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Elite *tae kwon do* athletes' satisfaction with custom-made mouthguards

Eroğlu E, Diljin KA, Lütfi BM. Elite *tae kwon do* athletes' satisfaction with custom-made mouthguards. © Blackwell Munksgaard, 2006.

Abstract – Mouthguards are considered by most authors to be an essential part of equipment for athletes participating in contact sports. However, there are few studies evaluating the satisfaction of the elite athlete with mouthguards. The purpose of this study was to evaluate the satisfaction of elite *tae kwon do* athletes with custom-made mouthguards in a period of 4 months. The subjects were 22 elite athletes (11 boys and 11 girls) aged between 15 and 17 years. Each athlete was provided with an individual mouthguard made of ethyl vinyl acetate (EVA) material. Using Visual Analog Scale (VAS) questionnaire, esthetic appearance, ability to talk and to breathe, kiyapping (yelling in *tae kwon do*), oral dryness, nausea, stability, ease in fitting into the mouth, inclination to chew and overall satisfaction were evaluated. Respective values of boys and girls were also compared. One-way ANOVA and paired sampled *t*-tests were performed for statistical analyses using SPSS 11.0 WINDOWS program. There was no significant difference in the level of satisfaction between the first week and fourth month values. Results also showed that the level of satisfaction did not change statistically between male and female athletes.

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Tae kwon do is the most popular type of martial arts in Turkey. On the contrary, martial arts carry 32.1% high risk of oral injury (1). A blow or kick from the rival most often causes injury to one tooth, while a fall or blow from a hard object often results in injuring more than one tooth (2). Dental damage following these injuries is usually irreversible and can cause functional, esthetic and psychological impairment. Consequently, prevention of these injuries must be the prime emphasis of sports dentistry (3).

The mouthguard was found to be the most effective way of preventing dental injuries (4, 5). With the introduction and widespread use of mouthguards, there has been a reduction in sports related dental injuries (1, 6). However, many athletes find them difficult to tolerate (7). Ferrari and Ferreria de Mederios (1) reported awareness rates of mouthguards as 71.9% for martial arts, while their use is still limited.

Indisputably, a custom-made mouthguard made by a dentist, on an individual model of the patient is more comfortable than the stock or boil and bite types (8, 9).

The Visual Analog Scale (VAS) is the most commonly known and used method for measurement of pain levels (10–12). In addition, it can be used to measure the perception of a variety of stimuli, such as emotional distress and nausea (13), quality of voice samples (14), or recall and recognition of material in an educational presentation (15). These scales measure the intensity or magnitude of sensations and subjective feelings, and the relative strength of attitudes and opinions about specific stimuli (16).

The aim of this study was to measure and evaluate elite *tae kwon do* athletes' satisfaction with the custom-made mouthguards using VAS.

Material and methods

Subjects

Twenty-two (11 male, 11 female) voluntary elite *tae kwon do* athletes (members of the Turkish young national team), who never wore a custom-made mouthguard, participated in the study. They were aged 15–17 (16 ± 1.11) years, had a training history of 4–8 (6.77 ± 2.53) years, and trained 9–10 h a week. Written informed consent was obtained from each athlete's parents for the study and photographs were taken.

Fabrication of mouthguards

Impressions were taken using standard trays using alginate impression material and poured with dental stone to get the working models. Ethyl vinyl acetate (EVA) sheets (Ultradent, UT, USA) (0.15 × 5 × 5 inch) were used to fabricate the mouthguards. Sheets were placed in a thermal-forming machine (MiniSTAR, Scheu-Dental, Iserlohn, Germany). They were softened in a period of 150 s and they were vacuumed 100 s under pressure (2 bar) (Fig. 1). Following the contouring of the mouthguards on the models, they were tried in the mouth of each athlete in terms of margin adaptation, stability and retention.

Fig. 1. Mouthguards were fabricated using a thermal-forming machine (MiniSTAR, Scheu-Dental, USA).

Study design

The athletes were allowed to become accustomed to custom-made mouthguard for a period of 1 week during training. The subjects then completed VAS questionnaire concerning the acceptability of the custom made mouthguard. This evaluation was repeated at the end of a 4 month period. Each athlete expressed his/her satisfaction with the mouthguard by drawing a line on a 10 cm long scale for each parameter (Table 1). This information was quantified for analysis by measuring the distance between the 0 point and the end of the 10 cm line with a ruler.

Statistical analysis

Two tailed *t*-test was used to determine the significance between first week and fourth month time. One-way ANOVA test was used to determine the significance between genders. $P < 0.05$ was considered as significant.

Results

All 22 subjects recruited for the study followed the procedure to the very end. The lowest value measured as 4.35 in oral dryness. The highest mean value among the questions was 9.73 in stability and ease in fitting (Fig. 2).

