Mouth Guard Use in Combat Sports. A Position Statement from the Association of Ringside Physicians

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Position Statement

Based on the available data, the Association of Ringside Physicians recommends that mouth guards should be used in all high- and intermediate-risk sports, including contact and combat sports, to aid in the prevention of orofacial trauma. Mouth guards are proven to reduce the risk of orofacial trauma in contact sports. They should be worn during all sparring, grappling, and competition. Custom mouth guards made by a skilled, qualified dentist are highly recommended over stock mouth guards or boil-and-bite mouth guards. ARP does not endorse over-the-counter "stock" or boil-and-bite mouth guards. Custom mouth guards provide more complete coverage of teeth and molars, fit more comfortably, remain in place better, have fewer side effects, and do not degrade athletic performance. Effective education on appropriate mouth guard use should be provid-ed to all athletes participating in these sports.

Preamble: Development of this Statement

This position statement expresses a collaborative effort among the Association of Ringside Physi-cians (ARP) Board of Directors, emeritus Board, and some subject matter experts. An extensive literature search including but not restricted to MEDLINE, Cochrane Reviews, and non-indexed peer-reviewed articles published in online medical journals was performed regarding combat sports, contact sports, and mouth guards. Unfortunately, significant studies/articles/information in combat sports regarding mouth guard use are lacking. Hence, much of this statement is an extrapolation of current recommendations on mouth guard use in contact sports with the current best practices in combat sports and the collective expertise and experience of its authors having provided ringside medical coverage over many years.

Definitions

Sports activities in general can increase risk of orofacial trauma. Orofacial trauma includes fractures of facial bones; lip and cheek soft tissue trauma; injuries to the dentition which can include subluxation, avulsion, and fracture; and lacerations of the gum and tongue.[1] In comparison to other soft tissue injuries, orofacial injuries are often more complex, require longer healing time, and can have both financial and psychological impact on affected athletes.

Combat sports are defined as competitive contact sports that generally involve one-on-one unarmed

combat. These include sports such as boxing, taekwondo, judo, karate, wrestling, and many others. A list of combat sports is provided in Table 1.

Mouth guards are defined by the American Society for Testing and Materials as a "resilient device or appliance placed inside the mouth to reduce mouth injuries, particularly to teeth and surrounding structures." The device separates the upper and lower dentition and protects at least a portion of the teeth from the surrounding soft tissue. They are hypothesized to reduce injury by absorbing or redistributing shock during direct impacts, stabilizing the jaw during traumatic jaw closure, and reducing incidence of bruising and laceration to adjacent soft tissue.[3]

Design of the mouth guard, including the materials used in construction, is key to its effectiveness in preventing injury. These materials affect the shock absorbing ability, the tensile strength and tear strength, among other important properties.[3] The thicker the material, the greater the resultant energy absorption.[4] Early mouth guards were composed of latex rubber, but this was found to lack shock absorbing quality, as well as tear and tensile strength compared to newer materials. More modern mouth guards are created with a variety of different materials, including ethinyl vinyl acetate, polyurethane, silicon, and other compounds. None of these newer compounds stands out as superior in comparison to the others, as they can all be manipulated and used in combination to create favorable characteristics in a mouth guard.[3]

Types of Mouth Guards

The most common types of mouth guards available to athletes are as follows (Figure 1).[5]

- Type I: Stock, or ready-made mouth guards, bought over the counter and designed to be used without further modification.
- Type II: "Boil-and-bite", or mouth-formed mouth guards, made with thermoplastic material that is immersed in hot water and then formed in the athlete's mouth using finger, tongue and biting pressure.
- Type III: Custom made mouth guards, based on a model of the athlete's jaw, and created by a dental professional.

