



Role of Mouthguards in Limiting Sports-Related Dental Injuries in Children: A Review

Sajeela Ismail^{1*}, Niyas Ummer² and Safeer Jaweed³

¹Consultant Pediatric Dentist, Malappuram, Kerala, India

²Consultant Maxillofacial Radiologist, Photonix Imaging Solutions, Kozhikode, Kerala, India

³Senior Lecturer, Department of Prosthodontics, Educare Institute of Dental Sciences, Malappuram, Kerala, India

*Corresponding Author: Sajeela Ismail, Consultant Pediatric Dentist, Malappuram, Kerala, India.

Received: September 27, 2018; Published: October 10, 2018

Abstract

Children and adolescents engaged in contact sports are at an increased risk of sustaining traumatic dental injuries. These injuries can lead to undesirable consequences for the children and their families because of associated orofacial pain, psychological effects and treatment costs that ensue. Orofacial and dental trauma in sport are largely preventable with proper equipment. Mouthguards must be used in contact sports to effectively reduce the severity of or prevent the occurrence of dento-alveolar injuries. Mouthguards are divided into three major types. Custom-made mouthguards have a number of advantages over the other types currently in use. Dentists are directly involved in the treatment of sports related dental injuries, but they should also become actively involved in the prevention of such injuries. Parents, sports coaches, sporting organizations and teachers should be educated regarding the risks of oral injury in sports and encouraged to insist on players wearing mouthguards even if the rules of the game may not demand their mandatory use. The purpose of this article is to review available literature on the protective role of mouthguards in sports, compare the different types and properties of currently available mouthguards, common fabrication methods and also barriers to their use.

Keywords: Mouthguard; Children; Prevention; Injury; Sports

Abbreviations

EVA: Ethylene Vinyl Acetate; ADA: American Dental Association; AAPD: American Academy of Pediatric Dentistry.

Introduction

Children and adolescents frequently take part in various contact sports, physical exercises and unsupervised recreational activities which pose increased risk of minor to extremely complex dental injuries in these individuals. Sporting accidents are reported to be accountable for 10 - 39% of dental injuries in children [1]. Contact sports are defined as those sports in which players physically interact with each other, trying to prevent the opposing team or person from winning [2]. In a study, 69% of all injuries were found to have occurred during competitive matches compared with 31% during training sessions [3]. Players of contact sports are estimated to have a 10% chance per playing season of sustaining an injury and up to a 50% chance of injury in their playing career [4]. Sta-

tistics regarding prevalence, nature, severity and impact of these injuries vary with geographical location, age, gender, type of sports and personal protective equipment used [5]. Orofacial and dental trauma in sport are largely preventable with proper equipment. This article aims to review available literature on the protective role of mouthguards in sports, compare the different types and properties of currently available mouthguards, common fabrication methods and also barriers to their use.

Mouthguards

Mouthguard (also called gumshield or mouth protector) is defined as 'a resilient device or appliance placed inside the mouth to reduce oral injuries, particularly to teeth and surrounding structures. [1,6] Mouthguards cover the teeth and some or all of the gingiva and act by dissipating forces and reducing the deflection of teeth which are subject to stresses [7]. They not only reduce the severity of or prevent the occurrence of injuries, but also help in

retaining any fractured or avulsed tooth thus preventing their loss, inhalation or ingestion [6]. Several studies had suggested mouthguards playing a role in decreasing incidence of concussion and reducing impact to the brain following a blow to the chin apparently by increasing the space between the head of the condyle and the mandibular fossa of the cranium. Latest research findings, however, refute these postulations [8-10].

A variety of materials are used for fabrication of mouthguards. They can be made of rubber, vinyl laminate, polyurethane and rubber, silicone rubber, urethane rubber, acrylic resin and thermoplastic vinyl, polyvinyl acetate, plasticized acrylic resin, and polyvinyl acetate and polyethylene [11]. Most commonly used is a thermoplastic polyvinyl-acetate-ethylene copolymer, typically ethylene vinyl acetate (EVA) due to its availability, formability and ease of manipulation [6].

History

Mouthguards were first introduced by Woolf Krause, a London dentist as a means of protecting boxers from lip lacerations [12].

By the 1920s and 1930s mouthguards came to be widely used by boxers and were soon adopted by footballers,

In 1948, Dr. Lilyquist, known as the Father of the Modern Mouth guard for Athletes, published in detail the procedure for fabrication of acrylic mouth guard in the Journal of the American Dental Association [13]. American dentists like Cohen, Borish and Cathcart popularized the use of mouthguards in the 1950s. In 1960, the ADA recommended the use of latex mouth guards in all contact sports.

