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The Effect of Short-term Taurine Amino Acid Supplement on Neuromuscular Fatigue, Serum Lactate Level and Choice Reaction Time after Maximal Athletic Performance

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ABSTRACT

The purpose of this paper is to shed light on the relationship between short-term intakes of Taurine. Amino Acid with neuromuscular fatigue and athletic performance after maximal athletic activity. To serve the purpose of this research, 20 professional squash players (all male, mean age of 25.1 ± 12.24 years, height ratio of 63.4 ± 59.174 cm, weight of 97.8 ± 52.71 kg, BMI of 19.2 ± 40.23 kg per square meter and body fat percentage of 21.1 ± 81.11) volunteered and were divided to two random groups: supplement and placebo, experiencing maximal athletic activity before and after amino acid intake. Both the supplement and placebo (starch) groups were provided with apparently identical 1gram capsules. Volunteers were monitored to take 5 capsules per day for a week. Supplementation was double-blind, and the assistant researcher was the only one who knew about the real content of every capsule. Post-test was conducted immediately after the supplementation period was terminated under exactly the same conditions of pre-test. A paired t-test was organized to determine the changes in group-internal dependent variables prior and posterior to test, while an independent t-test was performed to observe differences in performance of the experimental and control volunteers. The significance level was set at p <0.05. The results showed that short-term supplementation of taurine amino acid is effective upon reducing neuromuscular fatigue (p=0.002), choice reaction time (p= 0.012) and blood lactate accumulation (p=0.000) after performing maximal athletic activity. The results in this research support the statement that the supplementation of taurine can be suggested to improve performance in fast alternative exercises.

Keywords: Extraction, Non-extraction, Profile Attractiveness

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INTRODUCTION

During the past two decades, various amino acid supplements have been introduced to boost athletic performance, most of which have proved positively effective mostly due to the hormonal stimulation they cause, accompanied by an influence on brain metabolism and an increase in concentration and the tendency to maximal performance. Taurine is the most copious amino acid in excitable tissues such as skeletal muscles, heart and brain.

Taurine is categorized as a nonessential amino acid but plays a key role in physiological processes of the human body, specifically in regulating neural transmissions, adjusting cell volume, strengthening the cell-membrane, controlling adipose tissues, and regulating calcium homeostasis. In addition to regulating physiological processes, it has been suggested that taurine plays a role in reducing lag time, damage, and oxidative stress caused by athletic performances, along with regulating core body temperature, all of which advocate an increase in activity. Studies have reported that intracellular concentration of taurine is reduce as a result of exhaustive exercises lasting 30, 60, or 90 minutes, a loss which mostly takes place in fast-twitch muscle fibers [1-3]. Zhang *et al*., (2002) have reported an increase in athletic performance posterior to a week of taurine supplementation. Exhaustion time, maximal oxygen uptake and maximal work load were massively increased in subjects after a week of taurine intake. Due to its impact on core body temperature, taurine could reduce heat stress and heart rate [4]. In a study by Silva *et al*., (2011), the impact of taurine supplementation on oxidative stress biomarkers was evaluated after eccentric exercise. The same study proved the role of taurine in reducing muscular damage. This effect is probably related to potential of taurine to protect the cells by stabilizing cell membrane, which reduces the amount of leakage of creatine kinase (CK) that is usually caused by contraction-induced injuries [5]. In another study on human subjects, Zhang *et al*., (2004) investigated the role of taurine in preventing oxidative stress caused by physical activity.Significant increase was observed in VO_{2max}, endurance time and work load of maximum activity after a week of taurine supplementation [6].

Unfortunately, studies have been often engaged with investigating the effect of supplements on long-term stamina activities, and the body of research on performance of fast-alternative activities is limited. A closer look at the studies on this topic reminds us of the fact that the impact of fatigue on performance of athletes in fields such as squash, badminton, or table tennis has not been thoroughly studied, and the literature is fairly poor [7]. Racket sport athletes have the need to increase and decrease speed very swiftly. Abrupt changes of direction and quick moves are always in demand. Maintaining balance and hitting the ball repetitively and correctly are key ingredients of success in such sports. The physiological pressure brought about by such intense activities is governed by hydrating processes and conditions of nutrition. The present study is an attempt to investigate and bring into consciousness the impact of taurine on muscular fatigue and athletic performance after maximal athletic exercise in professional squash players.

