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Research Article

Comparing the effect of antioxidant and coenzyme 10Q supplementation on some indicators of muscle injury in water polo boys

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Abstract

Background: Reactive oxygen species are produced in response to strenuous, prolonged exercise, such as swimming, which results in cell damage. The aim of this study was to compare the effect of antioxidant and coenzyme 10Q supplementation on some indicators of muscle injury in water polo boys.

Materials and Methods: The 24 boy water polo players with at least 5 years of training experience and in the age range of 17 to 23 years were randomly divided into three groups (8 people)of vitamin C, coenzyme Q10 and control. Subjects in the vitamin C group (500 mg of vitamin C tablets) and subjects in the coenzyme Q10 group (300 mg of coenzyme Q10 tablets) were consumed daily with food for two weeks. Trainings were performed for two weeks, 6 sessions per week and 90 minutes per session. Evaluation of CK, LDH and AST indices in the state of at least twelve hours of fasting was performed in three stages: previous, immediately and 24 hours after the completion of the protocol. One-factor analysis of variance test with repeated measures was used.

Results: The results showed that CPK decreased significantly after fourteen days of supplementation in coenzyme Q10 group and increased significantly 24 hours after the last training session and in vitamin C group after fourteen days of supplementation and 24 hours after the last training session increased significantly. There was no significant difference in LDH and AST levels between the groups ($P < 0.05$).

Conclusion: It seems taking coenzyme Q10 supplements may possibly reduce some indicators of muscle damage after water polo training.

Keywords:
Antioxidant supplement, Coenzyme Q10, CK, LDH, AST

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1. Introduction

Water polo is an intermittent exercise with intense explosive activity lasting less than 15 seconds, which, combined with light periodic activity, is generally performed with an average duration of less than 20 seconds (1). These activities cause the uncontrolled production of free radicals, including reactive oxygen species, and upset the balance between oxidizing and antioxidant agents (oxidative stress), resulting in potential damage to large biological molecules, including nuclear acids, proteins and lipids(2). Intense training can lead to exercise-induced muscle damage. In this regard, different types of training such as resistance training, plyometrics, long endurance running and intermittent anaerobic running disrupt the sarcoplasmic reticulum and sarcoma Z protein and increase the metabolic cascade and progressive microscopic indicators of muscle damage (2, 3). Disorders of sarcomeres, followed by loss of function of actin and myosin proteins during exercise, negatively affect muscle function (3). This type of damage is associated with increased activity of serum enzymes such as lactate dehydrogenase, creatine phosphokinase, aspartate aminotransferase and alanine aminotransferase and reduces muscle function (4). Creatine kinase is an enzyme in the phosphagen system that is important for the greater energy metabolism of the body's cells, especially muscle cells and the brain (5). Lactate dehydrogenase is also an enzyme that is found in large amounts in the cytoplasm of all body tissues with different concentrations and accelerates the conversion of pyruvate to lactate or vice versa in the anaerobic glycolysis pathway(5) .

Normally, creatine kinase and lactate dehydrogenase enzymes are serum markers of cell damage in cell membranes, but their release into the bloodstream may increase due to rupture of cell membranes, induction of enzyme synthesis, increased cell proliferation, and increased cell degradation(6) .Nozari and Zare (2016) in a study reported a significant increase in serum creatine kinase levels after eight weeks of plyometric training (7). Sharifian et al (2016) also observed an increase in lactate dehydrogenase after 4 weeks of increasing training in wrestlers in the placebo group (8). It is important to take nutritional antioxidants and supplements to prevent injuries from strenuous exercise (9). One of these supplements, whose effects as an antioxidant and anti-fatigue agent have been reported in studies, is coenzyme Q10 (10). Coenzyme Q10 is a fat-soluble vitamin-like substance that is an essential carrier of electrons in mitochondria and plays an important role in energy production and antioxidant activity and it can neutralize some of the damage done by free foundations (10, 11). This supplement, as a kind of antioxidant, has a protective function against oxidative pressure (11, 12). Emami et al (2015) reported that coenzyme Q10 supplementation prevented adverse changes in muscle injury indices during strenuous exercise and swimming record-keeping (13). In a study by Changizi et al. (2015) that examined the effect of acute coenzyme Q10 supplementation on some serum markers of muscle damage following a resistance training session in male college athletes, it was observed that supplementation significantly reduces creatine kinase (14). Kazaki et al. (2015) investigated the effect of coenzyme Q10 supplementation on blood pressure and muscle damage during combat training.

Plasma creatine kinase concentration increased significantly during exercise, while no significant difference was observed in creatine kinase concentration after supplementation (15). Numerous antioxidants, including vitamins C, E, carotenoids, and flavonoids, have also been introduced to protect cells from free radicals, However, vitamins C and E are mostly used as sports supplements among antioxidants(16). The use of antioxidant supplements can delay the oxidative stress caused by exercise in the blood and skeletal muscle (16).In one study, vitamin C supplementation was shown to reduce some of the markers of muscle damage, such as creatine kinase and AST (17). Rabinejad et al (2014) reported in a study that short-term vitamin C supplementation had no effect on reducing pain and muscle damage and lipid peroxidation due to leg press and squat activity (18). Intense exercise is associated with an increase in creatine kinase and lactate dehydrogenase immediately after exercise, which increases muscle damage and undesirable changes in many indicators of cell damage (18). In such cases Consumption of antioxidant and nutritional supplements probably prevents metabolic pressure damage by increasing buffering capacity (18). However, no comprehensive studies have been performed on the effects of these supplements on the indicators of muscle damage caused by exercise. According to the contradictory results of previous studies, it is necessary to investigate the effect of vitamin C and coenzyme Q10 supplementation on the indicators of muscle damage in water polo boys in the Premier League. By conducting this study, athletes can be provided Practical supplementation recommendations to reduce the causes of injury and its subsequent consequences to provide the basis for improving health (injury prevention) and performance and improving quality of life and reducing treatment costs.