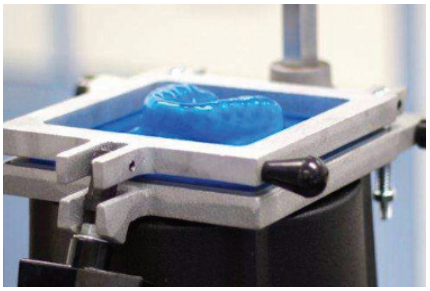
The type I and type II mouth guards are generally bulky and require constant occlusal pressure to be held in place.[5] During fabrication of these types of mouth guards, thickness decreases from 70 to 99 percent from pre-fabrication thickness.[4] This can result in the athlete biting through the material during the molding process and thinning the mouth guard, taking away its protective qualities. Sizing is also an issue with these mouth guards. Studies on arch length showed that even with the largest available mouth-formed mouth guards,

TABLE 1: Examples of Combat Sports

Striking Sports	Grappling Sports	Armed Sports
Boxing	Wrestling *	Fencing
Kickboxing	Judo	Kendo
Muy Thai	Jiu-Jitsu	Jousting
Karate	Sumo	Dueling
Taekwondo	Mixed martial arts	

*Many subtypes of wrestling including collegiate/scholastic, Greco-Roman, professional, and for entertainment.

FIGURE 1: Types of Mouth Guards

Stock Ready to Use Mouth Guard	Boil and Bite Mouth Guard	Custom Laminate Mouth Guard
		

these would cover the posterior teeth in only 15% of high school and collegiate athletes.[5]

The type III mouth guards allow dentists to address several critical issues in the fitting of the mouth guard, including providing additional protection for specific areas unique to each athlete, and the appropriateness of the design for the sport being played. In review, these types of mouth guards are considered to be more superior to any of the over-the-counter types (I, II) available. However, despite their superiority, there can still be some deficiencies in the mouth guard, depending on the fabrication process. Additionally, some materials used have elastic memory, and over time will lose their fit and retention. Changes in fabrication process have been recently employed (multiple layers of lamination with varying materials) to try to overcome these deficiencies.[5]

The primary role of mouth guards is the protection of the teeth and oral-facial structures. Mouth guards should be primarily designed to accomplish this goal, with adequate protection in the areas most likely to be traumatized (maxillary incisor teeth). A properly fitted mouth guard must be protective, comfortable, resilient, tear resistant, odorless, tasteless, not bulky, cause minimal interference with speaking and breathing, and have excellent retention, fit, and sufficient thickness in critical areas.

Epidemiology of Orofacial Injury in Combat Sports

Combat sports carry a high risk of orofacial trauma when compared to other contact sports.[1] The largest and most recent meta-analysis of dentofacial injury in combat sports found a pooled prevalence of 30%. Rates of prevalence by discipline included jiu-jitsu (52.9%), boxing (45.9%), wrestling (45.9%), karate (43.5%), taekwondo (37.5%) and judo (25.0%). The authors found wide variation in use of mouth guards in this review, with some studies having very high rates of usage and some very low, which confounded the results of injury prevalence.[2]

Effect of Mouth Guards on Prevalence of Orofacial/Dentofacial Injury

For over 50 years, the American Dental Association (ADA) has promoted the use of mouth guards in athletic activities that carry risk of dentofacial trauma.[7] Before the development of orofacial protectors (helmets, face shields, mouth guards), the ADA estimated that approximately one-half of injuries sustained by high school football players not wearing any type of face/mouth protection occurred in or around the mouth, and that these injuries could have been prevented with use of orofacial protectors. Through use of orofacial protectors including mouth guards, the preva-

lence of oral trauma has dropped from 50% to about 1%.[7] In a study involving NCAA basketball players, athletes wearing custom mouth guards sustained fewer injuries (1.16 injuries per 1,000 athletic exposures), compared to those who were not wearing mouth guards (3.00 injuries per 1,000 athletic exposures). The ADA also endorses the benefit of mouth guards in providing protection to athletes undergoing orthodontic treatment. For athletes with fixed orthodontic appliances in place, mouth guards aid in separating the soft tissue from the teeth and preventing intraoral lacerations and bruising.

