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Mouthguards During Orthodontic Treatment: Perspectives of Orthodontists and a Survey of Orthodontic Patients Playing School-Sponsored Basketball and Football

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Abstract

Introduction—The objectives were to: 1) identify the beliefs and practices of orthodontists about mouthguard use in orthodontic patients, and 2) survey orthodontic patients currently playing school-sponsored basketball and/or football about mouthguards.

Methods—Fifteen orthodontists were interviewed about mouthguard use in their patients. Patients (11–18 years old) playing organized school basketball (N=53) and/or football (N=22) from 13 of those 15 orthodontic practices participated in an online survey about mouthguards.

Results—Approximately half of the orthodontists interviewed had initiated discussion about mouthguards with their patients. Although boil-and-bite mouthguards were recommended most often by orthodontists with only a single orthodontist recommending a stock type, stock was the most commonly used type [football (59%), basketball (50%)] followed by boil-and-bite [football (27%), basketball (35%)]. Only two of the 75 patients surveyed (<3%) reported using a custom mouthguard. All football players reported using a mouthguard, as mandated by this sport. Basketball does not mandate mouthguard use and only 38% of basketball players reported wearing one. Players who used mouthguards cited forgetting as the most frequent reason for not always using one. A greater percentage of football (91%) than basketball (32%) players reported their coach recommended a mouthguard ($P<0.001$).

Conclusions—Orthodontists differ in how they approach mouthguard use by their patients, which likely reflects a lack of evidence-based guidelines. The beliefs, recommendations, and practices of orthodontists concerning mouthguard use and the use of mouthguards by orthodontic patients are discussed. Research directions to improve mouthguard use are suggested.

Keywords

Braces; Mouthguards; Dental Trauma; Injury; Youth Sports

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Introduction

Over 7.9 million high school students participated in school-sponsored athletics during the 2016/2017 academic year in the US,¹ increasing their risk of injury, including dental trauma. Estimates are that 10–39% of all dental injuries in children occur during sports-related activities.² Trauma to maxillary incisors account for up to 80% of all dental injuries.^{3,4} Because such injuries can have lasting negative effects on a young athlete's oral health- and health-related quality of life,⁵ the American Dental Association (ADA) Council recommends wearing a mouthguard to reduce the risk and severity of sports-related dental injuries.⁶

Use of a properly fitted mouthguard reduces the incidence of orofacial injuries in sports.^{2,7–11} A 2002 prospective cohort study on National Collegiate Athletic Association Division I men's college basketball teams compared injury rates of athletes who wore custom-fitted mouthguards over an entire season with those who did not.⁸ Mouthguard users had significantly lower rates of dental injuries than non-users. Similarly, a 2007 meta-analysis indicated that when a mouthguard is not used, risk of injury to the orofacial complex increases by 60 to 90%.¹² Injuries that can be reduced by wearing a mouthguard include orofacial injuries such as tooth fracture and dislocation, lip and soft tissue laceration, jaw fracture,¹² and in some reports risk of concussion by absorbing forces to the jaw normally transmitted to the brain.^{6,7,13–15} Although the latter claim has been promoted by mouthguard manufacturers, studies have consistently failed to link the use of mouthguards to lowered concussion risk.^{8,12,16–21}

The majority of traumatic dental injuries occur during childhood and adolescence, especially when participating in contact sports.^{22,23} Many individuals receive orthodontic treatment during this same developmental period, and having full fixed orthodontic appliances (i.e., wires and brackets) can increase risk of soft-tissue injury to the patient-athlete as well as his/her opponent. Three categories of mouthguards are available: 1) over-the-counter, ready-to-use stock, 2) over-the-counter, mouth-formed (e.g., boil-and-bite), and 3) dentist-fabricated, custom-made.²⁴ Custom-made mouthguards are generally preferred by dental professionals as they are believed to offer the best fit, retention, comfort, durability and protection.²⁵ However, providing a custom mouthguard to orthodontic patients whose teeth are moving or who are wearing fixed orthodontic appliances can pose difficulties.²⁶ Thus, despite potential benefit to the orthodontic patient, difficulty obtaining a comfortable, well-fitting mouthguard that does not interfere with braces or tooth movement can reduce the likelihood a mouthguard is recommended and/or used.

Since the mid 1990's, the ADA has promoted the protective value of wearing properly fitted mouthguards while participating in activities that carry risk of dental injury.⁶ Yet, in a large survey commissioned by the American Association of Orthodontics (AAO) as part of their 2009 "Play It Safe" campaign, 67% of 1,014 parent responders with children ages 9–17 reported their child did not wear a mouthguard during organized sports.²⁷ If a mouthguard is the best available protective device for reducing the incidence and severity of sports-related dental injuries, why aren't more children wearing them? Further, 31% of these parents responded their child had played an organized sport while being treated with braces or other

orthodontic appliances, but the survey did not address how orthodontic treatment influenced mouthguard selection or its use.

