

Sports dentistry: A review

Naveen Kumar Ramagoni, Vijaya Kumar Singamaneni¹, Saketh Rama Rao²,
Jamini Karthikeyan³

Department of Pediatric and Preventive Dentistry, Navodaya Dental College, Raichur, Karnataka, ¹Department of Conservative Dentistry and Endodontics, GSL Dental College, Rajahmundry, Andhra Pradesh, ²Department of Conservative Dentistry and Endodontics, Hi-Tech Dental College and Hospital, Bhubaneswar, Odisha, ³Department of Conservative Dentistry and Endodontics, Indira Gandhi Institute of Dental Sciences, Sri Bhalaji Vidyapeeth, Puducherry, Tamil Nadu, India

Corresponding author (email: <ramagoni14@gmail.com>)

Dr. Naveen Kumar Ramagoni, Department of Pediatric and Preventive Dentistry, Navodaya Dental College, Raichur - 584 103, Karnataka, India.

Abstract

Dental trauma in sports is the major linking channel between sports and dentistry. Sports dentistry is the prevention of oral/facial athletic injuries and related oral diseases and manifestations. In children, sports activities were found to be responsible for 13% of overall oral trauma. It is emphasized that there is a great need for “Team Dentist” from high schools to professional teams. In this review, we discuss the relationship between sports and dentistry, and the importance of educating parents, teachers, and children in prevention of injuries related to the sports.

Key words: *Contact sports, dental trauma, mouthguards, splints*

INTRODUCTION

It is common for the kids to get hurt during any form of sports, especially contact sports, and face is the main area of damage. As dentists, we have to deal with patients with various kinds of fractures of tooth and facial bones.

Dental trauma in sports is the major linking channel between the sports and dentistry. The combined impact of violence, traffic accidents, and sporting activities has contributed to the establishment of traumatic dental injuries as a public dental health problem.^[1]

Sports dentistry is the prevention of oral/facial athletic injuries and related oral diseases and manifestations.

It has two major components: First is the treatment of orofacial injuries and the second is the prevention of sports-related orofacial injuries. To provide comprehensive care, a dentist must be knowledgeable and adept in the areas of oral surgery, endodontics, operative dentistry, orthodontics, hospital dentistry, and patient behavior management.^[1]

Various dental traumas encountered during sports are luxation injuries to tooth, avulsion, fracture of the facial bones, and concussion injuries. Prevention of these injuries during sports is important.

Preventive aspects during sports have changed the incidence of the injuries to the athlete. The preventive measures like usage of helmets, mouthguards, and other protective gears have reduced the impact on the athlete, thereby reducing the injuries. Modifications of these protective gears also have been studied and changes have been made to make them more comfortable, user-friendly, and also safer. In this review article, we discuss the various aspects of sports-related injuries, the risk factors associated, protection, and prevention of trauma.

Access this article online	
Quick Response Code:	Website: www.jispcd.org
	DOI: 10.4103/2231-0762.149019

DENTISTRY AND SPORTS

A physically active lifestyle is important for all age groups.^[2] Reasons to participate in sports and physical activity are many, such as pleasure and relaxation, competition, socialization, maintenance, and improvement of fitness and health. Sports participation also carries a risk for injuries, which may, in some cases, lead to permanent disability.^[3,4]

Dental and facial traumas are common sports-related injuries. It has been widely reported that participation in sports carries the risk of sustaining dental injury.^[5] The National Youth Sports Foundation for the Prevention of Athletic Injuries, Inc. estimates that during the season of play, athletes have a 10% chance of sustaining an injury to the face or mouth.^[6] Other studies show that 13–39%^[7] of all dental injuries are sports related and of all sports accidents reported, 11–18% are maxillofacial injuries. Males are traumatized twice as often as females, with the maxillary central incisor being the most commonly injured tooth.^[8]

In children, sports activities were found to be responsible for 13% of overall oral trauma.^[9] With increased incidence of orofacial injuries in sports, there is a greater concern for the emergency and long-term care of orofacial injuries and usage of preventive measures like helmets, mouthguards in these sports.