Since the most recent ADA statement in 2006, empirical data has strengthened the position that mouth guards effectively prevent orofacial trauma in sports. A recent meta-analysis of 12 cohort trials and of 11 self-report trials showed that mouth guard use reduced overall risk of orofacial injuries, with a relative risk ratio of 2.32 (12). Four of the studies included combat sports athletes among other contact sport athletes, and one (13) involved only boxing and taekwondo athletes. It showed a dental trauma incidence of 12.6% in mouth guard users and 25.8% in non-mouth guard users. Another recent meta-analysis of four controlled studies in contact sports athletes showed a markedly decreased prevalence of dento-alveolar trauma in athletes wearing mouth guards (7.5%) compared to those not wearing mouth guards (59.5%).[8] The four studies analyzed only included one with combat sports athletes (Swiss boxers).[9] A retrospective study of several hundred US military recruits participating in hand-to-hand combat training showed that the risk of orofacial injury was reduced by a ratio of 1.76 after mouth guards were required compared to when they were not used. This study used boil-and-bite mouth guards that were fitted by dental professionals.[10]

Effect of Mouth Guards On Sport Concussion

Mouth guard use has a theoretical protective effect on the brain by positioning the jaw in an optimal way to absorb impact forces that might otherwise be transmitted through the base of the skull to the brain. However, mouth guard use has not been conclusively proven to reduce the incidence of concussion in contact sports. The most recent and comprehensive meta-analysis of five cohort studies showed a relative concussion risk of 1.25 (CI 0.90-1.74) without mouth guard use compared to with use.[12] None of the studies were done on combat sports athletes, the studies varied on the type of mouth guard used, and compliance was noted to be unreported in half of the studies. Further research is needed to determine if mouth guards have a significant effect on preventing sport concussion, and whether the type of mouth guard used is important in this regard.

Theoretically a properly fitted athletic mouth guard may reduce the severity of concussions by the following mechanisms:

1. Direct dissipation and/or absorption of force of an upward blow to the jaw. Forces from mandibular impact would be attenuated with a mouth guard, resulting in fewer injuries. It has been shown that mouth protectors reduced pressure changes and bone deformation within the skull in a cadaver model. The amplitude of the intracranial pressure after a blow to the chin when wearing a mouth guard may be decreased by 50%.[14,15,16]

2. Increased separation of the head of the condyle and glenoid fossa. When a properly fitted and balanced custom mouth guard is in place there is a forward/downward movement of the jaw, thus opening the space between the glenoid fossa and the condylar head. This may reduce the opportunity for the condylar head to directly impact the glenoid fossa after an upward blow to the jaw, thus reducing the impact and acceleration forces to the entire temporal region.

3. Increased head stabilization by activating and strengthening neck muscles. Activation of head and neck muscles at the time of impact will decrease the rotational forces on the skull, leading to less harmful movement of the brain inside the skull. Research has

suggested that being able to clench down on a mouth guard may activate muscles of the head and neck thus stabilizing the head.[16] Some have suggested that this effect might be in place whether or not the athlete sees the impact coming.

Effect of Mouth Guards on Athlete Perception and Athletic Performance

Regarding the comfort of mouth guards, the most common complaints with mouth guard use are breathing issues, difficulty speaking, bad breath, dry mouth, nausea, or high cost.[6,8] These complaints, along with lack of knowledge about use of this safety device, can affect the appropriate use of mouth guards and cause athletes to either forgo use altogether, or attempt to modify their mouth guards to allow for more comfortable wear.[5,8] The complaints regarding comfort with mouth guard use seem to be better ameliorated with the use of custom mouth guards (type III) compared to the over the counter versions (type I and II).[6]

A systematic review evaluating the effect of mouth guards on athletic performance in amateur, elite, and professional athletes showed that custom made mouth guards did not interfere or improve performance when compared to control (no mouth guard) in a preponderance of studies.[11] This review showed that boil-and-bite mouth guards were found to adversely affect athletic performance compared to control in four studies, with two studies describing no effect on performance and two describing enhanced performance. This same review showed that custom mouth guards showed a smaller effect on specific physiologic parameters of athletic performance (forced expiratory air volume at one second, peak expiratory flow rates, forced vital capacity, and counter-movement jump) when compared to boil and bite mouth guards.

