Title:

Risk of orofacial injuries and mouthguard use in water polo players

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Abstract

Background/aim. The incidence of orofacial injuries and the use of mouthguards in water polo players have not been well established. The aim of this study was to determine the incidence of orofacial injuries in water polo players. Frequency of mouthguard use, the types of mouthguards used and the degree of interference with oral functions were also assessed.

Material and Methods. In this cross-sectional study, 347 water polo players completed a questionnaire about the orofacial injuries suffered in the 2015-2016 season and the experience of using a mouthguard, such as the type of mouthguard used and the degree of interference with oral functions.

Results. In the 2015-2016 season, 57.9% of the players reported at least one orofacial injury, with mean numbers of 2.7 oral lacerations, 0.4 episodes of temporomandibular pain and 0.06 dental injuries. Among the 35 players (10.1%) who had tried a mouthguard, only four (1.2%) used it habitually. Some players had tried more than one type of mouthguard; 26 had tried the mouth-formed type, 11 the custom-made type and 7 the pre-fabricated mouthguard. Custom-made mouthguards were rated more comfortable than the mouth-formed type ($p < 0.05$). The main disadvantages of mouth-formed mouthguards are interferences with speaking, breathing and swallowing.

Conclusions. The incidence of orofacial injuries in water polo players is high. Although some players had tried a mouthguard, mainly the mouth-formed type, most of them do not wear them routinely for training and competition.

Introduction

Playing sports has physical and social benefits, with the number of individuals playing sports increasing among all social classes and ages as well as both genders. Unfortunately, there are some disadvantages of playing sports such as accidents and orofacial injuries, with sports causing a third of all dental injuries.[1,2] It has been reported that nearly 15% of handball, basketball, rugby or floorball players have suffered dental injuries.[3-6]

Water polo is gaining increasing popularity in Europe, the United States, China and Australia. It is a high-intensity sport that requires resistance, speed, strength and body contact. It carries a medium risk of orofacial injuries.[2,7] The majority of water polo injuries affect the head, with concussion, contusions and lacerations to the

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face being common.[8,9] It has been reported that 21% of adolescents and adults from different water polo clubs in Switzerland have suffered a tooth injury during training or competition.[10] However, the incidences of orofacial injuries in younger players and of pain in the temporomandibular joints (TMJ) or masticatory muscles due to playing water polo have not been well established. Predictors of orofacial injuries associated with playing water polo, such as age and gender, have not been well documented.[8-10]

Mouthguards dissipate the force of impact towards surrounding structures and also act as a barrier between the upper and lower dentitions, consequently reducing the risk of fractures or avulsions of the teeth, lacerations to the lips, tongue or cheeks, and other orofacial injuries.[11-15] Three main types of mouthguards are normally used: pre-fabricated mouthguards, which are not fitted to the patient; mouth-formed or 'boil-and-bite' mouthguards, which are made from a thermoplastic material that becomes soft and mouldable when heated; and custom-made mouthguards, which are fabricated from dental impressions. Custom-made mouthguards provide a better fit and more protection than mouth-formed and pre-fabricated mouthguards and they interfere less with oral functions.[13,14,16] The American Dental Association (ADA) recommends the use of mouthguards in 30 sports.[2] However, the frequency of mouthguard use is very low in sports in which its use is not mandatory, such as basketball, handball and rugby.[3,5,6,17] Water polo is included in the ADA's list of 30 sports, but the Fédération Internationale de Natation (FINA) does not stipulate the use of mouthguards. Thus, only 7.7% of water polo players in Switzerland have been reported to use mouthguards.[10] The main reasons for not using a mouthguard are that it is not considered necessary and that it interferes with breathing, speaking and aesthetics.[10,18] However, more information about the frequency of use and how it may interfere with oral functions is needed for the different types of mouthguards to determine the best design for water polo players.

The main aims of this study were to determine the incidence of orofacial injuries in water polo players from high-level clubs in Catalonia and to explore different factors associated with the incidence of orofacial injuries such as age and gender. The frequency of mouthguard use, the type of mouthguard used and the degree of interference with oral functions were also assessed.

