Should Caffeine Consumption Be Prohibited In Anaerobic Sporting Competitions ?

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Abstract

Introduction: Caffeine consumption has been quite popular in the athletic population. In fact, numerous studies have been done to investigate the ergogenic effects of caffeine in aerobic exercise. However, there are still ongoing studies examining the ergogenic effects in anaerobic exercise. We hypothesized that caffeine will reduce EMG amplitude of the biceps and triceps brachii during a nonischemic anaerobic forearm test with caffeine.

Methods: The EMG amplitude of 18 healthy (10 females and 8 males) individuals was measured using AD instruments PowerLabs during non-ischemic forearm contractions – with both a constant load and increasing loads. The experimental trial was conducted with 200mg of caffeine. The results were analyzed using a paired samples t-test and a repeated measures ANOVA.

Results: The EMG amplitude (a marker of motor unit recruitment and muscle fatigue) was significantly lower in caffeine trials compared to baseline with increasing load (5lbs, 10lbs and 15lbs) at 30 second intervals - $F(1, 17) = 5.940$, $p = 0.026$ for the biceps brachii and $F(1, 17) = 6.986$, $p = 0.017$ for the triceps brachii. Similarly, with a constant load of 10lbs held for 2 minutes the EMG amplitude was significantly lower in caffeine versus baseline trials for both biceps brachii [$t(17)=2.603$, $p=0.019$] and triceps brachii [$t(17)=3.469$, $p=0.003$].

Conclusion: The decrease in EMG amplitude of the muscles seen in the caffeine trials (compared to baseline) is indicative of a lesser degree of motor unit recruitment. This leads to a decrease in muscle fatigability and improved power output – ergogenic effects. The anaerobic athletic performer who consumes at least 200mg of caffeine undoubtedly enjoys this benefit compared to non-caffeine-consuming competitors therefore we suggest that the status of caffeine on the list of performance-enhancers be revisited by the relevant regulatory bodies.

Introduction

A surface electromyography (sEMG) is a recording of the electrical activity in muscles and is often used to measure motor unit recruitment during muscle contraction. Motor unit recruitment refers to the increase in strength of muscle contraction caused by the successive activation of more motor units, also called spatial recruitment. The CNS initiates recruitment in a manner that is proportional to the force of contraction required to overcome a resistance. The greater the work load on the muscle the more motor units are needed to sustain the hold. Thus, sEMG can be used to measure this phenomenon.

A cyclic measurement called average cyclic height was was used to calculate the EMG amplitude. The average cyclic height is the difference between the maximum and minimum value in selected cycles detected by the sEMG. Therefore, the higher the average cyclic height the greater the amount of motor units recruited.

Caffeine is a popular sympathomimetic with known ergogenic properties in aerobic exercise. Evidence of its ergogenic effects in anaerobic exercise is quite lacking. As a result, our study aims to explicate the effects of caffeine in nonischemic forearm contractions, a form of anaerobic exercise.

We hypothesized that the motor unit recruitment in both the triceps and biceps brachii would be decreased after the consumption of caffeine. These muscle groups would require less motor units to sustain an objectively heavy load with caffeine compared to baseline, resulting in reduced fatigability.

Results

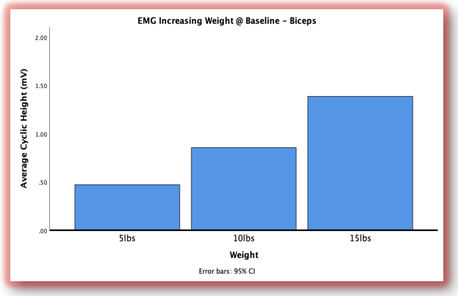

Figure 1a. The mean EMG amplitude of the biceps was significantly greater as the weights increased during the baseline trial, $F(1.062, 18.054) = 29.798$, $p< 0.0005$.

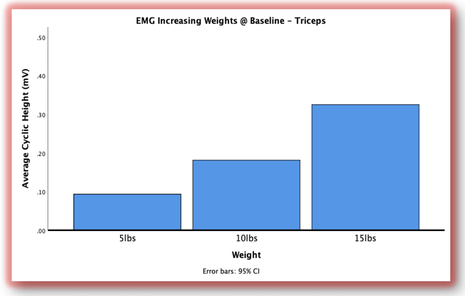

Figure 1b. The mean EMG amplitude of the triceps was statistically significantly higher over time in the control trial for the triceps, $F(1.114, 18.930) = 22.612$, $p<0.0005$.