Discussion of Guidelines

Properly diagnosed, designed, and custom form-fitted mouth guards are essential in the prevention of athletic oral-facial injuries. The National Youth Sports Foundation for the Prevention of Athletic Injuries, Inc. reports that dental injuries are the most common type of oral-facial injury sustained during participation in sports.[17] It is estimated by the American Dental Association that mouth guards prevent approximately 200,000 injuries each year in high school and collegiate football alone.[7]

Though boil-and-bite mouth guards are the most used type in sports (largely due to lower cost and wide availability), the Association of Ringside Physicians does not recommend their use in combat sports. Available in limited sizes, these mouth guards often lack proper extensions and often do not cover all the posterior teeth. Athletes also cut and alter these bulky and ill-fitting mouth guards due to their poor fit, poor retention, and gagging effects. This in turn further reduces the protective properties of these mouth guards. When the athlete cuts the posterior borders or bites through the mouth guard during forming, the athlete increases their chance of injury. It may also lead to poor compliance during a bout, as some athletes dislodge the poorly fitting mouth guard anteriorly to reduce its effect on airway and soft tissue.

However, there are some basic design elements that can and should be included in any mouth guard that might enhance the protective effects of mouth guards. All mouth guards should have an adequate thickness and should cover as much of the occlusal surface as the athlete can tolerate. Mouth guards must have proper retention built into them to ensure that they stay in place at the moment of impact. Mouth guards should not be over-trimmed in the posterior horns because this might actually force the condyles into the glenoid fossae. All mouth guards should be balanced occlusally to ensure an even distribution of force across the entire surface.

Some athletes may have developed habits that increase the risk of orofacial injury, one common example being opening the mouth during punching. Many martial artists are taught to use the kiai or kihap during their training and competition. This short yell is purported to focus their energy on the strike and tighten up the core musculature.

However, athletes who open the mouth during the kiai can lose some of the stabilizing protection of the mouth guard and be more likely to have the mouth guard dislodged or knocked out of their mouth. While these habits are often difficult to break, athletes and their coaches should be educated by ringside physicians on the benefits of a clenched jaw kiai.

Regulating commissions, referees, and officials also play an important role in injury prevention and mitigation during combat sports. While all state commissions currently require mouth guards for regulated combat sports, they should consider additional rules requiring custom-made mouth guards, which have been proven to prevent injury better than boil-and-bite or ready-made mouth guards. Referees should ensure that athletes always have their mouth guards in during a bout (other than between rounds) and consider disqualification of athletes whose mouth guards are repeatedly dislodged or knocked out.

The Association of Ringside Physicians recommends that custom-made, form-fitted mouth guards (especially those of the laboratory lamination type) be constructed for each athlete by a dentist and evaluated annually. This should afford the athlete the very best in oral-facial protection as well as possible concussion deterrence.

Qualifying Statement

These guidelines are recommendations to assist ringside physicians, combat sports athletes, trainers, promoters, sanctioning bodies, governmental bodies, and others in making decisions and setting policy. These recommendations may be adopted, modified, or rejected according to clinical needs and constraints and are not intended to replace local commission laws, regulations, or policies already in place. In addition, the guidelines developed by the ARP are not intended as standards or absolute requirements, and their use cannot guarantee any specific outcome. Guidelines are subject to revision as warranted by the evolution of medical knowledge, technology, and practice. They provide the basic recommendations that are supported by synthesis and analysis of the current literature, expert and practitioner opinion, commentary, and clinical feasibility.

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