Material and Methods

In this cross-sectional study, 707 male and female players from Catalan water polo clubs were invited. The inclusion criteria were playing in the 2016-2017 season with a federated tab for the under-10s, under-12s, under-14s, under-16s, under-18s or senior team of one of the four clubs (CN Mataró, CN Terrassa, CN Atlètic-Barceloneta and Club Esportiu (CE) Mediterrani) or training at the High Performance Sports Centre (HPSC) at Sant Cugat. Participants with missing data were excluded from the study. Each player was informed in detail about the study and gave their oral consent to their coach, who signed the informed consent approved by the local ethics committee (Code 2016-44).

The questionnaire that was administered to each player aimed to obtain data on the practice of or competing in water polo games, the episodes of orofacial injuries occurring in the 2015-2016 season, and the experience of using a mouthguard (Table 1). Orofacial injuries included dental injuries, oral lacerations and temporomandibular (TMD) pain. Dental injuries consisted of fractures or avulsions of the upper or lower teeth,

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while oral lacerations included bleeding of the lips, tongue, cheeks or gums. TMD pain referred to episodes of pain in the TMJ or masticatory muscles that increased during jaw movements. The questionnaire also asked about whether the player had ever tried a mouthguard, the type of mouthguard worn, the degree of interference with several oral functions, such as speaking, breathing and swallowing, and other adverse effects associated with each type of mouthguard. Gender, age and the use of braces were also recorded.

The incidence of each orofacial injury in the 2015-2016 season was expressed as a percentage of the players who had suffered the injury with respect to the total number of respondents. The mean number of each orofacial injury was calculated as the sum of injuries with respect to the total number of respondents. The relationship between the number of each type of injury and age was assessed using Spearman's rank correlation. The relationship between the number of each type of injury and gender or the use of braces was assessed using the Mann-Whitney U test. The relationship between mouthguard use and sports club, age or the use of braces was investigated using a chi-squared test. The degree of interference with oral functions and other adverse effects for each type of mouthguard was compared using pair-wise comparisons with the Kruskal-Wallis test. The level of significance was set at $p < 0.05$. Data analysis was undertaken using IBM SPSS Statistics v. 24.

Results

Of the 707 water polo players invited, 364 responded and 17 were excluded because information was missing in the questionnaire, constituting a response rate of 49.1%. The characteristics of the 347 participants included in this study are shown in Table 2. Among the participants, 57.9% reported at least one orofacial injury during the 2015-2016 season (Table 3). The mean number of orofacial injuries in each player was 3.2. Lacerations to the lip and tongue were the most frequent injuries reported. The percentage of episodes of TMD pain or the number of dental injuries did not vary between the age groups. However, the number of oral lacerations increased with age (Spearman's Rho = 0.17; $p = 0.001$). Among the orofacial injuries, only dental injuries were associated with gender with males suffering more than females ($p = 0.018$; Mann–Whitney U test). The use of braces was not associated with the number of any type of orofacial injury.

Among the 35 players (10.1%) who had ever tried a mouthguard, only four (1.2%) used a mouthguard habitually during training and three (0.9%) also used it during competition (Table 4). Four players had tried all three types of mouthguards, while another player had tried the mouth-formed and custom-made mouthguards. Consequently, 26 players had tried the mouth-formed mouthguard, 11 the custom-made type and 7 the pre-fabricated mouthguard. Among the clubs, 22% of the players from CE Mediterrani, 8% from HPSC Sant Cugat, 8% from CN Terrassa, 5% from CN Atlètic-Barceloneta and 4% from CN Mataró had tried a mouthguard ($p = 0.003$; chi–squared test). The percentage of players who had ever tried a mouthguard varied between the age groups ($p = 0.001$; chi–squared test), with the under-10s and under-12s showing the lowest percentages and the under-18s and senior team the highest. The use of braces was not associated with having ever tried a mouthguard.

The degree of interference with oral functions and other adverse effects for each type of mouthguard are summarised in Table 5. Custom-made mouthguards were rated as being more comfortable than mouth-formed

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ones in terms of loosening and soreness and they interfered less with speech, breathing and swallowing ($p < 0.05$; pair-wise comparisons, Kruskal-Wallis test).