Jackson proposed a systemic approach for how the dental profession should interact with the sports world, including opportunities for dentists in athletics.^[9] The author also emphasized that there is a great need for “Team Dentist” from high schools to professional teams.

Padilla had emphasized that dentists can assist athletes and incorporate knowledge into their private practices in three main ways, i.e. by conducting preseason oral health screenings, fabricating custom-made mouthguards, and being available for emergency care.^[10]

There was a raising concern about the prevalence of sports-related dental injuries in children and youth. In 2002, The Council of Clinical Affairs of American Academy of Pediatric Dentistry recommended the following policy statements:

- Dentists should play an active role in educating the public on the use of protective equipment for sporting activities, both organized and informal, not only to prevent injuries but also to reduce health care costs

- Continuation of preventive measures practiced in youth, high school, and college level football, lacrosse, and ice hockey
- Mandating the use of properly fitted mouthguards in sporting activities which have a risk of orofacial injury
- Advocating the administrators/coaches before initiating practices for a sporting season to consult a dentist who is expertise in orofacial injuries, for immediate management of injuries.

There is Continuous research in the development of a comfortable, efficacious, and cost-effective sport mouthguard to facilitate its more widespread use.^[11]

Also there has been a constant divergent view regarding the usage of appliance to reposition the mandible, which can enhance the strength during athletic performance. In 1950s and 1960s, Dr. John Stenger reported improvements in the performance of a number of Notre Dame football players fitted with custom-made mouthguards.^[11]

Dr. Harold Gelb coined the term MORA, i.e. mandibular orthopedic repositioning appliance, which is also called as Gelb appliance. The other terminologies like TMJ splint or TMJ appliance, acrylic splint, interocclusal splint, or bite plane are used, which have been claimed to increase the strength of an athlete during performance.^[12] In 1981, Greenberg conducted an objective measurement study on athletes who had worn bite opening appliance and he reported no change in the strength.^[13]

Whether for exercise, competition, or sheer joy of participating, an increasing number of health conscious and sports-minded individuals are finding their way onto the playing fields and into gymnasiums across the world. They are increasingly active, and their increased activity demands a response from the health professionals who serve them. Hence, dentistry has a pivotal role in providing good oral care for the athletes and also in preventing orofacial injuries for the athletes who are at risk for injury. However, there has been a constant controversy regarding these appliances, which shows the need to conduct further studies, particularly to check the placebo effect.

Stokes *et al.* compared the laboratory (L) and intraorally formed (I) mouth protectors. One type of mouth protector was worn for 8 weeks and then exchanged for the other. Subjects were not aware of

the type they had. They found both mouth protector types prevented dental injury, but the L type fitted better and was more comfortable.^[14]

Park *et al.* tested the ethylene-vinyl acetate copolymer materials varying in thickness and stiffness. They found that the thickness in the occlusal portion of the mouthguard should remain optimal for better energy absorption. The authors concluded that a mouthguard with a stiffer insert, which softens at a higher temperature in the occlusal portion, is proposed as a more protective mouthguard.^[12]

von Arx *et al.* compared the new dental trauma splint device titanium trauma splint (TTS) with three commonly used splinting techniques. They found that all tested splints appeared to maintain physiologic vertical and horizontal tooth mobility.^[15]

Takeda *et al.* studied the influence of occlusal supporting mouthguards in decreasing bone distortion and fractures. They stated that wearing a mouthguard with insufficient occlusion has the potential of causing a bone fracture of the mandible. Consequently, mouthguards should have proper occlusion.^[16]

The epidemiology of the occurrence of orofacial sports-related injuries has not been defined by any universally accepted national surveillance system. Of three major national systems in use today, no standardized system exists for the assessment of orofacial injuries. The National Electronic Injury Surveillance System (NEISS) surveys product-associated injuries in participating hospital emergency departments.^[17]

