

# 'Injury prevention versus performance': has the time come to mandate the use of mouthguards in all contact sports?

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## ABSTRACT

Mouthguard use continues to be a hotly debated issue in the domain of contact sports. Regulations from sports governing bodies on wearing mouthguards and attitudes towards their use from athletes vary significantly across 'at-risk sports'. We explore how recent advances in sports dentistry have led to the widespread availability of new customisable mouthguards and whether their use may impact athletic performance, reduce orofacial trauma or sport related concussion. We also discuss whether 'no mouthguard, no play' policies designed to mandate their use may help to promote a culture of safe participation in contact sport.

## Key points

- ▶ Mouthguards use is associated with a reduction in the risk of orofacial trauma during contact sports.
- ▶ Widely available, stock or boil and bite mouthguards are associated with a small reduction in maximal aerobic performance.
- ▶ Sports governing bodies should consider a 'no mouthguard, no play' policy to encourage a culture of safe participation for paediatric and adolescent athletes.

## INTRODUCTION

Mouthguard use in sport has traditionally been associated with preventing orofacial trauma (OFT) during training or competition. Recent advances in sports dentistry, however, have expanded the potential role of mouthguards, with new designs offering the promise of enhancing performance (jaw repositioning) or preventing and diagnosing sport-related concussion (SRC) (with integrated smart chip technology). We discuss here the quality of evidence supporting the use of mouthguards in the primary prevention of injury and consider whether mandating their use would be acceptable for athletes and sports governing bodies alike?

Despite expert opinion ([table 1](#)) advocating for the widespread use of mouthguards in 'high-risk' sports or recreational activities, there remains a lack of awareness among athletes. They commonly cite a lack of guidance from coaches, discomfort during talking, a perceived impact on performance and not being required to wear them as the main barriers to athletes wearing mouthguards regularly.<sup>1</sup> In addition to this, the cost both financially and potentially performance wise to the athlete has traditionally been a barrier to their widespread use.

As of yet, large-scale studies or data on mouthguard's effectiveness have been

hampered by a lack of centralised injury surveillance data across all contact sports. Single-sport studies and retrospective questionnaire studies at multievent games have however demonstrated that when worn mouthguard use is associated with a significant reduction in the risk of OFT.<sup>2-3</sup> We discuss the potential benefits and risk associated with mandating their use to encourage 'safe participation' in contact sports.

## INJURY PREVENTION

Previous studies in mouthguard users have shown that non-mouthguard use in contact sports is associated with a 1.6–1.9 increased relative risk of OFT trauma.<sup>2</sup> These injuries include tooth crown fractures, avulsions, subluxations, soft tissue injuries and maxillary fractures, some of which may require an athlete to withdraw from competition, incur treatment costs, lose time from training or be left with long-term cosmetic consequences. The evidence for mouthguard use preventing SRC, however, is less clear with studies reporting conflicting results. One meta-analysis reported that mouthguard use did not reduce the risk of concussion,<sup>2</sup> while other single-sport studies have shown that mouthguard use reduces the risk of concussion in adults<sup>4</sup> and children.<sup>5</sup>

SRC remains a topic of significant interest in contact sports, due to the potential link with the risk of long-term neurodegenerative disease. New mouthguards that monitor



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**Table 1** American Dental Association recommendations for the use of mouthguards<sup>15</sup>**American Dental Association**

▶ Acrobatics	▶ Field hockey	▶ Racquet ball	▶ Squash
▶ Basketball	▶ Football	▶ Rugby	▶ Surfing
▶ Bicycling	▶ Gymnastics	▶ Shot-putting	▶ Volleyball
▶ Boxing	▶ Handball	▶ Skateboarding	▶ Water polo
▶ Equestrian events	▶ Ice hockey	▶ Skiing	▶ Weight lifting
▶ Extreme sports	▶ Inline skating	▶ Sky diving	▶ Wrestling
▶ Field events	▶ Lacrosse	▶ Soccer	
	▶ Martial arts	▶ Softball	

Recommendations by the American Dental Association—sports where it is advised to wear a well-fitted mouthguard.

head movement with smart ship technology have been proposed as a novel way to screen for and prevent SRC. While these technologies are promising, there are currently no guidelines on how to interpret the data from these new mouthguards or how the data may correlate clinically with a diagnosis of concussion.<sup>6,7</sup> Current evidence therefore suggests that the primary prevention of OFT is the main benefit of mouthguard use during sport.