Several reviews have described mouthguard use, and barriers to their use,^{5,12} but there is a paucity of research related to mouthguard use for orthodontic patients. In 2014, Bussell and Barreto found orthodontists in the United Kingdom most frequently recommended a boil-and-bite, followed by custom-made and then stock type mouthguards for their patients.²⁸ In 1999, Maestrello and colleagues found general dentists and pediatric dentists most frequently recommended custom mouthguards while orthodontists most frequently recommended prefabricated stock-type mouthguards. Orthodontists were more likely than other providers to recommend mouthguards for patients playing basketball.²⁹ However, there are few data describing orthodontists' beliefs and practices about mouthguard use, or their role(s) in the prevention of sports-related dental injuries. Similarly, there is a scarcity of data about mouthguard use by patient athletes receiving orthodontic therapy. This study is an initial, descriptive investigation to better understand these issues.

There were two primary goals. First was to conduct semi-structured interviews with orthodontists to ascertain their beliefs about mouthguard use, to describe their existing practices regarding mouthguard recommendations, and to identify how they perceive their role(s) in the prevention of sports-related dental injuries. Second was to survey orthodontic patients involved in school-sponsored basketball and/or football to determine how often they wear mouthguards, their reasons for wearing or not wearing mouthguards, their overall views of mouthguards, the types of mouthguards they wear, and who advises and educates them about mouthguards. Football is one of five sports mandating (required by rule) mouthguard use by the National Federation of State High School Associations (i.e., football, ice hockey, field hockey, lacrosse for all athletes and wrestling only for those wearing orthodontic braces). Basketball, a non-mandated sport, was also selected since Maestrello and colleagues found orthodontists, pediatric dentists and general dentists recommended mouthguard use for football and basketball more than for any other sport.²⁹ High school basketball players are also at more risk of oral injuries than most other sports.³⁰

Materials and Methods

Subjects

Orthodontist Interviews—A sample of Washington State orthodontists (n=15) in private orthodontic practice was recruited to participate in a semi-structured interview using a snowball sampling method. Snowballing, also known as chain referral sampling, is a method of purposive sampling.^{31–33} One of the authors (NB) identified local orthodontists with an interest in mouthguards, who then suggested other possible orthodontists to interview until 15 orthodontists completed the phone interview. A sample size of 15 orthodontists was judged to provide a sufficient sample to approach the point of saturation, after which little new information would be derived from additional interviews.

Patient Surveys—Subjects (11–18 years old) were patients undergoing active orthodontic treatment with fixed appliances or clear aligner therapy at participating orthodontic offices. Subjects were currently playing football or basketball on their school team. Patients

participating in the online survey about mouthguards were recruited from 13 of the offices participating in the orthodontist interview; orthodontists from 2 practices completed the interview, but did not allow recruitment in their offices.

All study procedures and materials were approved by the Institutional Review Board of the University of Washington, Seattle, Washington. Informed consent was obtained from all participants prior to the interviews and electronic surveys.

Procedures

Semi-Structured Interviews with Orthodontists—A semi-structured interview guide containing open-ended and follow-up questions was created to allow for a 10- to 15-minute guided interview (Appendix 1). All interviews were conducted one-on-one by the lead author (NB) in person or by phone. Each orthodontist gave permission to have the interviews digitally recorded for transcription ([Rev.com](https://www.rev.com), San Francisco, CA) and analysis. At the end of the interview, each orthodontist was asked whether their patients playing football or basketball could be recruited to participate in the online survey.

Survey Instrument and Patient Survey Procedures—Orthodontists who agreed to allow patient recruitment in their offices were given an 8.5" x 11" recruitment poster (Appendix 2) to display during the appropriate 2016–2017 sports season (i.e., football poster from September–December; basketball from November–February). The poster described study inclusion criteria and stated eligible patient participants would receive a \$10 gift card for completing a brief online questionnaire. Receptionist were told to give interested subjects an instruction card explaining how to participate in the survey (Appendix 3). Cards directed subjects to an online survey programmed in REDCap (Research Electronic Data Capture) and hosted by the University of Washington. REDCap is a secure, web-based data collection service designed for freely programmable survey research.³⁴ Participants could complete the survey using a smart phone or computer. Each instruction card had a unique code allowing access to the survey and prevented individuals from completing it more than once. This code also linked the survey to their orthodontist's office location.

At the beginning of each survey, participants were informed that taking the survey was voluntary and all information gathered would be de-identified and would not impact their orthodontic care. Consent to participate was received when participants entered the website and clicked a checkbox agreeing to take the survey. Consent was not required from the subjects' parents as determined by the human subjects review. Once consent was obtained, subjects received a series of questions about their experience with mouthguards (Appendix 4). Each participant was given the opportunity to upload directly to the REDCap survey (or text message to NB) a photo of his/her mouthguard for entry into a lottery for an additional \$40 gift card. All participants were asked to provide their/or their parent's email address for the sole purpose of being able to receive the electronic gift card.

The fifteen transcribed interviews were assessed for accuracy by the interviewer. All transcripts were coded by two study investigators (NB and LJH) using a mixed-method, qualitative approach.³⁵ All responses from the interviews were compiled into a

comprehensive data summary. Responses to each interview question were recorded and organized into themes, codes and quotes.

Statistical analysis

Descriptive statistics were calculated for the survey data for frequency of mouthguard use, frequency of reasons for using or not using a mouthguard, frequency of types of mouthguards worn, and frequency of who recommends mouthguard use to the athletes. A two-sided chi-square test comparing two proportions for independent groups was used to evaluate whether athletes report receiving different recommendations for mouthguard use from relevant stakeholders (coaches, parents, orthodontists, dentists).

