

# Patterns of Mouthguard Utilization Among Atom and Pee Wee Minor Ice Hockey Players: A Pilot Study

Farhang Raaii, MD,\* Nicholas Vaidya, † Katherine Vaidya, † Nunziatina DiBacco, MSN,  
Clifford Les, DVM, PhD, ‡ Anil Sethi, MD,\* and Rahul Vaidya, MD, CM\*

**Objective:** To determine if youth hockey players wear their mouthguards properly, and if not, why?

**Design:** Descriptive cross-sectional study.

**Setting:** Tecumseh Shoreline Minor Hockey Association, Tecumseh, Ontario, Canada, during the 2007-2008 season.

**Participants:** Subjects were 180 travel hockey players of the Tecumseh Shoreline Minor Hockey Association at the Atom or Pee Wee level (aged 9-12 y) or their competitors.

**Assessment of Risk Factors:** Players were asked to complete a survey addressing mouthguard wear under their coach's supervision.

**Main Outcome Measures:** The type of mouthguard, whether mouthguards were worn at all and worn properly, and the reasons for noncompliance. The incidence of concussion and association to mouthguard-wearing tendencies were also assessed.

**Results:** Sixty-eight percent [95% confidence interval (CI), 60.4%-74.5%] of subjects always wore their mouthguards, but only 31.7% (95% CI, 25.0%-39.0%) wore them properly during games and 51.1% (95% CI, 43.6%-58.6%) during practice. Custom-made mouthguards were most likely to be worn properly, followed by boil-and-bite and stock-type guards. Younger players wore mouthguards more consistently than older players ( $P < 0.01$ ). Reasons for not wearing the guard included the following: 43.0% (95% CI, 35.4%-50.4%) of subjects felt it made talking difficult, 27.4% (95% CI, 20.9%-34.3%) felt it uncomfortable, 23.9% (95% CI, 17.9%-30.8%) felt it made breathing difficult, and 12.4% (95% CI, 8.3%-17.9%) thought it did not fit correctly. The incidence of concussion was 17.8%, but the study was underpowered for any association with mouthguard type.

**Conclusions:** Even when mouthguards are mandated to be worn in a children's travel hockey league, young players self-report that they routinely fail to wear them properly.

**Key Words:** mouthguards, ice hockey, children and adolescents, concussions, Ontario, Canada

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## INTRODUCTION

The utilization of mouthguards is important in reducing sports-related dental and maxillofacial trauma.<sup>1</sup> The role of mouthguards in preventing traumatic brain injury remains controversial. Only a few mouthguard varieties are commercially available in North America.<sup>2</sup> Stock-type mouthguards are purchased over the counter and worn without further modification (cost \$4-\$12). Boil-and-bite models are composed of various thermoplastic polymers that may be submerged in boiling water and fashioned under biting pressure to fit an athlete's dental profile (\$15-\$30). Custom-made forms are cast using a plaster mold of the athlete's mouth and subsequently fitted by dental professionals<sup>1</sup> (\$50-\$100).

Ice hockey is one of the most popular organized sports among Canada's youth, with 585 004 players registered with the Hockey Canada for the 2008-2009 season.<sup>3</sup> Although the helmet and face mask are mandatory protective equipment for all minor hockey players, mouthguards remain "recommended but optional" in Hockey Canada's Official Playing Rules.<sup>4</sup> Several local minor hockey leagues, however, have mandated the use of mouthguards during all games and practice sessions.

This study attempts to assess players' compliance with mouthguard wear in a league that mandates its use. In the Blue Water travel hockey league, players who do not wear mouthguards in a game or who are not wearing them properly can incur a 10-minute misconduct penalty. We define "properly" as wearing the appliance all the time in the proper position, not chewing on it, not holding it partially in the mouth, or keeping the guard inside the facial cage but not in the mouth. The term "travel" refers to a competitive elite team selected by the organization for each age group. The children included in this study were players in Atom (ages 9 and 10 y) or Pee Wee (ages 11 and 12 y).

We also examined the incidence of concussions in these age groups and sought out any association with mouthguard use. With an estimated annual incidence of 300 000 cases in the United States,<sup>5</sup> sports-related cerebral concussions represent a significant threat of morbidity for both amateur and professional athletes. Concussion accounted for 18% of the total injuries in a descriptive study, where 71 Canadian youth hockey teams in Calgary were followed for a year.<sup>6</sup> Emery et al<sup>7</sup> reported an incidence of 78 concussions in a Canadian youth checking league in 85 077 exposure hours or

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From the \*Department of Orthopedic Surgery, Detroit Medical Center, Detroit, Michigan; †Tecumseh Shoreline Minor Hockey Association, Tecumseh, Ontario, Canada; and ‡Department of Orthopedic Surgery, Henry Ford Hospital, Detroit, Michigan.

