Effect of Using Mouth Guard on Anaerobic and Aerobic Performance of Combat Sport Athletes

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Abstract

Purpose: The purpose of this study was to investigate the effect of using mouth guard on anaerobic and aerobic performance of combat sport athletes.

Design and Method: Eight highly active experienced male senior combat sport athletes accustomed to use mouth guard (mean ± SD, age: 22.0±2.2yr, height: 173.5±3.38 cm, body weight: 70.45±8.14 kg and training year: 8.37±4.24yr) were participated in this study as volunteers. In a randomized crossover manner hand grip strength (right and left hands), peak power, average power, fatigue index, maximum oxygen consumption and the total running time were measured via Wingate 30s Anaerobic test and Bruce protocol with and without mouth guard. Paired samples t-test was used for statistical analysis.

Results: No significant difference was found between the performance with and without using mouth guard regarding to hand grip strength (t=0.08; p=0.931 and t=0.64; p=0.532 respectively right and left hand), peak power (t=0.82; p=0.439), average power (t=-0.39; p=0.708), fatigue index (t=-0.93; p=0.381), maximum oxygen consumption (t=-0.27; p=0.790) and the total running time (t=-1.56; p=0.162).

Conclusions: As a conclusion, mouth guard usage had no adverse effect on the athletic performance of male senior combat sport athletes accustomed to use mouth guard.

Key words: Combat Sports; Hand Grip; Maximum Oxygen Consumption; Mouth guard; Protective Equipment; Wingate Anaerobic Test.

Introduction

Preventing from injuries and protecting the health of athlete is the most important fact during training and competitions. Today, sports competitions require more effort, struggle and competitiveness, which lead to an increased risk of injury. Many sporting activities have an associated risk of injuries due to falls, collisions, contact with hard surfaces, and contact from sports-related equipment (American Academy of Pediatric Dentistry, 2006). In order to prevent from these risks a lot of protective materials and athletic equipment (knee pads, helmets, facemasks, and mouth guards) have been developed by the manufacturers.

Especially in contact sports, injuries are more common situation than non-contact sports. The orofacial area, especially the front teeth are the most common injured part of the body in contact sports (Kay et al., 1990; Ferrari and Mederios, 2002), such as boxing, tae kwon do and karate. Therefore, mouth guard is the most important material for reducing the injury rate of mouth and teeth (ADA, 1962; 2006). Anyway this equipment has been used for many years for preventing orofacial injuries during sports activities.

Mouth guard usage was first seen in boxing in the early 1900s in the UK to protect the boxer's mouth and teeth (Newsome et al., 2001; Found et al., 2006). During the 1960s and 1970s, the use of mouth guards was made mandatory in many sports, including football, ice hockey, lacrosse, field hockey, and boxing (Daneshvar et al., 2011). Properly fitted mouth guards has many benefits such as; reducing fractures of teeth, protecting the lip and cheek tissues from being impacted and reducing...
the incidence of a mild traumatic brain injury (concussion) by possibly absorbing of physical shock (Chi, 2007; Francois et al., 1999; Klossner, 2011).

Even though the necessity of mouth guard usage has been stated and strongly recommended by the researchers, dentists and the Olympic committees in many times (Takeda et al., 2004), most of the athletes are thinking that using mouth guard during competition or training workouts have negative effects in terms of discomfort (Seals et al., 1985), feeling nausea (Chapman, 1990; Chapman and Nasser, 1993), lack of concentration (Tulunoglu and Ozbek, 2006), difficulties in oral communication and exchange of breath (Gardiner and Ranalli, 2000). Because mouth guard usage is mandatory in many sports in order to prevent dental injuries, the impact of mouth guard usage on athletic performance has become a subject of curiosity among sport scientists. In these studies, effects of mouth guard usage were examined on various athletic performance components.

Various studies done on examining the effect of mouth guard usage on anaerobic performance showed no significant changes in hand grip, isometric leg and back strength (Cetin et al., 2009), 20 meter sprint time (Cetin et al., 2009), explosive power (Bourdin et al., 2006; Vieira et al., 2008), jumping height (Cetin et al., 2009) and visual reaction time (Bourdin et al., 2006). Furthermore, several studies evaluating the impact of mouth guard on aerobic endurance performance showed no significant changes in heart rate (Gebauer et al., 2011; Rapisura et al., 2010), perceived exertion level (Rapisura et al., 2010), maximum oxygen consumption (VO$_2$-max) (Gebauer et al., 2011; Kececi et al., 2005; Von Arx et al., 2006; Bourdin et al., 2006), minute ventilation (Gebauer et al., 2011; Kececi et al., 2005; Rapisura et al., 2010; Von Arx et al., 2006; Bourdin et al., 2006), tidal volume (Kececi et al., 2005) and respiratory exchange ratio (Kececi et al., 2005; Rapisura et al., 2010). However, there are also several studies which investigated positive (Cetin et al., 2009) and negative (Francis and Brasher, 1991) effects of mouth guard usage on athletic performance. For instance, Cetin et al. (2009) found significant increase in peak and average power obtained by Wingate 30sec anaerobic test. On the other hand, in the study of Francis and Brasher (1991) significant decrease was stated in forced expiratory air volume, peak expiratory flow rates and VO$_2$ during heavy exercise while using mouth guard.