Results

Description of Study Participants

Descriptive data are provided for the interviewed orthodontists (Table 1) and for survey participants (Table 2). One female patient completed the football survey but her data are not included in Table 2 or the analysis. This decision was made because it was impossible to aggregate her data with other female participants or calculate descriptive statistics for female survey participants.

Qualitative Analysis of Orthodontist Interviews

Orthodontists were asked about their approach to mouthguards for their patients who play sports and are in active treatment with braces or aligners. Four general themes with fifteen sub-themes were identified from the interviews. [Quotations from orthodontist interviews representing these themes are available online in Supplemental Table S1.]

1. Talking with Patients about Mouthguards

a. Responsibility to Educate Patients About Mouthguards: Most orthodontists believed responsibility should be shared among the orthodontist, general dentist, coach and parent for educating student athlete-patients about mouthguard use.

b. Sports in which Patients Should Wear a Mouthguard: More than half of the orthodontists stated they recommended mouthguards for all sports, particularly those with a potential for incurring trauma to the face.

c. Initiating Conversation about Mouthguards: Over half of the orthodontists indicated they or their staff routinely initiated conversations about mouthguards with patients at the time of consent, at the initial exam, at the time of consultation, and/or at the bonding appointment.

2. Considerations when Recommending a Mouthguard

a. Patient Characteristics: Activity level and degree of competitiveness of the sport were considered when recommending mouthguards, as well as degree of increased overjet.

b. Types of Mouthguards: Most (n=9) orthodontists recommended a boil-and-bite mouthguard, followed by a custom mouthguard made in-office (n=4), and then a stock mouthguard (n=2).

c. Specific Brand-Name Mouthguards: Six orthodontists recommended a specific brand of mouthguard: Shock Doctor (Fountain Valley, CA) brand (n = 2), Under Armour (Baltimore, MD) mouthguard (n = 2), Totalgard (Woburn, MA) (n = 1) and Shock Doctor or Under Armour (n = 1).

d. Mouthguard Cost: Four orthodontists said cost influences their mouthguard recommendation, each of them recommending a boil-and-bite type as an inexpensive option.

e. Fees Versus No Fees: Most (n=11) orthodontists said they do not charge a fee when providing a mouthguard. One orthodontist only charges when providing a custom mouthguard, but usually provides a boil-and-bite mouthguard at no charge.

f. Perceptions of Liability: Personal liability was a concern for three orthodontists; one required a waiver be signed before providing a mouthguard, while another recommended a Shock Doctor mouthguard because of the company's dental warranty of up to \$10,000.

3. Factors Influencing Orthodontists' Approaches

a. Influence of Previous Doctor: Four orthodontists stated they formed their approach and recommendation for mouthguards based on the approach used by the doctor from whom they purchased their orthodontic practice.

b. Experience with Traumatic Injuries: Most (n=12) stated past experiences with patients presenting with trauma had a major influence on their approach and practices concerning mouthguards.

c. Belief that Orthodontic Appliances Can Be Protective: Some (n=4) orthodontists viewed braces as having protective qualities, protecting the teeth and reducing the severity of trauma, while also indicating a potential increased risk of soft tissue trauma with braces. Five orthodontists viewed wearing aligners during sports as being "safer than not wearing anything."

4. Mouthguard Characteristics

a. Obstacles for Mouthguard Use: Most orthodontists described barriers for mouthguard compliance, including fit and/or comfort; "because they are bulky and the patient has difficulty breathing"; and interference with speech.

b. Inhibit or Hinder Tooth Movement: Six orthodontists reported they believe a mouthguard will inhibit tooth movement or it will no longer fit well once the teeth are moving.

c. Techniques for Custom-Made Mouthguards: Base-plate wax, Triad® Gel, blue block-out resin, and Play-Doh were all reported to block-out, or create space around the

braces to allow insertion and removal of the appliance from the mouth as well as to provide relief to accommodate expected tooth movement. Laminating two layers of ethylene vinyl acetate (EVA) was used most commonly.

Survey Results from Orthodontic Patients Who Currently Play School-Sponsored Sports

Orthodontic patients were asked via an online survey about how often they wear a mouthguard, reasons for wearing and not wearing mouthguards, their views of mouthguards, the types of mouthguards they use, and who is advising and educating them about mouthguards.

1. Frequency of Mouthguard Use—All football players (n=22) reported wearing a mouthguard at least “most of the time” during their current football season (Table 3). Twenty (20/22; 91%) football players reported wearing a mouthguard “always” during the season while two (9%) reported wearing their mouthguard “most of the time.” No football players reported using mouthguards “half of the time,” “only sometimes,” or “never.” Conversely, basketball players were less likely to report frequent mouthguard use compared to football players. Compared to football players, fewer basketball players reported using a mouthguard “always” (5/53; 9%) or “most of the time” (11%) (Table 3). Most basketball players reported using a mouthguard “only sometimes” or “never” during their sport season (67% of males, 81% of females).

2. Reasons for Using a Mouthguard—The top reasons football players reported wearing mouthguards are: it is required (91%), it made their mouth/teeth feel protected (91%), and they were used to wearing it (77%). Seventy-three percent reported their reason for wearing a mouthguard was the recommendation of their dentist/orthodontist; the same percent reported they wore their mouthguard because it stayed in place well. Basketball players stated the top reason for wearing a mouthguard was it made their mouth/teeth feel protected (85%), followed by the mouthguard stays in place well (70%); they were given a mouthguard (65%); and their orthodontist/dentist told them to wear one (65%).

