Types of Mouthguards

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Properly diagnosed, designed, and custom fabricated mouthguards are essential in the prevention of athletic oral/facial injuries.

In Dr. Raymond Flanders 1995 study, he reported on the high incidence of injuries in sports other than football, in both male and female sporting activities. In football where mouthguards are worn, *.07%* of the injuries were orofacial. In basketball where mouthguards are not routinely worn, *34% of* the injuries were orofacial. Various degrees of injury, from simple contusions and lacerations to avulsions and fractured jaws are being reported.

The National Youth Sports Foundation for the Prevention of Athletic Injuries, Inc. reports several interesting statistics. Dental injuries are the most common type or orofacial injury sustained during participation in sports. Victims of total tooth avulsions who do not have teeth properly preserved or replanted may face lifetime dental costs of $10,000 - $15,000 per tooth, hours in the dentists chair, and the possible development of other dental problems such as periodontal disease.

It is estimated by the American Dental Association that mouthguards prevent approximately 200,000 injuries each year in high school and collegiate football alone.

A properly fitted mouthguard must be protective, comfortable, resilient, tear resistant, odorless, tasteless, not bulky, cause minimal interference to speaking and breathing, and (possibly the most important criteria) have excellent retention, fit, and sufficient thickness in critical areas.

Unfortunately, the word "mouth-guard" is universal and generic, and includes a large range and variety of products, from "over the counter" models bought at the sporting goods stores to professionally manufactured and dentist prescribed custom made mouthguards.

Presently, over *90%* of the mouth-guards worn are of the variety bought at sporting good stores. The other 10% are of the custom made variety diagnosed and designed by a health professional (dentist and/or athletic trainer).

There are four types of mouthguards presently available.

Stock Mouthguard: The stock mouthguard, available at most sporting good stores, come in limited sizes and are the least expensive and least protective. The stock mouthguard is the least acceptable. This type of mouthguard is often altered and cut by the athlete in an attempt to make it more comfortable, further reducing the protective properties of the mouthguard. It has been suggested and advised in the medical/dental literature that these types of mouthguards not be worn due to their lack of retention and protective properties. As sports dentists and health professionals interested in injury prevention, we do not recommend this type of mouthguard to our patients and athletic teams.

Mouth formed or Boil and Bite Mouthguard: Presently, this is the most commonly used mouthguard on the market. Made from thermoplastic material, they are immersed in boiling water and formed in the mouth by using finger, tongue, and biting pressure. Available in limited sizes, these mouth-guards often lack proper extensions and repeatedly do not cover all the posterior teeth. Dental mouth arch length studies have shown that most boil and bite mouthguards do not cover all posterior teeth in a majority of high school and collegiate athletes. Athletes also cut and alter these bulky and ill fitting boil and bite mouthguards due to their poor fit, poor retention, and gagging effects. This in turn further reduces the protective properties of these mouthguards. When the athlete cuts the posterior borders or bites through the mouthguard during forming, the athlete increases their chance of injury, especially concussion, from a blow to the chin. Some of these injuries, such as concussion, can cause life long effects. (See concussion section of Sports Dentistry On Line). Certain thicknesses and extensions are necessary for proper mouthguard protection.

Joon Park, PhD et al, at the First International Symposium on Biomaterials in August of 1993 reported that boil & bite mouthguards provide a false sense of protection due to the dramatic decrease in thickness occlusally during the molding and fabrication process. Dr. Park further stated that "Unless dramatic improvements are made, they (boil and bite mouthguards) should NOT be promoted to patients as they are now." He reported that boil

and bite mouthguards decrease in occlusal thickness 70%-99% during molding thus taking away the protective properties of the mouthguard.

Custom made mouthguards: Designed by your dentist and are the most satisfactory of all types of mouth protectors. They fulfill all the criteria for adaptation, retention, comfort, and stability of material. They interfere the least with speaking and studies have shown that the custom made mouthguard has virtually no effect on breathing. There are two categories of custom mouthguards, the Vacuum Mouthguard and the Pressure Laminated Mouthguard.

