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SELECTED DENTAL CONCERNS IN SPORTS MEDICINE

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Abstract

The following paper addresses selected dental problems in sports medicine including caries, orofacial trauma, and the influence of external factors on the stomatognathic system. A familiarity with these conditions will no doubt benefit health care professionals, coaches and athletes

Key words: dentistry, sport, orofacial injuries, dental injuries, prevention

Introduction

Dental issues play a significant, yet underestimated role in sport. While dentist and physicians have a role in the prevention and treatment of dental caries as well as orofacial injuries sustained during sport, it is highly recommended that coaches and athletes are also educated about the links between dental caries, orofacial trauma and sport.

The authors' aim to bring attention to dental problems in modern sport medicine by discussing the etiology and prevention of caries, problems associated with orofacial trauma, and the importance of mouthguards. The influence of numerous exogenous factors on stomatognathic system is also shown. This paper will address some of the above mentioned issues bases on current available literature.

Caries

In today's highly competitive environment, only absolutely healthy humans are able to live up to the high expectations. The term "healthy" refers equally to general and dental health.

Etiology of caries

Caries is a disease affecting all hard tissue namely: enamel, dentine and root cementum. The following causal processes are discussed in its etiology.

- Presence of bacteria in plaque

Streptococcus mutans and Lactobacillus acidophilus play an important role in decay. They are both capable of rapidly producing acids from bicarbonates and synthesizing extracellular polysaccharides that allow them to adhere to tooth tissue.

- Presence of carbohydrates in diet

Dietary carbohydrates are critical to the carious process. These carbohydrates are used as substrates by bacteria, which through a fermentation produce acids that lower the pH level of plaque below the so called 'critical pH' of 5.5. This reduced pH level may remain for over an hour after a meal and favors demineralization of enamel.

The cariogenic potential of a diet depends not only on the type of carbohydrate but also on the frequency of meals and time food remains in mouth. Hence, the longer food stays in the mouth and the more frequent meals are, the greater the risk of caries.

- Susceptibility of tooth tissues to harmful factors

Tooth surfaces most susceptible to caries are those regions where bacterial plaque accumulates. These include pits and fissures located on occlusal surfaces of posterior teeth, the interproximal and cervical areas, and surfaces in contact with prostheses and other dental appliances.

The inorganic component of hard tissue is responsible for the resistance of tooth tissues to decay. While dentine and cementum consists of approximately 50% inorganic minerals, enamel is the most resistant due to it's high inorganic content (96% dihydroxyapatites of calcium).

In order for teeth to be resistant to acid and caries, adequate mineralization during tooth development must occur. Vitamins A, C, $D_{3,}$ calcium, phosphorus and other trace elements, of which fluoride plays the most important role, have an influence on odontogenesis, the process of forming tooth hard tissues (from the first weeks of intra-uterine life to 12-13 years of age).

- Time of influence of harmful factors on teeth

Of the many pathogenic factors responsible for decay, the length of time for which teeth are exposed to carbohydrate, as well as the frequency of food intake appear have the greatest influence. It is said that food which deposits readily on teeth, for example bananas, raisins, chips or even bread, poses the greatest threat, The frequent intake of fluids such as coca-cola, coffee with sugar or sport drinks by athletes is especially harmful because they also lower oral pH for a long time.

Untreated caries may lead to acute or chronic inflammation of pulp and periapical tissues and is therefore a contraindication to participating in sport.

A problem of focal infection is directly connected with inflammatory processes. Over 80% of all inflammatory foci are located within a head, of which those located in the mouth are the most common. Having location in mind inflammatory focuses in the mouth can be divided into:

a) intradental (limited only to the pulp cavity e.g. pulp necrosis)
b) periapical (e.g. periapical granuloma)
c) periodontal disease
d) others (for example dentigerous cysts, foreign bodies)

The inflammations of pulp and periapical tissues as inflammatory focuses are contraindicated to participating in sport because of the possibility of inducing inflammatory processes in other parts of the body (for example heart, kidneys) as well as a greater probability of the occurrence of complications. Hence it is recommended that all possible inflammatory foci should be completely removed.