MATERIALS AND METHODS

Subjects

All the volunteers were professional squash players residing in Iran. 35 professional male squash players from Isfahan were invited to volunteer as subjects, 20 of whom proved to satisfy the selection criteria (Table 1).

Table 1: Physical and physiological characteristics of subjects in supplement and placebo groups

Variables	Weight (kg)	Height (cm)	Age (years)	Body fat (%)
Supplement	72.47 ±8.89	175.18 ±4.59	23.50 ±1.41	11.68 ±1.28
Placebo	70.57 ±9.56	174.10± 4.91	24.75 ±0.70	11.93 ±1.20

Total physical health (subjects had no background of injuries, fractures, lacerations, neural aggravations, etc.), perfect eyesight and hearing, right-handedness, age range of 21 to 26 years, at least three years of professional squash, not being on medications or supplements and not suffering neurological or mental illnesses were the main criteria of selection. Subjects had practiced at a competition level, for at least 30 minutes 4 days a week during the past 6 months. They were asked to stay away from being involved in intense athletic activities or taking any nutrients of supplementary nature (none of the subjects had been involved in any medical/nutritional studies since at least 3 months prior to the test).It was mandatory for the subjects not to have dairy, red meat, cheese and eggs (all of which contain high amounts of taurine) a few days prior to the test. Subjects were randomly divided into two groups of ten [including the supplement group (n=10) and the control/placebo group (n=10)]. Digital weight-calculator and RASA height calculator were used. To determine the body composition of the subjects, a Korean body composition analyzer (Model: Biospace 720) was utilized.

Installing electrodes and electromyography documentation

Documentation of muscle contractions was done using a sixteen-canalled Megawin EMG (model: ME6000) device .Three-centimeter chest leads were installed on muscles and the electrodes were placed on wide external muscles at a 15 degree angle, 10 centimeters upwards the top external edge of patella and parallel to muscle fibers. During Bruce test, EMG device recorded muscle contractions and the software within the device was used to interpret data. After analysis and drawing the diagram, the value indicating the negative line slope was considered as fatigue criterion.

Reaction time test

A reaction timer produced by the Iranian Satrap Company was used to keep track of the choice reaction time. Prior to the test, personal information of the volunteer was uploaded on the computer. Then, the test duration, the time between two beeps, warning time, test type (random, consecutive, right hand only, left hand only), and the stimuli type (audio-visual) were determined. The subject would hear a warning beep, focus on the screen, and respond by the left hand (in case the left light went on) and vice versa. The time required by every subject to react to a light was monitored and the relative score was documented.

Supplements

Taurine capsules were ordered and delivered from American Prima-Force Company in packs of 500. The supplement and the placebo (starch) were provided in apparently identical 1gram capsules. Volunteers were monitored to take 5 capsules a day for a week. Supplementation was double-blind, and it was only the assistant researcher who was aware of the real content of every capsule. During the Bruce test, an electrocardiogram recorded muscle contractions, and to analyze the data, the software on the same electrocardiogram device was used. After analysis and diagramming, the number indicating the slope of the line (negative) was taken as the criterion for exhaustion

Pretest

After becoming familiar with the test, subjects attended the squash court in the morning (7: 30 A.M.). Brachial vein blood samples were taken to measure lactate level. Subjects then had a standard breakfast, including wheat-bread with low-fat margarine, honey and tea. At 9:00 A.M., all participants pursued a warm-up program of 5 minutes. Soon after, EMG electrodes were installed. The exhaustive Bruce protocol then began. Subjects ran on Hi Life treadmill made in Switzerland. Measurements of choice reaction time and EMG signals were documented throughout the protocol. Immediately after the implementation of protocol, subjects followed a cooling down program for 5 minutes. Blood samples were taken about 6 minutes after the exercise protocol was ended.

Post-test

Immediately after the supplementation period came to an end, a post-test was carried out under exactly the same conditions of pre-test.