Discussion

In the present study, approximately 58% of the water polo players reported at least one orofacial injury during the 2015-2016 season, with the average number of orofacial injuries being 3.2 per player in one season. However, most of these injuries were mild and consisted of oral lacerations to soft tissues. Only 4.3% of the players reported a dental fracture or avulsion. In a study with Swiss water polo players, the percentage of players reporting at least one tooth injury was 21%.[10] However, that study included dental injuries occurring throughout the whole sporting life of the participants in a sample with a mean age of 29 years.[10] In the present study, the mean age of the participants was 15 years and both elite players and beginners were included. Therefore, the risk of tooth injury in a water polo player might be about 5% in one season and about 20% during a sporting life.

Players under 14 years reported fewer oral lacerations than older players, with the relationship between age and oral lacerations becoming insignificant in players older than 15 years. Males reported more dental injuries than females, but the other types of orofacial injuries were not associated with gender. Blumenfeld et al.[8] noted that more females than males reported at least one concussion as a result of playing water polo. However, males reported, on average, numerically more concussions. Gender as a risk factor for orofacial injuries while playing sports in general or water polo in particular is not well established.[10,19] In the present study, players who wore braces did not report more orofacial injuries than those who did not wear braces. Although it seems plausible that the use of braces could be a risk factor for orofacial injuries during sports, especially lip lacerations, no study has demonstrated a significant relationship to date.[20]

Despite the risk of orofacial injuries, only 10% of the players reported to have tried a mouthguard, with only 1% using it routinely for training and competition. The percentage of Swiss water polo players who wore a mouthguard was about 8%.[10] Differences in social and cultural aspects and the different mean ages of the samples could explain the discrepancies between the current results and those involving the Swiss water polo players. Water polo players had fewer complaints for the custom-made mouthguards compared to the mouth-formed ones, which is in accordance with the results obtained with players of other sports including field hockey and rugby.[21,22] The use of an appropriate mouthguard can reduce the severity of orofacial injuries and is recommended by the ADA for different sports including water polo.[2,22,23] Several strategies at the community and individual level could be considered to increase the frequency of mouthguard use in water polo players. Federations, clubs and coaches should be made aware of the convenience of wearing a mouthguard while playing water polo. Dentists and health professionals should also encourage the use of mouthguards during sports, both for professional and amateur players, and especially for teenagers.[18,19,24] To ensure maximum protection without compromising athletic strength and performance, custom-made mouthguards should be used.[13,25] Since this type of mouthguard is expensive and not easily accessible, there should be initiatives to make it cheaper and more accessible. Furthermore, the option of making mouthguard use mandatory in

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competitions, as proposed recently, could also be considered.[10] In fact, the mandatory use of mouthguards in rugby and ice hockey has been associated with a decreased number of dentofacial injuries.[26,27]

The best design of mouthguards for water polo players is not known. Regardless of the type of sport, the labial flange of the mouthguard should extend to within 2 mm of the vestibular reflection and the palatal flange to within 10 mm of the palatal gingival margins.[14] For water polo players, the palatal margin could be shortened to reduce interferences with oral functions, such as breathing, swallowing and speaking, without affecting tooth deflection or mouthguard retention.[28-30] All these oral functions are especially important while playing water polo because of the aquatic environment. Thus, further studies are warranted to determine the best design of mouthguards for water polo players. Although the risk of dental injury was similar between the age groups, the percentage of senior and under-18 players who had ever tried a mouthguard was ten times higher than that for the under-10 and under-12 players. Mouthguards in growing children should be replaced or adapted periodically to accommodate for tooth eruption and the growing mouth.[31] In addition, in players undergoing orthodontic treatment, mouthguards should also be replaced or remoulded during treatment depending on the magnitude of tooth movements.[14] Despite these inconveniences, it is important to encourage parents to convince their children to use a mouthguard, with the mouth-formed type being an alternative to the custom-made type during training and competition.

In the present study, 21% of the players reported at least one episode of TMD pain that is, muscle pain and TMJ pain during the 2015-2016 season. TMD pain has been reported to be the second most frequently reported type of orofacial injury among basketball players, after soft tissue lacerations.[17] These pain episodes may be produced by direct blows to the TMJ or masticatory muscles or by indirect TMJ overloading elicited by an impact striking the mandible from below which causes traumatic closure of the mandible. In the first case, a mouthguard would not be useful in preventing these types of orofacial injuries, but in the second case, a mouthguard with a bilateral and balanced occlusion could prevent the TMJ overloading produced by blows to the mandible. Although teeth clenching and/or wearing a mouthguard may reduce the magnitude of the impact to the TMJ,[32] more studies are needed to demonstrate the efficacy of mouthguards in preventing TMD pain.