IMPORTANCE OF SPORTS INJURY TO THE DENTAL PROFESSIONAL

The very fact that certain patients will need treatment for tooth, bone, or oral and perioral soft tissue injuries as a result of participation in sports makes an understanding of this field of dentistry practical. Beyond this obvious practicality, the overriding importance of dentistry's ability to meet the diagnostic and therapeutic needs of those with oral injuries lies in the emotional and psychological importance to the patient of having a normal appearance and function of the face.

Therefore, dentistry is needed for a practical side of health care as well as for the emotional consequences of facial or dental trauma. The patient suffering a sports injury of dental significance deserves both the

practical approach to immediate and long-range health problems as well as the one that accounts for the emotions associated with facial injury and its esthetic ramifications.^[18]

Fortunately, modern dentistry has developed numerous techniques and appliances to help protect the sports participant from a variety of orofacial injuries. In fact, preventive sports dentistry represents the most important contribution the dental profession can make to assure a sports participant's welfare.

RISK FACTORS FOR SPORTS INJURIES

An essential component of any injury prevention program is an appreciation and understanding of the risk factors and determinants that can be predictive of these undesirable events. There are two broad categories of injury risk factors in sports. These are extrinsic risk factors and intrinsic risk factors.^[18]

Extrinsic factors

Extrinsic risk factors are those potential predictors of injury that are independent of the individual. These are essentially the injury predictors that are related to the type of activity demanded by a particular sport. For example, the extrinsic factor of participation in running or jogging is more likely to produce a stress injury than that caused by engaging in contact sports such as American football or boxing.^[19]

Improper methods of preparing for competition, such as training mistakes, can also be significant extrinsic risk factors for sports injury. Other extrinsic factors include quality of the playing surface, status of the equipment to be used or worn, climatic conditions such as ice or rain, and the quality of supervision of the participants.^[20]

Intrinsic factors

Intrinsic risk factors are the predisposing characteristics present in the individual sports participant. These are the biologic and psycho-social characteristics that may predispose a particular person to a particular kind of sports injury.^[21] A recent review of intrinsic risk factors as they relate to athletic injuries has been presented by Taimela *et al.*^[21] These authors present convincing evidence that intrinsic factors play a significant role in the evolution of some sports injuries. They conclude that many potential intrinsic risk factors have received inadequate attention and that more studies are warranted to verify the overall significance of these factors to sports medicine and dentistry.^[21]

Age

Important contributing factors such as growth and development, physical maturity, body strength, coordination, and healing ability are all part of the complex realm of intrinsic risks. Robey *et al.*^[22] and Blyth and Mueller^[23] concluded in two separate studies that the risk of injury in high school football increases with age. Another study^[24,25] reported that the majority of sports injuries occurred in adolescents and young adults and that the risk of injury decreased with increasing age.

It should be noted that in young children, before the eruption of the permanent incisors, trauma directed to the primary dentition most often results in luxation injuries. This is in marked contrast to the young permanent dentition, where crown fractures are more frequent. A smaller crown to root ratio in association with denser and highly mineralized alveolar bone apparently contributes to this phenomenon.

Gender

The role of gender as a potential risk factor for sports-related traumatic injuries may be a reflection of an apparent tendency for men and boys to select more aggressively vigorous or “contact” sports. Stephens *et al.*^[26] have concluded that men and boys are more likely to participate both in vigorous exercise and sports competition than women and girls.

