

MOUTHGUARDS

Sports-related dental injuries are a global problem affecting 9-40% of children and adolescents each year. The incidence of injuries among boys is higher than that of girls, with a peak incidence of 8 to 11 years of age. Injury to the maxillary incisors is very common and can account for as much as 80% of all cases. In addition, the presence of an increased overjet and proclined upper incisors increases the risk of traumatic dental injury. The consequences of sports-related injuries are often irreversible and may result in functional, aesthetic, and psychological problems. Many orthodontic patients participate in contact sports without the protective benefit of wearing a mouthguard. Although the evidence base is not strong, a number of studies indicate that up to half of these injuries are preventable and wearing a mouthguard is an effective way to prevent or reduce the severity of dental trauma.

Orthodontic treatment is commonly carried out in adolescence, a period of time with a high incidence of dental injuries in relation to leisure and sporting activities. Prospective patients should be routinely questioned about their involvement in sports. An orthodontic fixed appliance can potentially increase the extent of damage following traumatic dental injury through debonding of brackets, archwire deformation, and soft tissue laceration. The presence of fixed orthodontic appliances and prospective tooth movement can present a challenge in the provision of a sports mouthguard for the orthodontic patient. Appropriate sports mouthguards are available that protect the patient's soft tissues during sport but do not interfere with orthodontic tooth movement. Orthodontic patients wearing removable appliances should be advised to remove their appliances and use mouthguards for contact sports.

Mouthguards are not available on the NHS and therefore need to be provided either free of charge or privately.

Mouthguards are protective equipment defined as "a resilient device or appliance placed inside the mouth to reduce oral injuries, particularly to teeth and surrounding structures". It acts by absorbing some of the energy from a direct blow at the site of impact and dissipating the remaining energy by cushioning and redistributing the force. Mouthguards cannot be expected, however, to provide "absolute" protection and contrary to previous evidence, do not appear to offer any additional protection from neurological injury. The proposed benefits of sports mouthguard wear during participation in contact sport includes the reduction of:

- The risk of injury to the maxillary anterior teeth by maintaining the position of the tooth relative to its socket and protecting the periodontal ligament;
- Damage to the posterior teeth of either jaw following traumatic closure of the mandible;
- Soft tissue lacerations;
- Tongue damage at impact;
- Fracture of the body of the mandible and damage to the temporomandibular joint.

Types of mouthguard

There are three general types of orthodontic mouthguards available for patients: pre-fabricated commercially available mouthguards (Stock mouthguards), thermoformable mouth-formed mouthguards and custom-made mouthguards.

1. Stock mouthguards

Stock mouthguards are preformed mouthguards available over the counter in a variety of sizes. They are mass-produced and designed for an 'instant fit' into the mouth. They are made from polyurethane, a co-polymer of EVA or silicone and rely upon a constant biting force to hold them in position, therefore potentially disturbing air exchange during exercise. They are poorly retentive, cannot be modified and offer limited protection to the teeth and soft tissues. Patient compliance is variable, as they may be poorly tolerated. Communication between team members can also become difficult due to the ill-fitting nature of the stock mouthguard. However, they are generally inexpensive and convenient to buy 'over the counter' from most sports outlets.

Many orthodontic-specific mouthguards are now commercially available and claim to provide an instant fit due to incorporated channels that accommodate a fixed appliance and any potential tooth movement. They do not require to be softened in hot water and may be sufficiently flexible to adapt around the shape of the teeth and orthodontic appliance. These non-customised mouthguards would appear to be a cheaper alternative to custom-formed mouthguards. Some of these mouthguards have specific design features to improve retention and fit. In-vitro studies have shown design features incorporating a brace bumper and slim rib-like structures can prevent displacement and offer adequate protection in low-impact sports where hard equipment is unlikely to be encountered. However, no published evidence of their clinical effectiveness exists.

2. Mouth-formed mouthguards

Mouth-formed mouthguards are also known as 'boil and bite' mouthguards. They are made from a thermoplastic material, which is softened in hot water for 45-60 seconds and then moulded by the patient onto their own teeth and gingivae by biting, sucking and using finger pressure. Many patients will not be adept at soft tissue moulding and there may be insufficient extension into the vestibular regions. Undersized mouthguards provide less protection than suitably adapted ones with the terminal teeth having an increased risk of trauma and an increased risk of serious head injury. Like the stock type, these mouthguards tend to be bulky, uncomfortable and poorly retentive. They are generally inexpensive and convenient to buy from most sports outlets. However, they are not as strong and resilient as custom-formed mouthguards.

3. Custom-made mouthguards

Currently, ethylene vinyl acetate (EVA) is the material of choice for fabricating custom-made mouthguards in terms of availability and ease of manipulation. Recently, pressure-laminated mouthguards have been introduced, which consist of two or more laminate layers fused together by heat and pressure on a dental model. Multiple laminations facilitate the use of variable stiffness and the insertion of reinforcement materials or team logos. It also increases the choice of colour and designs, therefore making the mouthguard more appealing to the young athlete.

Custom-made mouthguards are fabricated in a dental laboratory by a dental technician on a stone cast derived from an impression or intra-oral scan of the patient's dentition. These have the best adaptation to the patient's mouth/teeth and are also very retentive and comfortable. They are usually made for the maxillary dentition only. However, a mandibular mouthguard may be necessary for a patient with a Class III malocclusion. Traditionally these mouthguards are constructed by either vacuum or pressure-forming a thermo-plastic material, most commonly 3-5mm of ethyl-vinyl-acetate (EVA) in layers over a cast dental impression. A visit to the dentist for an impression or intra-oral scan is usually required, although there are now companies advertising on the internet offering custom-formed mouthguards using a home kit for patients to take their own impressions. A fitted custom-made mouthguard with minimal bulk and maximum retention, with areas to allow for planned tooth movements, appears to be the design of choice for orthodontic patients.