The authors report no conflicts of interest.

Corresponding Author: Rahul Vaidya, MD, CM, FRCSC, Department of Orthopedic Surgery, Detroit Medical Center, 4D4 UHC Detroit Receiving Hospital, 4201 St. Antoine Blvd, Detroit, MI 48201 (rahvaidya@hotmail.com).

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0.92 concussions per 1000 exposure hours. This rate must be evaluated in light of growing evidence for considerable underreporting of concussions through the surveillance mechanisms of minor hockey's governing bodies.<sup>8</sup> Several articles have demonstrated the increased incidence of concussion in youth hockey players where checking is allowed versus nonchecking competitive leagues and advocate removing checking in these age groups.<sup>7,9-12</sup>

It was our hypothesis that the type of mouthguard (stock, boil-and-bite, or custom-made) would determine the likelihood of proper mouthguard utilization in both practice and game settings. The purposes of this research were (1) to define the patterns of mouthguard's use in a minor league that requires mouthguards, (2) to define the etiology of complaints that discourage mouthguard use, and (3) to discover if young players wear their mouthguards properly. We also examined the incidence of concussion in this cohort and whether there was any association with mouthguard use.

## METHODS

### Data Collection Protocol

During winter 2007, a written questionnaire (Table) was administered under standardized conditions to 180 consenting travel hockey players aged 9 to 12 years under the supervision of their coach and the surveyor. The athletes were members of the Tecumseh Shoreline Minor Hockey Association (Tecumseh, Ontario, Canada) or teams competing against them. All players played in a "travel level checking league." At the time of this study, body contact or "checking" was allowed at these age levels. Recently, checking has been eliminated for 9-year-old and 10-year-old players (Atom) and begins only at the Pee Wee level (ages 11 and 12 y).

To perform this study, we first obtained permission from the Tecumseh Shoreline Minor Hockey Association. No personal identifying information was stored with the data. Our aim was to obtain survey data from 180 consecutive players, which would comprise approximately 12 teams, with 14 to 17 players per team. Each team's coach was asked if he/she would allow the players on his/her team to fill out the questionnaire after a game or practice. Players also had the individual option of participating or declining. The questionnaires were filled out under the supervision of coaches and a researcher. The players who completed the survey were rewarded with a chocolate bar. Because no validated measurement tools exist for mouthguard use by athletes, we performed an internal quality control analysis involving questions 7 and 11 from the Table, documenting a strong concordance between the subjects' responses to these 2 questions ( $\chi^2$ ,  $P < 0.001$ ). As a second means of internal quality control, uniform agreement was confirmed between each individual respondent's behavior during practices versus games ( $\chi^2 = 45.080$  with 16 degrees of freedom,  $P < 0.001$ ).

### Statistical Analysis

Nonparametric inferential methods were initially used, thus making no assumptions about the probability distributions of the assessed variables. Chi-square tests were performed to

**TABLE.** The Following Standardized Questionnaire Was Voluntarily Completed by All 180 Participants in This Study

1. Name:
2. Age:
3. Gender: Male/Female
4. Have you ever had a concussion while playing hockey? Yes/No
5. Do you own a mouthguard? Yes/No
6. If yes, what type of mouthguard do you own? (Please select one choice.)
  - Stock
  - Boil and Bite
  - Custom-made
7. Do you find it hard to breathe while wearing your mouthguard? Yes/No
8. How often do you wear your mouthguard? (Please select one choice.)
  - Always
  - Almost always
  - Sometimes
  - Almost never
  - Never
9. How often do you wear your mouthguard properly (in the correct position)? (Please select one choice.)
  - Always
  - Almost always
  - Sometimes
  - Almost never
  - Never
10. Do you wear your mouthguard properly during games? (Please select one choice.)
  - Always
  - Almost always
  - Sometimes
  - Almost never
  - Never
11. Do you wear your mouthguard properly during practice? (Please select one choice.)
  - Always
  - Almost always
  - Sometimes
  - Almost never
  - Never
12. If you don't wear your mouthguard while playing, why not? You can pick more than one
  - The mouthguard is uncomfortable.
  - The mouthguard makes it hard to breathe.
  - The mouthguard makes it hard to talk.
  - The mouthguard doesn't fit right.

measure differences between categorical variables. One-way analysis of variance (ANOVA) tests were used to determine if age had a significant effect on a player's behavior with respect to mouthguard use (1) during practice sessions, (2) in competitive games, and (3) across both settings. Post hoc Student–Newman–Keuls analysis was carried out in conjunction with the ANOVA tests to confirm which specific categories of mouthguard utilization frequency are the ones where statistical differences occur. An  $\alpha$  level of  $<0.05$  was considered to be the threshold for statistical significance, and 95% binomial confidence intervals (CIs) were calculated for all proportional results.

