

# Influence of “boil and bite” mouthguards used by mixed martial arts athletes on the stomatognathic system

## Wpływ użytkowania ochraniaczy typu „boil and bite” przez zawodników mieszanych sztuk walki (MMA) na układ stomatognatyczny

Katarzyna Mańka-Malara<sup>1</sup>, Maciej Trzaskowski<sup>1</sup>, Kristina Kovalenko<sup>2</sup>

<sup>1</sup> Department of Prosthodontics, Medical University of Warsaw

Katedra Protetyki Stomatologicznej, Warszawski Uniwersytet Medyczny, Polska

Head: prof. dr hab. n. med. Jolanta Kostrzewa-Janicka

<sup>2</sup> Department of Orthodontics, Medical University of Warsaw

Katedra Ortodoncji, Warszawski Uniwersytet Medyczny, Polska

Head: prof. dr hab. n. med. Małgorzata Zadurska

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### KEY WORDS:

combat sports, martial arts, head injuries, dental hygiene, temporomandibular disorders

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### HASŁA INDEKSOWE:

sporty walki, sztuki walki, urazy głowy, higiena stomatologiczna, zaburzenia skroniowo-żuchwowe

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### Summary

**Introduction.** The most used type of intra-oral protective splint is a “boil and bite” mouthguard – an appliance adapted by the athlete directly in the oral cavity after its plasticization with hot water. According to the literature, they may have inadequate size and retention.

**Aim of the study.** To evaluate the influence of “boil and bite” mouthguards used by mixed martial arts professionals on the stomatognathic system.

**Material and methods.** Seventeen male combat sports competitors, professionally training mixed martial arts (MMA) with the “boil and bite” mouthguards were examined. Medical interview and dental examination were performed. The participants answered questions concerning the habits of mouthguard’s use, problems or dysfunctions in the head and mouth area, and maxillofacial trauma which occurred during martial arts training.

**Results.** The average participant was 27.16 years old (M: 24; SD: 8.67) and had a training experience of 7.94 years (M: 4; SD: 9.07). 76.48%

### Streszczenie

**Wstęp.** Ochraniacze typu „boil and bite” – stosowywane przez sportowców po uplastycznieniu w gorącej wodzie – są najczęściej stosowanym rodzajem wewnątrzustnych szyn ochronnych. Jak wynika z piśmiennictwa, uzupełnienia te mogą mieć niewłaściwą retencję lub wielkość.

**Cel pracy.** Ocena wpływu użytkowania ochraniaczy typu „boil and bite” przez zawodników mieszanych sztuk walki na układ stomatognatyczny.

**Materiał i metody.** Przebadano 17 mężczyzn profesjonalnie trenujących MMA z zastosowaniem ochraniaczy typu „boil and bite”. Przeprowadzono wywiad lekarski oraz badanie stomatologiczne. Uczestnicy odpowiadali na pytania dotyczące zwyczajów związanych z użytkowaniem ochraniacza, problemów lub dysfunkcji z obszaru głowy i jamy ustnej oraz urazów szczękowo-twarzowych, które wystąpiły podczas treningu MMA.

**Wyniki.** Przeciętny uczestnik miał 27,16 lat (M: 24; SD: 8,67), a jego staż treningowy wyniósł 7,94 lat (M: 4; SD: 9,07). 76,48% uczestników stosowało ochraniacze wewnątrzustne kilka razy

of participants used mouthguards several times a week. 52.94% of the evaluated group experienced gum bleeding during toothbrushing, 58.82% teeth clenching during training, and 47.07% headaches after training. 29.41% of athletes taking part in the study reported a concussion during martial arts training, and 23.53% had dentine and enamel fracture. Only 29.41% of participants used a mouthguard that fully covered their teeth, and 35.29% stated that their protective splint is well adapted.

**Conclusions.** The use of “boil and bite” mouthguards by mixed martial arts athletes can affect the stomatognathic system. Standard protective splint users should be subjected to regular controls by a dentist.

w tygodniu. 52,94% ocenianej grupy zgłaszało występowanie krwawienia z dziąseł podczas szczotkowania zębów, 58,82% zaciskanie zębów podczas treningu, a 47,07% bóle głowy po treningu. 29,41% sportowców biorących udział w badaniu doznało wstrząsu mózgu podczas treningu sztuk walki, a 23,53% złamania zębiny i szkliwa. Jedynie 29,41% uczestników badania używało ochraniacz w pełni pokrywający powierzchnię zębów, a 35,29% oceniało, że ich szyna ochronna jest dobrze dopasowana.