Injury history

Blyth and Mueller several studies in which the relationship between previous injuries and the risk of recurrence was assessed. They concluded that previous injuries, if treated properly and thoroughly, do not necessarily predict a repeat injury. However, they also noted that certain individuals with injury-prone biologic characteristics, like children with muscular imbalance, cerebral palsy, or epilepsy, may remain at higher risk for a particular injury.^[27]

Body size

A number of factors may contribute to an increased chance of injury for sports participants with increased body size. These include a higher center of gravity, increased leverage due to greater length of limbs and/or limb strength, and stress on joints due to additional weight. A number of research studies have documented that excessive height and weight predispose athletes to injury.^[28]

Central motor control

A review of the literature suggests that beginners are at a greater risk of injury in many types of sports than

are veterans. This information is pertinent to the dentist who is counseling young patients and their parents about sports injuries. Physically handicapped populations, which display central motor disabilities, are probably also at a greater potential risk for injuries associated with physical endeavors such as sports, than might be true for those without impaired coordination. The burgeoning area of sports for the developmentally disabled presents a new set of challenges for clinicians and researchers in sports medicine and dentistry.^[28]

Psychological and psychosocial factors

Kerr and Fowler observed that any psychological factor like stress, trait anxiety, low self-confidence, or performance pressure would reduce the participant’s attention to the challenges of the sport and/or increase the possibility of fatigue, which may be an etiologic factor in sports injury. Further research is indicated in this area.^[29]

General mental ability

Studies demonstrated a correlation between sports injuries and lower scores on intelligence tests, suggesting that intelligence may be predictive of injury proneness. This relationship needs to be elucidated more clearly, as injury proneness appears to cross intellectual boundaries.^[30]

Other factors

Other factors that may impact upon the risk for sports injury include miscellaneous considerations such as body type, physiologic age, nutritional status, metabolic variations, and a multiplicity of genetic factors. This is a relatively poorly characterized set of predictors at present, but many are strongly suggestive. For example, there are experimental data documenting individual differences in connective tissue repair after injury.^[31]

PREVENTION OF SPORTS-RELATED TRAUMATIC OROFACIAL INJURIES

Many sports-related traumatic dental injuries are preventable; the risk-to-benefit ratio can be improved by the use of appropriate, properly fitted, protective athletic equipment. Furthermore, as the predictive risk factors associated with such injuries are more clearly identified and defined, the design and development of new protective devices may contribute positively to future athletic injury prevention.

At present, helmets, facemasks, and mouthguards are required in some sports to reduce both the likelihood and the severity of sports-related traumatic injuries to

the head, face, and mouth of an athlete. The imperative for future independent scientific research is emphasized to transform current clinical empiricism into statistically significant, evidence-based knowledge.

Helmets are designed to protect the skin of the scalp and ears from abrasions, contusions, and lacerations. They protect the bones of the skull from fractures, and the brain and central nervous system from direct concussions, unconsciousness, cerebral hemorrhage, brain damage, paralysis, and death. Facemasks are designed to protect the eyes, nose, nasal pyramid, zygomatic arches, and mouth from traumatic forces such as a fist, ball, puck, or stick directed toward the face. When used properly, helmets and facemasks enhance player safety and reduce morbidity.

Facemasks are manufactured from plastic or rubber tubing or welded steel or aluminum of different diameters and are covered with a coating of vinyl plastisol. The earliest style of facemask introduced into football in the 1950s consisted of a contoured single bar. All styles of facemasks provide varying degrees of protection to the maxilla horizontally from an extended finger, a clenched fist, a forearm, or a helmet directed respectively toward the eye nasal pyramid zygomatic region or the mandibular arch.^[32,33]

One major disadvantage of the facemask is that it has a protruding object within the ready grasp of an opposing player. When the facemask is pulled or twisted by an opponent during the course of a play, serious physical consequences such as muscle, neck, or spinal column damage can result.^[34]

Mouthguards or “gum shields” were originally developed in 1890 by Woolf Krause, a London dentist, as a means of protecting boxers from lip lacerations. Such injuries were a common and often disabling accompaniment of boxing contests in that era.^[35] These gum shields were originally made from gutta percha and were held in place by clenching the teeth. By 1930s, mouthguards were part of the standard boxers’ equipment and have remained so since that time.^[36]