### RESULTS

We recruited 12 teams, and the first 180 players were included in this analysis. A total of 13 teams were initially approached, and 1 team declined to participate. All except 2 players on these 12 teams participated, and those 2 players had to leave after the ice time for other engagements. There were 178 boys and 2 girls, with a median age of 10 years (range, 9-13 y). The surveys were performed in February 2007, so all the players were a minimum of 9 years at the Atom level (ages 9 and 10 y), and some Pee Wee (ages 11 and 12 y) kids were already aged 13 years because of January and February birthdays. All respondents owned a mouthguard, and all reported wearing their mouthguards. Of the 180 players, 35 (19.4%) (95% CI, 13.9%-26.0%) used a stock, 83 boil-and-bite (46.1%) (95% CI, 38.7%-53.7%), and 62 custom-made (34.4%) (95% CI, 27.5%-41.9%) mouthguards.

Based on their survey responses, individual players were categorized in accordance with their self-reported frequency of mouthguard wear. The percentage of players who reported they “always” wore their mouthguards was 68% (95%CI, 60.4%-74.5%), “almost always” 23% (95% CI, 17.4%-29.6%), and “sometimes” 9% (95% CI, 5.6%-14.0%). No players reported wearing their mouthguards “almost never” or “never.” In comparing mouthguard types, players who had a custom-made mouthguard wore the guard 77.4% (95% CI, 65.0%-87.1%) of the time versus 63.9% (95% CI, 52.6%-74.1%) for boil-and-bite and 62.7% (95% CI, 44.9%-78.5%) for stock guards. Although there was a trend toward children with custom-made mouthguards wearing them more often than the boil-and-bite or the stock type ( $\chi^2 = 9.401$  with 8 degrees of freedom,  $P = 0.310$ , power = 0.547), this was not demonstrable statistically.

Subjects were then asked if they wore their mouthguards properly as mandated by the league (ie, seated in the correct position inside the mouth), we found a surprisingly low compliance rate, with only 57 players (31.7%) (95% CI, 25.0%-39.0%) stating they “always” wore the device properly during games and 92 players (51.1%) (95% CI, 43.6%-58.6%) stating “always” wearing the guard properly during practice sessions.

The type of mouthguard owned by the subject was strongly associated with the likelihood of its proper wear. Custom-made models garnered more “always” and “almost always” responses than expected; boil-and-bite brands were close to expected for all categories, and stock-type mouthguards featured more “sometimes,” “almost never,” and “never” responses than expected ( $\chi^2 = 10.936$  with 8 degrees

of freedom,  $P = 0.01$ ). For the 3 types of guards, the frequencies of proper mouthguard utilization during games and practice sessions are graphically displayed in Figures 1 and 2, respectively.

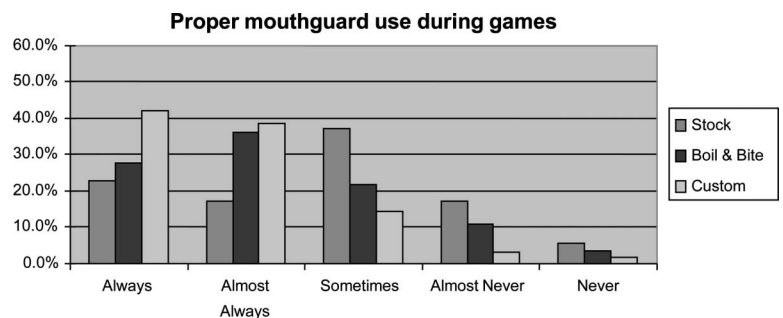
Older players owned a higher proportion of custom-made mouthguards than their younger counterparts. Older players showed such a high intrinsic propensity for not wearing their mouthguards properly that their advantage of owning more custom-made mouthguards was fully eclipsed. In fact, younger players wore their mouthguards properly more religiously in both practice and game settings (ANOVA,  $F = 5.386$  with 2 degrees of freedom,  $P = 0.005$ ) but especially during practice (ANOVA,  $F = 4.889$  with 4 degrees of freedom,  $P < 0.001$ ). All study subjects were then divided into 2 age groups based on being above or below the median age of 10 years, and a  $\chi^2$  analysis was completed. Again, a total of 89 individuals aged 11 years or older used their mouthguards properly significantly less often than 91 of their fellow players who were aged 10 years or younger ( $\chi^2 = 5.519$  with 2 degrees of freedom,  $P = 0.063$ , power = 0.537).