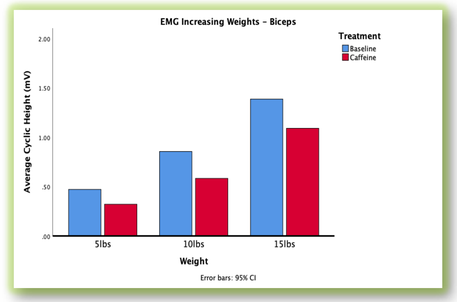

Figure 2a. The main effect of caffeine showed a significant difference in EMG amplitude. between the baseline and caffeine trials as the weights were increasing $F(1, 17) = 5.940$, $p = 0.026$. Over time as the weights increased, caffeine consistently reduced the EMG amplitude.

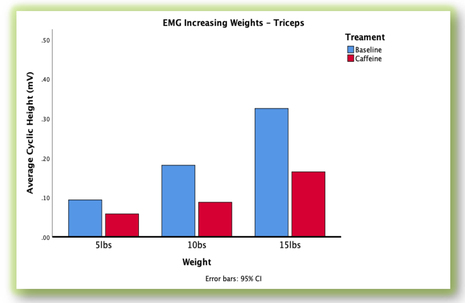

Figure 2b. The main effect of caffeine showed a significant difference in EMG amplitude between the baseline and caffeine trials as the weights were increasing $F(1, 17) = 6.986$, $p = 0.017$.

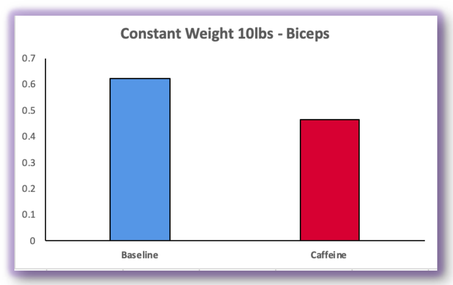

Figure 3a. The EMG amplitude is lower in the biceps after caffeine consumption hold a 10bs dumbell for 2min $t(17)=2.603$, $p=0.019$.

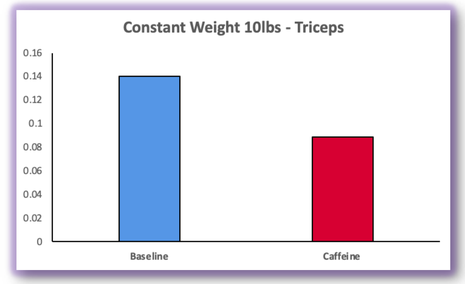

Figure 3b. The EMG amplitudeis lower in the triceps after caffeine consumption hold a 10bs dumbell for 2min. $t(17)=3.469$, $p=0.003$.

Methods

The EMG amplitude of 18 healthy (10 females and 8 males) young individuals were measured using AD instruments software and equipment. The Bio Amp cable with 5 shielded leads and electrodes was set up similar to the image below. Two experiments were conducted:

1. Subjects performed non-ischemic forearm contractions with a 10lbs dumbbell for 2mins using the dominant hand. The experimental trial was performed 30min after the consumption of 200mg of caffeine.
2. Subjects performed non-ischemic forearm contractions with increasing disc plate weights of 5lbs, 10lbs, and 15lbs every 30s using the dominant hand. The experimental trial was performed 30min after the consumption of 200mg of caffeine.

The results were analyzed using a paired samples t-test and a repeated measures ANOVA.

Conclusion

- ❑ Caffeine does reduce motor unit recruitment in the biceps brachii thus reducing fatigability and improving power output. This effect is dose-dependent (200mg) as we observed in the previous research project (Spring 2019)
- ❑ Caffeine also decreases the motor unit recruitment in the triceps brachii which are responsible to stabilize the joint.
- ❑ Caffeine confers ergogenic benefits to athletes in anaerobic sporting activities therefore, caffeine's status as a performance enhancer should be reviewed by the relevant bodies.

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