**Wnioski.** Stosowanie przez zawodników mieszanych sztuk walki ochraniaczy wewnątrzustnych typu „boil and bite” może wpływać na układ stomatognatyczny. Użytkownicy tego rodzaju szyn ochronnych powinni być poddawani regularnym kontrolom przez lekarza dentystę.

## Introduction

Athletes use intra-oral mouthguards in many contact sports. The American Dental Association and the International Academy of Sports Dentistry recommend their use in acrobatics, basketball, cycling, boxing, horseback riding, extreme sports, field hockey, football, jump rope, gymnastics, handball, skiing, lacrosse, martial arts, tennis, rugby, ball pushing, skateboarding, skating, surfing, soccer, softball, squash, volleyball, wrestling and water polo.<sup>1</sup> However, a major field of mouthguard application is combat sports. Mouthguards were introduced in 1890 by a dentist Woolf Krause, who used gutta-percha strips on the occlusal surfaces of a boxer Ted “Kid” Lewis’ teeth for protective purposes. At the time it caused controversies; - the manager of his opponent objected to such treatment as an illegal form of doping.<sup>1</sup> An improvement in the design of the protective splints, and a change in material to rubber, was introduced by Krause’s son, who was both a professional dentist and an amateur boxer.<sup>2</sup> At a similar time, the intra-oral protector was used by an

American dentist Thomas A. Carlos. After a boxing fight in 1927, which had to be stopped due to an injury to one of the athletes (cutting his lip against a broken tooth), permission was given to use the protectors.<sup>2</sup> In the literature, the first description of their performance on a model cast from an impression was presented by Abrams et al.<sup>3</sup> In 1947, Lilyquist<sup>4</sup> developed an innovative individual protector made of transparent acrylic resin, characterized by smaller dimensions and optimal retention. Nowadays, customized mouthguards are made from a variety of polymeric materials, using thermoforming, traditional polymerization, and thermal injection techniques.<sup>5-11</sup> However, according to the literature, the most used type is a “boil and bite” mouthguard. There are standard splints, adapted by the athlete directly in the oral cavity after its plasticization using hot water. Due to easy accessibility and low price, they are the most commonly used type of protective appliances.<sup>12</sup> The aim of this study was to evaluate the effect of “boil and bite” mouthguards used by martial arts athletes on the stomatognathic system.

## Materials and methods

The study involved seventeen male combat sports competitors, professionally training mixed martial arts (MMA). The average participant was 27.16 years old (M: 24; SD: 8.67), was 178.23 cm tall (M: 178; SD: 6.28) and weighed 77.56 kg (M: 78; SD: 9.51). Their training experience lasted on average 7.94 years (M: 4; SD: 9.07) of which 6.41 years (M: 4; SD: 7.93) involved the use of a mouthguard. 76.48% of participants used mouthguards several times a week, 17.64% every day, and 5.88% twice a week. The mouthguard used currently was, on average, 13.5 months old (M: 4; SD: 20.5). All participants used the “boil and bite” protective splint, adapted by the user after plasticizing it with hot water. The inclusion criteria were: age between 18-60 years, male gender, at least three years of Mixed Martial Arts training experience, the use of the “boil and bite” type mouthguard during trainings and competitions. The exclusion criteria were acute or systemic diseases, allergies, intake of medicines, previously diagnosed temporomandibular joint dysfunctions, traumatic injuries to the maxillofacial area which did not occur during training, refusal to give informed consent. The study protocol was accepted by the Bioethics Committee of the Medical University of Warsaw no. KB/7/A2020.

The masticatory muscles and the TMJ area were palpated, and the head and face were examined for the presence of scars or cauliflower ears. During mandibular motions the occurrence of TMJ sounds was verified. The degree and symmetry of mandibular opening was verified, as well as the range of lateral movements. All teeth were evaluated for the presence of caries, abfractions, tooth fractures or other pathologies. The participants answered questions concerning the problems or dysfunctions in the head and mouth area including maxillofacial traumas which occurred during MMA training (teeth

fractures, luxations and concussions), gums bleeding during toothbrushing, and gingival inflammations. They were asked in detail about teeth clenching, myalgia in the TMJ area, and headaches and related to jaw movement, function, or parafunction, with the emphasis on their occurrence during or after training with a “boil and bite” mouthguard. Additional questions were asked about the habits related to mouthguard usage— participants were asked how often they train with a “boil and bite” mouthguard, for how long it is placed in the mouth during training, what sanitization methods are applied (flushing with water, brushing with soap or toothpaste, using disinfection tablets, spray, or a UV lamp), and the frequency of replacement. Each athlete also evaluated the protective appliance they used by answering questions concerning the need for replacement, whether it was safe, comfortable, clean, had good retention, correct occlusal contacts, adequate tooth coverage, size, and a smooth surface.

