

MOUThPIECE BURIAL

Final nails for the mouthpiece/strength gain coffin

By Dan Wagman, PhD, CSCS
Publisher/Editor in Chief, JOPPP

Apparently my recent review of mouthpieces for the strength and power athlete ruffled some feathers ([January JOPPP eNewsletter](#)). I highlighted how the science on mouthpieces has been hijacked for purposes of profit, and although the overwhelming number of responses we received were positive and welcoming, there have also been those that completely rejected scientific facts. A few of our subscribers forwarded us a [rebuttal](#) they found online by one of the companies I mentioned and they wanted to know what I thought. Since this rebuttal serves to discredit the company even further, I might as well use this company-provided opportunity to add a few more nails to the mouthpiece coffin.

Let's briefly recap the claims. The company that took issue with my research review is [Bite Tech](#), which claims that if you use its mouthpiece you'll increase your strength by 20%, increase your endurance and decrease your lactic acid by 25%, and reduce your cortisol levels.

Distinctions

Scientists are people who follow the path of reason and pay very, very close attention to detail. All too often, however, scientists get a bad rap because their research gets misinterpreted, misrepresented, and generalized by the media and laypersons beyond what the researchers actually found.

With that said, I want you to pay particularly close attention to the distinction between what Bite Tech claims its product can do for you and what Drs. Cross and Garner

As you look at the references the Bite Tech rebuttal lists, you'll note that only two actually deal with muscle performance.

In this issue:

- [The Mouthpiece Coffin](#)
- [Current Issue Previews](#)

We're excited about being able to offer you the JOPPP eNewsletter. For each issue of JOPPP we review [50 scientific journals](#) in the sports sciences and related fields and get very excited about these new developments—particularly about how this research can increase your performance. So our aim here is to share this excitement with you by summarizing some of the research we discuss in JOPPP. Unlike JOPPP, however, we do editorialize here. We don't feel that JOPPP is the place to go beyond the research facts, but here we'll go farther in an attempt to generate more thought and discussion about the awesome new sports science discoveries.

state in their rebuttal to my article. Though their rebuttal is on Bite Tech letterhead, it would be a grave mistake to view the company claims as synonymous with what the researchers are stating or to believe that my criticisms bring disrepute upon the researchers themselves. I fully understand that this represents a fine line, but as you'll see, there's

nevertheless a line to consider.

Staying on Track

JOPP focuses on strength and power sport, and since USA Powerlifting (USAPL) has accepted sponsorship from Bite Tech and has made wholly unsubstantiated claims about mouthpieces, what we need to focus on is

this: **Will a mouthpiece make you 20% stronger?**

This claim means that if you can squat 500 pounds right now, if you get one of their mouthpieces, put it in your mouth, and bite down on it while you squat, your squat will go



WHEN ASKED WHAT HE THOUGHT ABOUT A MOUTHPIECE INCREASING HIS STRENGTH BY 20%, IPF WORLD RECORD HOLDER WADE HOOPER STATED: "WOW, I WOULD'VE INCREASED MY WORLD RECORD BENCH PRESS OF 567 TO 680 POUNDS. JUST BY WEARING A LITTLE MOUTHPIECE. THAT'S RIDICULOUS." PHOTO: COURTESY WADE HOOPER

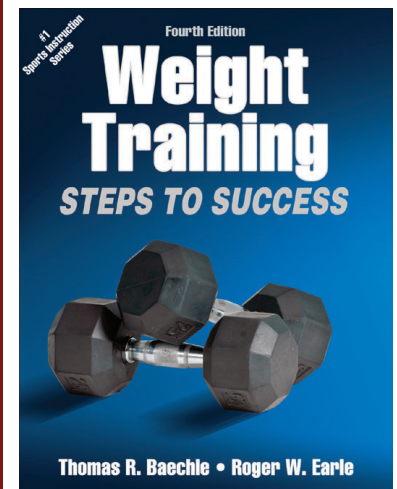
up to 600 pounds. Of course nobody with half a brain would actually believe this and I know that none of JOPP's readers are that

Bite Tech...conveniently overlooks this critical point.

gullible. But since science is being used to support this claim, it's necessary to take a closer look.