The Academy for Sports Dentistry recently listed some 40 sports in which mouth protection would be advantageous for the participant; the list includes the following sports and activities.^[37] There are many types of mouthguards, e.g. stock mouthguards. They are the least expensive of the three types of mouthguards available and come in different styles and colors, with or without straps. They are ready to wear because one size

is intended for all users, and they must be held in place by biting the teeth together. Because they are the least retentive and often bulky, stock mouthguards interfere the most with the athlete’s ability to breathe and speak and often cause the athlete to gag. Because of all these factors, stock mouthguards are unacceptable to most athletes and offer the least protection for the prevention of sports-related traumatic dental injuries.^[38]

Mouth-formed mouthguards come in two varieties: Shell-lined and boil-and-bite. The shell-lined variety is fabricated by placing freshly mixed ethyl methacrylate into a hard shell, which is then inserted into the athlete’s mouth and molded over the maxillary teeth and soft tissues. The excess is trimmed with crown and bridge scissors and the mouthguards are then ready for use.^[37]

The thermoplastic boil-and-bite mouthguard is fabricated by placing the mouthguard in boiling water to soften the material. The softened material is then placed into the athlete’s mouth, where it is molded with finger pressure as well as with facial and intraoral muscular movements to enhance adaptation to the hard and soft tissue structures of the mouth.^[38]

Custom-fabricated mouthguards are made professionally over a dental cast of the athlete’s arch. Because of their superior adaptation and retention, custom-fabricated mouthguards are believed to interfere least with breathing (oxygen exchange) and speech. Because of superior fit and comfort, they are more likely to be accepted by athletes.^[37]

Photopolymerized urethane diacrylate custom lip guards and mouthguards are also used nowadays for better adaptation and better comfort and protection. Studies done by various scientists show that there is always lesser trauma caused to a person wearing any kind of protective gear than that caused to a person without wearing it.^[37]

Kataoka *et al.* performed a study on impact absorption and force dissipation of protective mouthguards with or without titanium reinforcement. The mean effective total impact energy that reached the maxillae-mouth guard models was 5.66 J. The mean absorbed energy in group Ethylene Vinyl Acetate (EVA) was 4.39 J (77.8% of total impact energy). The mean (SD) absorbed energy in group EVA-Ti was 4.28 J (75.9% of total impact energy). The mean (SD) total dissipated energy was 1.26 J in group EVA and 1.36 J in group EVA-Ti. There was no statistically significant difference between

the groups in terms of any energy transmission or absorption. They concluded that an additional intermediate titanium layer in the anterior area of a mouthguard may have a beneficial effect on impact absorption and dissipation.^[39]

Liew *et al.* conducted a cross-sectional study on rugby players who preferred to use a mouthguard, to determine the factors contributing to the use and discontinuation of a mouthguard. Overall mouthguard use was low as 31.1%, especially for custom-fitted mouthguard (1.8%), followed by stock mouthguard (7.7%). Boil-and-bite type was most commonly used (21.1%). Of those who wore a mouthguard before, only 28% continued using it. The discontinuation rate for each type was as follows: Stock, 57.1%; boil-and-bite, 80.2%; and custom-made, 37.5%. Age was a significant factor for mouthguard use. Breathing disturbance and general discomfort were significant factors in discontinuing mouthguard use. Among those who discontinued wearing mouthguards due to breathing difficulties and comfort, there was higher incidence of injury.^[40]

PREVENTION IN SPORTS DENTISTRY

All preventive services offered by the private practitioner should be made available to athletes and

others who are susceptible to sustain sports-related trauma. Specific counseling regarding the prevention of trauma, correction of malocclusion, removal of impacted teeth, use of mouth protectors, and treatment of any anomaly and prevention of pathology is important. Proper training of the school teachers, emergency management kits, and training are important.^[41]

Professional responsibility of dentists

A rapid proliferation of sports programs for children and adolescents has taken place over the past few years. The participation has grown dramatically at both the recreational and organized sports levels. The dentist has a professional responsibility to educate himself and the public regarding the issues related to sports dentistry, specifically to the prevention of sports-related orofacial trauma. Dentists should also take the lead in educational, research, and public service activities.