This study had several limitations. First, the high number of non-responders could have affected the validity of the results. However, the characteristics of this sample regarding gender and age were representative of the whole population and the response rate was similar to those of other studies.[10,22] Second, the retrospective nature of this study and the fact that the orofacial injuries were reported by the participants themselves may have affected the accuracy of the diagnosis, especially those related to TMD disorders. Furthermore, younger participants could have more difficulty with the responses, although they were instructed about the meaning of each question. Hence, prospective studies are required to confirm the results. Finally, the number of training sessions and matches played differed among the participants; thus, the amount of time playing water polo and being exposed to the risk of injury was not similar among the participants.

In conclusion, the incidence of orofacial injuries in water polo players is high. The incidence of oral lacerations increased with age in players aged below 15 years. Although some players have tried a mouthguard, mainly the

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mouth-formed type, most of them do not use it routinely for training and competition. The main disadvantages for mouth-formed mouthguards were interferences with speaking, breathing and swallowing, while the main disadvantage for custom-made mouthguards was the cost.

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Tables

Table 1. The questionnaire

Player code _____ Birth date___/___/ _____ Club_____

Do you wear braces?___ Gender _____ Age group _____

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Number of orofacial injuries during training or competition

Season 2015-2016

Dental injuries (fractures or avulsions)

Number of dental fractures in the upper jaw	
Number of dental fractures in the lower jaw	
Number of dental avulsions in the upper jaw	
Number of dental avulsions in the lower jaw	

Soft tissue injuries with bleeding

Number of lip injuries	
Number of tongue injuries	
Number of cheek injuries	
Number of gum injuries	

Number of episodes of Temporomandibular pain

(in your jaw, temple, in the ear, or in front of the ear)

Articular pain (preauricular) that increased with chewing and/or mouth opening	
Masticatory muscle pain that increased with chewing AND/OR mouth opening	

Mouthguard use and type of mouthguard

	Prefabricated	Boil and bite	Custom-made
Have you ever tried a mouthguard? Yes or No?			
Do you usually use it during training? Yes or No?			
Do you usually use it during competition? Yes or No?			

If you have ever tried it, please score the degree of discomfort, considering 0 as not annoying at all and 10 as very annoying

	Prefabricated	Boil and bite	Custom-made
Speech			
Breathing			
Swallowing			
Nausea			
Soreness			
Loosening			
Price			

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Table 2. Decription of the participants regarding their gender, age, clubs and use of braces

Characteristics	Frequency (Percentage)
Gender	
Male	224 (64.6%)
Female	123 (35.4%)
Age group	
Senior	44 (12.7%)
Under-18	61 (17.6%)
Under-16	80 (23.1%)
Under-14	67 (19.3%)
Under-12	56 (16.1%)
Under-10	39 (11.2%)
Club	
CN Terrassa	114 (32.9%)
CE Mediterrani	78 (22.5%)
CNA Barceloneta	61 (17.6%)
CN Mataró	46 (13.2%)
HPSC Sant Cugat	48 (13.8%)
Use of braces	

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No	315 (90.8%)
Yes	32 (9.2%)

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Table 3. Incidence and number of orofacial injuries reported by the participants for the 2015-2016 season