The company's rebuttal contains several red herrings designed to distract attention from the main point—**will the mouthpiece make you 20% stronger?** As an example, one complaint is that my original article referenced too many older studies. What's wrong with providing you with a historical context of the scientific work done on mouthpieces? Then the rebuttal goes on talking about certain physiological changes that have been observed in people using a

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mouthpiece. The writers mention the H reflex, motor system excitability, cerebral blood flow, trigeminal motor nuclei, etc. Red herrings! **Will a mouthpiece take your bench press from 400 pounds to 480 pounds**—the 20% increase the company promises?

Another complaint is that I didn't refer to newer research. Of course I addressed why I didn't cover all studies in my original writing. But as you look at the references the Bite Tech rebuttal lists, you'll note that only two deal with the type of muscle performance a strength and power athlete needs to be concerned about—the main issue at hand.^{1,2} So let's look at them **and see if you can believe that a mouthpiece will make you 20% stronger.**

The First Nail. The first study looked at a "neuromuscular dentistry-designed mouthguard" from one of Bite Tech's Canadian competitors (Pure Power Athletics) vs. a regular custom-fitted mouthguard. The researchers looked at the vertical jump, bench press, and 30-second Wingate anaerobic power test. The results reveal that the dentistry-designed mouthpiece increased vertical jump and peak power, yet

average power and—perhaps most important to the powerlifter—the bench press didn't change significantly when compared to bench press performed by a lifter wearing a regular custom-fit mouthguard. Now consider that there was no control group that *didn't* use a mouthpiece.

This means that you don't know how those findings might have compared to a non-mouthguard

condition. Therefore, how can you claim that a mouthguard will make you stronger? This example represents precisely the sort of company exaggeration I've been talking about. And of course in keeping with the highest standards of professionalism, this study's researchers actually recognize this is a limitation of their work. Bite Tech, however, conveniently overlooks this critical point.

It simply doesn't bolster the argument that a mouthpiece will make you stronger on the platform or in the gym.

The Second Nail. The second study Bite Tech wants to use as proof that a mouthpiece will enhance your performance looked at an isometric contraction of the knee in an effort to see whether a phenomenon known as concurrent activation potentiation

exists—that is, if muscles other than the main muscles in a movement might be activated in order to help out while not contributing directly to the

movement. So in this study the scientists wanted to see whether clenching the jaw, gripping hard, and using the Valsalva maneuver might impact isometric knee strength. They found that teeth clenching on a mouthpiece produced by Cramer Products did indeed increase isometric knee strength over those subjects who were prevented from clenching their jaw—if the

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James Krieger is the founder of weightology
and editor of JOPP.

subjects also gripped hard *and* performed the Valsalva. Of course you don't have to have something additional in your mouth in order to clench your jaw—your teeth would seem to be sufficient for that—and most of you clench your jaw while you lift anyway (not to mention gripping the barbell hard), so the clenching and gripping issue seems somewhat silly in the context of bending a barbell in a cloud of chalk. In addition, I already discussed in my previous article why you can't compare an isometric or static muscle contraction to something as dynamic as the muscle contractions you see in a squat. This is so elementary it hardly requires more mention. This study simply doesn't bolster the argument that a mouthpiece will make you stronger on the platform or in the gym. In fact, the researchers highlight that additional research is necessary before any practical applications

regarding athletic performance enhancement can be attached to their findings. Of course, as you review Bite Tech's promotional materials, this

The issue at hand is whether cortisol is something you need to worry about...the clear scientific consensus is—no, and Bite Tech offers nothing to refute this basic truth.

fact is conveniently left out, too.

Cortisol...Shmortisol

So let's move on to cortisol. Why? Because Bite Tech and USAPL want you to believe that cortisol will shrink your muscles and make you weak and that using a mouthpiece will change this equation in your favor. As you'll note, the Bite Tech scientists didn't address the research I cited indicating that acutely elevated levels of cortisol are

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of no concern to the well-trained strength and power athlete. They did, however, take issue with my mention



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of cortisol in connection with gluconeogenesis and energy metabolism. You need to understand that a muscle's energy metabolism is a highly complex matter that can be difficult to explain in layman's terms. At JOPP we struggle in every issue to explain matters of physiology in simple English while not diminishing accuracy. Upon review and reflection, I believe that my cursory mention of gluconeogenesis and the role of cortisol was perhaps oversimplified, yet not false.