It is the duty of dentists to create awareness among the people, teachers as well as students, and children. Two recent studies showed that people are not much aware of the possible outcomes of the injury, and emergency management, and that only a few people knew the usage of protective gears like mouthguards and helmets during contact sports.

Recent studies related to sports injuries, incidence, awareness, and protection

Study	Age group	Topic	Inference
Ferrari <i>et al.</i> , 2002	Male athletes 18-30 years	Dental trauma	28.8% had dental trauma 15.9% used mouthguard
Muller-Bolla <i>et al.</i> , 2003	Sports club members	TLMPF	29.57% had TLMPF 64.3% used mouthguards
Cagri Delilbasi <i>et al.</i> , 2004	8-62 years	Maxillofacial fractures	43% impact against players Majority mandibular fractures- 56% Midface- 31% Alveolar fractures- 12%
Cohenca <i>et al.</i> , 2007	Athletes	Dental injuries in basketball	10.6 per 100 men 5.0 per 100 women Reduced incidence after using mouthguard
Love <i>et al.</i> , 2008	16-25 years	Dental and maxillofacial injuries	Preventive measures reduced the incidence of sports injury
Cetinbas <i>et al.</i> , 2008	7-13 years	Injury to central incisors	14.14% injury rate to incisors during sports
Biagi <i>et al.</i> , 2010	8-15 years	Dental injuries	Incidence reduced after using protective gears
Schildknecht <i>et al.</i> , 2012	Rugby players	Dental injuries	88% used mouthguards and decrease in injury was seen
Karande <i>et al.</i> , 2012	School teachers in Pune	Awareness	Awareness and training needed
Ozbay <i>et al.</i> , 2013	Pediatric handball players	Traumatic injuries	19% had dental injuries 15% not used mouthguards
Sepet <i>et al.</i> , 2014	6-18 years age	Awareness	10% had injury 12.5% would look for emergency treatment 34.5% will re-implant tooth 55% knew to use mouthguards
Inness <i>et al.</i> , 2014	Adults	Polo pony injuries	10% injuries with protective gear

TLMPF=Trauma to lower and middle part of the face

A study done on school teachers showed that the incidence of injury and emergency management improved significantly after the sports injury management programs were conducted by the dentists.^[42]

In another awareness study by Sepet *et al.*,^[43,44] it was found that 10.9% had experienced a kind of dental trauma and 12.5% would look for a dentist for treatment in emergency. 34.5% would re-implant the avulsed tooth, 33.4% would maintain the avulsed tooth in handkerchief, and 25.3% would maintain it in saline solution. 41.1% were aware of the possibility of oral injuries during sports practice, and 55.4% knew about mouthguards but only 11.2% of the participants reported using them.

These studies show that proper guidance and awareness in people by dentists can improve the knowledge of protection, prevention, and incidence of sports injuries.

CONCLUSION

Sports dentistry encompasses a wide range of preventive and treatment modalities of oral/facial athletic injuries and related oral diseases and their manifestations. The pediatric dentist must possess a sound clinical working knowledge regarding sports-related orofacial injuries in children and adolescents and the various methods of prevention. With the increasing trend of sports participation in schools and colleges, protective devices and preventive options gain significance. Sports-related dental injuries are not uncommon during participation and they deserve our immediate attention. In this regard, the pediatric dentist must work in close association with the teachers, coaches/trainers, parents, and other health professional to ensure comprehensive dent-facial care. Preventive programmers should include information regarding sports-related orofacial injuries, preventive measures like helmets and mouthguards, and their management, resulting in better awareness of the general population. It is also our responsibility to identify, educate, and provide the athletes preventive measures like mouthguards.