Common dental injuries and risk factors

A large proportion of the injuries involve teeth and the surrounding soft and hard tissues. Coronal fractures, radicular fractures, subluxation and avulsion of the teeth, soft tissue lacerations to the gingiva and oral mucosa, fractures of the alveolar processes, condyles, gonial angles, and body of the mandible, concussions and temporomandibular joint dislocation involve the most frequently encountered injuries [14-16].

There are two broad categories of injury risk factors in sports, namely extrinsic risk factors and intrinsic risk factors. Extrinsic risk factors are those potential predictors of injury that are independent of the individual. Intrinsic risk factors are the biologic and psycho-social characteristics that may predispose a particular person to a particular kind of sports injury [17].

Majority of injuries are sustained in the maxilla, with the incisors being most prone to injury, accounting for approximately 80% of all cases [18]. Accentuated overjet and inadequate lip coverage are significant contributory factors in traumatic dental injuries in children [19].

Traumatic incidents are two times higher in boys than that in girls [20]. The highest incidence occurs between the ages of eight and eleven [21].

Mouth guard features

To provide adequate protection, a mouthguard should be properly fitted to the wearer's mouth and accurately adapted to his or her oral structures, be made of resilient material approved by the U.S. Food and Drug Administration [22], cover all teeth in an arch, stay in place comfortably and securely, be physiologically compatible with the wearer, be relatively easy to fabricate and clean, have high-impact energy absorption and reduce transmitted forces upon impact [23], should be tear-resistant, odourless, tasteless and should not interfere with speech [24].

The optimal thickness for custom-made mouthguards has been recommended to be 4 to 5 millimeters occlusally, 3 mm labially and 1 mm palatally for enhanced reduction and absorption of transmitted forces during impact [25,26]. But according to ADA, the final mouthguard thickness should be a matter of clinical judgment, patient preferences and the specific needs of the athlete or sport [22].

Types of mouthguards

The American Society for Testing and Materials designated three categories for athletic mouthguards [27]:

- A. Pre-fabricated, ready-made, or stock mouthguard,
- B. Mouth-formed, "boil-and-bite" protector,
- C. Custom-made, either vacuum-formed or pressure-laminated (based on the dentist's instructions).

Pre-fabricated, ready-made or stock mouthguard

Pre-fabricated mouthguards are preformed thermoplastic trays that fits loosely over the wearer's teeth. They come in different limited sizes (ranging from small to large) with the patient choosing their 'best fit' size [6]. They have little-to-no retention or adaptability to hard and soft tissues. So, the stock mouthguard requires the wearer's mouth to be closed to provide any protective benefit, which can interfere with breathing and speaking [22].

There are three types of pre-fabricated mouthguard

- Single jaw
- Bimaxillary
- Orthoguard (for patients undergoing fixed appliance orthodontic treatment).

Mouth-formed mouth guards

Mouth-formed mouth guards are formed directly in the mouth. There are 2 types of mouth-formed mouth guards, the shell-liner type and the thermoplastic type. The mouth-guard is placed in hot water (according to the manufacturer's instructions). When the plastic becomes mouldable, it is formed to the patient's teeth, soft tissues and occlusion by soft tissue moulding and applying firm occlusal pressure. The moulding process is completed by the patient with minimal input from their dentist or orthodontist [6,15,22].

A variation of mouth-formed mouthguard is the "jaw-joint protector," a bimaxillary device which is postulated to protect the associated basal skull surface from concussion by positioning the mandible forward. However, further studies are required to substantiate the claim [22].

Custom-made mouthguards

Custom-made mouthguards are fabricated by dental laboratories from dental impressions and based on dentist's recommendations. They are usually made from polyethylene vinyl acetate (EVA) and are suitable for both orthodontic and non-orthodontic patients [1,6]. They can be either single jaw mouthguard or bimaxillary.

The two categories of custom mouth guards are the vacuum mouthguard and the pressure laminated mouthguard. Although custom mouthguards can be the most expensive option, they generally offer better retention and comfort, less interference with speech and breathing, and more adaptability to orthodontic appliances as they are individually designed, and form fitted under the dentist's supervision.

Fabrication of custom-fitted mouthguard

Fabrication of custom fitted mouthguards require five standard steps

- A. An alginate impression, which includes all teeth (except erupting third molars), the gingivae (up to the mucolabial fold), labial frenum, complete palate, full vestibular extensions and borders, is made. If a wax bite is required by the dental laboratory, it is recommended to be taken with the teeth approximately 1.5 mm apart [6].

- B. The impression is poured with high-strength stone to produce a model of the dentition and other oral structures.
- C. The mouthguard is formed using one or more sheets of thermoplastic material (most commonly ethylene vinyl acetate) on the stone model.
- D. The mouthguard is seated with proper occlusal balance and equilibration.
- E. Excess material is trimmed from the mouthguard. The labial flange should extend to within 2 mm of the vestibular reflection and have rounded edges, and the palatal flange should extend to within 10 mm of the palatal gingival margins and have a tapered edge [26].