Regardless, the issue at hand is whether cortisol is something you need to worry about, whether a mouthpiece has an effect on this hormone or not. The clear scientific consensus is—no, and of course Drs. Cross and Garner don't even try to refute this basic truth. They instead seem to support my original points by stating that "excess levels of cortisol *can* impair the body's ability to repair and thus, *could* slow

the recovery process which is necessary for muscle hypertrophy [growth]." Of course, the qualifiers I italicized are key, as is the fact that Dr. Garner's research on mouthpieces and cortisol levels never addresses whether in fact the subjects in her research actually experienced excess levels of cortisol.³ Without knowing that, and without knowing whether cortisol levels were also chronically elevated, there simply is no sports performance argument to be made. Of course, in holding true to science, Dr. Garner never made such a claim; instead, scientific facts have been misrepresented by the Bite Tech

company.

Like-Minded

You should recognize that Bite Tech's researchers never claimed that a mouthpiece will increase your strength by 20%, nor that it can reduce your cortisol levels and in so doing enhance your performance. In fact, they seem to agree with my



ACCORDING TO COMPANY CLAIMS, A MOUTHPIECE COULD'VE BUMPED OUR PUBLISHER'S RECENT AMERICAN RECORD STRICT CURL FROM 204 UP TO 244 POUNDS AND HIS LONG-TIME AAU AMERICAN RAW POWERLIFTING SQUAT RECORD FROM 586 TO JUST OVER 700 POUNDS. UNLIKELY!

bottom line, that you need to pay close attention to research details. They state, "it is unreasonable to generalize the findings of one study in a specific population (collegiate football players) using a specific training protocol to a specific discipline such as powerlifting." Of course, that's precisely what Bite Tech and USAPL have done. At the end of the day,

Of course I agree, and I wonder what it would take for Bite Tech to actually listen to what its scientists say.

scientists tend to agree on the finer points of research. I believe that Drs. Cross and Garner have been placed in a difficult position by a company that has misinterpreted, misrepresented, and overgeneralized their research. I can empathize

with the predicament they must be in as I experienced something similar working for a major magazine. Eventually the situation led to my resignation and the creation of *Pure Power* and the *Journal of Pure Power*. Here, credibility and integrity rule supreme and are never compromised based on profit margin calculations.

In the end, all you have to do is ask yourself if it's even remotely believable that biting down on any mouthpiece will take your deadlift from 600 pounds to 720 pounds, the 20% increase in strength Bite Tech promises. That's a pretty silly notion that I'm sure none of you believe no matter how much the company stretches the actual research findings. Drs. Cross and Garner close with the suggestion "that as the body of peer-reviewed literature builds, one would critically examine the work and draw conclusions as to how it pertains to his/her specific

LESSONS LEARNED

The original research we reviewed in our January issue of *JOPP*, along with our two eNewsletter articles in January and February, point to the following lessons:

- **Companies** ought to listen to the researchers whose education and expertise they tap into. If they did, it's unlikely that exaggerated and unsubstantiated claims would damage their reputation.
- **Sports organizations** should consider that there's a difference between accepting sponsorship money from a company and endorsing a product. Endorsements based on fiction violate the membership's trust and diminish the organization's credibility.
- **Athletes**, you've heard this before—hear it again: If it sounds too good to be true, it ain't true. It's not enough for a company to simply list research to gain your trust; *you* have to take the extra step and dig deeper into the scientific facts about the claims.

sport." Of course I agree, and I wonder what it would take for Bite Tech to actually listen to what its scientists say.

