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Over-the-counter performance enhancing mouthguards are unable to decrease blood lactate and improve power output during a Wingate anaerobic test (WAnT)

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ABSTRACT

Mouthguards are the primary mode of protection against maxillofacial injuries in contact sports, but recent research has also linked performance enhancement to this piece of equipment. The purpose of this study was to test the claims of the Under Armour ArmourBite (UAAB) mouthguard to decrease blood lactate concentration ([BL]) and increase power when compared to a generic over-the-counter mouthguard (OTC) and no mouthguard (NOMG) during an anaerobic performance test. Seventeen recreationally active males (23.4 ± 2.7 years; 179.6 ± 7.4 cm; 83.0 ± 14.0 kg) were tested using the 30 s Wingate anaerobic test (WAnT) during three separate testing sessions. There were no differences in [BL] between any of the conditions immediately or 5 min posttest. There were also no differences in peak, relative or average power, or fatigue index during the WAnT. The UAAB mouthguard was therefore unsuccessful in improving anaerobic performance. It is likely that more expensive, custom-fit dental mouthguards may be necessary for individuals to see any benefits to athletic performance.

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Introduction

Mouthguards are often used for protection against dental and maxillofacial injuries by separating the maxillary and mandibular teeth and acting as impact-absorbing devices. This aids in prevention of injuries such as tooth root fractures and lacerations or bruising of the intraoral tissues.[1] Because mouthguards help protect against various oral injuries, they are mandatory in many sports such as ice hockey, football, lacrosse, and field hockey.

While the primary use is protective, some studies have shown mouthguards to have performance-enhancing benefits as well, such as reducing blood lactate concentration ([BL]) during exercise. In one study, a vented mouthguard was used during maximal aerobic exercise and [BL] was found to be lower at the end of a cycle-based VO_2max test when compared to both a generic mouthguard and a control (no mouthguard).[2] Similarly, lower [BL] was shown at the end of a 30 min treadmill run while using an over-the-counter (OTC) mouthguard compared to a control condition.[3] However, another study found no difference in [BL] at submaximal workloads or peak fatigue when comparing custom-fit and OTC mouthguards to a control condition.[4] While previous studies have primarily investigated the effect of mouthguards during aerobic testing conditions, minimal research has been conducted on anaerobic performance. Because mouthguards are generally marketed towards contact sports that have a high occurrence of short, intense bouts of activity, there is a need to examine the effectiveness of the performance enhancing aspects of mouthguards during a test that simulates these anaerobic conditions, rather than an aerobic test such as a steady-state run or a VO_2max test. The Wingate anaerobic test (WAnT) involves 30 s of cycling on an ergometer against a percentage of the subject's body mass, usually 7.5%, and is a valid and reliable test of anaerobic power[5] that has been used in sports science research for over 30 years.

The Under Armour ArmourBite mouthguard (UAAB; Under Armour Bite Tech Inc., Norwalk, CT) with Power Wedges™ is an OTC mouthguard purported by the company to improve gas exchange, increase strength, endurance, and reduce [BL]. The purpose of this

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study was to determine if there are differences between the UAAB versus a standard, inexpensive over-the-counter mouthguard (OTC) and a control condition with no mouthguard (NOMG), on [BL] and anaerobic performance in healthy, recreationally active male subjects. We hypothesized that there would be no differences seen between conditions on blood lactate concentration or any power variables associated with a WAnT.

Methods

Study design

This study implemented a repeated-measures design. Our purpose was to test claims from the manufacturer of a commercially available OTC mouthguard of improved strength and decreased blood lactate concentration. As strength is important in power generation,[6,7] the WAnT was chosen as the method of assessing the efficacy of the mouthguard to improve performance. Participants volunteered for the study and were all recreationally active. They were asked to come to the lab for four visits in total: an orientation session and three testing sessions.

Participants

This study utilized 17 healthy male recreationally active participants (age: 23.4 ± 2.7 yrs, mean ± SD; height: 179.6 ± 7.4 cm; mass: 83.0 ± 14.0 kg). Participants that participated in sports requiring mouthguards were strongly encouraged to participate, but this was not a requirement for inclusion into the study. During the orientation session, all subjects were familiarized with each mouthguard in an effort to increase comfort during the testing sessions. Exclusion criteria included tobacco use, lower extremity injury, and if they were not considered "low risk" according to the AHA/ACSM Health/Fitness Facility Pre-participation Screening Questionnaire. Participants were instructed to maintain normal eating habits and to refrain from intense physical activity 24 h prior to each session. This study was approved by the university Human Subjects Institutional Review Board.