The obtained values were compiled using descriptive statistics (mean values and standard deviations – SD). The frequency of positive answers to each question was calculated and presented on the graphs.

## Results

During anamnesis, the athletes reported stomatognathic system ailments (Fig. 1). More than half of them experienced gum bleeding during toothbrushing and teeth clenching during training. Additionally, almost half of the evaluated group suffered from headaches after training. The clinical examination revealed that over half of the participants had active caries (Fig. 2), 35.29% had masticatory muscles pain, and a similar percentage had abfractions, enamel fractures and worn teeth. Almost three out of ten athletes taking part in the study reported a concussion during martial

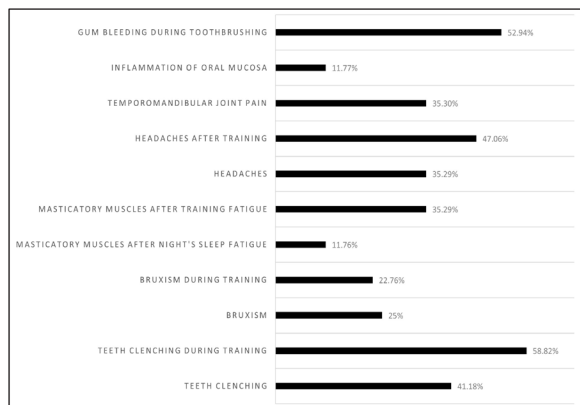


Fig. 1. Stomatognathic system ailments reported by martial arts athletes.

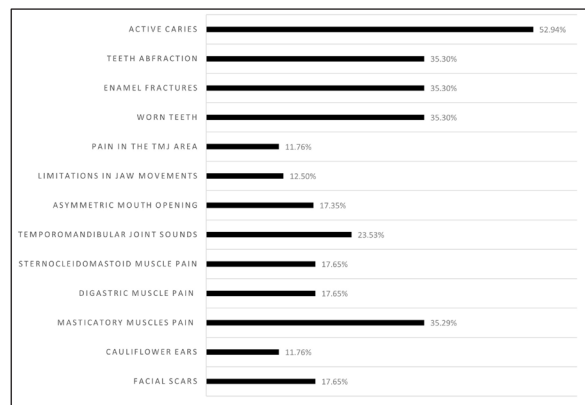


Fig. 2. Clinical examination of the stomatognathic system of martial arts athletes using "boil and bite" mouthguards.

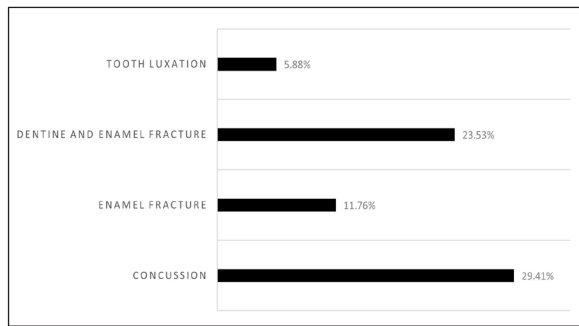


Fig. 3. Injuries sustained during martial arts training.



Fig. 4. "Boil and bite" mouthguards evaluation by martial arts athletes.

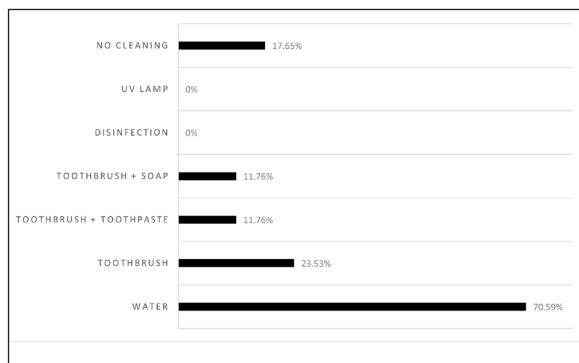


Fig. 5. "Boil and bite" mouthguards cleaning by martial arts athletes.

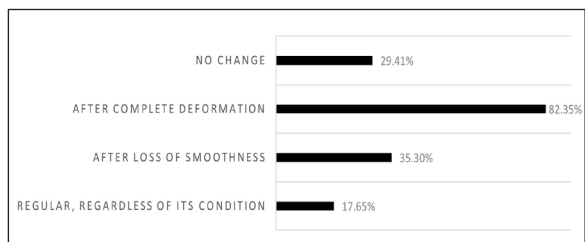


Fig. 6. The frequency of "boil and bite" mouthguards replacement by martial arts athletes.

arts training, and more than twenty percent had dentine and enamel fracture (Fig. 3).