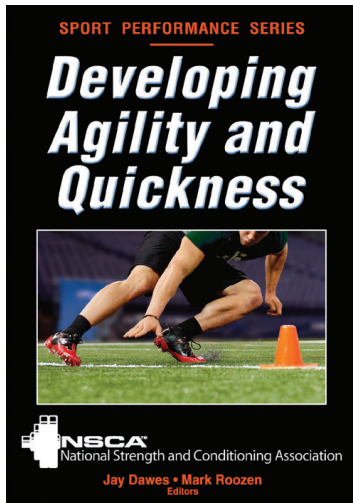
References

1. Arent, S. M., et al. Effects of neuromuscular dentistry-designed mouthguard on muscular endurance and anaerobic power. *Comparative Exercise Physiology* 7:73-79, 2010.

2. Ebben, W. P., et al. The effect of remote voluntary contractions on knee extensor torque. *Medicine and Science in Sports and Exercise* 40:1805-1809, 2008.

3. Garner, D. P., et al. The effects of mouthpiece use on cortisol levels during an intense bout of resistance exercise. *Journal of Strength and Conditioning Research* 25:2866-2871, 2011.

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A FEW PREVIEWS FROM OUR CURRENT (JANUARY) ISSUE:

STRENGTH AND CONDITIONING

Using chains in training is a popular approach to increasing strength and power. Scientifically speaking, this approach is termed variable resistance training (VRT)—“variable” because with chains attached to the ends of the barbell, as the chain links leave the ground the weight you lift increases. So for the first fourth of the lift the amount of weight you lift is less than that of the last fourth. Then there is explosive resistance training (ERT). Here the objective is to lift the weight as explosively as possible. It is said that doing so will increase your power. So a lot of athletes combine VRT and ERT in an effort to increase their strength and power. And although this approach holds intuitive appeal, what

actually happens when you train that way? You need to look at force, power, barbell velocity, rate of force development, and other kinematic and kinetic variables to know for sure. In **CHAINED** we look at new research that investigated what happens to your deadlift when you use chains and compared that to regular deadlifts. If you train with chains, or if you think this is something you should invest in, don’t miss this research review because it’ll provide you with the facts as opposed to all the myth and conjecture you hear in gyms and on the Net.

NUTRITION

As you train and compete, the level of fatigue you experience can become troublesome. Obviously, as

you fatigue, your performance declines—not just your physical performance, but your mental acuity too, and that can impact your decision-making abilities. Alone, each of these effects is bad enough, but in combination they can be absolutely devastating to your performance. Interestingly, serotonin plays an important role in both physical and mental components of fatigue. So what if you could take a supplement that would limit the effects of serotonin? What if a supplement could

We look at new research that investigated what happens to your deadlift when you use chains and compared that to regular deadlifts.

even block the production of serotonin? This type of supplement exists and in **FATIGUE FIGHTING** we share the details with you. The good news is that it works and that it’s pretty easy for you to obtain. The bad news is that it could end up being expensive. But your

performance just might be worth it, which is why you should not overlook this important research review.

SPORT PSYCHOLOGY

We have discussed the issue of self-talk in several past issues of *JOPP*. The topic is important because self-talk can have significant performance-increasing effects for you. But you need to know how to do it properly, what differences there may be between types of sports and athletes, etc. In short, self-talk is far, far more complex than just telling yourself "You can do it!" But the complexity of this mental skill is nothing that should scare you off. The more you learn about it, the better you'll get at it and the better you'll perform. It's also important for you to learn more about it so that you can discern fact from fiction. There are a lot of gurus out there who know nothing about self-talk, but make their approach sound real good. In

TALK YOURSELF INTO EXCELLENCE we review new research that itself is a review—a review of scientific self-talk studies. This study is critically important to your sporting success as it addresses the proverbial

You'd think that...the athlete's heart will always be a stronger heart than a sedentary person's. But that's not what this research found.

bottom line for self-talk and sports performance. In addition, a few commonly held beliefs are dethroned, allowing you to approach your sport with a greater sense of success.