The Vacuum Mouthguard: Made from a stone cast of the mouth, usually of the maxillary (upper) arch, using an impression (mold) fabricated by your dentist. A thermoplastic mouthguard material is adapted over the cast with a special vacuum machine

Vacuum Machine. The most common material for this use is a poly-EVA (ethylene vinyl acetate) copolymer. The vacuum mouthguard is then trimmed and polished to allow for proper tooth and gum adaptation. All posterior teeth should be covered and muscle attachments unimpinged. Vacuum machines are adequate for single layer mouth-guards. However, it is now being shown in the dental literature that multiple layer mouthguards (laboratory pressure laminated) may be preferred to the single layer vacuum mouthguards.

It should be noted that these vacuum custom mouthguards are still superior to the store bought stock and boil and bite mouthguards because they have a much better fit, made from a mold of your mouth, and are designed by your dentist.

Strap attachments to helmets may be requested and are easily adapted to the custom made mouthguard, although not needed because of the good fit. Custom made mouthguards can be fabricated through the dental office or commercial laboratory for a nominal fee.

Laboratory Pressure Laminated Mouthguard: A custom made multiple layered mouthguard that can be modified for full contact sports by laminating two or three layers of EVA material to achieve the necessary thickness. Lamination is defined as the layering of mouthguard material to achieve a defined end result and thickness under a high heat and pressure environment. Efficient and complete lamination cannot be achieved under low heat and vacuum. The layers will not properly fuse together with the vacuum machine, but will chemically fuse under high heat and pressure with machines such as the Drufomat, the Erkopress 2004, or the Biostar.

Drufomat Machine: Protective thickness is important because as the thickness of the mouthguard material increases logarithmically, the transmitted impact force decreases logarithmically. Also, the mouthguard does not fully adapt to the model with so little pressure and vacuum. Until recently, vacuum fabricated mouthguards have been the standard of care for protective mouthguards.

Dr. Keith Hunter reported that mouthguards should be of certain thickness, without being bulky. He suggests labial thickness of 3mm, palatal thickness of 2mm, and occlusal thickness of 3mm. The mouthguard material should be biocompatible and have good physical properties and last for at least 2 years. These are recommended thicknesses. It should be noted that each athlete should be evaluated individually for thickness and design as to promote comfort and sufficient protection.

Dr. Hunter further states the advantages of pressure formed lamination to be:

1. Precise adaptation.
2. Negligible deformation when worn for a period of time. The combination of the relatively high heat and pressure used in construction of laminated mouthguard means that the mouthguard material has virtually no elastic memory.
3. The ability to thicken any area as required as well as place any inserts that may be needed for additional wearer protection.

Therefore, mouthguards must maintain minimal and consistent thicknesses * in critical areas. These thicknesses may have to vary according to the athletes individual needs for optimal protection. The thicker materials (3-4mm) are more effective in absorbing impact energy and the thinner materials show marked deformation at the site of impact. These mouthguards are not bulky and uncomfortable.

The clinician cannot expect that a 3mm thick material will remain 3 mm thick after fabrication. This is a physical impossibility due to shrinkage during fabrication adaptation. Vacuuming a commercially laminated 3mm sheet of EVA will give the same unsatisfactory results. Therefore, laboratory pressure lamination procedures must be used incorporating two or more EVA materials to achieve our end result of 3mm - 4mm thickness occlusally. This will allow the clinician to monitor and measure these results before delivery of these mouthguards.

There are presently two ways of obtaining a Pressure Laminated Mouthguard; dentist fabrication with either the Drufomat, Erkopress-2004 or Biostar in the dental office; or referral to a qualified commercial laboratory presently using the pressure lamination technique.

As sports dentists and health professionals, we highly recommend the custom made mouthguard, especially those of the laboratory lamination type for the very best in oral/facial protection as well as concussion deterrence.

This section has presented a discussion of the various issues relating to injury prevention and mouthguards. By acknowledging these significant differences in mouthguards, the public will be better informed and educated to seek their dental sports protection from dental health professionals.