3. Reasons for Using a Mouthguard Sporadically—The most common response given for not always wearing a mouthguard was forgetting to wear it (Football: 100%, Basketball: 73%). Basketball players also reported that wearing their mouthguard made it hard to breathe or talk (60%) and their mouthguard was uncomfortable (60%). Other reasons given were uncomfortableness, poor fit, and breathing difficulty.

4. Reasons for Never Using a Mouthguard—Most (77%) basketball players who never wore a mouthguard reported that hardly anyone on their team wears one, 74% believed it might make it hard to breathe or talk, and 68% said they never thought about wearing one.

5. Types of Mouthguards Worn—Overall, stock mouthguards were most commonly worn (23/42; 54.8%; Table 4) followed by boil-and-bite (31%); custom mouthguards were not commonly worn (4.7%). Nearly 10% could not identify the type of mouthguard they wore. Two participants uploaded a photo of their boil-and-bite mouthguard on REDCap.

6. Who Recommends Mouthguards?—Most football players (91%) reported their coach instructed them to wear a mouthguard; followed by a parent (82%), orthodontist (68%) and dentist (50%). Basketball players reported fewer recommendations to wear a mouthguard (Figure 1). Most basketball players reported a parent told them to wear a mouthguard (58%); followed by orthodontists (52%), coaches (32%), and dentist (23%). Based on patient reports, general dentists were statistically less likely to recommend mouthguard use for basketball than for football ($p=0.038$; 95% CI, 0.0, 53.0). Patients reported that 91% of football coaches recommended mouthguard use, which was statistically greater than the 32%, that basketball players reported ($p<0.0001$; 95% CI, 38.2, 79.0).

Discussion

Orthodontic treatment can present challenges for obtaining a well-fitting and comfortable mouthguard that accommodates braces. In the absence of clear evidence-based guidelines for mouthguard use in student-athlete orthodontic patients,^{26,28} we investigated how orthodontists view this issue relative to their patients. We also asked how often orthodontic patients who play football or basketball wear mouthguards, types of mouthguard they wear, and influences on their mouthguard use. To the best of our knowledge, this is the first study directly surveying orthodontic patients playing school-sponsored sports about mouthguard use.

Similar to a previous study that found a high percent (97%) of orthodontists recommending mouthguards to their athlete patients,²⁹ most orthodontists surveyed for this report felt they had a responsibility to inform patients about mouthguard use. Most orthodontists interviewed intend to discuss mouthguards with their athlete and usually have that conversation at the consult or time of bonding appliances. In our study, boil-and-bite mouthguards were the most often recommended type, and stock mouthguards the least. In contrast, patients of these same orthodontists reported they used the stock type most often. Custom mouthguards were rarely recommended and rarely worn. Patients participating in football (a mandated sport) reported a high rate of mouthguard use, while patients playing basketball (a non-mandated sport) reported a considerably lower use of mouthguards.

Published literature suggests only 4.2 – 17% of athletes playing basketball, baseball, softball and soccer wear mouthguards during competition.^{36–40} However, those studies did not report mouthguard-use data for athletes in active orthodontic treatment. We hypothesized orthodontic patients would have greater difficulty finding an acceptable mouthguard, and thus a lower frequency of mouthguard use. However, 100% of football players surveyed who were orthodontic patients wore a mouthguard at least most of the time, while 44% of male basketball players and 31% of female basketball players wore a mouthguard at least sometimes during the season. It is possible that a consequence of actively undergoing orthodontic treatment is a greater awareness of preventing dental trauma. Or, reported frequencies of mouthguard use may be outdated. Alternatively, the observed rate of mouthguard use found in this study's sample may not be representative of the orthodontic patient population.

Some orthodontists interviewed considered patient characteristics when recommending mouthguards, such as increased overjet. A recent meta-analysis suggests overjet greater than 3 mm in children doubles the risk of injury to anterior teeth; this risk increases as the overjet increases.⁴¹ Indeed, increased overjet is an oral predisposing risk factor for traumatic dental injuries, but such injuries are not limited to those with increased overjet. For this reason, recommending a mouthguard to anyone participating in a sport is advised regardless of the degree of overjet.

Some orthodontists also stated they consider the athlete's level of ability, such that as the level of play increases, so does the importance of mouthguard use. Most orthodontists recommended that everyone playing a sport or activity with a potential for injury to the mouth or face should wear a mouthguard. Given the availability of mouthguards and the potential for sustaining an injurious blow to the face, it stands to reason that all players participating in contact sports should wear a mouthguard.

Many orthodontists interviewed believed most athletes won't wear a mouthguard unless required. Consistent with this, our sample of football players reported 91% of players wore their mouthguard all the time with the other players wearing it most of the time. Only 38% of basketball players wore a mouthguard at least some of the time; they described their mouthguard as being uncomfortable and that it made it hard to breathe and talk. Thus, player acceptability of mouthguards may vary by sport. Many orthodontists reported that they believe most athletes will not use a mouthguard that is bulky, uncomfortable, expensive, or inhibits breathing or speech.

