

## **Mouthguard Use in Sports**

The most significant factor in preventing sports-related or recreational orofacial injuries is wearing basic protective devices such as properly fitting helmets, face masks, or mouthguards. Well-fitted mouthguards prevent violent contact between the maxillary and mandibular dentition, which can result in soft tissue lacerations, tooth avulsions, tooth or bone fractures, endodontic injuries, and concussions.<sup>1</sup> Statistically, sporting activities contribute to nearly one-third of all dental injuries.<sup>2,3,4</sup> Consequently, the dentist plays an important role in informing patients, athletes and their parents, and coaches of the importance of prevention, diagnosis, and treatment of orofacial injuries in sports and recreational activities.<sup>1</sup> Currently, mouthguard application is recommended in 29 sports, including water polo, karate, taekwondo, and handball.<sup>5</sup>

For a mouthguard to be protective and effectively worn by the patient, it should fulfill the following basic requirements:

1. Enclose all the maxillary teeth to the distal surfaces of the second molars in class I and class II patients.<sup>5</sup> Enclose all the mandibular teeth to the distal surfaces of the second molar in class III patients.<sup>4,7,8</sup> If the patient has a severe gag reflex, the mouthguard may be reduced to cover the distal surfaces of the first molars.<sup>4</sup>
2. The labial flange should extend to within 2 mm of the sulcus.<sup>6</sup>
3. The palatal flange should extend approximately 2 mm above the gingival margin.<sup>6</sup>
4. The edge of the labial flange should be rounded, and the palatal edge should be tapered.<sup>6</sup>
5. Be fabricated from a material approved by the U.S. Food and Drug Administration that can reduce the impact force to teeth, surrounding soft tissues, and bone.<sup>4,10</sup>
6. Be comfortable and retentive and fit properly.<sup>10</sup>
7. Be easy to clean.<sup>10</sup>
8. Not interfere with breathing or speech.<sup>4,6,10</sup>

There are three types of sports mouthguards available:

### **Stock**

This is a ready-made or over-the-counter device available in a few sizes. This type of mouthguard is usually made from polyurethane, a copolymer of vinyl acetate, or ethylene. It is inexpensive, provides a low level of protection, has little retention, and is often not comfortable. Since retention is poor, the athlete holds the mouthguard in place by clenching his or her teeth together.

### **Self-adapting**

This is known as the “boil-and-bite” type and is available over-the-counter. This type of mouthguard is usually made from ethylene-vinyl acetate (EVA). This device is a thermoplastic rim, which is heated in hot water and then placed in the mouth to be adapted to the teeth by biting down. This type of appliance is

relatively inexpensive and can be replaced frequently in athletes with a mixed dentition or by individuals who are experiencing rapid growth. However, it is often bulky and does not retain its shape over time.

**Custom-made**

This type of device is fabricated in a dental laboratory on a cast taken from an impression or intraoral scans made by a dentist. This type of mouthguard is usually made of a thermoplastic material that is heated and adapted to the cast under pressure or with a vacuum form machine. Although it is the most expensive, this type of mouthguard is the most durable and the most retentive of the three types available. The custom-made mouthguard offers the best fit and the most protection of any of the protective devices.<sup>4,6,10</sup>

The American College of Prosthodontists (ACP) supports the use of mouthguards for all contact sports and for any recreational activities that may potentially result in orofacial injuries. The ACP recommends the use of custom-made mouthguards to better protect the teeth and jaws from trauma during athletic activity.

It is recommended that dentists produce casts from accurate maxillary and mandibular alginate impressions or from intraoral scans and a centric occlusion registration at approximately 5 mm opening anteriorly.<sup>4,6</sup> The registration at an open vertical dimension can be facilitated by using a leaf gauge, an acrylic jig, or multiple rubber occlusal reduction guides between the anterior teeth to achieve the desired 5-mm opening.