The results of the studies examining the effects of mouth guard usage on athletic performance appear to be doubtful. For this reason, further scientific studies are needed to prove the impacts of using mouth guard on performance. Therefore, the purpose of this study was to investigate the effects of using mouth guard on anaerobic and aerobic performance of combat sport athletes.

Materials and Methods

Participants:

Eight highly active experienced male senior combat sport athletes accustomed to use mouth guard were participated in this study as volunteers. Age, height, body weight, body fat percentage, fat free mass, training age, and training session per week are shown in table 1. All subjects have been informed about the aim of study, and completed a medical history form and signed an informed consent approved by the Clinical Research Ethics Committee of Abant Izzet Baysal University.

| Table 1: Descriptive Characteristics of Subjects (n=8) |
|----------------------------------|----------------|----------------|
| Mean    | SD    |                    |
| Age (year) | 22.0  | 2.2              |
| Height (cm) | 173.5 | 3.38            |
| Body Weight (kg) | 70.45 | 8.14          |
| Body Fat Percentage (%) | 9.95  | 2.66            |
| Fat Free Mass (kg) | 63.18 | 6.01            |
| Training Age (year) | 8.37  | 4.24            |
| Training Session / Week | 4.0   | 0.92            |

Study Design:

During the week before the beginning of the experiment, athletes were familiarized with the test battery to avoid the learning effect during the testing period of the study. At this stage each athlete had repeated the tests (Handgrip strength, Wingate 30s anaerobic test and Treadmill test) with and without mouth guards. Before the test during last 24 hours, athletes were asked to refrain from consuming alcohol and caffeine containing beverages and heavy physical activity in order to provide full rest. Also, they were asked to eat at least 3 hours before tests and were allowed to drink only...
water between test and last meal. They were instructed to continue their daily sleep routine, with a minimum 7 hours sleep in the last night prior the test. At the first day of the study, anthropometric measurements and body composition analysis were applied before the standard warm up. In the first week of the study handgrip strength and Wingate 30 sec anaerobic test were performed respectively. Next week treadmill test was performed for the assessment of VO\(_2\)max. All participants performed the each test protocol twice in a week, via randomized crossover design with and without mouth guard with a three day interval. All measurements were taken in the Exercise and Sport Physiology Laboratory of Abant Izzet Baysal University, in a constant temperature (22-24\(^\circ\)C). In order to avoid the possible effects of circadian rhythm measurements were performed at the same time period (14:30 to 16:30).

Body composition:

Height was measured to the nearest ±0.1cm via a stadiometer and body weight was measured to the nearest ±0.1kg via a manual scale (Seca 700; Secagmbh& co, Germany). Participants were asked to remove all clothing, shoes, jewellers and other accessories except a light shorts for the measurements. Body fat percentage and fat free mass measurements were performed by bioelectrical impedance analyser (Tanita BC-418 MA; TanitaCorp., Japan) with bare feet.

Handgrip strength:

Isometric hand-grip dynamometer (Takei TKK 5101, Japan) was used to assess hand-grip strength for both hands. Before the measurement hand-grip dynamometer was adjusted according to each athlete’s hand size. During the test the shoulder position was at 45° with extended elbow. Following a practice trial of a firm grip, the participant was asked to grip firmly and release for the measurement (Mackenzie, 2005). After three maximum efforts the best score was recorded in kg.

Wingate 30s Anaerobic Test:

Wingate 30s Anaerobic Test (WAnT) was conducted on a computerized cycle ergometer (Monark Ergomedic 894E, Peak Bike, and Sweden). Seat height was adjusted for each subject and toe clips were used to prevent the slipping off the feet from the pedals. Subjects warmed up by pedalling for three minutes against a 2kpm load. At the beginning of the test, the subjects were instructed to pedal as fast as possible against unloaded resistance (Inbar et al., 1996). The resistance applied was adjusted relative to body weight (0.075 · body weight in kg). During the test when the participant was reached 150 rpm 30s measurement phase was started automatically. Verbal encouragement was given to every participant, especially during the last 10-15s when the willpower was needed. After the test, Peak Power (PP), Average Power (AP), and their relative values were obtained from the software. In addition, the difference between PP and minimum power was calculated relative to PP used as fatigue index (FI).