If any orthodontic tooth movements are to be undertaken, the laboratory should be informed of the proposed movements so that the mouth-guard can be fabricated to accommodate them. Depending on the extent of the tooth movement, the mouthguard may need to be remade as treatment progresses [6].

Vacuum formation

A vacuum formed mouthguard is constructed using a conventional vacuum machine which applies low heat and vacuum (equivalent to approximately one atmosphere of pressure) to soften a single layer of thermoplastic material.

Pressure lamination

Pressure lamination technique utilizes a combination of heat and pressure which facilitates proper lamination and precise adaptation of the mouthguard within the specifications of the copolymer material, technique and machinery used. Up to 10 atmospheres of positive pressure is applied using the pressure lamination machine [28].

How to care for mouthguards [29]

- Do not chew on or alter the mouthguard as this will affect the fit and possibly damage it or decrease its effectiveness
- Rinse the mouthguard with cold water or with a mouth-rinse before and after each use. Avoid contact with hot water because this can cause distortion.
- Since the mouth contains bacteria and plaque, it is important to clean your mouthguard after each use. Clean it with toothpaste and a toothbrush or clean it in cool, soapy water and rinse thoroughly.
- Store and transport the mouthguard in a firm, perforated container to prevent damage and permit air circulation. Do not close the mouthguard container until the freshly washed mouthguard is dry.

- Do not share your mouthguard with others.
- Avoid high temperatures or direct sunlight to minimize distortion.
- Check the condition of the mouthguard occasionally and replace it if it has holes or tears, becomes loose, or irritates the teeth or gums.
- It is recommended to avoid use of removable orthodontic appliances simultaneously with the mouthguard.
- Mouthguards wear out over time. Replacement is recommended every two to three years, earlier if torn, cracked or significantly worn out.

Barriers to mouthguard use among children

Many studies have determined the reasons for not wearing mouthguards to be cost, lack of knowledge and information and lack of a mouthguard policy [30]. Poor retention with a slipping sensation, interference with breathing and speaking, parental

perceptions regarding mouthguard use were found to be other significant contributors to limited use of mouthguards by children [6].

Discussion

Based on literature it can be stated with certainty that mouthguards offer considerable protection against sports-related dental injuries. They reduce the severity of or prevent the occurrence of injuries. The different types of mouthguards available have merits and demerits to their account table 1 compares the various types of mouthguards. Of the types currently in use, custom-made mouthguards can be established to offer the greatest protection and superior fit in comparison with the other categories. Such mouthguards should be recommended for use by children and adolescents engaged in contact sports and other recreational activities. The American Academy of Pediatric Dentistry (AAPD) recommends the use of properly fitted mouthguards in “organized sporting activities with risk of orofacial injury [31].

Type of mouthguard	Cost	Retention and adaptability	Protection	Dentist’s role	Other factors
Pre-fabricated	Cheapest	Poor	Poor	Not required	Readily available, not adaptable
Mouth formed	Moderate	Average	Average	Minimal	Available from retailers, adaptable
Custom made	Most expensive	Good	Good	Required	Provision can be made for orthodontic tooth movement
Orthoguard	Moderate	Average	Average	Minimal	Best suited with orthodontic appliances, adaptable
Bimaxillary	Moderate	Average	Average	Minimal	Adaptable

Table 1: Comparison of different types of mouthguards [6].

Conclusion and Recommendations

For more than 50 years, the ADA has promoted the use of properly fitted mouthguards as the primary means of protection against oral injury during sporting activities that pose a risk of oral injury, including acrobatics, baseball, basketball, bicycling, boxing, equestrian events, field events, field hockey, football, gymnastics, handball, ice hockey, in-line skating, lacrosse, martial arts, racquetball, rugby, shot-putting, skateboarding, skiing, skydiving, soccer, softball, squash, surfing, volleyball, water polo, weightlifting and wrestling [22].

Athletes often do not wear mouthguards despite being aware of their protective capabilities. Considering the prevalence of oral injury in sports, dental professionals, dental organizations and health care agencies should advocate the use of properly fitted

mouthguards to reduce oral trauma among the general public. Parents, sports coaches, sporting organizations and teachers should be educated regarding the risks of oral injury in sports and encouraged to insist on players wearing mouthguards even if the rules of the game may not demand their mandatory use.