Sampling and laboratory analysis

Vienoject syringes were used by a specialist to take samples from arm veins while subjects were seated. To measure the lactate level in plasma, 6 cc of blood samples was poured (twice) into tubes containing EDTA anticoagulant citrate (ratio= 1:9). Lactate kits were provided by Pars-Azmun Company and samples were immediately taken to the laboratory to examine lactate levels.

Statistical methods

The information gathered throughout the study was represented in relative tables and diagrams using SPSS (ver.20). One-Sample Kolmogorov-Smirnov Test was applied to examine the normality of data, and Levene's *test* was used to determine the homogeneity of variants. In order to determine the difference in group-internal dependent variables before and after the test, the double T-test was conducted. An independent T-test was also carried out to identify differences between experimental and placebo groups. At times, Microsoft Excel was used in diagramming and other relevant statistical operations. The 'P' value in all calculations was deliberately considered to be always smaller than 0.05 ($p<0.05$).

RESULTS

At the beginning, there were no significant statistical differences in terms of weight, age, and body composition between supplement and placebo groups, yet after the exhaustive protocol was practiced, a notable increase was observed in lactate level in both groups. The supplement group experienced a slight drop of lactate levels in post-test (p=0.557), which was rather significant comparing to the placebo group (p=0.000) (Figure 1).

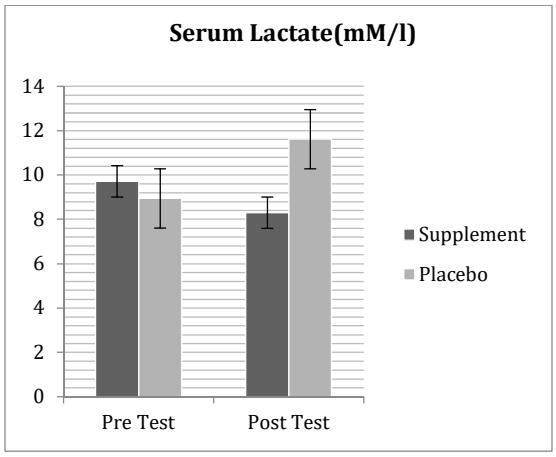

Figure1: Serum lactate results in placebo and Supplement groups

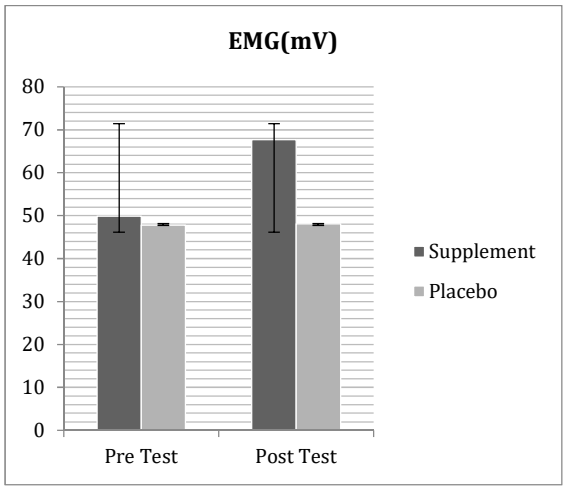

Figure 2: Electromyography results in placebo and Supplement groups

Furthermore, EMG diagrams illustrated a gradual decrease in electric activity of the wide side muscle, advocating a surge of neuromuscular fatigue. The supplement group experienced less of a downfall both in comparison to pre-test (p=0.025) and placebo group (p= 0.002), indicating a less effective presence of neuromuscular fatigue in the taurine group (Figure 2).

The choice reaction time rocketed after the exhaustion protocol took place in both groups, but the supplement group enjoyed a lessening of time by post-test, which indicated an improvement (p=0.002). Additionally, the group showed a significant fall in the choice reaction time when compared to the placebo group (p=0.012) (Figure 3).