Prophylaxis of caries – current directions

The most effective way of dealing with caries is prevention. Nowadays it is possible to prevent this civilization-related disease by adequate oral hygiene, diet, delivery of fluoride and procedures, such as fissure sealing which aims at protecting the tooth surface.

Adequate oral hygiene consists of:

- Precise toothbrushing after each meal, supported by additional procedures using flosses, dental tapes, toothpicks and interdental brushes.

Nowadays it is advised to use one of the following brushing techniques: roll, vibratory and circular.

Toothbrush choice depends on the patient's age, his/her motivation, manual capability and condition of the periodontium. Toothbrushes with medium size heads and soft bristles are usually recommended. Electric toothbrushes are often recommended because they are easier to use. Traditional toothbrushes require more time, energy and higher dexterity to achieve similar results compared to electric toothbrushes. Apart from being highly effective at removing plaque from interdental spaces and around gingival margins, electric toothbrushes also have a positive influence on periodontal health. There is a wide variety of electric toothbrush models available on the market. Those offered by reputable companies use rotating, oscillating movements or even sonic waves to efficiently remove plaque. The right choice of toothbrush is very important, so the purchase should be preceded by a consultation with a dentist. Regardless of toothbrush used or technique, teeth should be brushed using toothpaste. Currently most toothpaste contains fluoride in recommended doses of between 525 and 1450 ppm. in the form of sodium fluorine (NaF) or aminofluorides. Consumers should be aware that adult pastes are not suitable for children under 5 years of age because of the risk of swallowing the paste and fluoride overdose. Hence children under 5 years of age should use toothpastes with reduced fluoride content (500 – 600 ppm).

- Use of water irrigation and mouthwashes containing substances which reduce formation and adhesion of bacterial plaque to teeth surfaces (chlorhexsidine, triclosan)
- Use of chewing gums with cariostatic substitutes of sugar (xylitol, sorbitol)

Chewing gum may complement daily oral hygiene practices, however it should not replace it. Chewing gum should last not longer than 10 minutes because of risk of addiction and its negative influence on the stomatognathic system, tempomandibular joint lesions and hypertrophy of the muscles of mastication.

- Fluoride delivery

Fluorine is a trace element of great importance in caries prevention. At low concentrations in saliva, it can be incorporated into enamel structure creating hydroxy - fluorapatite. Enamel strengthened in this way is much more resistant to caries than conventional hydroxyapatite. At higher concentrations in saliva it creates compounds of insoluble calcium fluorides, which can act as reserves for this element. Besides, fluoride has also bacteriostatic activity (blocks bacterial enzymes and is toxic to Streptococcus mutans).

Fluoride can be delivered either endo- or exogenously.

- Endogenous fluoride consists of fluoride intake through diet. It can be a passive fluoridation (drinking water, salt enriched with fluoride) or an active fluoridation (tablets, drops). Active fluoridation is applied to children during the odontogenesis period (from the first weeks of intra uterine life to 12-13 years of age). Both methods should be used carefully because of the risk of overdosing and the development of fluorosis. Bearing this in mind, active endogenous fluoridation under dentist's supervision and taking into account patient's individual needs seems to be safest approach.
- Exogenous fluoridation consists of direct contact of fluoride compounds with enamel. Agents such as toothpastes (fluorine concentration: 525 – 1450 ppm) and mouthwashes (0,05% - 0,2% NaF) containing low concentrations of fluoride can be used frequently.

Higher concentration fluoride gels (for example Elmex-gel, containing 2% of fluorine) and varnishes

can be applied by a dentist occasionally to enhance resistance to caries.

Fluoridation may not only be used during tooth development (until approximately 25 year of age), but also later in adulthood as a way of late prophylaxis. Under the influence of fluoride active caries processes may be arrested for many years or even, in case of incipient caries, can be reversed.

Dental oral trauma in sport

Epidemiology of orofacial injuries in sport

The increasing intensity of competition, a will to beat records and rising brutality in some sport disciplines is contributing to a growing amount of orofacial injuries.