Several options in the manufacture of custom-made mouthguards are available with respect to materials and developed techniques. The standard thickness is 4 mm for most contact sports. The prosthodontist should determine the thickness of the device depending on the risk of injury involved with the particular sport or activity. It is recommended that a 5- or 6-mm thickness be used to better protect the athlete for extreme sports.<sup>4</sup>

Mouthguards can be either single-layered or multi-layered. Currently, the most commonly used materials in the construction of custom mouthguards are EVA copolymer, soft acrylic resin, polyvinyl chloride, polyvinyl acetate-polyethylene (pEVA), and elastomers.<sup>1,9,10</sup> Many different designs of multi-layered materials are available. The most frequently used is a double layer made of similar materials. Dual laminated mouthguards possess an outer hard shell of styrolbutadiene copolymerisate, and a soft inner layer of ethylene copolymer and vinyl acetate. This design of a more rigid outer material with an inner softer material will reduce the impact force transferred to the teeth due to the shock-absorbing capability of the softer layer.<sup>4,6</sup>

The critical areas in terms of energy absorption and transmitted forces are the incisal edges of the anterior teeth and the attached (marginal) gingiva. Therefore, an optimal thickness of the device is achieved by the application of vacuum forming pressure-lamination technique of two layers of a thermoplastic sheet (EVA copolymer) and if necessary, by placing two layers of protective air-cells against the critical areas. An acrylic-resin-based elastomer may be processed over the thermoplastic sheet to improve protection for the athlete.<sup>4</sup>

Custom-made mouthguards should be fabricated for adolescents with mixed dentitions. In the mixed

dentition patient, the dentist may consider relieving the erupting teeth with 1-2 mm of wax prior to the fabrication of the device in order to accommodate the erupting permanent teeth. This will reduce the number of mouthguards necessary during the adolescent years. If the patient is wearing orthodontic appliances, the mouthguard should be adaptable over any fixed orthodontic appliances.<sup>4</sup> The undercuts in the orthodontic brackets will need to be relieved with wax prior to construction of the mouthguard.

Mouthguards are also indicated for partially edentulous patients. The protective device should be made with the removable partial denture in place.<sup>4</sup> However, the dentist may elect to fabricate a mouthguard without the partial denture in place in order to reduce the risk of injury from the clasps or decrease the number of appliances worn during competition.

Completely edentulous patients also need to wear mouthguards if they are not wearing their denture during competition. If an edentulous individual is playing a contact sport and is not wearing his or her dentures and gets hit in the chin, it is likely he or she will be forced to over close the mandible, which may result in a fracture of the condyle or ramus. Edentulous athletes do not need a laminated and multi-layered mouthguard. They require a device to prevent over closure if they are not wearing their dentures during the activity. It is recommended that mouthguards fabricated to fit over edentulous ridges are made at a slightly open vertical dimension in a single layered material.<sup>6</sup>

The prosthodontist should be the professional who selects which materials are best suited for the construction, determines the design, and decides which activity or sport requires protection. It is the responsibility of the prosthodontist to inform patients, athletes and their parents, and coaches of the importance of prevention, treatment, and diagnosis of orofacial injuries. Patients who have previously suffered orofacial trauma or a concussion while participating in a sport or recreational activity need to be reminded of proper protective devices to reduce the risk of repeated injury to the orofacial areas.

Custom-made mouthguards have proved to be the most effective means of prevention of injuries to the orofacial structures.<sup>1,4,6</sup> They are superior in quality, comfort, retention, and prevention of injuries when compared to stock or self-adapting devices. Although custom-made mouthguards are the most expensive type of protective oral device, they are the most highly recommended. The benefits far exceed the expenditure when considering the fees and discomfort associated with a traumatic dental injury and subsequent prosthodontic treatment. With the advent of digital technology in dentistry, it is acceptable to use a completely digital workflow for the design and manufacture of sports mouthguards, possibly simplifying the acquisition of the oral structures and the manufacturing process.<sup>11</sup> In addition, the prosthodontist should stress that mouthguards be worn during competition as well as during practice sessions. The profession should make every effort to promote the use of mouthguards in athletes and patients who participate in any sport or recreational activity that may lead to a potential injury to the orofacial region. It is the responsibility of the prosthodontist to stay current with the most recent developments in research surrounding oral protection devices so they can provide the best recommendations to their patients.<sup>12</sup>

## References

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Approved ACP Board of Directors: March 3, 2015

Revision Approved ACP Board of Directors: August 29, 2023