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Sporting Mouthguards

Preventing Sports-Induced Orofacial Injuries

Dealing With Negative Reviews

3 Steps to Team Success



White House Concussion Summit
Constituent Advocacy: Georgia AGD
Healthy People 2020 Report Update
AGD Members' Advocacy Efforts

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Sporting Mouthguards

Preventing Sports-Induced Orofacial Injuries

BY CLAIRE ALTSCHULER

School and community sports provide lifelong benefits for athletes, offering them the opportunity to achieve physical fitness and improve their overall health. However, many of these high-impact activities, such as football, soccer, ice hockey, wrestling, boxing, and lacrosse, pose serious health risks as well.

Impact during these sports can lead to chipped or lost teeth, facial lacerations, broken bones, and other injuries. According to the American Academy of Pediatric Dentistry's Policy on Prevention of Sports-Related Orofacial Injuries, sports accidents account for 10 to 39 percent of all dental injuries in children.

According to Richard Knowlton, DMD, MAGD, past president of the Academy for Sports Dentistry (ASD), athletic mouthguards can "reduce the severity and prevent the occurrence of injuries, such as coronal and radicular fractures, corpus fractures of the mandible, and fractures of the alveolar processes, condyle, and gonial angles." Mouthguards also prevent tooth avulsion and displacement, as well as "soft tissue lacerations to the gingiva and oral mucosa."

These painful injuries take time to treat and heal, and treatment can be expensive, especially when an athlete

requires a crown or root canal. A report published in the January 2003 edition of *Sports Medicine*, "Overview of Injuries in the Young Athlete," estimated the annual cost for all sports-related pediatric orofacial injuries to be as high as \$1.8 billion.

According to the American Dental Association's Council on Scientific Affairs, "Surveillance studies of mouthguard users and nonusers have consistently shown that mouthguards offer significant protection against sports-related injuries to the teeth and soft tissues." Learn more about the types of mouthguards your patients may be using, and how you can help them protect their smiles with custom-made athletic mouthguards.

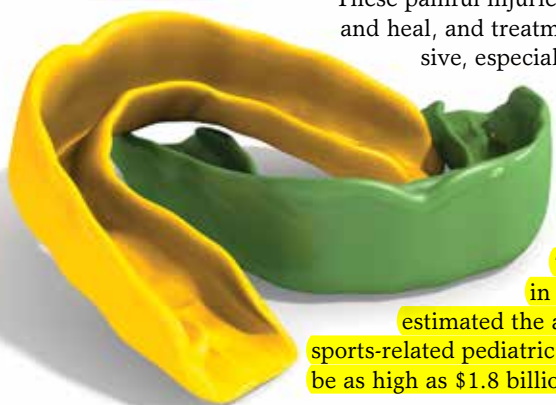
Types of mouthguards

To help prevent injuries, there are a number of mouthguard types available to patients that offer varying degrees of protection. Both stock guards and mouth-formed "boil-and-bite" guards are available to athletes over-the-counter and can be purchased at most sporting goods stores. Custom-made mouthguards, which are created from a cast of the individual athlete's dentition, require the expertise of a dentist and special fabrication equipment.

Over-the-counter devices

According to Sports Dentistry Online, more than 90 percent of mouthguards used are purchased by athletes at sporting goods stores. Of these, stock guards are the least expensive (\$3 to \$25 each). These guards are made of rubber and come in a limited number of sizes that cannot be altered to improve fit. Because of this, athletes must hold the mouthguard in place with their teeth, constantly biting down on the device. Stock guards offer the least amount of protection, and they also can interfere with breathing and speech.

Boil-and-bite mouthguards, made of a thermoplastic material called ethylene-vinyl acetate (EVA), are heated in water and allowed to cool for about 20 seconds before being placed in the athlete's



mouth, where they are formed to the teeth with pressure from the mouth and fingers. While these devices fit better and offer more protection than stock mouthguards, they tend to be bulky and uncomfortable, also interfering with breathing and speech. They also can be difficult to fit around braces and other orthodontic devices, which can result in damaged appliances, or cut lips and cheeks when a player is hit in the mouth.