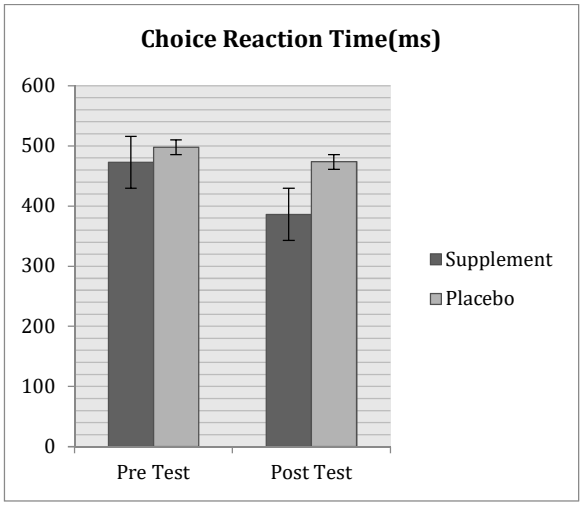

Figure 3: Choice reaction time results in placebo and Supplement groups

DISCUSSION

The data collected in the present research supports the hypothesis that short-term supplementation of taurine amino acid can lead to a minimization of choice reaction time following maximal athletic performance. The body of research on the impact of taurine on choice reaction time is fairly poor and has given repetitive results. The majority of field studies have focused on pathology of a certain kind as well as moods or neurological functions; however, Seidl *et al*., (2000) have conducted a study to comprehend the impact of drinks containing taurine on cognitive performance of university students.10 university students were engaged as subjects in a double-blind study. Reaction time and mood status of students were

studied at night one hour after students drank placebo or taurine-containing drinks. Results indicated a favorable impact on mental performance, reaction time, and mood status of participants. Researchers concluded that taurine can be used in mental states, stress and behavior. The above mentioned mechanisms of taurine may be a function of the role it plays in various interactions with glycinergic, gamma aminobutyric acid, cholinergic and adrenergic mediators [8]. In another study, Horn and Rainer (2000) examined the beneficial effects of consumption of drinks containing taurine on reaction time of 11 drivers for a period of two hours. Nutrition and relaxation were well provided under professional control, and a horn was honked every 2 to 4 minutes to cause a reaction, the duration of which was carefully registered by a computer. Researchers observed that having taurine in their nutrition, the drivers had swifter reactions in comparison to the placebo group, especially in the first hour. It was concluded that the amino acid has various impacts on central nervous system, principally the mechanisms of control, while fatigue and exhaustion cause a deterioration of the neural and visual organs. Thereby, it can be concluded, from the convergence between the results of the present and past studies, that taurine can be considered as an element of improvement and an ingredient of success in sports where a dependence on a favorable reaction time is foremost.

The amino acid taurine plays a major role in physiological functions of the body, especially in control of neural transmissions, regulation of cell volume, cell membrane stability, regulation of fat tissues and calcium homeostasis. [9,10]. Additionally, it has been suggested that taurine improves exhaustion, injury and oxidative stress caused by athletic exercise, reduces and regulates core body temperature, all of which can indicate improved quality of athletic activity [11, 6]. It has also been observed that under certain conditions, such as intense exercise, the body cannot synthesize sufficient amounts of taurine, which indicates the importance of taurine-based supplementation.Studies have reported that intracellular concentrations of taurine are reduced as a result of 30, 60, or 90 minutes of exhaustive exercise, a reduction which is especially noticeable in fast-twitch muscle fibers [1-3].

We observed that short-term supplementation of this amino acid results in reduced neuromuscular fatigue after maximal athletic performance. A review of the relative studies provides further evidence in favor of the hypothesis [12-15].

Heim *et al*., (2003) examined the effects of supplementation with taurine, carnitine and glutamine on stamina in performance and fatigue factors in male university students of physical education. For this purpose, 24 subjects were divided in 4 groups, namely placebo taurine, carnitine, and glutamine. They consumed supplements in two weeks period.The results showed that after taking taurine or carnitine, the concentration of lactate, phosphorus and ammonia in serum were significantly decreased, indicating that these two supplements can improve endurance and performance-related fatigue factors [14]. Bakker *et al*., (2010) studied the consequences of soaking EDL muscle fibers in two solutions containing 5 and 20 μmol of taurine and showed that taurine reduces sensitivity to calcium in contractions along with a lowering of maximal force production. The peak response caused by depolarization increased calcium channel activity and accumulation of calcium in the sarcoplasm network. The study also found that taurine increases activity in calcium pump of sarcoplasm network, resulting in increased calcium accumulation. In conclusion, it can be stated that concentration of endogenous taurine plays an important role in maintaining proper output power of mammalian skeletal muscle during contraction [12].