Different types of mouthguards may be preferable in different sports. For example, a stock mouthguard does not have any retentive features, as it relies on the athlete to hold it in the mouth by biting into it. This type may be easier for football players to use, as they generally communicate verbally between plays, which generally last less than 30 seconds. Also, football players often take out their mouthguards between plays. One might assume basketball players would prefer boil-and-bite mouthguards over stock because of its more retentive features. In basketball, it would seem more challenging to hold a stock mouthguard in the mouth as verbal communication during active play is more common than in football. However, our sample found more male basketball players wore a stock mouthguard and slightly more female basketball players wore boil-and-bite. Perhaps mouthguard usage by basketball players would increase if more players owned a better fitting mouthguard or if they had a way to conveniently remove and temporarily store the mouthguard as they do in football. Basketball uniforms do not currently allow pockets, but a structural solution such as a small convenient pocket in the shorts or jersey would offer a place for players to store their mouthguard in-between plays or while sitting on the bench.

Some orthodontists were concerned custom mouthguards might hinder tooth movement unless the custom mouthguard was re-made several times as orthodontic treatment progresses. To the best of our knowledge, no published research has evaluated whether mouthguard use has an effect on orthodontic tooth movement. Another concern raised by the orthodontists was that adaptable mouthguards can lock-on to braces during the process of forming it over the patient's teeth, requiring an orthodontist to cut off the mouthguard; some

reported they had seen this occur. A relatively new type of mouthguard called SISU (Akervall Technologies, Saline, MI) is made of a thin rigid thermoadaptable plastic the patient can fit at home. However, to avoid the material from locking onto braces, the company recommends the mouthguard should be fit by an orthodontist.⁴²

A few orthodontists had concerns about liability. Some required a signed waiver before delivering a mouthguard to the patient. Two orthodontists recommended a commercial mouthguard with its own insurance policy to relieve possible liability. The issue of mouthguards and liability was discussed in a 2017 AAO podcast.⁴³ The AAO's legal counsel indicated orthodontists may unexpectedly assume liability when providing mouthguards to individuals who are not their patients. The podcast suggested orthodontists who wish to offer mouthguards to non-patients may avoid assuming liability by making a monetary donation to the team or club so the team can purchase and provide over-the-counter mouthguards.⁴³

Based on the comments of the orthodontists interviewed, the ideal mouthguard would be adaptable more than once; it would be comfortable, not bulky, and have little interference with speech and breathing. It would be relatively inexpensive, would have its own insurance policy and would be widely available for purchase in stores. With increasing attention paid to player safety, more mouthguards are becoming available. There are new mouthguards on the market today attempting to fulfill many of the criteria desired by orthodontists and that are more acceptable to athletes. Although different styles of mouthguards have been evaluated for comfort in non-orthodontic patients,^{44,45} similar investigations have not been conducted specifically with orthodontic patients.

The key issue is how to increase mouthguard usage in student-athletes. Basketball players who sporadically wore their mouthguard reported forgetfulness (n=11/15) as being a factor and those who never wore a mouthguard (n=21/31) reported having never thought about wearing one. Thus, a reminder to players before and during practice and games may be a simple intervention to improve mouthguard wear. A previously published survey of coaches' knowledge and views about mouthguard use reported 73% understood their athletes were at risk for orofacial injury, yet nearly one-third would still not support mouthguard use when not mandated by the sport, even if the mouthguards were provided for free.⁴⁶ If the National Federation of State High School Association mandated mouthguard use for basketball and other sports, coaches, parents, orthodontists and dentists may be more likely to encourage mouthguard use. Marketing campaigns with sports stars might be useful to increase mouthguard awareness and use.

This study has limitations. We did not interview a randomly selected group of orthodontists, but rather selected them using a snowball sampling method. Thus, views expressed by these orthodontists are better used to understand issues surrounding mouthguard use rather than how common these perspectives are among practicing orthodontists. Similarly, patients surveyed were not selected randomly from orthodontic patients in Washington State and thus results may not be representative of the state or nation. Our survey neglected to ask athletes who wore mouthguards to evaluate their mouthguards on numerous factors (e.g. comfort, breathing, speaking), which would have been useful to evaluate overall player satisfaction

with different types of mouthguards as has been done in non-orthodontic patients.^{45,46} This study's findings are limited to the two sports evaluated, football and basketball, which are among the highest sports in terms of mouthguard use. Delta Dental conducted a national online survey about children (using the Kelton survey firm Nov 6–13, 2017) that asked parents whose children participate in Fall sports whether “My child participates in this sport and wears a mouthguard” followed by a list of 12 contact sports. The results found only 32% of football players and 24% of basketball players wear a mouthguard and these were the two highest ranked sports in terms of mouthguard use.⁴⁷ Despite these limitations, this initial study describes perspectives of orthodontists and orthodontic patients playing sports about mouthguards and provides a foundation for future research on this topic.