Evolving rules, increased safety precautions and improved awareness by athletes and coaches seem to be insufficient in combating this increase (Fig.1).

Sports injuries account for over 30% of all injuries among children and adults (Fig. 1, 2).

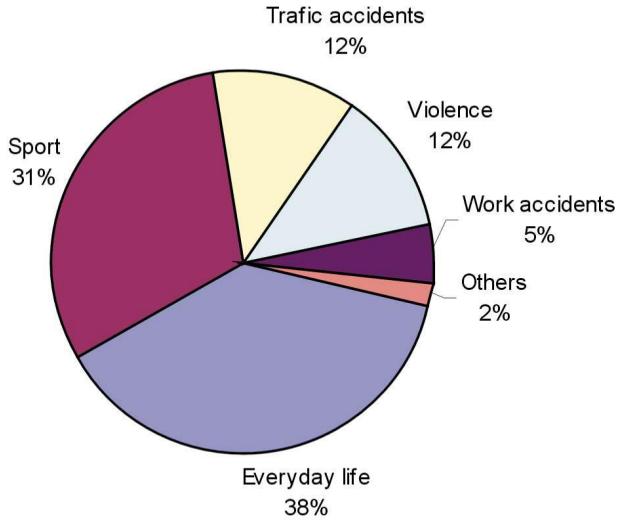

Fig 1. *Cause of orofacial injuries among adults by Gassner (3)*

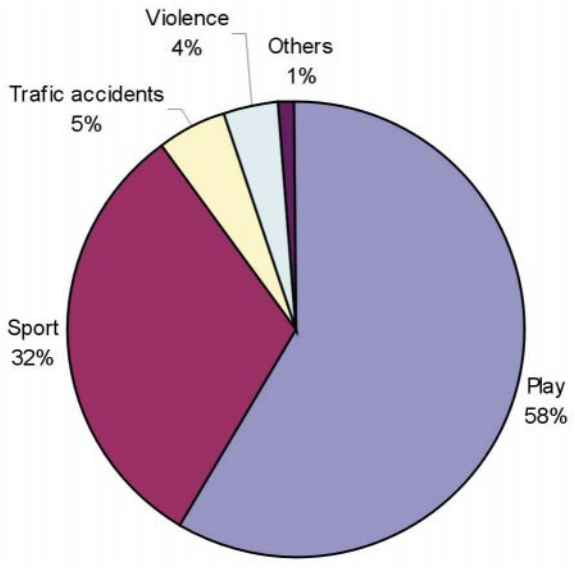

Fig.2. *Cause of orofacial injuries among children by Gassner (4)*

According to De Gioanni, sports with the highest risk for sustaining an orofacial injury are football, cycling and skiing (5). Other authors, rate several other sport disciplines such as combat sports (judo, karate) (6,7), hokey (7,8), basketball (7) or even gymnastics (9) equally dangerous.

Men sustain injuries more often than women in a ratio of 2:1 (10), 5,6:1 (5) while young people aged 25.8+/-19.9 years (10) are the most susceptible to trauma (Fig. 2).

The most frequent cited causes of injury are: collisions with other players (5,10), with sport equipment such as hockey-sticks in ice hockey (6,8) or falls (12-15). In disciplines such as hockey or basketball, injuries occur most frequent during game, while in gymnastics and combat sports, trauma is commonly sustained during training (6,9).

Dental injuries in sport

Orofacial injuries make up 4 to 18% of all sport injuries. Dental injuries are the most frequent among them (>50%).

Injuries are usually sustained in hockey, ice-skating (>40%) and in combat sports (>25%). A relationship has been observed between the type of trauma and injury sustained. Quick hits lead to dental fracture while slow ones often result in soft tissue trauma.

Elis' dental injuries classification, with the authors own modifications is shown in Fig. 3.