In the self-evaluation of the used "boil and bite" mouthguard less than half of a group stated that it had good retention and was comfortable (Fig. 4). Only 29.41% reported that it fully covered their teeth, and four out of ten athletes

admitted that the used appliance should be replaced. The most frequently used method of appliance sanitization was flushing it with tap water – it was declared by more than seventy percent of the participants (Fig. 5). Two out of ten athletes additionally used a toothbrush. Less than twenty percent of the group declared regular replacement of the appliance (Fig. 6).

## Discussion

Due to the essential function of mouthguards, athletes should use them during all training and sports competitions. *DeYoung* et al.<sup>13</sup> compared the comfort of custom-made and “boil-and-bite” splints among male and female college lacrosse players and determined that most athletes found custom-made mouthguards to be more comfortable. In a study comparing the performance characteristics of various appliances, athletes noted the difficulty with keeping them in the mouth and speaking, complained about inadequate size, difficulty with breathing, and the increased tendency to bite when using standard splints.<sup>12,14</sup> *Ifkovits* et al.<sup>15</sup> found that 89.9% of evaluated standard mouthguards were defective due to their incomplete coverage of the labial surface of the teeth, improper interocclusal contacts, the inadequate thickness, and damage of the splint surface. Inaccurate adjustment of the mouthguard tends to result in the need to clench teeth to keep it in place; improper retention of the “boil-and-bite” protectors was reported in the literature by 42% of their users.<sup>13</sup> In the present study, 58.82% of the participants reported teeth clenching during training. Only 41.18% of athletes reported good retention of the used “boil and bite” appliance, and 29.41% used a mouthguard that adequately covered teeth. 35.29% of the examined fighters reported masticatory muscles pain. Research conducted by *Loster* et al.<sup>16</sup> on Polish young adults showed the 20% occurrence of myofascial pain. To diagnose the exact impact of the “boil and bite” appliance on the masticatory muscles and the TMJ, a randomized prospective study using the Research Diagnostic Criteria of Temporomandibular Joint Disorders should be conducted.<sup>17</sup> However, current results suggest that during clinical examination of a MMA-training patient, such ailments and used type of protective splint should be taken into

consideration. In the present study, 29.41% of mixed martial arts athletes who used the “boil and bite” mouthguards reported a concussion sustained during training, almost 6% had teeth luxation, and over 20% fractured tooth crown during combat sport activity. However, due to the small number of participants, such information can only be used as a pilot study; in order to properly assess the occurrence of particular types of injuries the study should be conducted on larger groups.

The “boil and bite” mouthguards are adjusted by users by immersing them in boiling water for a few seconds, cooling, inserting into the mouth, pressing firmly against the upper dental arch, and clenching teeth for about 30 seconds. Proper shaping of the appliance is possible only at a strictly defined temperature, at the moment of plasticity of the material.<sup>18-21</sup> According to *Guerard* et al.<sup>22</sup> there are large discrepancies in the range of temperatures indicated by manufacturers as being optimal for obtaining the most favourable material properties, with the risk of causing thermal damage to the mucosa, insufficient retention, or inadequate molecular structure of the finished protective splint. This adds to the difficulty of obtaining the optimal “boil and bite” splint shape. In a present study, only 35.29% of participants claimed that their mouthguard was well-adapted. Research conducted by *D’Ercole* et al.<sup>23</sup> showed that the use of intra-oral protectors interferes with the oral environment: pH change of saliva, reduction of its buffering capacity, as well as increase of plaque accumulation and bleeding. The porous surface of the protective splint accumulates opportunistic or pathogenic bacteria and fungi, and its roughness, which develops after too long and unhygienic use, can cause minor soft tissue injuries.<sup>24,25</sup> According to *Glass* et al.<sup>26</sup> wearing a protective athletic mouthguard may increase the number and severity of oral mucosal injuries. In the present study, more than half of the examined participants reported bleeding

during tooth brushing, and 11.77% complained they had problems with inflammations of the oral mucosa. The most frequently used sanitizing method, however, was tap water, which is consistent with previous results, but insufficient from the clinical point of view.<sup>27</sup>

## Conclusions

Based on the study findings, it can be concluded that the use of “boil and bite” mouthguards by mixed martial arts athletes can affect the stomatognathic system. High incidence of bleeding when teeth are brushed, active caries, inadequate hygienic habits, and the increased incidence of stomatognathic system disorders suggest that this population should be further examined and subjected to regular dental reviews.

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- Zaakceptowano do druku: 6.12.2022 r.  
Adres autorów: 02-097 Warszawa, ul. Binieckiego 6.  
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