Future research

There is a need for high-quality data concerning which mouthguard styles are most easily worn and are most protective for orthodontic patients. Prospective randomized trials of different styles to determine player use, comfort and satisfaction are important, yet may be challenging to conduct because the low occurrence of dental injury would require a large sample size.⁴⁸ However, other types of research designs (see for example a case-control study on effectiveness of bicycle safety helmets⁴⁹) may be feasible to conduct and improve the level of evidence regarding mouthguard effectiveness. In 2006, the ADA Council on Access, Prevention and Interprofessional Relations, and the ADA Council on Scientific Affairs, co-authored an article on the use of mouthguards to reduce sport-related injury.⁶ That article stated, “*The key educational message is that the best mouthguard is one that is worn. While custom mouthguards are considered by many to be the most protective option, other mouthguards can be effective if worn properly.*” If true, by learning which mouthguard has the greatest comfort and player satisfaction, usage may then increase and in turn reduce traumatic dental injuries.

Conclusions

We conducted semi-structured interviews with orthodontists and surveys of orthodontic patients playing on school-sponsored football or basketball teams. Orthodontists described different approaches for how they discuss mouthguard use with patients, types of mouthguards they recommend, and their perceptions of the protective ability of mouthguards in patients undergoing orthodontic treatment. More patients reported wearing a mouthguard while playing football than basketball. Patient surveys revealed football coaches are significantly more likely to recommend mouthguard use than are basketball coaches. Differences in what orthodontists in our sample tended to recommend (boil-and-bite) and what their patients tended to use (stock) suggests research is needed to establish clear, evidence-based guidelines and a comprehensive public health message about best practices for mouthguard use.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. <http://www.nfhs.org/ParticipationStatistics/ParticipationStatistics> Accessed 12/22/2017.
2. Newsome PRH, Tran DC, Cooke MS. The role of the mouthguard in the prevention of sports-related dental injuries: a review. *Int J Paediatr Dent* 2001;11:396–404. [PubMed: 11759098]
3. Davis GT, Knott SC. Dental trauma in Australia. *Aust Dent J* 1984;29:217–21. [PubMed: 6151831]
4. Zerman N, Cavalleri G. Traumatic injuries to permanent incisors. *Dent Traumatol* 1993;9:61–4.
5. Tuna EB, Ozel E. Factors affecting sports-related orofacial injuries and the importance of mouthguards. *Sports Med* 2014;44:777–83. [PubMed: 24647854]
6. American Dental Association. Using mouthguards to reduce the incidence and severity of sport related oral injuries. ADA council on access, prevention and interprofessional relations; ADA council on scientific affairs. *J Am Dent Assoc* 2006;137:1712–20. [PubMed: 17138717]
7. Kang Y, Franco CS. A story of dental injury and orthodontics. *Oral Health Dent Manag* 2014;13:243–53. [PubMed: 24984628]
8. Labella CR, Smith BW, Sigurdsson A. Effect of mouthguards on dental injuries and concussions in college basketball. *Med Sci Sports Exerc* 2002;34:41–4. [PubMed: 11782645]
9. Lieger O, Von Arx T Orofacial/cerebral injuries and the use of mouthguards by professional athletes in Switzerland. *Dent Traumatol* 2006;22:1–6. [PubMed: 16422751]
10. Marshall SW, Loomis DP, Waller AE, Chalmers DJ, Bird YN, Quarrie KL, et al. Evaluation of protective equipment for prevention of injuries in rugby union. *Int J Epidemiol* 2005;34:113–8. [PubMed: 15561749]
11. Truman BI, Gooch BF, Sulemana I, Gift HC, Horowitz AM, Evans CA Jr, et al. Reviews of evidence on interventions to prevent dental caries, oral and pharyngeal cancers, and sports-related craniofacial injuries. *Am J Prev Med* 2002;23:21–54. [PubMed: 12091093]
12. Knapik JJ, Marshall SW, Lee RB, Darakjy SS, Jones SB, Mitchener TA, et al. Mouthguards in sports activities. History, Physical Properties and Injury Prevention Effectiveness. *Sports Med* 2007;37:117–44. [PubMed: 17241103]
13. Chapman PJ. Orofacial injuries and international rugby players' attitudes to mouthguards. *Br J Sports Med* 1990;24:156–8. [PubMed: 2078799]
14. Chandler NP, Wilson NH, Daber BS. A modified maxillary mouthguard. *Br J Sports Med* 1987;21:27–8.
15. Takeda T, Ishigami K, Hoshina S, Ogawa T, Handa J, Nakajima K, et al. Can mouthguards prevent mandibular bone fractures and concussions? A laboratory study with an artificial skull model. *Dent Traumatol* 2005;21:134–40. [PubMed: 15876323]
16. Barbic D, Pater J, Brison RJ. Comparison of mouthguard design and concussion prevention in contact sports: a multicenter randomized controlled trial. *Clin J Sport Med* 2005;15:294–8. [PubMed: 16162986]
17. Benson BW, Hamilton GM, Meeuwisse WH, McCrory P, Dvorak J. Is protective equipment useful in preventing concussion? A systematic review of the literature. *Br J Sports Med* 2009;43(Suppl 1):i56–67. [PubMed: 19433427]
18. Mihalik JP, McCaffrey MA, Rivera EM, Pardini JE, Guskiewicz KM, Collins MW, et al. Effectiveness of mouthguards in reducing neurocognitive deficits following sports-related cerebral concussion. *Dent Traumatol* 2007;23:14–20. [PubMed: 17227375]
19. Navarro R Protective equipment and the prevention of concussion – what is the evidence? *Curr Sports Med Rep* 2011;10:27–31. [PubMed: 21228647]
20. Viano D, Withnall C, Wonnacott M. Effects of mouthguards on head responses and mandible forces in football helmet impacts. *Ann Biomed Eng* 2012;40:47–69. [PubMed: 21994059]