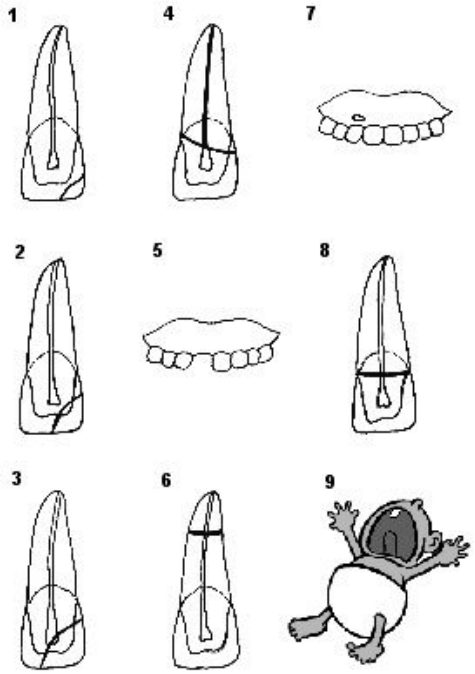

Fig. 3. *Elis'dental injuries classification (modified).*
1 – Enamel fracture; 2 – Enamel - dentine fracture; 3 – Enamel - dentine fracture with pulp exposure; 4 – Injury leading to loss of pulp vitality (with or without fracture); 5 – Avulsion; 6 – Root fracture; 7 – Subluxation; 8 – Crown fracture in the cervical zone; 9 – Primary dentition traumas.

First aid in dental injuries (16)

The most important factor in managing dental injuries is time. Even luxated teeth can be successfully treated if appropriate treatment is provided within a couple of hours of the accident.

In cases when a fragment of a tooth is fractured (1st, 2nd, 3rd Class), it is important to keep it as it may be useful for the dentist when restoring the tooth.

In trauma belonging to the 3rd Class of injury (pulp exposure, sign of which there is bleeding from the pulp), prompt dental intervention is crucial. Treatment which aims at preserving pulp vitality may be successful only up to 2 hours from accident. The more time that passes, the poorer the chances for pulp survival.

In the case of tooth avulsion, immediate dental intervention is critical. If possible, replanting the tooth by oneself is recommended. The tooth and socket should first be briefly rinsed with physiologic saline before replanting it with gentle finger pressure. Otherwise, storage in moist conditions favorable to cell survival (saliva, milk, or special transport solution containing antibiotic) is recommended while seeking dental assistance. Even if our treatment seems to be successful it is important to go to the dentist, who will check occlusion conditions and continue treatment by splinting.

Characterisctics of orofacial injuries in selected sport disciplines

Orofacial injuries sustained during cycling (12,13)

Almost half of road accidents involve cyclists, with orofacial injuries being most frequently reported (Fig.4). These include injuries to the alveolar process (50.8%), soft tissue (34.5%) and facial bones fractures (34.5%), of which fractures of the zygomatic bone are most common. The situation is more dramatic among mountain-bikers, where facial bone fractures (55%) involving mainly maxillary bones are most common, followed by soft tissue (23%) and alveolar process injuries (22%) (Fig. 4). In order to prevent such injuries, the authors recommend the use of helmets should be compulsory for all cyclist, especially those involved in mountain biking.

Orofacial injuries sustained during football

Facial injuries are also often reported in football as a result of direct contact between players through head-elbow impact or head-head impact causing zygomatic and nasal bones fractures (17). 80% of all injuries involve the teeth and alveolar processes (18). The mean cost of orofacial and dental injuries treatment surpasses the treatment of other injuries in football twofold, yet the introduction of compulsory mouthguards to football is still disputed.

Orofacial injuries sustained during skiing (14,15)

In the past two decades, the number of injuries among skiers has increased. According to Gassner, orofacial injuries are usually caused by falls (42%) and collisions with other people (24.1%) while injuries caused by the skiers own ski equipment (11%), collisions against stationary objects (9%) and ski-lift accidents (5,6%) account for the remaining trauma. Injuries to the facial bones mainly involve zygomatic and mandibular fractures (43,5%). Soft tissue lacerations and haematomas (32,2%) and dental injuries such as crown fractures (24,3%) are among the other most frequently reported injuries.

In spite of the increasing tendency of all ski injuries, there is no increase in facial injuries observed in the past 5 years.