Carl Vorhies, DDS, MAGD, team dentist for the Portland Winterhawks junior ice hockey team in Portland, Ore., says boil-and-bite devices provide limited protection because of the way they are made. When the material is stretched to form the guard, its thickness "depends on how it is placed [in the mouth], how large the individual's teeth are, and how deeply they bite into it," he says. "You don't have very much control over the end result." Additionally, he has found that many athletes also trim these mouthguards for a more comfortable fit, leaving their posterior teeth uncovered.

According to Dr. Vorhies, because boil-and-bites can be uncomfortable, players often chew on them, or stop wearing them altogether. Chewing on mouthguards or wedging them in helmets (another common practice) degrades the devices, which means they often don't last through an entire season. However, the prices for these mouthguards are fairly consumer-friendly, ranging from \$15 to \$50 (though frequent replacement increases costs).





Many patients find that custom-made devices provide the most comfortable fit and the best protection against injuries, and they are more durable than many over-the-counter varieties.

Despite some limitations, boil-and-bite mouthguards can prevent many orofacial injuries when formed properly and worn consistently. The large demand for these over-the-counter devices (They remain the most popular.) also means manufacturers are continually working to improve them.

Custom-made mouthguards

Many patients find that custom-made devices provide the most comfortable fit and the best protection against injuries, and they are more durable than many over-the-counter varieties. Dentists can easily create these custom mouthguards by taking an impression of the athlete's mouth and either sending the cast to a dental laboratory for fabrication or making the device in-house using their own equipment. These mouthguards can be fabricated using either the vacuum method or the pressure-laminated technique.

The vacuum process involves heating a single layer of thermoplastic and stretching it onto the cast of the athlete's dentition. The vacuum then sucks the air out, pulling the plastic tight so it adheres to the mold's shape.

Many agree that pressure-laminated mouthguards are the standard of care because they provide athletes with the greatest levels of comfort and protection. The technique creates devices with multiple layers of thermoplastic that provide more cushion, as well as a fit that is superior to that of over-the-counter mouthguards.

Although they consist of several layers rather than one, pressure-laminated mouthguards are still "relatively thin and small," says Timothy Kosinski, DDS, MAGD, of Bingham Farms, Mich., who provides his local high school teams with mouthguards. As a result, they don't

interfere with play, and athletes keep them in their mouths. For example, he says, "a quarterback can easily keep it in his mouth when he's calling out signals."

As in the vacuum process, the first step in creating a pressure-laminated mouthguard is making a mold of the player's dentition. The cast is then placed in the pressure laminating machine. Rather than sucking air out and creating a vacuum to pull the material around the cast, pressure lamination involves pushing air into the chamber and pressing the plastic down and around the cast at high heat.

Pressure lamination allows the thickness in each part of the mouthguard to be adjusted precisely, ensuring that the finished device has the best configuration for the individual player and provides the best protection. According to the ASD's position statement "A Properly Fitted Mouthguard," these devices should "cover and protect both the teeth in the arch and the surrounding tissues" and have "a minimum of 3 mm thickness in the occlusal [and] labial areas" in order to absorb and dissipate energy from a blow. Optimal palatal thickness is 2 mm.

While most dentists don't make entirely different guards for different sports, custom fabrication does allow them to tailor the device to the individual player and his or her sport, increasing both comfort and protection. "The advantage of customized lamination," says Dr. Vorhies, "is that the design and thickness can be modified."

Dr. Knowlton agrees. Some sports, such as basketball, wrestling, and boxing, involve more hits to the front teeth, for example, while skiing or the luge often involve more impact to the occlusal areas of the teeth. He believes the ability to increase the thickness in

various areas of the guard can provide greater protection.

