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Effects of jaw clenching wearing customized mouthguards on agility, power and vertical jump in male high-standard basketball players

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ABSTRACT

Background: Basketball players commonly use mouthguards for protecting their mouths from collisions with other players. Besides, literature reports that specific types of mouthguards may become an ergogenic device that facilitates a powerful jaw clenching, and a subsequent concurrent activation potentiation through this remote voluntary contraction of the mandible muscles.
Methods: A randomized within-subjects design was used to study the effects of this mechanism on muscular performance (vertical jump, agility, bench press power and leg press power) into two different conditions (mouthguard and no mouthguard) in high-standard basketball players (n = 13). A mean differences analysis and a responder analysis were conducted.
Results: Significant improvements were found ($p < 0.05$) in all vertical jump protocols using the mouthguard when compared to the no mouthguard conditions. However, no significant differences were found between the two conditions in agility and power (except in one load of bench press). Nevertheless, p-values were closer to statistical significance when analyzing the total time for the agility T-Test than when the first split time was under consideration ($p = 0.111$ and $p = 0.944$, respectively).
Conclusion: This study demonstrated that the use of custom-made, bite-aligning mouthguard had an ergogenic effect on jump outcomes and inconclusive results in agility T-Test in professional basketball players. From the results obtained in the present study, the use of this type of mouthguards seems to be more justified in power actions on the court than in the strength and conditioning sessions at the gym in well-trained players.

1. Introduction

In basketball, the players are continuously connecting accelerations, sprinting, changing of direction, jumping, and throwing. Together with these actions, players collide with opponents in different situations (e.g. pick and roll). In this context, some basketball players use different types of mouthguards to prevent dental injuries and to protect the maxillofacial structure from possible violent contacts during matches or training sessions. Different bodies and organizations recommend the use of mouthguards in sports such as judo, boxing, football, soccer, basketball, karate or field hockey.[1–3] With these mouthguards, players usually feel protected, but not always comfortable. Customized mouthguards manufacturing, requires dental impressions or scanning processes of the dental structure of an individual's teeth and are the most expensive ones available in the market. Two other types of mouthguards are also common in sports: standard and self-adapted. The standard type is initially ready to be used, and it does not require any fitting process. The standard type is a low-cost solution with great athlete acceptance, but it is also considered among the most uncomfortable types of dental guards.[4,5]

Beyond the protecting function of the mouthguards, possible benefits of jaw clenching maneuvers while wearing mouthguards on strength, jump height and muscular power are in the literature. Remote voluntary contraction (RVC) from a clenched jaw provokes a concurrent activation potentiation (CAP) mechanism that is the

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possible cause of an ergogenic effect. Furthermore, wearing mandibular orthopedic repositioning appliances has been shown as a CAP contributor.[6,7] The neuromuscular effects of jaw-repositioning and contraction of the mandible muscles may translate to improved neuromuscular responses in the agonist muscles of the sports movements. As a consequence, the activation of different muscles, like jaw muscles, contributes to strength movements like rowing, pedaling, running, or jumping.[8] Indeed, a contraction of the mandible muscles might improve the neuromuscular responses of the main muscles involved in the performance action. For instance, when analyzing the muscle activation via electromyography in a group of healthy and active men and women, the muscles involved in an RVC are more active; this increase in activity results in a greater activity in the prime movers in isokinetic knee extension-flexion.[9] The link between RVC and powerful and rapid movements is fairly clear. A sensory neuron from the muscle spindle communicates with a motor neuron in the spine, which sends the signal to the brainstem when performing rapid movements and changes of force production. Thus, performing a countermovement vertical jump (CMVJ), the stretch reflex is activated because the information from the muscle spindles and the central nervous system during the eccentric braking phase of these actions flows and promotes the subsequent powerful propulsion.[6,10] Although agility movements are also high demanding tasks on neuromuscular system, the complexity of the different agile movements seem to be clear.[11] The variety of factors contributing to agility performance and the neuromuscular differences between a simple strength/power muscular action, in respect to a complete agility task, might explain the lack of consistent relationship between both paradigms of neuromuscular action.[12]