Hamilton *et al*., (2005) in a study on mice examined the effects of taurine release on fatigue and contractile properties of fast type skeletal muscle. Skeletal muscles were depleted of taurine via treatment with guanodinoethane sulfonate (GES). The results showed a decrease in the yield strength after depletion. Impact of taurine on reducing fatigue was described to be amazing.Reduced release of calcium by sarcoplasmic network is known as one of the fatigue mechanisms. As mentioned above, taurine can increase the release of calcium in sarcoplasmic network, thus delaying the triumph of exhaustion (9). Goodman *et al*., (2009) showed that taurine supplementation increases muscle power and maintains muscle performance during and after high-frequency stimulation.Taurine supplements were fed to rats for 2 weeks, after

which researchers observed an improvement in recovery from fatigue and a reduction in oxidative stress.Finally, it was concluded that high-dose supplementation with taurine increases energy production and develops general resistance to fatigue [13]. This protective quality may be due to lipid membrane structures that prevent direct attacks of oxidants and/or reduce the production of free radicals.This effect helps recover from the damage caused by muscle activity. It should be noted that very high taurine doses can call upon digestive problems. Contradictions following increased taurine levels in muscles can be attributed to taking low doses or taking in short periods.

A notable difference was observed between the two groups with regards to the impact of taurine on lactate accumulation following maximal athletic performance. Very few national and international studies have been carried out on this subject, covering both divergent [16] and convergent [17, 14] viewpoints.

In a divergent study, Rahnama *et al*., (2010) examined the impact of taurine drinks on cardio-respiratory preparation by monitoring blood lactate levels in male athletes.10 university student athletes participated in a Bruce test on treadmills and were monitored while their maximum oxygen consumption, exhaustion, heart rate and lactate were measured.The results illustrated an improvement in maximal oxygen uptake and time to exhaustion while showing no significant differences in blood lactate levels [16]. Balshaw *et al.,* (2012) also tested the effects of taurine on athletic performance. Eight people took supplements in a double-blind crossover manner for a week. In the end, heart rate, RPE and blood lactate showed no significant differences after performing 3 miles running exercise [17]. In a parallel study, Heim *et al.,* (2003) investigated the effect of supplementation with taurine, carnitine or glutamine on endurance performance and fatigue factors in male students of physical education. To serve this purpose, 24 subjects were placed in 4 groups, namely placebo, taurine, carnitine and glutamine. Supplementation was provided for a two weeks period. The results showed that after taking taurine or carnitine, lactate, phosphorus and ammonia concentrations were significantly decreased in serum.It was concluded that these supplements improve endurance performance as well as factors associated with fatigue. Despite the decrease of lactate in serum posterior to supplementation of taurine, the exact mechanism is unknown, and reliable concluding remarks in this regard require further studies [14].

It is difficult and rather unprofessional to make absolute statements about the relationship between taurine and lactate levels in blood, due to a certain lack of an adequate number of studies. On the other hand, no matter how hard the researcher attempts to keep the participants upbeat and motivated, it is undeniable that the very mental states of athletes were not under total control, A fact that makes it even more difficult to come up with an absolute statement. However, it can be stated with high scientific cautiousness that taurine can have a positive impact on the performance of athletes when fast-alternative activities are concerned. It might be considered a huge step forward for athletes in fields where reaction time plays a critical role. The effect of taurine on cross-bridge cycle and endoplasmic reticulum is well depicted, and the significance of such effective factors in the enrichment of power and stamina of athletes is suggestive of the fact that future research on the subject will be of great practicality and value when athletic performance is considered. Given the poor body of research regarding the relationship between taurine supplementation and serum lactate congestion, it is suggested that future studies be focused on this topic.

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