton, 2016; Glass et al., 2007). The prolonged stay in the mouth of the device causes changes in the ecological factors of the oral cavity, as the mouthguard increases the plaque index, bleeding index, and causes salivary pH and buffer capacity to be reduced. The mouthguard therefore increases the retentive capacity against plaque and inhibits the protective capacity of saliva. (D'Ercole et al., 2014) Studies conducted on hockey and football players have reported that "boil and bite" mouthguards harbor a high number of pathogenic and opportunistic bacteria, yeasts and molds. (Glass et al., 2007; Glass et al., 2011).

The prevention of oral damage that the pathogenic flora of a mouthguard can cause, could be carried out through different strategies, for example using of protective substances slowly released by a mouthguard. EVA material itself provides a growth support for different microbial species. The addition of chlorhexidine into the mouthguard counteracts these effects and inhibits microbial growth on the medium itself. It also increases the value of salivary pH and buffer capacity, while reducing the salivary load of *S. mutans* and *Candida spp.* (D'Ercole et al., 2017)

It is also essential to respect the basic rules of oral hygiene and cleansing the device after each use. One of the factors that determines poor compliance by the users is the difficulty in preserving and cleaning the mouthguard, which tends to accumulate both plaque and dawn in its interior and consequently emanates a bad odor; this drawback is amplified by the presence of bacteria and salivary and food residues. This can be prevented by properly caring over a mouthguard by placing it in the box provided by the dentist and carrying out a correct and constant disinfection (water, commercial detergents, hydrogen peroxide).

The athlete's task is to take care of and constantly monitor the wear and tear of his mouthguard, subjecting him to periodic checks by the specialists.

Individual mouthguards have much longer life, do not deform over time and are worn longer without replacement as compared to semi-individual and standard devices. Del Rossi reports a reduction in occlusal thickness of 16% in the anterior region and 23% in the molar region after 6 weeks of sporting activity at a competitive level in individual mouthguards (Del Rossi et al., 2007). Glass and coll. (Glass et al., 2011) have shown a significant deterioration of the stock mouthguard after a few

weeks of activity. Through the use of SEM images, the authors explain how the increase in the numbers of pathogenic microorganisms present in the mouthguard can depend precisely on the wear of the material itself and perhaps by the difficulties of conservation for athletes during and after performances.

Furthermore the mouthguard can be of help in the athlete's performance, ensuring a psychological advantage (sense of protection) and another physical because an individual mouthguard allows all the normal physiological functions of speaking, whistling, rinsing, drinking and even eating during the sport activity.

Although the role of the mouthguard is known, significant efforts are still required to educate sport community about the use of oral protectors. Athletes are often reluctant to wear mouthguards, despite being aware of the risks they can run, because they are very often linked to known problems created by commercial mouthguards.

The International Dental Federation (FDI) recommends that national dental associations should inform the population and oral health practitioners about the benefits of using mouthguards during physical activities.

Surely, it's clear that more information campaigns about comfort, possibility of communicating between athletes, possibility of not altering one's eating habits (drinking or chewing during sporting activities), should be promoted. This promotion will lead the athlete to wear more willingly the mouthguard.

One of the most interesting aspects of modern dentistry is the evaluation of correlations between the stomatognathic apparatus and the body posture. In the last decade the relationships between postural imbalances, malocclusions and craniomandibular disorders have been widely analyzed. The interest in this field of Dentistry has also been favored by the great social impact resulting from the growing information, linked to the disclosure of these issues by the mass media. The formulation of numerous hypotheses of correlation between occlusion and posture is fundamentally justified by the presence of anatomical-functional connections between the two body districts. An analysis of the scientific literature shows that the existence of a correlation between dental occlusion and posture is very probable: different mandibular positions determine a different postural attitude and the use of a gnathologic bite can improve postural control in some subjects allowing a better muscle relaxation and therefore can help in the treatment of algic diseases derived from incorrect postural attitudes. (Bernkopf, 2003; Baldini and

Cravino, 2011; Spinass et al., 2014; Raquel et al., 2017)

This correlation seems to be important also in the sports field because in recent years it has been realized that malocclusion can actually affect the athlete's posture, thus compromising sports performance and increasing the risk of injuries. (Needleman et al., 2017)

In professional sportsmen, in particular, even a slight change in balance can result in changes in intensity of strength and coordination skills, as well as causing the onset of a state of muscular tension that negatively affects the whole body, decreasing the overall athletic potential.

