

# Athletic Mouthguards: Indications, Types, and Benefits

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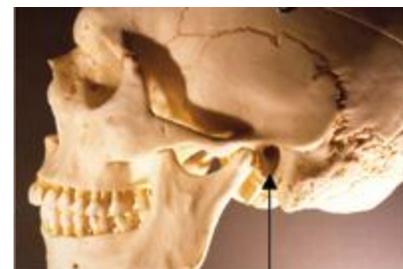
More than 5 million teeth are avulsed each year due to sports injuries and trauma,<sup>1</sup> and in certain cases these avulsions can be attributed to the absence of a mouthguard or to improperly fabricated and fitted mouthguards. **Not only do mouthguards protect the teeth, but they also protect the head against a blow to the jaw that can result in a concussion and loss of consciousness.** This article will review the indications for athletic mouthguard use, types of mouthguards, and benefits to the wearer.

## MOUTHGUARDS AND INJURY PREVENTION

Dental injuries are the most frequently incurred orofacial injuries from sports activities.<sup>2</sup> In addition to injuries to teeth that may result in pulpal injury and the need for endodontic treatment or loss of teeth, an impact to the base of the skull via a blow to the chin in a vertical direction may result in concussion. In both types of injuries, use of a mouthguard could have a significant preventive role. Heintz<sup>3</sup> and Chapman<sup>4</sup> confirmed that properly fabricated, custom-fitted mouthguards reduce the incidence of concussion as well as dental and mandibular jaw injuries. Masahiro et al<sup>5</sup> reported that mouthguards relieve the stress concentrated on the anterior teeth in a frontal collision by absorbing and dispersing some of the shock energy, quickly stopping the vibration of the maxillary teeth.

Research from Bloorview MacMillan Children's Center and the Hospital for Sick Children<sup>6</sup> indicates that the various types of sports injuries create a need for sports-specific models of mouthguards, stating that the injuries associated with basketball (eg, elbows impacting the maxillary jaw, loosening a tooth) are different from baseball (eg, ball impacting the teeth) and different from horseback riding (eg, teeth driven up into the jaw from the impact of a fall). Based on how the mandibular condyle articulates within the glenoid fossa, these different types of trauma have different clinical implications, and different types of mouthguards may prevent or minimize resultant injuries (Figure 1).

Unfortunately, the public is largely uninformed about the serious consequences of sports trauma as well as methods of prevention. Trauma resulting from orofacial sports injuries can range from the considerable pain and expense in replacing a lost tooth to the greater impairment and cost resulting from a concussion that can end a sports career. Parents, athletes (professional and nonprofessional), coaches, and trainers largely minimize and deny these consequences, perhaps as a defensive mechanism to protect psychologically against the possibility of an injury. A survey by Karl<sup>7</sup> reported that even in the National Hockey League, only 51.6% of NHL players wear a mouthguard. It is understandable that it may not be possible to force a professional athlete to wear a mouthguard, but it is unfortunate that owners and the league administration do not educate the players and then make mouthguards mandatory, as are protective helmets in hockey.



**Figure 1.** Any trauma to the mandible can cause the condyles to be displaced upward within the glenoid fossa, thereby causing trauma to the base of the skull. A concussion can result. (Courtesy: International Academy for Sports Dentistry.)

## FUNCTIONS OF MOUTHGUARDS

In their book *Textbook and Color Atlas of Traumatic Injuries to the Teeth*, Andreasen and Andreasen<sup>8</sup> list 8 basic mouthguard functions:

- (1) Mouthguards prevent laceration and bruising during impact by acting as a buffer between the soft tissues of the lips and cheeks and the teeth.
- (2) Mouthguards prevent tooth fractures or dislocations by cushioning the teeth from direct frontal blows while redistributing the forces of impact.
- (3) Opposing teeth are protected from seismic contact with each other.
- (4) The mandible is afforded elastic, recuperative support that can prevent fracture or damage to the unsupported angle of the lower jaw.
- (5) Mouthguards help reduce neurologic injury by acting as shock absorbers between the upper and lower jaws. Without a mouthguard, the trauma of the jaws violently jarring together can distribute the impact from the condyles of the mandible against the base of the skull, resulting in concussion.
- (6) Mouthguards can provide positive reinforcement in the prevention of neck injuries.<sup>9</sup>
- (7) Mouthguards provide a psychologic benefit to athletes. Findings suggest athletes feel more confident and aggressive when they have the proper protection.<sup>10</sup>
- (8) Mouthguards fill edentulous spaces and thereby help support adjacent teeth. This allows removable prostheses to be taken out during athletic competition.