REFERENCES

1. Andresean JO, Andresean FM. Textbook of Color Atlas of Traumatic Injuries to the Teeth. 3rd ed. Copenhagen: Munksgaard; 1994.
2. Bijur PE, Trumble A, Harel Y, Overpeck MD, Jones D, Scheidt PC. Sports and recreation injuries in US children and adolescents. *Arch Pediatr Adolesc Med* 1995;149:1009-16.
3. Newsome PR, Tran DC, Cooke MS. The role of the mouthguard in the prevention of sports-related dental injuries: A review. *Int J Paediatr Dent* 2001;11:396-404.
4. Padilla R, Balikov S. Sports dentistry: Coming of age in the '90s. *J Calif Dent Assoc* 1993;21:27-34, 36-7.
5. Camp J. Emergency dealing with sports-related dental trauma. *J Am Dent Assoc* 1996;127:812-5.
6. Andreassen JO, Ravn JJ. Epidemiology of traumatic dental injuries to primary and permanent teeth in a Danish population sample. *Int J Oral Surg* 1972;1:235-9.
7. Sane J. Maxillofacial and dental injuries in contact team sports. *Proc Finn Dent Soc* 1988;84(Suppl 6-7):1-45.
8. Meadow D, Lindner G, Needleman H. Oral trauma in children. *Pediatr Dent* 1994;6:248-51.
9. Winters JE. Sports dentistry: The profession's role in athletics. *JADA* 1996;127:810-1.
10. Padilla RR. Sports in daily practice. *JADA* 1996;127:815-6.
11. American Academy of Pediatric Dentistry. Policy on prevention of sports-related oro-facial injuries. *Pediatr Dent* 2002-2003;24:32.
12. Park JB, Shaull KL, Overton B, Donly KJ. Improving mouth guards. *J Prosthet Dent* 1994;72:373-80.
13. Gelb H. Effective management and treatment of craniomandibular syndrome. In: Gelb H, editor. *Clinical Management of Head, Neck and TMJ Pain and Dysfunction*. Philadelphia: WB Saunders Co.; 1977.
14. Stokes AN, Croft GC, Gee D. Comparison of laboratory and intraorally formed mouth protectors. *Endod Dent Traumatol* 1987;3:255-8.
15. von Arx T, Filippi A, Lussi A. Comparison of a new dental trauma splint device (ITS) with three commonly used splinting techniques. *Dent Traumatol* 2001;17:266-74.
16. Takeda T, Ishigami K, Ogawa T, Nakajima K, Shibusawa M, Shimada A, *et al.* Are all mouthguards the same and safe to use? The influence of occlusal supporting mouthguards in decreasing bone distortion and fractures. *Dent Traumatol* 2004;20:150-6.
17. National Youth Sports Safety Foundation. Fact Sheet. Needham, MA; 1994.
18. Taimela S, Kujala UM, Osterman K. Intrinsic risk factors in athletic injuries. *Sports Med* 1990;9:205-15.
19. Chambers RB. Orthopaedic injuries in athletes (ages 6 to 17). Comparison of injuries occurring in six sports. *Am J Sports Med* 1979;7:195-7.
20. Cannel H. Oral, dental and maxillo-facial injuries. *Sports Injuries and their Treatment*. London: Chapman and Hall; 1986.
21. Taimela S, Kujala UM, Osterman K. Individual characteristics are related to musculoskeletal injuries (Abstract). Turku, Finland: PAADO Nurmi Congress; 1989.
22. Robey JM, Blyth CS, Mueller FO. Athletic injuries. Application of epidemiologic methods. *JAMA* 1971;217:184-9.
23. Bahr R, Holme I. Risk factors for sports injuries—a methodological approach. *Br J Sports Med* 2003;37:384-92.
24. De Loes M, Goldie I. Incidence rate of injuries and their mechanisms: A prospective study. *Med Sci Sports Exerc* 1983;15:267-70.
25. Ekstrand J, Gillquist J. Soccer injuries and their mechanisms: A prospective study. *Med Sci Sports Exerc* 1983;15:267-70.
26. Stephens T, Jacobs DR Jr, White CC. A descriptive epidemiology of leisure-time physical activity. *Public Health Rep* 1985;100:147-58.
27. Blyth CS, Mueller FO. Football injury survey: Part I. When and where players get hurt. *Physician Sports Med* 1974;2:45-52.
28. Berson BL, Rolnick AM, Ramos CG, Thornton J. An epidemiologic study of squash injuries. *Am J Sports Med* 1981;9:103-6.