Improving fit by tailoring the device to an individual's unique needs makes them more comfortable and allows the athlete to breathe easier—increasing compliance. Modifications also can be made "to accommodate gaggers and different occlusions," adds Dr. Vorhies. Dentists also can offer patients a variety of ways in which to customize these devices, including colors, designs, and even team logos. Dentists charge varying amounts for these devices, with some practices choosing to utilize this service as a production improver.

Recent innovations

Though there are numerous products available to athletes, the mouthguard market continues to grow. Andrew D. Gould, DMD, team dentist for the AHL Hershey Bears Hockey Club in Hershey, Pa., believes another type of custom-made mouthguard, which is made of acrylic, a material that "adds stability to the bite and the occlusion," can help prevent injuries. He recommends the Maher Orthotic, a device created by Gerald Maher, DMD, FAHND, a temporomandibular joint specialist. In addition to providing these mouthguards for his patients, Dr. Maher is the team dentist for the New England Patriots.

Unlike other custom mouthguards, the Maher Orthotic is made like a denture—acrylic is syringed into a cast of the patient's dentition and cured overnight. Dr. Maher says the device is worn on the lower teeth because athletes find it more comfortable. It is designed to advance the mandible forward, increasing the space in the oral pharynx and making it easier to breathe and speak.

"It works very similarly to a sleep apnea appliance," Dr. Maher says. "The

Mouthguards and Head Injuries

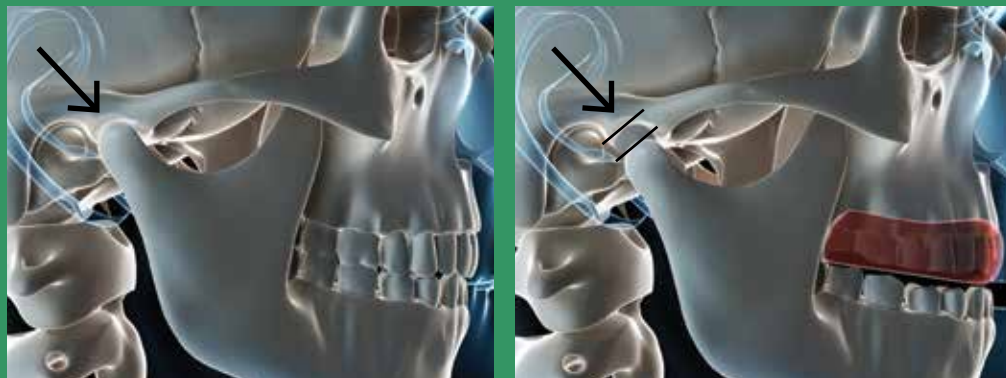
Can These Devices Help Reduce the Incidence of Concussions?

Recent dental research has shown that properly fitted mouthguards may help reduce the incidence of severe concussions or sports-related mild traumatic brain injuries (MTBI) in athletes. Richard Knowlton, DMD, MAGD, past president of the Academy for Sports Dentistry, says that the theory that mouthguards can prevent concussions is based on the position of the brain relative to the jaw.

The brain sits directly above the temporomandibular joint, which is formed by the connection between the mandible and the temporal bone. When an athlete is struck in the jaw, the energy from the impact can travel to the brain, causing injury. Some experts believe that a mouthguard with adequate thickness and a proper fit that increases the space in the temporomandibular joint could help dissipate this energy before it reaches the brain, preventing, or at least lessening, damage.

The crucial issue for both oral health and MTBI prevention, Dr. Knowlton says, is "the amount of mouthguard material that is on the top surface, the occlusal surface of the teeth." When fabricated correctly, the guard can provide a cushion and keep the lower teeth from hitting the upper teeth if the jaw is thrust upward.

In addition, Dr. Knowlton says,



A skull without a pressure-laminated mouthguard in position (left), and a skull with such a mouthguard in place (right). The pressure-laminated mouthguard creates a separation of the condyle that some researchers believe may reposition or align the mandible to better absorb, dissipate, or reduce possible concussion forces.