Facts from the National Youth Sports Foundation for Safety<sup>11,12</sup>

- (1) An athlete is 60 times more likely to sustain damage to the teeth when not wearing a protective mouthguard. Mouthguards and faceguards prevent an estimated 200,000 high school and college football injuries.
- (2) The cost of replanting a tooth and follow-up dental treatment is estimated to be approximately \$5,000. Individuals who experience an avulsed tooth that is not properly preserved or replanted may face lifetime dental costs of \$15,000 to \$20,000 per tooth.
- (3) Each athlete involved in a contact sport has about a 10% chance per season of an orofacial injury, or a 35% to 56% chance during his or her athletic career. Approximately one third of all dental injuries are sports related.
- (4) Every year hospitals in the United States see thousands of cases of lost or damaged teeth as a result of sports injuries. Treating these injuries can cost thousands, even tens of thousands of dollars per individual.<sup>6</sup>
- (5) The total cost to replace an avulsed tooth (complete displacement of the tooth out of its socket) can be 20 times more than the cost of a custom-fabricated mouthguard.<sup>13</sup>
- (6) The ADA recommends wearing custom mouthguards for the following sports: acrobatics, basketball,



**Figure 2.** Trauma to the mandibular teeth during athletic competition.

Mouthguard was not worn.

boxing, field hockey, football, gymnastics, handball, ice hockey, lacrosse, martial arts, racquetball, roller hockey, rugby, shot-putting, skateboarding, skiing, skydiving, soccer, squash, surfing, volleyball, water polo, weight lifting, and wrestling. There are newer sports such as rollerblading, mountain biking, and skateboarding, or sports such as racquetball and gymnastics, in which wearing a mouthguard may prove beneficial. With their increased participation in sports, female athletes need the protection a mouthguard offers (Figure 2).

## CONCUSSION

The most serious and life-threatening consequence of orofacial sports trauma is a concussion. During contact sports, blows of varying degrees are repeatedly delivered to the jaw and chin. The concussive vibration from these blows is conducted to the temporal bone of the skull, which contains cranial nerve trunks that exit the base of the brain and affect hearing, balance, and blood supply to the brain. The brain “floats” in cerebrospinal fluid and is protected by the skull. Unfortunately, the skull cannot protect or prevent the brain from incurring forces from a violent impact. The result is the chance of the brain rotating within the skull, causing a concussion.



**Figure 3.** Custom mouthguards help protect the teeth while at the same time aid in diffusing the impact to the jaws by separating the mandible from the maxilla.

The resulting separation within the glenoid fossa decreases the chance of concussive effects to the base of the brain.

(Courtesy: International Academy for Sports Dentistry.)

A properly fabricated mouthguard covers and protects all of the teeth, especially the posterior teeth, with a prescribed thickness to diffuse impact to the jaw. The mouthguard separates the mandible and maxilla, thereby buffering the transmission of concussive effect to the base of the brain<sup>3,4</sup> (Figure 3). The mouthguard also protects the anterior teeth from frontal blows by absorbing and dispersing the shock vibration that could cause severe damage to the maxillary anterior teeth.

## Levels of Concussion

The American Academy of Neurology (AAN) categorizes concussions into 4 grades. Robert C. Cantu, MD,<sup>14</sup> chief of neurosurgery service and director of service of sports medicine, Emerson Hospital, Concord, Mass, developed this system. Dr. Cantu has 30 years of experience as a neurosurgeon and football team physician.

Asymptomatic: no head-ache or dizziness and no impaired orientation, concentration, or memory during exertion.

Grade 1 (mild): no loss of consciousness (LOC); post-traumatic amnesia (PTA) less than 30 minutes.

Grade 2 (moderate): LOC less than 5 minutes or PTA greater than 30 minutes.