The Rugby Football Union, England Hockey, British Dental Association, the Amateur Boxing

Association (ABA) of England and many other sports all recommend custom- formed mouthguards.

Custom-made mouthguard construction

The orthodontist must ensure that the appliance is made by a suitably registered laboratory and is fit for purpose to comply with EU regulations. It must:

- Provide appropriate protection to the highest possible level.
- Be designed to enable correct positioning.
- Remain in place for the intended period of use.

Custom-formed mouthguards should be closely adapted to the teeth and fixed appliances. Care must be taken that the mouthguard is not too closely fitting as this could result in damage to the fixed appliance when the mouthguard is inserted or removed. In addition, as tooth movement occurs, the mouthguard may soon not fit properly. Patients should be advised that adjustment or replacement may be necessary at a later date if the mouthguard becomes loose, ill-fitting or uncomfortable. It is advisable for a new, replacement mouthguard to be made at the completion of active orthodontic treatment, if it is still required by the patient.

The following is required from the clinician:

- Fully extended upper and lower dental alginate impressions/intra-oral scans including the second molars in the permanent dentition and in the mixed dentition to the distal surface of the first permanent molars).
- Arch wires should be removed, and brackets blocked out beforehand.
- A wax squash bite with the teeth approximately 1.5mm apart.
- Notify the laboratory of the patient's name, age and colour choice.
- Inform the lab of current and proposed orthodontic tooth movements.
- Specification of sport to be played and at what level e.g. school, club or professional.

The following is required from the laboratory:

- Thoroughly dried working cast with blocked-out areas of the fixed attachments and prospective tooth movements.
- The mouthguard should have a labial flange extension within 2mm of the vestibular reflection.
- Rounded edges on the labial flange and tapered palatal edge.
- Extension of the palatal flange 10mm above the gingival margin.
- The dimensional thickness of the material should be 3mm labially, 3mm occlusally and 2mm palatally.
- There should be even contact between the occlusal surface of the mouthguard and the teeth in the opposing arch.

Which mouthguard should I recommend?

The literature does not provide clear evidence on which type of mouthguard should be recommended for orthodontic patients with fixed appliances. Orthodontic-specific stock mouthguards incorporating a brace bumper and slim rib-like structures can be used with fixed appliances for low-impact sports. It is suggested that custom-formed laminate mouthguards with their greater number of layers and thickness have led to greatly improved orofacial protection. Custom-formed mouthguards also have the benefits of a better fit, allowing the athlete to breathe and speak more easily and are more comfortable. The addition of air cells has been shown to improve EVA's energy absorption and reduce transmitted forces to the teeth. For all mouthguards, patients should be advised to:

- Rinse the mouthguard before and after use in cold water with a soft

- Store the mouthguard in a clean, rigid and ventilated plastic container.
- Keep the mouthguard away from sunlight, hot water and heat.
- Check the mouthguard regularly for signs of deterioration, and replace if it is cracking or the bite is changing

Legislation

Custom-formed mouthguards are defined as “personal protective equipment”. Therefore a CE mark is required from the laboratory constructing mouthguards to confirm that the required standards set by the Personal Protective Equipment Regulation (EU) 2016/42527 have been met. However, no British standard (BSI) yet exists and so this regulation cannot be applied in Britain.

Within the UK, mouthguards are mandatory for all school players participating in rugby and above school level, lacrosse competitions and while participating in boxing. Most organisations recommend the use of mouthguards for field hockey and martial arts.

The England Boxing governing body insists that all boxers must have a mouthguard that can stay in place when the boxer is breathing heavily with their mouth open. This is assessed by the Ringside Physician at the pre-bout medical. No red or partly-red coloured mouthguards may be worn by the boxer. The IABA guidance also states that boxers wearing braces should have the written consent of their orthodontist and have a mouthguard fitted to their own braces. However, England Boxing has advised the BOS that it is the individual boxer who is ultimately responsible for their own safety. England Boxing will not hold the orthodontist responsible for any damage sustained.

Further recommendations

- Class III malocclusions may require a mandibular mouthguard as well as a conventional maxillary mouthguard. These should be provided separately, to avoid potential disturbance to the air exchange. Alternatively, a single arch mouthguard with a labial flange extension could be made to protect the opposing dentition.
- Removable appliances should be removed for contact sports and a mouthguard inserted.
- Ligature-free brackets may pose an additional problem with impression-taking.
- The mouthguard should include space requirements for planned tooth movements.
- Fixed expansion appliances, e.g. RME or quadhelix may require regular trimming/modification of the mouthguard.
- Fixed functional appliances e.g. Herbst, do not support the wearing of a mouthguard. Advise the patient to refrain from contact sports during this phase of their treatment.

Summary

All orthodontic patients wearing fixed appliances, who participate in contact sports (any sport where significant contact can occur between opponents) should wear a sports mouthguard to protect against possible dental injury. Custom-formed mouthguards have shown to provide the best protection and appear to be the only group which comes close to conforming to current legislation.

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Updated by the Clinical Governance Directorate of the British Orthodontic Society July 2023.
Recommendations may change in the light of new evidence.