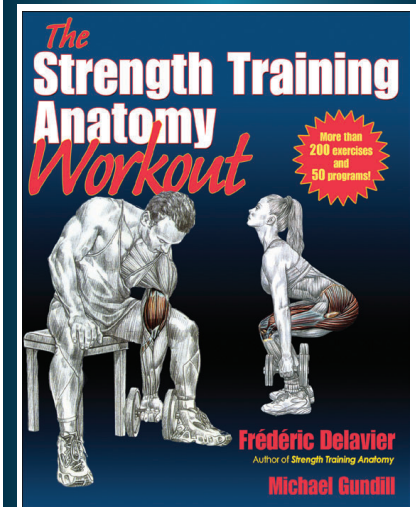
SPORTS MEDICINE

It seems obvious and intuitive that your heart will adapt to the type of training that you do. So you would

expect a powerlifter's or strongman athlete's heart to look different from a marathoner's heart. The problem is that there is no science to back up this seemingly obvious conclusion. In **THE STRONGMAN'S HEART** we present you with the first study of its kind to compare the hearts of strongman athletes, marathon runners, and sedentary people. You'd think that, generally speaking, the athlete's heart will always be a stronger heart than a sedentary person's. But that's not what this research found. And if you're big-time into strength and power sport, you will learn how your training can negatively impact your heart function. We realize that your main concern is to become as big, strong, and powerful as possible. But if you also want to be alive, then you should attend closely to this research review.

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Rebuttal to Dan Wagman's article published in the eNews edition of the Journal of Pure Power (January 11, 2012)

Prepared by Dr. Hank Cross, Executive Vice President, Research & Development for Bite Tech and Dr. Dena Garner, Head of the Department of Health, Exercise and Sports Science at The Citadel

There are a number of flaws with Dr. Wagman's article which stated that mouthpiece claims were exaggerated. One of the key weaknesses is his lack of current research in this area and his focus on research with the MORA device that took place in the 1980s and 1990s. We too have refuted the research completed with the MORA device. However, there have been many pivotal, objective research studies within the last 5 to 10 years that have focused on the effects of mouthpiece use or clenching during stress.

Miyahara et al. (Miyahara, Hagiya, Ohyama, & Nakamura, 1996) cite the improvement in the human soleus H reflex with voluntary clenching, while Boroojerdi et al. (Borgersen, Skatvedt, & Akre, 2000) cite that voluntary teeth clenching leads improved human motor system excitability. Ebben and colleagues (Ebben, Leigh, & Geiser, 2008) cite an ergogenic effect of jaw clenching on improved mean and peak knee extensor force. In all three of these studies, there is a cited improvement in power output with clenching. Although the mechanisms for this improved occurrence have not been clearly defined, there is much work in our lab to show that the connection lies in the improvement in cerebral blood flow that may occur with clenching. One of the studies that may support this supposition was done by Hasegawa and colleagues (Hasegawa, Ono, Hori, & Nokubi, 2007) in which they see a significant improvement in cerebral blood flow with clenching. The most recent article was published this month and is cited below. In summary it finds that jaw clenching leads to improved cerebral arterial blood flow. All of these studies demonstrate that there are mechanisms at play which may explain the improvement in performance. Per our own observations and findings, we believe that the cited improvements in cortisol stems from a direct effect on the hypothalamus. A study by Mascaro and colleagues (2009) (Mascaro, Prosdocimi, Bittencourt, & Elias, 2009) find such a link with a population of rats. They show in this study a link between the trigeminal motor nucleus (those involved in clenching, "The trigeminal motor nucleus contains **motor neurons** that innervate muscles of the **first branchial arch**, namely the muscles of **mastication**, the **tensor tympani**, **tensor veli palatini**, **mylohyoid**, and anterior belly of the **digastric**. This nucleus is located in the mid-pons (i.e. in the middle of the pons going inferior to superior")¹) with the in the lateral area of the hypothalamus. Therefore the supposition that there is interaction between the trigeminal nerves (those nerves responsible for chewing and clenching) and the hypothalamus is supported by Mascaro et al study (Mascaro et al., 2009).

Effects of unilateral jaw **clenching** on **cerebral**/systemic circulation and related autonomic nerve activity.