\(\text{VO}_2\)maxTest:

The Bruce protocol, a validated test for estimating \(\text{VO}_2\)max during maximal performance, was performed on a treadmill (h/p/ cosmos mercury, Traunstein, Germany; 0- 22.0 km/hr speed, 0- 24 % angle of inclination, 150 cm x 50 cm running surface). The test started at a speed of 2.74 km/h, at 10 % degree of inclination. At the end of every three minute the degree of inclination of the treadmill was increased 2%. The treadmill speed also increased progressively in the following sequence: 4.02, 5.47, 6.76, 8.05, 8.85, 9.65 km/h (Heyward, 1998). During the exercise test, expired gases (oxygen and carbon dioxide concentration) were collected and analysed continuously breath by breath using the Cortex Metalyzer II gas analyser (Cortex Biophysik, Leipzig, Germany). According to the manufacturers manual, calibration of the gas analyser was performed before each testing session using a 3-liter syringe and calibration gases of known concentration of \(\text{O}_2\) and \(\text{CO}_2\) (15.06 % \(\text{O}_2\), 5.11 % \(\text{CO}_2\)& bal. in \(\text{N}_2\)).

Statistical Analysis:

Mean and standard deviations (SD) were calculated for all variables. Paired Samples t-test was used to compare the collected data with and without mouth guard usage. Significance level of
alpha for statistical analysis was accepted as 0.05 and all analyses were performed on statistical package for the social sciences (SPSS version 16.0, SPSS Inc., Chicago, IL, USA).

**Results**

As shown in table 2 there is no significant difference between with and without mouth guard, regarding to hand grip strength (right and left hand) and, Wingate 30s anaerobic test parameters (PP, AP and Fl).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Measures</th>
<th>Mean</th>
<th>SD</th>
<th>df</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grip Strength (Right Hand) (kg)</td>
<td>With Mouth guard</td>
<td>48.56</td>
<td>5.10</td>
<td>7</td>
<td>-0.08</td>
<td>0.931</td>
</tr>
<tr>
<td></td>
<td>Without Mouth guard</td>
<td>48.72</td>
<td>5.88</td>
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<tr>
<td>Grip Strength (Left Hand) (kg)</td>
<td>With Mouth guard</td>
<td>49.90</td>
<td>5.32</td>
<td>7</td>
<td>0.64</td>
<td>0.539</td>
</tr>
<tr>
<td></td>
<td>Without Mouth guard</td>
<td>48.63</td>
<td>6.96</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP (W)</td>
<td>With Mouth guard</td>
<td>722.70</td>
<td>158.09</td>
<td>7</td>
<td>-0.82</td>
<td>0.439</td>
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<tr>
<td></td>
<td>Without Mouth guard</td>
<td>739.66</td>
<td>155.89</td>
<td></td>
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<tr>
<td>AP (W)</td>
<td>With Mouth guard</td>
<td>530.16</td>
<td>71.37</td>
<td>7</td>
<td>-0.39</td>
<td>0.708</td>
</tr>
<tr>
<td></td>
<td>Without Mouth guard</td>
<td>533.53</td>
<td>76.59</td>
<td></td>
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<tr>
<td>PP (W/kg)</td>
<td>With Mouth guard</td>
<td>10.16</td>
<td>1.41</td>
<td>7</td>
<td>-0.67</td>
<td>0.521</td>
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<tr>
<td></td>
<td>Without Mouth guard</td>
<td>10.37</td>
<td>1.12</td>
<td></td>
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</tr>
<tr>
<td>AP(W/kg)</td>
<td>With Mouth guard</td>
<td>7.49</td>
<td>0.47</td>
<td>7</td>
<td>-0.24</td>
<td>0.816</td>
</tr>
<tr>
<td></td>
<td>Without Mouth guard</td>
<td>7.52</td>
<td>0.41</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FI (%)</td>
<td>With Mouth guard</td>
<td>52.62</td>
<td>7.28</td>
<td>7</td>
<td>-0.93</td>
<td>0.381</td>
</tr>
<tr>
<td></td>
<td>Without Mouth guard</td>
<td>54.98</td>
<td>4.41</td>
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</tr>
</tbody>
</table>