29. Kerr G, Fowler B. The relationship between psychological factors and sports injuries. *Sports Med* 1988;6:127-34.
30. Sedgwick AW, Smith DS, Davies MJ. Musculoskeletal status of men and women who entered a fitness program. *Med J Aust* 1988;148:385, 388-91.
31. Taimela S, Kujala UM, Osterman K. Intrinsic risk factors in athletic injuries. *Sports Med* 1990;9:205-15.
32. Watterson JS. Inventing modern football. *Am Herit* 1988;39:113.
33. Creative Services Division. National Football League Properties, Inc. In: Bill B, editor. *The Official NFL Encyclopedia of Pro Football*. New York: New American Library; 1985. p. 7-16.
34. Reed RV Jr. Origin and early history of the dental mouthpiece. *Br Dent J* 1994;77:478-80.
35. American Dental Association and Academy for Sports Dentistry. *Protect Your Smile with a Mouthguard*; 1999.
36. American Society for Testing and Materials: Standard Practice for Care and Use of Mouthguards. Designation: F 697-80. Philadelphia: American Society for Testing and Materials; 1986. p. 323.
37. Guevara PA, Ranalli DN. Techniques for mouthguard fabrication. *Dent Clin North Am* 1991;35:667-82.
38. Padilla RR, Lee TK. Pressure-laminated athletic mouth guards: A step-by-step process. *J Calif Dent Assoc* 1999;27:200-9.
39. Kataoka SH, Setzer FC, Gondim E Jr, Caldeira CL. Impact absorption and force dissipation of protective mouth guards with or without titanium reinforcement. *J Am Dent Assoc* 2014;145:956-9.
40. Liew AK, Abdullah D, Wan Noorina WA, Khoo S. Factors associated with mouthguard use and discontinuation among rugby players in Malaysia. *Dent Traumatol* 2014.
41. Dhillon BS, Sood N, Sood N, Sah N, Arora D, Mahendra A. Guarding the precious smile: Incidence and prevention of injury in sports: A review. *J Int Oral Health* 2014;6:104-7.
42. Karande N, Shah P, Bhatia M, Lakade L, Bijle MN, Arora N, *et al.* Assessment of awareness amongst school teachers regarding prevention and emergency management of dentoalveolar traumatic injuries in school children in Pune City, before and 3 months after dental educational program. *J Contemp Dent Pract* 2012;13:873-7.
43. Sepet E, Aren G, Dogan Onur O, Pinar Erdem A, Kuru S, Tolgay CG, *et al.* Knowledge of sports participants about dental emergency procedures and the use of mouthguards. *Dent Traumatol* 2014;30:391-5.
44. Schildknecht S, Krastl G, Kühl S, Filippi A. Dental injury and its prevention in Swiss rugby. *Dent Traumatol* 2012;28:465-9.

How to cite this article: Ramagoni NK, Singamaneni VK, Rao SR, Karthikeyan J. Sports dentistry: A review. *J Int Soc Prevent Communit Dent* 2014;4:S139-46.

Source of Support: Nil, **Conflict of Interest:** None declared.