Source: Adapted from *General Dentistry*, May/June 2014; reproduced with permission from the Academy for Sports Dentistry

a properly fitted mouthguard should retain "a space between the end of the jaw, the condyle, and the temporal bone in the temporomandibular joint." If the space and cushioning in that area is inadequate, a hit to the jaw could result in a temporal bone fracture.

Until recently, evidence supporting the mouthguard's ability to reduce the incidence of concussion was mostly anecdotal. In the *British Journal of Sports Medicine* in 2001, Paul McCrory, MD, wrote, "The ability of mouthguards to protect against head and spinal injuries in sport falls into the realm of

'neuromyology' rather than hard science." A 2011 *Clinical Sports Medicine* study reported that "there [was] not yet significant evidence to advocate [helmets' and mouthguards'] effectiveness in preventing concussion." The paper's authors recommended further study.

However, research published in the May/June 2014 issue of *General Dentistry*, "Role of Mouthguards in Reducing Mild Traumatic Brain Injury/Concussion Incidence in High School Football Athletes," suggests that a custom-made, properly fitted mouthguard may reduce the incidence of sports-related concussions. Authors Jackson Winters, DDS, and Richard DeMont, PhD, CAT(C), ATC, performed a randomized, prospective study of six high school football teams (412 total players). Players on three teams wore over-the-counter (OTC) mouthguards, while players on the other three teams wore custom-made, pressure-laminated mouthguards. All players wore the same helmets.

This study found a "nearly 2-to-1 ratio between the two groups' incidence of MTBI/concussion injury, which was statistically significant." The researchers concluded that "custom-made, properly fitted, pressure-laminated

mouthguards with more than 3 mm thicknesses in the posterior occlusal area statistically reduced the incidence of MTBI/concussion injury when compared to OTC mouthguards."

"Previously, the rap was that mouthguards don't make a difference, but I disagree," believes Dr. Winters. Even though properly fitted mouthguards won't prevent all concussions, Dr. Winters says his study shows they can play a role in prevention, and he hopes these results will stimulate further research.

Dr. Knowlton believes additional study is necessary to determine if and how mouthguards can impact concussions. "As time goes on, and we have better and better research, I believe you are going to find that a quality mouthguard can make a difference," he says.



**ONLINE
EDITION**

Read the May/June 2014 *General Dentistry* study on mouthguards.



Mouthguard Requirements for Athletes

High School Athletes

Per the National Federation of State High School Associations (NFSH), mouthguards are currently required for participation in these high school sports:

- Football
- Field hockey
- Ice hockey
- Lacrosse
- Wrestling (for wrestlers wearing braces)

All mouthguards, excluding wrestling devices, must be made with a visible color—not white or clear. Additionally, NFSH rules require all mouthguards used in wrestling (for those with braces) to cover both the upper and lower orthodontic appliances.

Source: NFSH 2011 Position Statement and Recommendations for Mouthguard Use in Sports

College Athletes

The National Collegiate Athletic Association’s (NCAA) 2012–2013 NCAA Sports Medicine Handbook requires athletes to use mouthguards when participating in several sports. Stock, mouth-formed, and custom mouthguards are recognized as acceptable devices.

| Sport | Position | Intraoral Mouthguard | Color | Covers All Upper Teeth | When |
|------------------|----------|---|--|---|--|
| Field Hockey | Field | Mandatory; strongly recommended for goalkeepers | Not specified | Not specified | Regular season competition and NCAA Championships |
| Football | All | Mandatory | Readily visible color (not white or transparent) | Yes | Regular season competition, postseason competition, and NCAA Championships |
| Ice Hockey | All | Mandatory | Recommended | Covers all the remaining teeth on one jaw | Regular season competition and NCAA Championships |
| Women’s Lacrosse | All | Mandatory | Not Specified | Yes | Regular season competition and NCAA Championships |
| Men’s Lacrosse | All | Mandatory | Yellow or any other visible color | Yes | Regular season competition and NCAA Championships |

Adapted from: 2012-2013 NCAA Sports Medicine Handbook

big difference between my guard and others is that it is based on the temporomandibular joint. It's an orthopedic device that places the joint in the best physiological position."