Procedures

Orientation session

The orientation session consisted of reading and signing an informed consent, followed by completion of the health screening questionnaire. The familiarization session consisted of 5 min of cycling between 50 and 70 rpm against no resistance on the ergometer (Monark Ergomedic 894E; Monark Exercise AB, Vansboro, Sweden). Participants were then fitted with each type of mouthguard (UAAB or OTC) per manufacturer guidelines.

Testing sessions

Counterbalancing was used to determine the order of testing in an attempt to prevent a learning or practice effect.[8] The session began with a baseline finger-stick analysis of [BL] (Accusport; Sport Resource Group, Hawthorne, NY). Participants completed the same warm-up protocol performed during the orientation session and then immediately began the WAnT, a 30s maximal anaerobic exercise test on a cycle ergometer against 7.5% of the their body mass.[5] Immediately after the WAnT, they remained on the ergometer for a second [BL] measurement. Participants were then instructed to rest in a seated or supine position for 5 min, after which a final [BL] measurement was taken. During the rest period of the two mouthguard conditions, they also completed a survey, which was modified to include questions tailored to the study and assessed the their attitudes toward the mouthguards; analysis of the survey showed sufficient internal consistency.[9] There was at least 48 h between sessions with a maximum of three weeks to complete all three visits. Every attempt was made to schedule all three testing sessions at the same time of day and the majority of subjects were scheduled within a 2.5 h rage in time with a maximum difference was around 5 h.

Statistical analysis

SPSS Statistics Version 23 (IBM, Armonk, NY) was used for data analysis. Repeated-measures analyses of variance (ANOVA) were utilized to assess [BL] and the WAnT variables such as peak power (PP), relative peak power (RPP), average power (AP), and fatigue index (FI) between conditions (NOMG, UAAB, OTC). Paired samples t-tests were used to compare answers to the questions on the survey (OTC vs. UAAB). The significance level was set *a priori* at $p \leq .05$. Greenhouse-Geiser corrections were used when the assumption of sphericity was violated.

Results

There were no significant differences in [BL] between NOMG, UAAB, and OTC immediately post-exercise (5.4 ± 2.3, 6.6 ± 2.4 and 6.2 ± 2.5 mmol L^{-1}, respectively; Fig. 1). There were also no differences between conditions 5 min post-exercise (8.6 ± 2.6, 9.6 ± 2.3, and 8.9 ± 2.4 mmol L^{-1}). Across all time points, there was no main effect of condition ($p = .087$) and no interactions were present ($p = .527$). There were also no differences between conditions on any WAnT power variables (Table 1).

The mouthguard survey (Table 2) revealed a significant difference ($p = .014$) regarding the perception of the effects of each mouthguards. Specifically, 75% of participants reported they would use the UAAB for the purpose of performance enhancement compared to only 31% for the OTC mouthguard.

Discussion

The aim of this study was to compare the effects of the UAAB mouthguard on anaerobic performance and blood lactate concentration when compared to an inexpensive over-the-counter mouthguard and a control condition. The results showed no differences between any of the testing conditions, supporting our hypothesis. A substantial amount of research on mouthguards and their effects on [BL] has utilized aerobic activities; to the best of our knowledge, only two other studies have used anaerobic testing conditions. Morales and colleagues reported lower [BL] with a mouthguard following a WAnT; however, custom-fit mouthguards were used which interfere less in ventilation compared to their OTC counterparts and may be the causative factor for their findings.[10] A recent study by Golem et al. showed no significant decrease in [BL] following a maximal exercise test to exhaustion, with an OTC jaw-repositioning mouthguard.[11] Although the focus was on testing aerobic performance in the latter study, blood lactate was measured after the maximal exercise test, which ends with subjects in a highly anaerobic state.

In the present study, there may have been no differences in [BL] between the mouthguard conditions because of the bulky designs used to ensure a universal fit for most mouth sizes, potentially reducing airway openings. This idea is supported by previous research showing the effects of mouthguards on ventilation, which was evaluated via a spirometer.[12] A custom-fit mouthguard impeded breathing less than an OTC mouthguard, which may have created better gas exchange, and in turn decreased [BL]. It is reasonable to assume that an OTC mouthguard has less contact between the teeth and gums compared to a custom-fit

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