### PERFORMANCE

Mouthguards are designed to fit one maxilla/mandible or both. It has been suggested that in doing so they alter the bite position and obstruct the anatomical airway during ventilation. Previous studies have relied on the composite measure maximal oxygen uptake ( $\text{VO}_2$ —mL/kg/min) to assess if this affects athletic performance. A meta-analysis of 10 studies demonstrated that  $\text{VO}_2$  max was reduced in maximal aerobic efforts with mouthguard (all types) compared to control conditions.<sup>8</sup> However, a subgroup analysis showed that custom-made mouthguards had no impact on maximal aerobic performance<sup>8</sup> and there was no impact on  $\text{VO}_2$  at submaximal aerobic efforts for all mouthguard types<sup>9,10</sup> (table 2).

The advent of commercially available customised mouthguards from direct impression or intraoral scanners has significantly improved user comfort. Anecdotal accounts from athletes has started to question the commonly held wisdom that mouthguards hinder performance and some manufactures claim that they may even improve it. It has also been suggested that custom-made mouthguards may be used to alter the bite position of the jaw and improve ventilatory efficiency during exercise.<sup>11</sup> Francis *et al* proposed in 1991 that mouthguard may allow athletes to mimic pursed-lip breathing (PLB) patterns, which have been shown to improve gas exchange in non-athletic populations with chronic lung disease.<sup>12</sup> Despite PLB patterns being regularly referenced,

in the literature since, there have been no further studies published that confirm this finding in true maximal aerobic testing conditions.

Further studies measuring direct markers of ventilation during exercise (Cardiopulmonary Exercise Test) will be needed to determine if mouthguards are performance enhancing. It is also important to take into account the rules, sport specific injury risk and athletic requirements of each sport. Players performing in short anaerobic bursts, at submaximal aerobic levels or participating in sports with frequent rest periods, are less likely to be affected by mouthguard use. The impact of mouthguards on aerobic performance during competitions conditions is likely to be small, however, with one study (amateur boxers) estimating that stock mouthguards reduced  $\text{VO}_2$  max by 5.83 mL/kg/min<sup>13</sup> while having no significant effect at submaximal aerobic efforts.

### IS IT TIME TO MANDATE THE USE OF MOUTHGUARDS?

Governing bodies across all sports have adopted varying approaches: with some mandating use at a national level (rugby union—New Zealand) and others at an international level (amateur boxing and lacrosse). New Zealand rugby has demonstrated that a ‘no mouthguard, no play’ policy can reduce the estimated risk of OFT by 43%<sup>14</sup> while encouraging a culture of continued safe participation in sport. Further well-designed injury surveillance studies with consistent methodology and case definitions will be needed to determine if and what types of mouthguards reduce the incidence of concussion in specific sports. Even in the absence of these data, a strong case can still be made for adopting a more cautious approach with paediatric or adolescent athletes partaking in contact sports.

We propose that for under-16 athletes, sports governing bodies should consider mandating by rule the use of mouthguards for ‘at-risk sports’. On balance, we believe the small reduction in maximal aerobic performance is outweighed by the known risk of OFT trauma in this age group. The consequences of which could have permanent cosmetic and long-term dental issues for these individuals and the risk of which could be reasonably reduced by wearing an over the counter (stock or boil and bite) mouthguard. Improved dental

**Table 2** Mouthguard types

	Cost	Custom made	Customised by
Stock	\$5–10	No	N/A
Boil and bite	\$5–10	Yes	Athlete
Custom made	\$50–200	Yes	Dental professional

materials (thermoplastics) and new designs have also significantly lowered the cost and availability of these mouthguards (\$5–10) both over the counter and online.

We believe that athletes at all levels should continue to be advised on the use of well-fitted mouthguards, where appropriate to prevent OFT. Educational materials alongside efforts by coaches, sports clinicians and governing bodies can help by promoting a culture of acceptability among athletes. This may include efforts to encourage athletes to wear mouthguards during an acclimatisation period and pre competition in training session or to consider the use of custom-made mouthguards to improve comfort. Local or national policies may help to incentivise athletes to use mouthguards while respecting players' autonomy and the financial implications of mandating their use.

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