By balancing the articular disk and the condyles in the joint, he says, the mouthguard keeps the muscles on both sides of the joint in harmony. The Maher Orthotic also keeps the jaw slightly open, which helps reduce the impact when an athlete is hit during play.

"That is the whole key to the device—its balance," Dr. Maher says. Increasing the space in the jaw allows the device to disperse energy and lessen the impact of a blow. Dr. Gould charges patients \$450 for the Maher Orthotic; prices vary by provider.

The role of the general dentist

As research continues to point to the importance of mouthguards for athletes, dentists increasingly find themselves in a position to help their patients and local communities improve sports safety and reduce dental injuries—and it all starts with a conversation about mouthguards. "I challenge the dentists out there to get involved," Dr. Kosinski says. "It's very rewarding. And the kids really appreciate it."

Dr. Kosinski began making custom mouthguards when a close friend asked him to recommend one for his son who had taken up wrestling. The friend had seen a child lose a tooth during a match and wanted to protect his son from the same fate.

Dr. Kosinski says he offered to make custom-fitted mouthguards for the wrestling team, first vacuum-formed and eventually pressure-laminated devices. Over the years, he has created an efficient system for making mouthguards that do not require much time for him or his staff.

According to Dr. Knowlton, material costs for pressure-laminated mouthguards run approximately \$20 per device. Each sheet of EVA costs about \$6.50, while the impression material is about \$1 for each guard. (Vacuum-formed mouthguards use only one sheet of thermoplastic, so they are slightly less expensive.)



By offering these devices, dentists can set themselves apart from others, helping them expand and enhance their practices.

The rest of the cost covers the dentist's time, as well as the fabrication equipment, if the dentist decides to make the mouthguard in his office. Most vacuum machines cost \$300 to \$500; pressure laminating devices run \$2,500 to \$3,000. For those sending the cast out for fabrication, Dr. Knowlton says laboratory fees can run anywhere from \$30 to \$120 per device. These costs should all be taken into account when determining the prices for these devices.

Dr. Kosinski says that in addition to providing an important service to patients and the community, making mouthguards for local teams also can be a good marketing tool. By offering these devices, dentists can set themselves apart from others, helping them expand and enhance their practices.

Before providing a mouthguard, the dentist should assess the patient's oral health, including any cavities or missing teeth; determine what sport he or she plays and at what level; and consider whether he or she is receiving any orthodontic treatment or expects to in the near future. The answers to these questions will help the dentist to determine which device to recommend. Many athletes are unfamiliar with custom-made mouthguards, so reviewing all of the options could be enlightening—and result in better protection for the player.

Dentists also should take the opportunity to discuss sports safety with their athletic patients and encourage them to wear mouthguards during practice as well as in competition—as injuries can occur in both situations. In fact, Dr. Vorhies says, one the most significant injuries he's encountered occurred during a practice session.

The patient, a 17-year-old ice hockey player, was hit in the mouth by a puck at practice. According to Dr. Vorhies, the patient's injuries included a "severe laceration of the upper lip [and] a lost lateral tooth, a central incisor was pushed backwards, and the whole buckle plate of that anterior segment was shattered." A mouthguard may not have prevented all of those injuries, Dr. Vorhies says, but it "certainly would have made a difference." He believes dentists, coaches, and referees should insist that players wear their mouthguards whenever they play and enforce the rule in both practice and competition.

General dentists can provide a valuable service by educating athletes, parents, coaches, trainers, and other school officials about mouthguards and their proper use, and the ASD encourages general dentists who offer mouthguards to take the lead in their communities.

Mouthguards may be small, but they can make a big difference in protecting athletes from orofacial injuries. By educating patients on the importance of properly fitted athletic mouthguards, general dentists can help care for athletes both in the office and on the playing field. ♦

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