Several studies have focused the efforts in figuring out the ergogenic effects of wearing a jaw-repositioning mouthpiece on strength and muscular power performance. Jaw clenching shows positive effects on isometric, dynamic, and isokinetic strength of lower limbs in young population in some studies.[13–17] However, other authors have not found any significant beneficial effects.[18–21] Nevertheless, very few studies have studied the effects in high-standard athletes. Subject's profile and training status highly influence the response of the neuromuscular system in different actions such as CMVJ or agility.[22–24] For this reason, it is necessary to study the effects of RVC of the mandible using a jaw-repositioning appliance on jumping and agility performance in this type of population. In this direction, Duarte-Pereira et al.[21] found no significant increases in the CMVJ and 15 s rebound jump test mean power when comparing the acute effects on performance of three conditions tested in elite taekwondo athletes (no mouthguard, self-adapted, and customized pieces). Additionally, elite taekwondo athletes showed no significant improvements in CMVJ and 20 m sprint when comparing mouthguard (MG) and no-mouthguard (NO-MG) conditions. However, significant improvements wearing MG were found in Wingate Anaerobic Test peak power.[25] Collares et al.[26] found no significant adverse effects on the aerobic performance, regarding ventilation and VO2max, for soccer and futsal players. In a different study performed with NCAA Division I players, a significantly higher mean performance in knee extension isokinetic force of 6.2%–12.5% was found when comparing RVC conditions and NO-RVC.[27] The RVC conditions included the use of a self-adapted mouthguard. Duddy et al.[28] did not find significant improvements in a 3-stroke maximum strength when using a mouthguard in well-trained rowers either. Likewise, Queiroz et al.[29] did not find significant improvements of using different types of mouthguards in an agility test (shuttle-run test) in female soccer players.

To the best of our knowledge, no studies about the effects of wearing customized mouthguards on jump, power, and agility have been conducted in basketball players where these devices are frequently used.[1,30] The aim of this study was to investigate the acute effects of jaw clenching on different measurements of agility, leg press power, bench press power, and CMVJ performance parameters among high-performance male basketball players, wearing or not a customized bite-aligning mouthpiece. Mouthpieces were made using a new scanning method that simplifies its manufacturing and reduces the final cost.

2. Methods

2.1. Study design

A randomized within-subjects design was used to examine the acute ergogenic effects of jaw clenching using a bite-aligning mouthguard in jump, agility and muscular power in high-standard basketball players. Subjects participated in two testing sessions. In the first session the subjects provided informed consent, their mouth structure was scanned. In the second session, an expert dentist finished the fitting process for all subjects, the subjects were familiarized with testing protocols and the performance data was collected. Mouthguards were designed to promote mandible arch's stability in a long centric position. Several head movements were performed to neutralize a possible postural or neuromuscular disorder that might influence the mandible position with respect to cranio and the cervical muscle activation. The mouthpieces were built with minimal dentoalveolar discrepancy regarding the morphology of the mouth structure of each subject. All subjects were also asked to refrain from participating in any activity that would negatively impact the outcome of the assessments. Subjects were also asked not to drink alcohol or any other type of drug or stimulant before testing, or abnormal eating or sleeping.

A within-subject comparison between the two conditions, mouthguard (MG) and no-mouthguard (NO-MG), in CMVJ, CMVJ with arms (CMVJa), time of the first tranche of agility T-test (Tt-Time1), the final time of agility T-Test (Tt-Time), the power of the bench press (BP30, BP40, BP50, BP60) and leg press (LP190, LP220, LP235 and LP250) in different loads. Strength, jump and agility test have been widely used to assess performance among basketball players.[31–33]

2.2. Subjects

Thirteen high-standard male basketball players (age: 21.07 ± 4.11 years, height: 1.98 ± 7.31 m, weight: 91.05 ± 10.92 kg) participated voluntarily in this study. All participants were involved in a Spanish 'ACB-Liga Endesa' club and participated in at least, five training sessions and an official match per week. All of them took part in at least ten regular games under FIBA rules. According to FIBA ranking, 'Liga endesa' is best national league in Europe and the second in the world. Eleven players were from Spain, one from Macedonia and one from Montenegro. All of them have played in their national team (junior or senior teams). After being fully informed verbally and in writing of the purposes and potential risks of the study, all subjects gave their written consent to participate in the study. Only one subject regularly declared an irregular use of self-adapted mouthguards but not in all training sessions or matches. The study and its protocol was reviewed and approved by the institution's internal review board and conducted in accordance with the Declaration of Helsinki (revised in 2013) on Ethical Principles for Research. The participants had the option to withdraw from the study at any time voluntarily.