When asked about the reasons they did not wear their mouthguards properly, 80 (43.0%) (95% CI, 37.0%-52.0%) felt it made talking difficult, 51 (27.4%) (95% CI, 21.9%-35.5%) viewed it as uncomfortable, 43 (23.9%) (95% CI, 17.9%-30.8%) felt it made breathing difficult, and 23 (12.4%) (95% CI, 8.3%-18.6%) thought it did not fit correctly. Many players selected more than 1 response. The most frequent reason for noncompliance was interference with speech, regardless of the type of mouthguard (Figure 3). We were unable to show any correlation between the type of mouthguard worn and the complaints attributable to it (Figure 3).

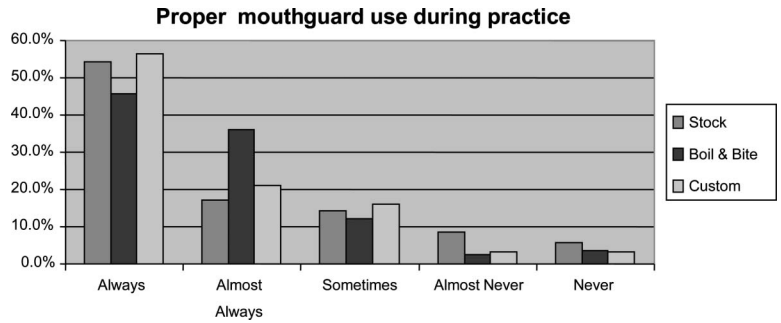
There were 32 children (31 boys and 1 girl) who self-reported sustaining a cerebral concussion over the one-half to 3½ years that they were eligible to play travel hockey. This corresponds to an incidence proportion of 17.8% (95% CI, 12.5%-24.2%) in this cohort. Several questions related to mouthguard use were assessed to determine if suffering a concussion influences future behavior by that child. We found that both the frequency of wearing a mouthguard and the specific variety of guard owned by the player bore no relation to the incidence of self-reported previous concussions.

### DISCUSSION

In this study, we found that although 100% of our study population owned a mouthguard, only 68% wore it all the time,



**FIGURE 1.** Frequency of proper mouthguard utilization during games, displayed as a percentage of the players who use each mouthguard type.



**FIGURE 2.** Frequency of proper mouthguard utilization during practices, displayed as a percentage of the players who use each mouthguard type.

with another 23% wearing it most of the time during games and practices. In addition, only 31.7% of the participants self-reported that they wore the devices properly during games and 51.1% during practices. We had felt before the survey that the players probably wore mouthguards properly more often during games, but the data did not bear that out. We thought that at the age group we were studying a lot of the practices focus on individual skill and less team play so conversing among your line mates may not be required as often as in a game but do not have any other plausible explanation. Participants who owned custom-made mouthguards wore them more consistently than teammates with stock-type or boil-and-bite models.

In reviewing the rationale given for not wearing the mouthguard properly, 23.9% of the players felt it made breathing difficult. In a prospective crossover study of 12 female intercollegiate hockey players, Delaney and Montgomery<sup>13</sup> demonstrated that, during maximal exertion, both mean expired ventilation and mean oxygen uptake declined significantly in the setting of stock-type mouthguard utilization. Custom-made mouthguards, on the other hand, have shown no interference with oral breathing at a ventilator rate of 1.0 L/s.<sup>14</sup> We were unable to correlate complaints of breathing difficulty encountered by the participants with the type of mouthguard used.