**Figure 1:** Right and Left Hand Grip Strength Scores (kg) With and Without Mouth Guard.

**Figure 2:** Wingate 30s Anaerobic Test Values (W/kg) With and Without Mouth Guard.

No significant difference was found between with and without mouth guard regarding to VO$_2$ max and total running time (Table 3).
Table 3: Means and SD of The Aerobic Values Measured With and Without Mouth Guard (n= 8)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Measurements</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>df</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>VO₂ max (ml/kg/min)</td>
<td>With Mouth guard</td>
<td>8</td>
<td>53.37</td>
<td>5.57</td>
<td>7</td>
<td>-0.27</td>
<td>0.790</td>
</tr>
<tr>
<td></td>
<td>Without Mouth guard</td>
<td>8</td>
<td>53.87</td>
<td>6.42</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total running time (s)</td>
<td>With Mouth guard</td>
<td>8</td>
<td>802.00</td>
<td>5.35</td>
<td>7</td>
<td>-1.56</td>
<td>0.162</td>
</tr>
<tr>
<td></td>
<td>Without Mouth guard</td>
<td>8</td>
<td>830.00</td>
<td>6.96</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 3: VO₂ max (ml/kg/min) with and Without Mouth Guard.

Figure 4: Total Running Time (s) With and Without Mouth Guard

Discussion and Conclusion

Impact of using mouth guard on anaerobic and aerobic performance of combat sport athletes was investigated in this study. In this case, the effect of using mouth guard on hand grip strength (right and left hands), PP, AP, FI, VO₂ max and total running time of combat sport athletes will be discussed and interpreted.

Hand grip strength test is commonly used as an indicator of general strength level of athletes. In the present study, no significant difference was reported between with and without mouth guard use regarding to hand grip strength values for each hand (Table 2; Figure 1). In a previous study Cetin et al. (2009) examined the effect of mouth guard usage on the athletic performance of tae kwon do athletes. The results and the characteristics of the participants of this study were similar with present study. Both, the present and the Cetin and colleagues' (2009) study reported no detrimental effect of mouth guard usage on hand grip strength.
Wingate 30s Anaerobic test is one of the most popular tests all over the world which used to measure anaerobic power. PP is the highest power output during any 5s period of the test and AP is the mean of total 30s period (Inbar et al., 1996). As shown in figure 2, the results of this study revealed that there was no significant difference between the scores obtained with and without mouth guard, regarding to Wingate 30s anaerobic test variables (PP, AP and Fl) (Table 2). Similar to the results of the present study, Vieira et al. (2008) and Bourdin et al. (2006) reported no changes in explosive power values by the use of mouth guard. Different than the present study, the results of Cetin et al. (2009) showed significant increase in PP and AP while wearing mouth guard. The authors of this study assumed that the increase in PP and AP scores could be due to the high motivational levels of the athletes. They emphasized on the impossibility of restricting the higher motivation of the athletes during testing with mouth guard. According to the studies discussed above, using mouth guard has no negative effect on anaerobic performance. Furthermore, in the study of Cetin et al. (2009), mouth guard use caused positive effect on the Wingate 30s Anaerobic test variables.

VO2 max is considered as the best indicator of aerobic capacity and endurance. It is defined as the point that oxygen consumption remains at a steady state in spite of an increase in workload during progressive incremental exercise (Heyward, 1998). In this study, no significant difference was found between with and without mouth guard use regarding to VO2 max (Table 3; Figure 3). Parallel to the results of the present study, Gebauer et al.(2011), Kecceci et al.(2005), Von Arx et al.(2008), Bourdin et al.(2006) and Rapisura et al.(2010) also reported no significant changes on VO2 max due to usage of mouth guard. On the other hand, Francis and Brasher (1991) stated significant decrease in VO2 during heavy exercise while using mouth guard. Their explanation to this result was the improvement of tissue oxygenation and lower metabolic cost due to the pursed-lip breathing caused by the usage of mouth guard. Moreover, results of the present study stated no significant difference between with and without mouth guard use regarding to total running time (Table 3) as shown in figure 4. To the best of our knowledge there is no study in the literature, which examined the effect of mouth guard usage on total running time. To the studies discussed above; using mouth guard has no negative effect on oxygen consumption and total running time.

According to the results of the present study, no negative effect of using mouth guard was stated regarding to hand grip strength (right and left hands), PP, AP, Fl, VO2 max and the total running time. Also many studies in the literature investigated that there is no negative effect of using mouth guard. Possible explanation for the results of the present study could be the level of the experience of the athletes. Since, the participants of this study were highly active experienced male senior combat sport athletes accustomed to use mouth guard. It is considered that the athletes participated in this study were accustomed to mouth guard because of long-term use.

As a conclusion, mouth guard usage had no adverse effect on the athletic performance of male senior combat sport athletes accustomed to use mouth guard. Since, mouth guard usage does not restrict the athletic performance; it should be advised to athletes for preventing injuries.

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References


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