	Category by age						**ALL (n=347)**
	Senior	Under-18	Under-16	Under-14	Under-12	Under-10	
At least 1 dental injury (%)	0	3.3	1.3	7.5	8.9	5.1	**4.3**
Mean of dental injuries (95%CI)	0	0.03 (0 to 0.08)	0.01 (0 to 0.04)	0.15 (0 to 0.3)	0.11 (0 to 0.2)	0.08 (0 to 0.2)	**0.06 (0.03 to 0.10)**
Mean of dental fracture upper jaw	0	0	0.01	0.09	0.07	0.08	**0.04 (0.01 to 0.07**
Mean of dental fracture lower jaw	0	0.03	0	0.01	0	0	**0.01 (0 to 0.02)**
Mean of dental avulsion upper jaw	0	0	0	0.04	0.04	0	**0.02 (0 to 0.03)**
Mean of dental avulsion lower jaw	0	0	0	0	0	0	**0**
At least 1 oral laceration (%)	59.1	65.6	61.3	47.8	48.2	35.9	**54.2**
Mean of oral lacerations (95%CI)	3.7 (1.5 to 5.9)	3.2 (0 to 6.5)	4.0 (1.7 to 6.3)	2.1 (0.9 to 3.3)	1.4 (0.8 to 1.9)	1.1 (0.3 to 1.9)	**2.7 (1.9 to 3.6)**
Mean of lacerations on the lip	2.02	2.72	2.43	1.09	0.66	0.41	**1.7 (1.0 to 2.3)**
Mean of lacerations on the tongue	0.57	0.20	0.69	0.25	0.38	0.21	**0.4 (0.2 to 0.6)**
Mean of lacerations on the cheek	0.84	0.10	0.36	0.24	0.07	0.18	**0.3 (0.2 to 0.4)**
Mean of lacerations on the gums	0.30	0.20	0.53	0.49	0.25	0.33	**0.4 (0.2 to 0.5)**
At least 1 episode of TMD pain (%)	27.3	24.6	20.0	13.4	21.4	15.4	**20.2**
Mean of episodes of TMD pain (95%CI)	0.64 (0.2 to 1.1)	0.39 (0.2 to 0.6)	0.46 (0.2 to 0.7)	0.18 (0.1 to 0.3)	0.32 (0.1 to 0.5)	0.51 (0.1 to 0.9)	**0.4 (0.3 to 0.5)**
Mean of episodes of TMJ pain	0.39	0.23	0.29	0.09	0.16	0.26	**0.2 (0.2 to 0.3)**
Mean of episodes of muscle pain	0.25	0.16	0.18	0.09	0.16	0.26	**0.2 (0.1 to 0.2)**

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At least 1 orofacial injury (%)	**61.4**	**68.9**	**66.3**	**50.7**	**53.6**	**38.5**	**57.9**
Mean of orofacial injuries (95% CI)	**4.4 (1.9 to 6.8)**	**3.6 (0.2 to 7.0)**	**4.5 (2.1 to 6.8)**	**2.4 (1.1 to 3.7)**	**1.8 (1.1 to 2.5)**	**1.7 (0.5 to 2.9)**	**3.2 (2.3 to 4.1)**

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Table 4. Percentage of participants who had ever tried a mouthguard and percentage of players who habitually used mouthguards among the different age groups

	Category by age						**ALL**
	Senior (n=44)	Under-18 (N=61)	Under-16 (n=80)	Under-14 (n=67)	Under-12 (n=56)	Under-10 (n=39)	**(n=347)**
Had ever tried a mouthguard (%)	9 (20.5%)	12 (19.7%)	9 (11.3%)	3 (4.5%)	1 (1.8)	1 (2.6)	**35 (10.1%)**
Habitual use in practice (%)	1 (2.3%)	0	1 (1.3%)	2 (3.0%)	0	0	**4 (1.2%)**
Habitual use in competition (%)	0	0	1 (1.3%)	2 (3.0%)	0	0	**3 (0.9%)**

Table 5. The degree of interference with oral functions and other adverse effects for each type of mouthguard (assessed on a 10-point scale).

	1- Pre-fabricated (n = 7)	2- Mouth-formed (n = 26)	3- Custom-made (n = 11)	Kruskal-Wallis	Pairwise comparisons		
					1_2	1_3	2_3
Speech	4.86	7.73	3.27	0.003	0.128	0.249	0.001
Breathing	2.14	5.40	2.00	0.011	0.036	0.925	0.009

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Swallowing	2.71	6.00	2.27	0.007	0.038	0.769	0.004
Nausea	1.14	2.32	0.91	0.141			
Soreness	0	1.96	0.27	0.013	0.022	0.699	0.018
Loosening	2.14	3.73	0.91	0.016	0.15	0.426	0.006
Price	2.43	2.42	4.27	0.587			

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