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Source:

Physiology & Behavior; Jan2012, Vol. 105 Issue 2, p292-297, 6p

Article

Abstract:

Abstract: Jaw **clenching** (**clenching**) is the result of an isometric contraction of jaw closing muscles. Because of the location of working muscles and afferent information during tooth contact, the effect of **clenching** on the **cerebral** and systemic circulation might differ from that of isometric limb exercise. This study aimed to investigate the characteristic changes in **cerebral** and systemic circulation during jaw **clenching** by comparing those during handgrip exercise. Subjects were 17 right-handed men. Bilateral middle **cerebral** arterial **blood flow** velocity (MCAV), electromyography (EMG) of contracting muscles, heart rate (HR) and **blood** pressure (BP) were measured during unilateral handgrip exercise and **clenching** tasks. Autonomic nerve activity was evaluated by analyzing fluctuations in HR and BP. MCAV was significantly increased during the task with significantly higher values on the non-working than working side irrespective of unilateral handgrip or unilateral jaw **clenching**. Changes in HR during jaw **clenching** were lower than those during handgrip exercise, and changes in vaso-motor sympathetic nerve activity during left jaw **clenching** were lower than those during left handgrip exercise. The present results indicate that, compared with handgrip exercise, unilateral jaw **clenching** promotes bilateral activation of MCAV with smaller effects on cardiac output and sympathetic nervous system activity. [Copyright &y& Elsevier]

Regarding the cortisol and performance issue, Dr. Wagman is correct in that the effects of mouthpieces, of any kind, on human performance are greatly unknown. There exists a body of anecdotal evidence; however the scientific evidence is in its infancy. What our laboratory has done is based initially on the rat and human data collected within the dental and physiology research faculty in Japan. Within these laboratories they have cited improvements (in both rat and human models) in cortisol and other byproducts of stress when clenching down and or chewing during a stressor. One of the first in the area to discovery this phenomena was Hori and colleagues who cited that when rats were stressed and bit down on a wooden board, then there was a subsequent suppression of corticotrophin releasing hormone (a precursor to cortisol release in rats)(Hori, Yuyama, & Tamura, 2004). A similar outcome was supported in work with Sasaguri and colleagues in which they found a reduction in stress hormones when rats bit down on a wooden stick (Sasaguri et al., 2005). In humans, Tahara and colleagues found a reduction in cortisol when humans clenched or chewed during a stressor (Tahara, Sakurai, & Ando, 2007).

Mouthpiece research has substantiated the results found in the Japanese laboratories. Recent scientific work that appears in peer-reviewed journals (4 articles) and proceedings of scientific conferences (5 abstracts) has shown that when the Bite Tech, Inc. mouthpiece is worn it does alter human physiology (Garner, Dudgeon, Scheett, & McDivitt, 2011.; Garner & Miskimin, 2009; Garner & McDivitt, 2009; Garner & McDivitt, 2009; Garner, Dudgeon, & McDivitt, 2011; Garner et al., 2011). This research demonstrates scientifically that use of the mouthpiece decreases lactate, improves reaction time, alters oxygen kinetics and lowers post exercise cortisol that in turn may be reasonably assumed to improve human performance. To corroborate this claim, a study by Arent and colleagues found significant increases in peak power and vertical jump with a mouthpiece versus a control condition, thereby stating a link between mouthpiece use and improvements in performance parameters (Arent, McKenna, & Golem, 2010).

Dr. Wagman only addressed one of these published works (Garner et al., 2011)and made errors in his critique. First, as the overlapping error bars suggest there is no statistical difference in resting cortisol between the two groups, however that was not the finding of interest, rather the finding of interest was there was a difference in responses between groups when comparing the post time point (groups were nearly identical) to the 10 minutes post. Next, it is very important to see a reduction in cortisol post exercise. Cortisol is not as Dr. Wagman suggests a “by-product of energy metabolism” (and for matter of clarification gluconeogenesis is not energy metabolism (Wilmore, Costill, & Kenney, 2011), rather cortisol is a hormone released by the adrenal glands in response to psychological and physical (exercise) stressors (Wilmore et al., 2011). Cortisol does many necessary things in the body and is absolutely needed for normal function; however excess levels of cortisol can impair the body’s ability to repair and thus, could slow the recovery process which is