Prevention of orofacial injuries – the role of mouthguards

The mouthguard is one of the most effective, but unfortunately still not well known, safety equipment that can be used in a variety of sporting disciplines. It protects not only the teeth but also prevents soft tissue trauma, temporomandibular joint injuries, maxillary bone and mandible fractures, and even lowers the probability of brain concussion by absorbing and dispersing impact forces.

Its effectiveness is seen in many statistics. Orofacial injuries sustained during American football matches accounted for over 50% of all injuries, however after the introduction of the compulsory use of mouthguards, these injuries were nearly eliminated (19).

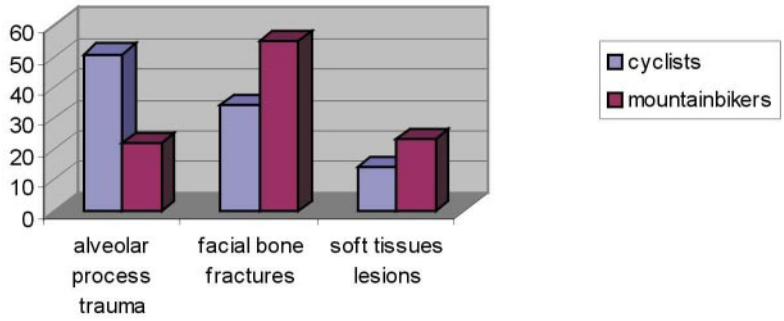

Fig.4. *Orofacial injuries in cycling (12)*

The American Dental Association estimates that mouthguards prevent over 200 000 injuries a year in American school football games alone.

Based on available literature, the authors would like to stress the need to promote mouthguards not only in contact sports (boxing, hockey) but also in disciplines commonly not perceived as dangerous (basketball) (20,21). Nowadays in Poland, the use of mouthguards is only compulsory in boxing and kick-boxing (19).

There are three types of mouthguards available:

- Stock – produced in three sizes. It is not possible to adjust the mouthguards to ideally fit each individual mouth, hence they do not stay in their position very well. Moreover, they make it difficult to breathe and talk, and pose a threat of their aspiration.
- Mouth-formed – the most popular group of mouthguards. The most popular among this group are the „boil and bite" type. After warming the mouthguard, it is possible to adjust it to fit the mouth, however results are usually not satisfactory. They have similar disadvanteges as stock-type mouthguards, but they are more clinically acceptable.
- Custom-made mouthguards – made individually based on the patient's study model. They are usually made for the upper jaw, but in cases of malocclusion they may be prepared for the lower jaw based on a lower jaw model. These moughguards are generally comfortable, do not impair breathing and talking, and are the only ones that can be used by athletes with mixed dentition or undergoing orthodontic treatment. The authors recommend polyethylene-polyvinylacetate copolymer (EVA) as the material of choice for making these custom-made mouthguards (Fig.5. Example of custom-made mouthguard, which can be used in sport).

There is a constant need to inform not only athletes, but coaches, sport team physicians and young athletes' parents about the importance of using mouthguards. This concerns not only professional sport people but equally amateurs, whether participating in competitions or training, where most injuries are sustained (6).

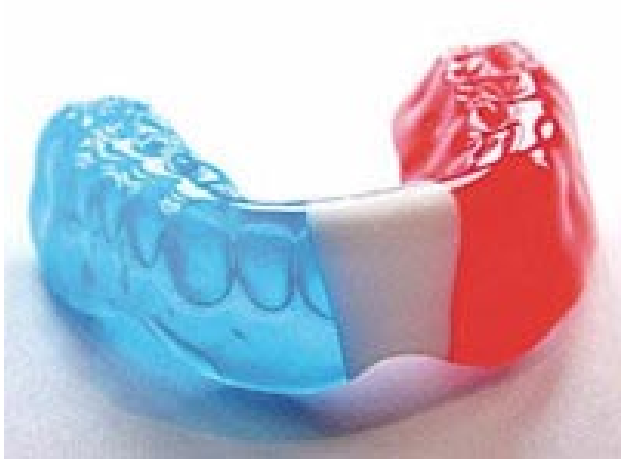

Fig. 5. *Example of custommade mouthguard, which can be used in sport*

The role of external factors in the selected pathologies of the stomatognathic system

Enamel erosion among swimmers

Cases of erosion (tooth hard tissues loss caused by chemical processes and without a bacterial influence) among competitive swimmers have been reported (22,23).