The lack of occlusal stability would create an energetic vanishing point similar to the slipping of the athlete's support foot and an imbalance between the agonist and antagonist muscles, connected together in synergistic chains, which could be the cause of injuries and repeated muscle tears. (Bernkopf, 2003)

Therefore the mouthguard could be used also with the aim of establishing a better neuromuscular balance of the masticatory muscles.

In order for an individual mouthguard to have a positive influence on the athletic performance and physical condition of the athletes it is necessary that it is developed and perfected by a qualified Sport Dentist and dental technician, according to the established rules, which provide an accurate gnathological visit and the aid of various instrumental examinations such as stabilometric platform, electromyography, computerized occlusion analysis devices, thermography, etc.

Having ascertained that in the sport activity the muscles of the cranio-cervicomandibular district are involved, it is still uncertain whether the application of an individual mouthguard may or may not improve sports performance. The studies in the literature are few and appear to be discordant. The reason for this discrepancy lies in the inter-individual variability that assumes a fundamental role, because it can lead to the failure of any treatment despite the best quality standards are respected. Surely each athlete should be assessed individually with appropriate clinical and instrumental analysis. (Baldini and Cravino, 2011)

Raquel et al (Raquel et al., 2017) reported that with the use of the individual mouth guard, the electromyographic parameters measured before and after training remain unchanged. According to this study mouthguard therefore allows stable muscle activity during training.

Another study was conducted at the Department of Medical, Oral and Biotechnological Sciences of the University of Chieti-Pescara, to analyze

masticatory muscles activity in athletes wearing individual mouthguards. This was carried on by use of electromyographic examination and wanted to evaluate the variations on the neuromuscular balance of the masticatory musculature, inducted by the use of the same mouthguard, making the comparison with the dental occlusion of the subject in maximum intercuspitation.

It has been shown that the individual mouthguard significantly improves the neuromuscular balance of the masticatory musculature, symmetrizing the work of the masseter and temporal muscles to the point of better balancing the distribution of occlusal loads both in the anterior-posterior direction and in the lateral direction and offers the possibility of produce more muscle work.

The task of the Sports Dentist is to monitor any variations that occur at an oral level of athletes from different sports. The visit protocol of an athlete (agonist or not) provides a thorough medical history, knowledge of the characteristics of the sport followed (training hours, etc.), knowledge of oral hygiene habits, eating habits, clinical examination of the oral cavity, use of quantitative and qualitative salivary analysis, gnathological examination, postural assessment using a stabilometric platform, electromyographic evaluation of the stomatognathic musculature even with the aid of new technologies such as thermography and accelerometer. In sports where it is recommended, it is essential to employ an individual mouthguard for athletes. Mouthguard should be realized after all previous analysis to ensure the best function to the athlete.

At the same time to evaluate the efficiency of the mouthguard in the health benefit and performance improvement, the Sport Dentist, in collaboration with the Sports Physician and the athletic trainer, establishes, for each sporting discipline, specific Physical efficiency tests to be performed in the gym under strict control, with and without mouthguard.

3 CONCLUSIONS

It is important to establish the changes that occur in the oral cavity of people who perform competitive and non-competitive sports, and implement all the available related prevention measures, in order to preserve oral health, especially in young athletes.

It is evident that sports clubs in their screening and medical-sports evaluation plans should have to plan and schedule the athlete's subjection to periodic oral health assessments, inserting a sports dentist into their staff. A good campaign to raise awareness among

sports doctors, sports clubs, coaches, masseurs, the entire sports health team and parents in the case of athletes in developmental age would be appropriate. For proper prevention at several levels (disciplinary, medico-legal and insurance) it is essential the mandatory use of the individual type of mouthguard, which ensures, among the various advantages, greater durability and protection compared to commercial devices, as highlighted by Glass et al. can be considered "as single-use mouthguards." (Glass et al., 2009)

As amply demonstrated, the mouthguard is recommended by the authors for its triple function: traumatological protection, reservoir of substances, aid in the performance of the athlete.

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