necessary for muscle hypertrophy. In fact, it is common to measure the testosterone to cortisol ratio in athletes as a means of ensuring an athlete is not “overtraining” and thus hampered with too much cortisol which can then lead to muscle atrophy, immune suppression, etc. Finally, it is unreasonable to generalize the findings of one study in a specific population (collegiate football players) using a specific training protocol to a specific discipline such a Power Lifting. As Dr. Wagman accurately points out, training mode, duration, intensity and frequency all contribute to the hormonal responses of a particular exercise regimen. We suggest that as the body of peer-reviewed literature builds, one would critically examine the work and draw conclusions as to how it pertains to his/her specific sport.

References

- Arent, S. M., McKenna, J., & Golem, D. L. (2010). Effects of neuromuscular dentistry-designed mouthguard on muscular endurance and anaerobic power. *Comparative Exercise Physiology*, 7, 73-79.
- Borgersen, A. K., Skatvedt, O., & Akre, H. (2000). Does the oral device Noiselezz prevent sleep apnoea? *Acta Otolaryngol.Suppl*, 543, 179-182.
- Ebben, W. P., Leigh, D. H., & Geiser, C. F. (2008). The effect of remote voluntary contractions on knee extensor torque. *Med.Sci.Sports Exerc.* 40, 1805-1809.
- Garner, D. P., Dudgeon, W. D., & McDivitt, E. (2011). The effects of mouthpiece use on cortisol levels during an intense bout of resistance exercise. *Journal of Strength and Conditioning Research*, 25, 2866-2871.
- Garner, D. P., Dudgeon, W. D., Scheett, T. P., & McDivitt, E. (9-1-0011). The effects of mouthpiece use on gas exchange parameters during steady-state exercise in college-aged men and women. *JADA* 142[9], 1041-1047.
- Garner, D. P. & McDivitt, E. (2009). Effects of mouthpiece use on airway openings and lactate levels in healthy college males. *Compendium of Continuing Education in Dentistry*, 30 Spec No 2, 9-13.
- Garner, D. P. & McDivitt, E. J. (2009). The effects of mouthpiece use on salivary cortisol and lactate levels during exercise. *Medicine and Science in Sports and Exercise*, 41, S448.
- Garner, D. P. & Miskimin, J. (2009). Effects of mouthpiece use on auditory and visual reaction time in college males and females. *Compend.Contin.Educ.Dent.*, 30 Spec No 2, 14-17.

Hasegawa, Y., Ono, T., Hori, K., & Nokubi, T. (2007). Influence of human jaw movement on cerebral blood flow. *Journal of Dental Research*, *86*, 64-68.

Hori, N., Yuyama, N., & Tamura, K. (2004). Biting suppresses stress-induced expression of corticotropin-releasing factor (CRF) in the rat hypothalamus. *Journal of Dental Research*, *83*, 124-128.

Mascaro, M., Prosdocimi, F., Bittencourt, J., & Elias, C. (2009). Forebrain projections to brainstem nuclei involved in the control of mandibular movements in rats. *European Journal of Oral Science* *117*[6], 676-684.

Miyahara, T., Hagiya, N., Ohyama, T., & Nakamura, Y. (1996). Modulation of human soleus H reflex in association with voluntary clenching of the teeth. *Journal of Neurophysiology*, *76*, 2033-2041.

Sasaguri, K., Kikuchi, M., Hori, N., Yuyama, N., Onozuka, M., & Sato, S. (2005). Suppression of stress immobilization-induced phosphorylation of ERK 1/2 by biting in the rat hypothalamic paraventricular nucleus. *Neurosci.Lett.*, *383*, 160-164.

Tahara, Y., Sakurai, K., & Ando, T. (2007). Influence of chewing and clenching on salivary cortisol levels as an indicator of stress. *J.Prostodont.*, *16*, 129-135.

Wilmore, H., Costill, D., & Kenney, W. (2011). *Physiology of Sport and Exercise*. (5th ed.) Human Kinetics.

1. <http://thalamus.wustl.edu/course/brstem.html>, Washington University School of Medicine as cited on Wikipedia