Table 1. Parameters to evaluate the satisfaction with custom-made mouthguards via VAS

1. Esthetically unacceptable	Very good esthetics
2. Extreme difficulties in breathing	No difficulties in breathing
3. Extreme difficulties in speaking	No difficulties in speaking
4. Extreme difficulties in kiyapping	No difficulties in kiyapping
5. Extreme oral dryness	No oral dryness
6. Permanent nausea	No nausea
7. Unstable	Stable
8. Can easily fit into mouth	Can hardly fit into mouth
9. Permanent inclination to chew	No inclination to chew
10. Overall satisfaction is poor	Overall satisfaction is excellent

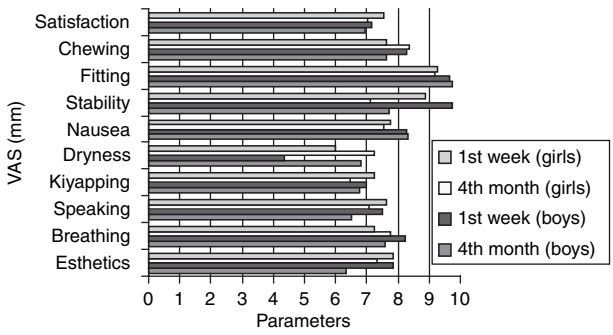

Fig. 2. Visual Analog Scale (VAS) values of the answers in the first week and fourth month of each gender.

In the first week, the parameter related to oral dryness was the lowest VAS value (4.35) obtained from boys. The parameters related to kiyapping (6.99), speaking (7.50), esthetics (7.85), breathing (8.25), nausea (8.27), chewing (8.28) and fitting (9.67) followed respectively. In the fourth month, the values increased for the parameters related with dryness (6.82), nausea (8.34) and fitting (9.73), while for esthetics (6.32), speaking (6.50), kiyapping (6.75), breathing (7.59), chewing (7.65) and stability (7.72) decreased.

The lowest VAS value (6.00) of the girls in the first week was also the parameter related with oral dryness. The parameters related with breathing (7.22), kiyapping (7.25), speaking (7.65), chewing (7.65), nausea (7.75), esthetics (7.84), stability (8.89) and fitting (9.25) followed respectively. In the fourth month, these values increased for the parameters related with dryness (7.25), breathing (7.77) and chewing (8.35), while for kiyapping (6.45), speaking (7.05), stability (7.10), esthetics (7.31), nausea (7.55), and fitting (9.17) decreased. Overall satisfaction values decreased slightly, but not significantly for each gender (Fig. 2).

However, the mean values of VAS for each answer did not show a statistical difference according to gender or to time elapsed between first week and fourth month ($P > 0.05$; Tables 2 and 3).

Discussion

Whether amateur or professional, sports and athletes are always related with health. Consequently, the major aim of sports dentistry and sports medicine is to take preventive measures before deformity and disability occurs. Most of the *tae kwon do* athletes are biased against mouthguard use as it could negatively affect their performance and hinder them from kiyapping and breathing. Yet, mouthguard use is not considered mandatory by most of the professional sport federations. As mouthguards are not considered to be a therapeutic device by physicians; athletes, amateurs in particular will avoid using them unless they are encouraged. According to Gardiner and Ranalli (17), this avoidance of mouthguard use is caused by the physical characteristics of mouthguard. Therefore, athletes' satisfaction with mouthguards is of vital importance. Levin et al. (18) reported oral and dental trauma incidence as 27% in an Israeli population of 943 athletes participating in different sport activities. This is in accordance with the study of Ferrari and Ferreira de Medeiros (1) reporting a rate of dental trauma in 1029 Brazilian professional and semi-professional athletes. A recent study reports dental trauma rates in Turkish elite *tae kwon do* and handball athletes as 24% and 26% respect-

Table 2. Mean VAS values (cm) of the answers at first week

	Boys			Girls		
Answers	Mean ± SD	Minimum	Maximum	Mean ± SD	Minimum	Maximum
1	7.85 ± 2.24	4.3	10	7.84 ± 2.40	4.2	10
2	8.25 ± 2.26	4	10	7.22 ± 2.41	4	10
3	7.50 ± 2.36	3.8	10	7.65 ± 2.02	4.5	10
4	6.99 ± 2.85	3	10	7.25 ± 2.28	4.5	10
5	4.35 ± 3.73	0	10	6.00 ± 3.26	0	10
6	8.27 ± 2.60	1.5	10	7.75 ± 3.68	1	10
7	9.73 ± 0.65	8	10	8.89 ± 2.18	2.8	10
8	9.67 ± 0.73	8	10	9.25 ± 1.30	6	10
9	8.28 ± 3.13	0	10	7.65 ± 3.91	0	10
10	7.16 ± 2.50	4	10	7.55 ± 2.95	1.5	10

Table 3. Mean VAS values (cm) of the answers at fourth month

	Boys			Girls		
Answers	Mean ± SD	Minimum	Maximum	Mean ± SD	Minimum	Maximum
1	6.32 ± 3.39	0	10	7.31 ± 3.56	0	10
2	7.59 ± 3.10	0	10	7.77 ± 2.90	0	10
3	6.50 ± 2.76	1.7	10	7.05 ± 2.24	1.7	10
4	6.75 ± 3.52	1	10	6.45 ± 3.47	1	10
5	6.82 ± 3.63	0	10	7.25 ± 3.01	0	10
6	8.34 ± 3.13	0	10	7.55 ± 2.92	0	10
7	7.72 ± 3.26	1	10	7.10 ± 3.92	1	10
8	9.73 ± 0.90	7	10	9.17 ± 1.44	6.4	10
9	7.65 ± 3.56	0	10	8.35 ± 2.29	3.2	10
10	6.93 ± 2.74	2	10	7.04 ± 2.99	2	10

ively (19). In a study carried by Sane et al., 80 patients with sports related maxillofacial fractures were analyzed and a 5.6% incidence of facial bone fracture was found (5). Thus, maxillary mouthguards are recommended to prevent such injuries (6). Several authors reported that custom-made mouthguards are superior to the other two types, which are bulky and lack proper retention (6, 20, 21). It was for this reason that custom-made mouthguards were chosen for this study.