21. Wisniewski JF, Guskiewicz K, Trope M, Sigurdsson A. Incidence of cerebral concussions associated with type of mouthguard used in college football. *Dent Traumatol* 2004;20:143–9. [PubMed: 15144445]
22. Love RM, Carman N, Carmichael S, MacFayden E. Sport-related dental injury claims to the New Zealand Accident Rehabilitation & Compensation Insurance Corporation, 1993–1996: analysis of the 10 most common sports, excluding rugby union. *N Z Dent J*. 1998;94:146–9. [PubMed: 9889533]
23. Glendor UL. Aetiology and risk factors related to traumatic dental injuries - a review of the literature. *Dent Traumatol* 2009;25:19–31. [PubMed: 19208007]
24. <https://www.aaoinfo.org/system/files/media/documents/Choosing%20Mouth%20Guard%202015.pdf> Accessed 12/26/2017.
25. Badel T, Jerolimov V, Panduric J. Dental/orofacial trauma in contact sports and intraoral mouthguard programmes. *Kinesiology* 2007;39:97–105.
26. Salem S, Caldwell S. Mouthguards and orthodontic patients. *J Orthod* 2008;35:270–5. [PubMed: 19074365]
27. American Association of Orthodontists. (2009). AAO-NFPM Mouthguard Survey. Unpublished survey results.
28. Bussell MA, Barreto LS. The recommendation and provision of mouthguards: a survey of consultant orthodontists in the UK. *J Orthod* 2014;41:141–6. [PubMed: 24526716]
29. Maestrello CL, Mourino AP, Farrington FH. Dentists' attitudes toward mouthguard protection. *Pediatr Dent* 1999;21:340–6. [PubMed: 10509335]
30. Capote R Epidemiology of sport-related traumatic dental injury among United States High School Athletes. University of Washington, 2015; (MPH thesis).
31. <https://www.fhi360.org/sites/default/files/media/documents/Qualitative%20Research%20Methods%20-%20A%20Data%20Collector%27s%20Field%20Guide.pdf> Accessed 1/18/2018.
32. Biernacki P, Waldorf D. Snowball sampling: Problems and techniques of chain referral sampling *Sociol Methods Res* 1981;10:141–631.
33. Noy C Sampling knowledge: The hermeneutics of snowball sampling in qualitative research. *Int J Soc Res Methodol* 2008;11:327–44.
34. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap) – A metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;42:377–81. [PubMed: 18929686]
35. Hsieh HF, Shannon SE. Three approaches to qualitative content analysis. *Qual Health Res* 2005;15:1277–88. [PubMed: 16204405]
36. Pribble JM, Maio RF, Freed GL. Parental perceptions regarding mandatory mouthguard use in competitive youth soccer. *Inj Prev* 2004;10:159–62. [PubMed: 15178672]
37. Cornwell H, Messer LB, Speed H. Use of mouthguards by basketball players in Victoria, Australia. *Dent Traumatol* 2003;19:193–203. [PubMed: 12848712]
38. Collins C, McKenzie L, Roberts K, Fields S, Comstock R. Mouthguard BITES (Behavior, Impulsivity, Theory, Evaluation Study): What drives mouthguard use among high school basketball and baseball/softball athletes. *J Prim Prev* 2015;36:323–34. [PubMed: 26391156]
39. Khodae M, Fetters MD, Gorenflo DW. Football (soccer) safety equipment use and parental attitudes toward safety equipment in a community youth sports program. *Res Sports Med* 2011;19:129–43. [PubMed: 21480059]
40. Maestrello-deMoya MG, Primosch RE. Orofacial trauma and mouth-protector wear among high school varsity basketball players. *ASDC J Dent Child* 1989;56:36–9. [PubMed: 2913086]
41. Petti S Over two hundred million injuries to anterior teeth attributable to large overjet: A meta-analysis. *Dent Traumatol* 2015;31:1–8. [PubMed: 25263806]
42. <https://www.sisuguard.com/fitting-instructions> Accessed 1/19/2018.
43. Episode 21. The Business of Orthodontics, American Association of Orthodontics, 20 6 2017 <https://aao.podbean.com/e/the-business-of-orthodontics-podcast-episode-21>.

44. Gawlak D, Mierzwinska-Nastalska E, Manka-Malara K, Kaminski T. Assessment of custom and standard, self-adapted mouthguards in terms of comfort and users subjective impressions of their protective function. *Dent Traumatol* 2015;31:113–7. [PubMed: 25264187]
45. DeYoung AK, Robinson E, Godwin WC. Comparing comfort and wearability: Custom-made vs. self-adapted mouthguards. *J Am Dent Assoc* 1994;125:1112–8. [PubMed: 8064053]
46. Berg R, Berkey DB, Tang JM, Altman DS, Londeree KA. Knowledge and attitudes of Arizona high-school coaches regarding oral-facial injuries and mouthguard use among athletes. *J Am Dent Assoc* 1998;129:1425–32. [PubMed: 9787539]
47. Personal Communication. Email on May 4, 2018 to Dr. Douglas Ramsay from Bill Kohn, DDS, vice president of dental science and policy at the Delta Dental Plans Association.
48. Sigurdsson A Evidence-based review of prevention of dental injuries. *J Endod* 2013;39:S88–S93. [PubMed: 23439051]
49. Thompson RS, Rivara FP, Thompson DC. A case-control study of the effectiveness of bicycle safety helmets. *New Eng J Med* 1989;320:1361–7. [PubMed: 2716781]