Grade 3 (severe): LOC greater than 5 minutes or PTA greater than 24 hours.

## **Consequences of Concussion**

### **(Guidelines for Grades 1 to 3 According to AAN)**

Although loss of consciousness is not a prerequisite of concussion, CT scanning should be performed, as this is the most sensitive and specific mode for identifying such injuries. Plain radiographs are not specific enough to determine the level of damage. For those people who are asymptomatic from the initial, minimal force with no intracranial hemorrhage, the long-term chance exists for subtle abnormalities in specific cognitive function.<sup>15</sup>

**Grade 1 Concussion.** Re-turn to play after 15 minutes if the athlete shows complete recovery (no symptoms at rest or with exertion). The injured player should be examined immediately and at 5-minute intervals until the symptoms disappear. A second Grade 1 concussion in the same game should result in the player leaving the game for its duration. Before the player can return to competition, the player should show no symptoms at rest and exertion for a week and should also receive a neurological exam.

**Grade 2 Concussion.** Not allowed to return to play again that day. The player should be examined at frequent intervals. A trained person should re-examine the player the following day. Before the player can return to competition, the player should show no symptoms at rest or exertion for a week and should receive a neurological exam. A second Grade 2 concussion requires no symptoms at rest or exertion for 2 weeks with a neurological examination.

**Grade 3 Concussion.** Taken by ambulance to the nearest emergency department if still unconscious or if worrisome signs are detected such as a vacant stare, delayed verbal or motor responses, confusion or inability to focus, slurred speech pattern, or any loss of consciousness. A thorough neurological examination, including a CT scan, should be performed promptly with admission to the hospital on signs of pathology such as diffuse swelling of the brain, small subdural hema-toma, and/or elevated intracranial pressure, or if the player's mental status remains abnormal. If a player experiences a Grade 3 concussion, that player should not return to play until there are no symptoms at rest or exertion for 2 weeks. The player should also receive a neurological examination. A second Grade 3 concussion requires rest for at least 1 month.

## **BASIC TYPES OF MOUTHGUARDS<sup>16</sup>**

Mouthguards are available in 3 basic types:



**Figure 4.** Stock mouthguard.

(1) Stock. For sale in sporting goods and department stores, stock mouthguards are the least preferred type. These devices are the least expensive, least effective, and are only available in a limited number of sizes. For comfort, they are often modified by the athlete for better fit. This can negate their usefulness (Figure 4). Stock mouthguards have been shown to provide only a low level of protection.<sup>17</sup> If the wearer is rendered unconscious, the mouthguard may become unseated and cause an airway obstruction.<sup>18</sup> In 1997, Division III football players were wearing stock-grade mouthguards that did not provide support for posterior teeth. Further, athletes were buying these poor-quality appliances and trimming them to improve speech and breathing. It was noted that these athletes sustained concussions while wearing the mouthguards. As a result, the Academy for Sports Dentistry (now called the International Academy for Sports Dentistry) formulated a position statement defining a “properly fitted mouthguard” with adequate posterior support. That statement has helped to educate athletes and trainers/coaches regarding what is meant by a proper mouthguard.<sup>19</sup>



**Figures 5 and 6.** Boil-and-bite mouthguards.

(2) Boil and bite. Most commonly used, these mouthguards do not provide the proper thickness, comfort, or critical protection of the posterior teeth. They are made of a thermoplastic material that when immersed in boiling water can be fit and formed in the mouth with the use of the lips, tongue, cheeks, and biting pressure. Often, because of the inaccurate fit, clenching pressure is required to obtain satisfactory retention (Figures 5 and 6).



**Figure 7.** Custom mouthguard  
in various colors.

(3) Custom made: Designed by a qualified dentist, these mouthguards provide comfort, correct thickness, and maximum protection of all teeth, including the posterior teeth (Figures 3 and 7). They are designed with consideration of the patient's dental history, and may be designed for a particular sport and with full knowledge of any past history of concussion. For example, if the athlete plays a sport such as tennis, which does not entail a high degree of traumatic contact, then the design of the mouthguard can be constructed with a thinner layer of ethylene vinyl acetate (EVA). For a single-layer mouthguard (approximately 0.08 inches [2 mm]) thick, EVA is used in a vacuum machine. This type of mouthguard would be best suited for those who participate in noncontact sports. The dentist can fabricate them directly in-office or send them to the laboratory. Multiple-layer mouthguards (approximately 0.15 inches [4 mm] or thicker) are also constructed by pressure lamination. These types of mouthguards are made by using multiple sheets that are laminated upon one another over a cast of the athlete's teeth using heat and high pressure. The pressure enhances the accuracy of the lamination process. These mouthguards are constructed by a dentist in-office or by a dental laboratory and are best suited for those who participate in heavy contact sports such as boxing.