Erosion is caused in all probability by low pH levels of gas-chlorinated water in swimming-pools. In these cases, as opposed to other erosion factors, the process is generalized and tissue loss is observed either on facial or lingual surfaces of the teeth.

This process can be very quick as seen in the following case, where generalized tooth erosion has developed within 27 days (23).

The authors stress that regular pH monitoring of gas-chlorinated swimming pools' water is essential (22,23). Recommended pH values range from 7,2 to 8,0. Regular teeth fluoridation also plays a significant role in the prevention of enamel erosion (23).

Temporomandibular joint dysfunction associated with scuba-diving

Many divers suffer from so called „diver's mouth syndrome". The protruded mandibular position while using the mouthpieces as well as biting forces exerted by the anterior occlusion during diving can cause pain and temporomandibular dysfunction (TMD). This concerns particularly those situations, where a predisposing factor to TMD such as bruxism (pathological mandibular movements) exists (24,25). The prevalence of this syndrome has been reported to be greater among female divers (26).

As far as prevention is concerned, it is suggested to use a customized mouthpieces (24,27) or to carefully choose the best fitting one from available models. When choosing a piece, it is important to assess muscle tension and comfort, which has been found to be a good predictor of whether joint dysfunction would occur (25).

Nowadays, it is suspected that, because of enhanced construction of mouthpieces and lighter demand valves; scuba-diving can only be responsible for exacerbation of ailments and is not the main etiological factor (26).

Toothache caused by outer pressure changes

Toothache can occur as a result of a rapid change (decrease or increase) of pressure surrounding the patient (28-30). This condition, known as barodontalgia concerns mainly people, who practice diving and high altitude sports like flying, paragliding or sky diving.

The causal process of barodontalgia is not well understood. However, in all probability it is connected with pulpal hyperemia (30,31), increase of nitrogen pressure within pulp (31), or gases that are trapped in the root canals (28).

There are many predisposing factors such as denudated dentinal tubules (29), free spaces (e.g. incompletely filled root canals, poor fillings, dental cysts, or dental abscess) (28,29,31), cavities (28,31), pulpitis (28,31), and pulp necrosis (28). Pain may be also occur in healthy teeth (30).

In order to avoid barodontalgia, patients exposed to considerable pressure changes should be precisely examined and all predisposing factors should be eliminated. Proper conservative and endodontic treatment (28,30,31) as well as regular controls (30,31) are indispensable.

Influence of sports drinks on hard tissues

The frequent use of sports drinks, characteristic of a physically active life style, is considered to be a potential threat to the tooth's hard tissues.

The authors state unanimously that sport drinks with pH levels ranging from 2.4 to 4.5, have a considerable erosive potential and are therefore a threat to tooth erosion (32-35) and caries (32). Also fruit juices, with pH level of 2,5-2.8, may cause demineralization of enamel (36). The critical pH level for enamel, at which hydroxyapatite and fluoroapatite dissolve is 5.5.

Additional co-factors include reduced saliva secretion, which accompanies physical activity, and lower buffer capacity of saliva (32,34). Furthermore the authors claim that fluoride concentration in sports drinks, which could counteract erosion, is very low (33,34).

Research does not support a significant association between dental erosion and the use of sports drinks (34,35,37). However, a relationship between frequency of sport drinks consumption and erosion has been found (35) and in the authors' opinion, sports drinks pose a potential risk factor to erosion that athletes should be aware of. In order to minimize the threat, it is suggested to reduce the frequency of intake of these sports drinks. It is also advisable to provide athletes with neutralizing products like sugar – free chewing gums or milk-based products and regular fluoride exposure (van Nieuw Amerongen). It is also worth considering choosing sports drinks where the very erosive citric acid has been replaced with malic acid which has a pH level of 5.9 that is higher than critical pH level of enamel and therefore minimizes erosion (38).

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