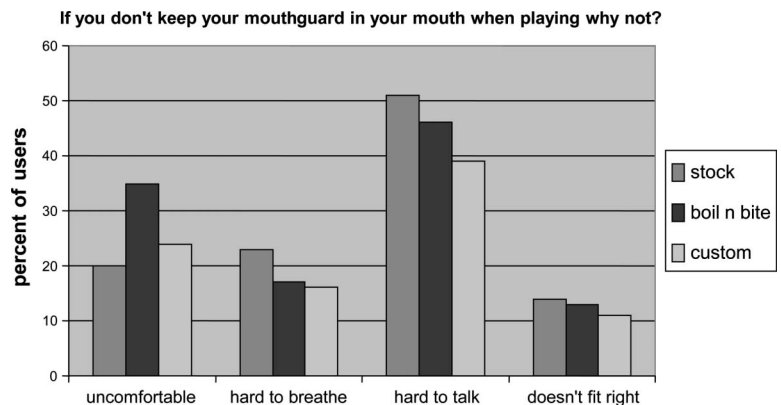
We also observed a robust link between younger age and the likelihood of wearing a mouthguard properly. This overshadowed the tendency for older children to wear custom-made varieties and highlights the significance of establishing

safe habits early on and then reinforcing these teachings as the players age.

Our global concussion rate of 17.8% is a reflection of the rapid accelerating and decelerating forces experienced by these players, the enclosed rink environment within which they compete, and the body checks that are often used as an elemental tactic in their repertoire. In fact, Williamson and Goodman<sup>8</sup> reported 290 concussions among 823 adolescent hockey players (35.2%) via retrospective player surveys, nearly twice the rate observed within the present cohort.

No relationship was demonstrable between a concussion event for an athlete and either the frequency of mouthguard wear or the type of mouthguard worn by that athlete. The study was underpowered with respect to both these variables to definitively answer either question. This lack of a demonstrable relationship is consistent with previous studies of concussion in athletes.

Barbic et al<sup>15</sup> performed a cluster-randomized controlled trial among 646 intercollegiate varsity football and rugby athletes in Ontario to evaluate a specific double-layered boil-and-bite brand against other mouthguard varieties, finding no significant difference in the incidence of concussions. Similarly, Wisniewski et al<sup>16</sup> demonstrated no advantage to wearing custom-made versus boil-and-bite models with respect to risk reduction for concussions among 87 National Collegiate Athletic Association (NCAA) Division I-A football teams. Other mouthguard studies have failed to discern a protective effect against concussions for either NCAA basketball players<sup>17</sup> or South African rugby team members.<sup>18</sup>



**FIGURE 3.** Frequency distribution of reasons provided by the players for refusing to wear stock-type, boil-and-bite, and custom-made mouthguards during competition.

A research report published last year evaluated 353 adolescent athletes using the Immediate Post-Concussion Assessment and Cognitive Test, discovering that mouthguard use achieved no reduction in the severity of neurocognitive dysfunction and onset of postconcussion syndrome (eg, headache, emesis, or vertigo, among other symptoms) after sports-related concussions.<sup>19</sup> Not surprisingly, a recent meta-analysis found the evidence for mouthguards protecting against concussions to be inconsistent.<sup>20</sup>

Previous studies have documented the use of mouthguards in sports; however, after watching children play in contact hockey, we felt many league members did not wear this piece of equipment properly, and our study confirms this. The fact that all the players use face masks in minor hockey may underscore the importance of mouthguards and their relationship to injury and the ability to police the players. Referees are concentrating on the play during a game, and it is difficult to determine if a player is wearing the appliance properly due to the face mask unless at a face-off or in close proximity to the official. This study did not address whether players, coaches, or parents felt that wearing a mouthguard is important, and that is often related to how compliant players are with their use. The league obviously feels there is a benefit to wearing these devices reflected by the rules of play. The low rate of compliance among this league's players should be a focus point for youth hockey organizers.

The concussion data were solely provided by the participants and may differ if parents had been involved. However, most young hockey players are already quite familiar with the occurrence of head injury in this sport. The limitation of this study is the number of participants, because the study was likely underpowered to discover if concussion is related to mouthguard type. There were trends toward the more consistent use of custom-made mouthguards; however, statistical significance was again not found due to the number of participants. There was no consideration given to cluster in our analysis because privacy considerations kept us from noting the team data, and thus, responses of the individuals were treated as independent. There is certainly some measurement bias associated with self-report of these players. Involving the parents may have given us better data on concussions but might have confounded the answers of the players with regard to wearing their mouthguards.

Many mouthguards were incidentally noted to have been worn out by chewing, resulting in probable loss of their protective function. Some consideration should also be made regarding the quality or condition of this protective piece of equipment.

## CONCLUSIONS

This study demonstrated that young travel hockey players who were mandated to wear mouthguards often did not wear the devices properly during games or practices. We found that children who were younger and who owned custom-made

appliances were more likely to wear them properly. It is hoped that educating players, parents, coaches, and referees of these results will help underscore the importance of wearing mouthguards properly and consistently.

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