Highlights

Orthodontists and patients were questioned about mouthguards for student athletes.
Half the orthodontists surveyed talked to their athlete patients about mouthguards.
Football coaches were more likely to recommend mouthguards than basketball coaches.
Evidence-based guidelines on mouthguard use are lacking.
Research directions to improve mouthguard use are suggested.

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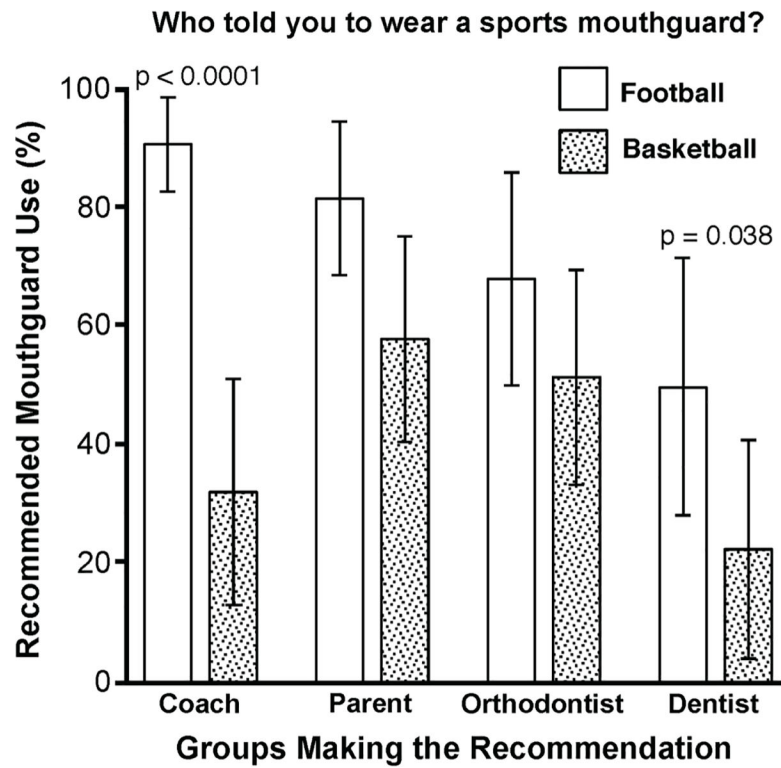


Figure 1. Mean percent (95% confidence interval) of orthodontic patient athletes who indicated whether a coach, parent, orthodontist, and / or dentist recommended that a mouthguard be used while playing football or basketball.

Table 1:

Description of Orthodontists Interviewed (N=15)

	Male	Female
Orthodontists Interviewed (N)	9	6
Years in Practice (Mean) (SD, Range)	11.1 (7.9, 3–26)	16.5 (7.5, 6–23)
Orthodontists Providing Subjects (N)	8	5
Patients per Orthodontist (Mean) (SD, Range)	6.4 (3.2, 2–12)	4.8 (4.5, 1–12)

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Table 2:

Description of Orthodontic Patients Surveyed by Sport and Gender (N=75)

	Football	Basketball	
	Male *	Male	Female
Patients (N)	22	27	26
Patient Age in Years (Mean) (SD, Range)	14.3 (1.3, 11–16)	14.2 (1.9, 11–18)	14.0 (1.4, 11–18)
Orthodontists (N) Providing Patients	10	11	10
Patients per Orthodontist (Mean) (SD, Range)	2.2 (1.2, 1–4)	2.5 (2.3, 1–9)	2.6 (1.8, 1–7)
Patients with Fixed Appliances (N)	20	24	21
Patients with Aligners (N)	2	3	5

* One female participant reported playing football; this participant's data are not reported.

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Table 3:

Frequency of Mouthguard Use by Orthodontic Patients (N=75)

	Football Male (n=22)	Basketball Male (n=27)	Basketball Female (n=26)
Always	20 (91%)	4 (15%)	1 (2%)
Most of the time	2 (9%)	3 (11%)	3 (12%)
Half of the time	0 (0%)	2 (7%)	1 (4%)
Only sometimes	0 (0%)	3 (11%)	3 (12%)
Never	0 (0%)	15 (56%)	18 (69%)

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Table 4:

Category of Mouthguard Type that Patients Reported Wearing (N=42)

Mouthguard Type	Football	Basketball		
	Male (n=22)	Male (n=12)	Female (n=8)	Both Genders (n=20)
Stock	13 (59%)	7 (58%)	3 (38%)	10 (50%)
Boil-and-bite	6 (27%)	3 (25%)	4 (50%)	7 (35%)
Custom	1 (5%)	1 (8%)	0 (0%)	1 (5%)
Not shown	2 (9%)	1 (8%)	1 (12%)	2 (10%)

Footnote. Patients who reported not wearing a mouthguard are excluded from this table.

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