Bibliography

1. Newsome PRH., et al. “The role of the mouthguard in the prevention of sports-related dental injuries: a review”. *International Journal of Paediatric Dentistry* 11.6 (2001): 396-404.
2. Dorney B. “Dental screening for rugby players in New South Wales, Australia”. *FDI World* 7 (1998): 10-13.
3. Sane Juha and Pekka Ylipaavalniemi. “Dental trauma in contact team sports”. *Dental Traumatology* 4.4 (1988): 164-169.

4. Newsome Philip., *et al.* "The dentist's role in the prevention of sports-related oro-facial injuries". *International Dental Journal* 12.1 (2010): 50-60.
5. Agbor MA., *et al.* "Dentofacial injuries in contact sports in Yaounde, Cameroon". *European Journal of General Dentistry* 1.1 (2012): 24.
6. Parker K., *et al.* "A review of mouthguards: effectiveness, types, characteristics and indications for use". *British Dental Journal* 222.8 (2017): 629.
7. Hoffmann J., *et al.* "Experimental comparative study of various mouthguards". *Dental Traumatology* 15.4 (1999): 157-163.
8. Benson Brian W., *et al.* "Is protective equipment useful in preventing concussion? A systematic review of the literature". *British Journal of Sports Medicine* 43 (2009): i56-i67.
9. Mihalik Jason P., *et al.* "Effectiveness of mouthguards in reducing neurocognitive deficits following sports-related cerebral concussion". *Dental Traumatology* 23.1 (2007): 14-20.
10. McCrory, Paul, *et al.* "Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012". *British Journal of Sports Medicine* 47.5 (2013): 250-258.
11. Guevara PA., and DN Ranalli. "Techniques for mouthguard fabrication". *Dental Clinics of North America* 35.4 (1991): 667-682.
12. Reed RV. "Origin and early history of the dental mouthpiece". *British Dental Journal* 176.12 (1994): 478.
13. Acrylic Splints for Athletes: "Transparent Slip Casings for the Teeth as a Protection from Blows". *Journal of the American Dental Association* 36.1 (1948) 109-110
14. Hickey Judson C., *et al.* "The relation of mouth protectors to cranial pressure and deformation". *The Journal of the American Dental Association* 74.3 (1967): 735-740.
15. Mekayarajananonth Trakol., *et al.* "Improved mouth guard design for protection and comfort". *The Journal of Prosthetic Dentistry* 82.6 (1999): 627-630.
16. Young EG., *et al.* "Common dental injury Management in Athletes". *Sports health* 7.3 (2015): 250-255.
17. Ramagoni Naveen Kumar., *et al.* "Sports dentistry: A review". *Journal of International Society of Preventive and Community Dentistry* 4 (2014): S139.
18. Cavalleri G and N Zerman. "Traumatic crown fractures in permanent incisors with immature roots: a follow-up study". *Dental Traumatology* 11.6 (1995): 294-296.
19. Norton Eimear and Anne C O'Connell. "Traumatic dental injuries and their association with malocclusion in the primary dentition of Irish children". *Dental Traumatology* 28.1 (2012): 81-86.
20. Azami-Aghdash Saber., *et al.* "Prevalence, etiology, and types of dental trauma in children and adolescents: systematic review and meta-analysis". *Medical journal of the Islamic Republic of Iran* 29.4 (2015): 234.
21. Rodd Helen D and David J Chesham. "Sports-related oral injury and mouthguard use among Sheffield school children". *Community Dental Health* 14.1 (1997): 25-30.
22. "Using mouthguards to reduce the incidence and severity of sports-related oral injuries". *The Journal of the American Dental Association* 137.12 (2006): 1712-1720.
23. Westerman B., *et al.* "Effect of ethylene vinyl acetate (EVA) closed cell foam on transmitted forces in mouthguard material". *British journal of Sports Medicine* 36.3 (2002): 205-208.
24. Scott J., *et al.* "A review of dental injuries and the use of mouthguards in contact team sports". *British dental journal* 176.8 (1994): 310.
25. Westerman Bill., *et al.* "EVA mouthguards: how thick should they be?". *Dental traumatology* 18.1 (2002): 24-27.
26. Mouthguards Advice Sheet *British Orthodontic Society* (2012).
27. American Society for Testing and Materials. Standard practice for care and uses of mouthguards. Designation: F 697-80. Philadelphia: American Society for Testing and Materials (1986).
28. Padilla Ray R. "A technique for fabricating modern athletic mouthguards". *Journal-California Dental Association* 33.5 (2005): 399-408.
29. Mouthguard Use and Care.
30. O'Malley., *et al.* "Mouthguard use and dental injury in sport: a questionnaire study of national school children in the west of Ireland". *Journal of the Irish Dental Association* (2012).
31. "Policy on prevention of sports-related orofacial injuries" *American Academy of Pediatric Dentistry*.

Volume 2 Issue 11 November 2018

© All rights are reserved by Sajeela Ismail, et al.