We specifically chose the elite athletes as they were training more than 10 h a week for the last 4 years. We thought that these athletes were 'role models' for amateur athletes, in that they would be encouraging in regards to the use of this protective device.

The VAS questionnaire was chosen to evaluate satisfaction level in this study, as it is one of the most frequently used measurement methods in healthcare research as well as dentistry. In a study carried out by Brionnet et al. (22), the use of mouthguards was also evaluated via VAS. However, the material used (poly vinyl acetate), the population investigated (amateur rugby players) and the type of mouthguard (bimaxillary) did not allow a direct comparison of the results with those of the present study.

The athletes' high satisfaction with the esthetic appearance level of their mouthguards can be dependent on the color of the mouthguards preferred by the athletes themselves (Fig. 3).

Breathing without any obstruction is vital for an athlete. In the present study, satisfaction with breathing also reported high values. Amis et al. (23) investigated the effects of custom-made mouthguards on the airflow dynamics of oral breathing in 10 normal subjects. They suggest that these mouthguards are unlikely to interfere with breathing at high ventilatory rates and where recruitment of compensatory mechanism is possible. Thus, the high satisfaction values related to breathing were confirmed, although the subjects were not athletes and they were not exercising unlike our subjects.

Fig. 3. The most preferred colors by the athletes were red, green, white or transparent.

Satisfaction with speaking and kiyapping had also higher scores than expected. It was assumed that proper fitting of the custom-made mouthguard did not prevent the speaking and kiyapping. Kiyapping is very essential for a *tae kwon do* athlete to express himself/herself and to discourage his/her rival during training and competition. If mouthguards had prevented athletes from kiyapping, they would have given them up.

Oral dryness had nearly the lowest level among the other parameters. The thickness of the mouthguard limits a proper closing of the mouth. The athlete feels oral dryness because of heavy exercise and stress during competition. However, the increase of satisfaction level seemed to increase probably because of adaptation of mouthguard use. Brionnet et al. (22) have reported a similar complaint about mouthguards and recommended drinking water at frequent intervals. However, it is unlikely to cause oral dryness because a *tae kwon do* competition lasts for 6 min.

Feeling nausea because of mouthguard use was reported in a very low degree. During the fabrication period and try-in sessions of the custom-made mouthguards, special care was taken not to overlap the palatal posterior limit. Allowing the athletes to get used to their mothguards for 1 week may have had positive effects on this parameter.

Stability was another high ranked satisfaction parameter. Compared with custom-made mouthguards, stock and boil-and-bite types were considered as 'ill fitting'. Ranalli (24) reported that they interfere with breathing and speech and may even cause the athlete to gag. It was also reported that a 17-year-old athlete's boil and bite mouthguard dislodged upon impact and became wedged in the oropharinx and resulted in collapse (25). Gardiner and Ranalli (17) also emphasized the importance of properly fitted mouthguards to prevent injuries.

Ease of fitting into the mouth was ranked the highest. Resilience of this material enables it to easily fit into mouth (17). Westermann et al. (26) recommended a thickness of EVA material about 4 mm and added that increased thickness results in less comfort and dissatisfaction of the user. A similar EVA material (0.150 inch = 3.810 mm) was selected for this study. This thickness is needed for optimal energy adsorption. According to Brionnet et al. (21) chewing or grinding of teeth may often

serve as an emotional release during competition. Therefore, the high rating for inclination to chew can be accepted as normal.

The last question concerning the overall satisfaction of the athletes allowed a general evaluation of the mouthguard by the athlete. These high ratings confirm the ratings of the parameters above.

Conclusion

Within the limitations of this study, it can be concluded that the custom-made mouthguards used were well accepted by elite *tae kwon do* athletes in terms of esthetic appearance, ability to talk and to breathe, kiyapping, oral dryness, nausea, stability, ease of fitting into the mouth, inclination to chew and overall satisfaction.

Although there was no significant difference between the values measured in two periods, there is a decrease in oral dryness and inclination to chew, while minor differences were observed in the other parameters. This shows the increased adaptation of the athlete to mouthguard use with time. Esthetic satisfaction seemed also to decrease with time. The reasons for it can be investigated within a longer period of time though. The decrease in stability suggests that this parameter needs to be investigated for a long-term in order to determine the expiry date of mouthguards. Further studies are necessary to allow athletes to derive more satisfaction, so that mouthguard could be universalized.

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