### **SUGGESTIONS FOR INCREASING THE USE OF MOUTHGUARDS**

It can be suggested that in order to increase the use of mouthguards during sports activities, professional athletes should serve as role models for young athletes, performing public service announcements promoting the use of properly fitting mouthguards. If the professional athlete suggests the use of this appliance, it would enhance the willingness of young athletes to follow that example. Professional athletes, team physicians, trainers, and team dentists should be advocates for the use of sports mouthguards.

Local dentists can also contribute by educating their communities, even by fabricating mouthguards for school teams at a low cost.

### **FUTURE RESEARCH**

Study is underway at Ryerson University in Toronto to suggest new mouthguard designs based on analysis of the forces that can affect the jaws and teeth during sports contests. Using mathematical models and cadavers, the goal is to predict the stresses exerted on the jaws and teeth when protected by various experimental mouthguard designs. A crash "test jaw," similar in principle to human-sized dummies used in the auto industry to test car safety, will be used in this research.<sup>6</sup>

### **CONCLUSION**

Dental injuries are the most frequently occurring orofacial injuries in sports activities. Further, the most serious and life-threatening consequence of orofacial trauma is concussion. Not only do mouthguards protect teeth, but they also protect the head from blows to the jaw that can result in concussions and unconsciousness. This article has reviewed the indications for mouthguard use, the types of mouthguards, and benefits of mouthguard use.

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### Continuing Education Test No. 72.2

After reading this article, the individual will learn:

- the indications for using a mouthguard during athletic competition, and
- the types of mouthguards that are available for use.

**1. How many teeth are lost each year in the United States due to sports injuries and trauma?**

- a. 1 million
- b. 3 million
- c. 5 million
- d. 8 million

**2. The following statement is FALSE:**

- a. Mouthguards help prevent laceration and bruising during impact.
- b. Mouthguards cannot help prevent fracture or damage to the unsupported angle of the lower jaw.
- c. Mouthguards can help reduce neurological injury.
- d. Mouthguards provide a psychological benefit to athletes.

**3. Each athlete involved in a contact sport has approximately a \_\_\_\_ chance per season of an orofacial injury.**

- a. 5%
- b. 10%
- c. 15%
- d. 35%

**4. A concussion resulting in loss of consciousness of less than 5 minutes or post-traumatic amnesia greater than 30 minutes is classified as \_\_\_\_.**

- a. Grade 1
- b. Grade 2
- c. Grade 3
- d. Grade 4

**5. If a player experiences a Grade 3 concussion, he or she should not return to play until there are no symptoms at rest or exertion for \_\_\_\_\_.**

- a. 1 week
- b. 2 weeks
- c. 3 weeks
- d. 4 weeks

**6. The most commonly used type of mouthguard, but one that does not provide adequate protection, is \_\_\_\_\_.**

- a. boil and bite
- b. stock
- c. custom
- d. All of the above provide adequate protection against injury.

**7. The following type of mouthguard is best suited for those who participate in noncontact sports:**

- a. boil and bite.
- b. stock.
- c. multiple-layer custom mouthguard.
- d. single-layer custom mouthguard.

**8. An athlete is \_\_\_\_\_ times more likely to sustain damage to the teeth when not wearing a protective mouthguard.**

- a. 20%
- b. 40%
- c. 60%
- d. 75%

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To submit Continuing Education answers, download the answer sheet in PDF format (click Download Now button below). Print the answer sheet, identify the article (this one is Test 72.2), place an X in the box corresponding to the answer you believe is correct, and mail to Dentistry Today Department of Continuing Education (complete address is on the answer sheet).