2. Materials and Methods

Subjects

This quasi-experimental study was performed in two experimental groups and a control group with pre-test and post-test. The statistical population of the present study consisted of all water polo boys in the Premier League. A total of 24 people according to Morgan table were selected from people with a history of participating in two national water polo leagues and in the age range of 18 to 23 years who were eligible for the study. After obtaining the permission of the Research Ethics Committee of Islamic Azad University, East Tehran Branch, and participating in the introductory session with the objectives and method of research, after obtaining consent, the subjects were randomly divided into 3 groups of 8: control, Q10 supplement and vitamin. C were exposed. Inclusion criteria include: having at least 5 years of experience in continuous water polo practice, having at least two years of participation in the country's premier water polo league and no history of illness and injury and not consuming alcohol, drugs, tobacco and effective nnatural and industrial dietary supplements influenced the research results. One week before the start of the protocol, the variables of age, height, weight and body mass index of the subjects were measured and recorded. 24 hours before the first stage of blood sampling, the record of 100 meters breaststroke was recorded. Blood samples were taken from three groups in a 12-hour fasting period and then interventions were performed for fourteen days. The vitamin C supplement group received 500 mg of vitamin C daily from Vitamin House Company and the coenzyme Q10 supplement group consumed 300 mg daily of Golden Life co-supplement tablets.

The control group also received the same amount of lactose supplementation during the supplementation period. Subjects in all three groups performed 90 minutes of exercise 6 days a week. Exercises included 15 minutes of warm-up, 30 minutes of high-intensity swimming, 30 minutes of intensive ball training (passing, shooting, defense, goalkeeping and carrying the ball) and 15 minutes of cooling. On the 14th day of supplementation, the second record of 100-meter breaststroke was recorded. Immediately and 24 hours after the last training session, the second and third samples were taken from each of the three groups in the 12-hour fasting position. The subject was placed in a sitting position and 5 cc of blood was taken from the pre-elbow vein of the right arm. Blood samples were placed in a centrifuge at 3000 rpm for 15 minutes to separate serum. Plasma levels of creatine kinase, lactate dehydrogenase and aspartate aminotransferase enzymes were measured using the kits of Pars Azmoun Company (Tehran, Iran) with sensitivity of one unit, five units and one unit respectively with Hitachi (902 Japan) auto-analyzer. After confirming the normality of data distribution using Kolmogorov-Smirnov test and homogeneity of variances by Levin test, analysis of variance with repeated measures was used to compare the means within the group and between groups, and if a statistically significant difference was observed to determine the location of the difference between the groups, Bon Foroni post hoc test was used ($P \leq 0.05$).

3. Results

The characteristics of the subjects in the three control, coenzyme Q10 and vitamin C groups are shown in Table 1. Table 2 presents the average swimming record of 100 meters of the research subjects in the two stages of pre-test and post-test .Table 3 presents the mean± Standard deviation of research variables. According to the results of Table 2, there was no significant difference between the three groups. The results of repeated measures analysis of variance showed that there was a significant difference between changes in serum creatine kinase levels of the three groups at different sampling times(P=./001). The results of Bon Foroni post hoc test showed that there was a significant difference between vitamin C group with control group and Q10 supplement group. (P<0/05). Creatine kinase levels in coenzyme Q10 decreased significantly after fourteen days of supplementation and increased significantly 24 hours after the last training session (P=./001). In the control group and the vitamin C group, there was a significant increase after fourteen days of supplementation and 24 hours after the last training session. The results of repeated measures analysis of variance showed that there was no significant difference between changes in serum levels of lactate dehydrogenase in the three groups at different times of blood sampling (P=./125). Lactate dehydrogenase levels increased after 14 days of training in the control group and decreased 24 hours after the last training session. In the Q10 and vitamin C supplement groups , this amount decreased after 14 days of training and supplementation and 24 hours after the last training session. The results showed that there was no significant difference between the changes in AST levels in the three groups (P =. / 598). In the second and third blood samples the sserum AST levels increased in the control group and decreased in the Q10 and vitamin C supplement groups.

Table 1: Demographic characteristics of research subjects

Groups		Vitaminc (n=8)	Q10(n=8)	Control (n=8)	P
Age (years)		17/8±1/8	19/3±6/4	18/1±1/4	./263
Height (Cm)		180±2/2	182±6/2	5±178/9	./346
Weight (Kg)	Pre-test	79/2±2/8	78/8±1/7	75/1±1/5	./546
Weight (Kg)	Post-test	78/6±1/3	77/3±1/7	75/6±1/5	./612
BMI(kg/m^2	Pre-test	23/2±2/1	23/4±5/1	23/3±7/3	./258
BMI(kg/m^2	Post-test	22/4±3/6	22/9±4/9	23/5±3/9	./186

Table 2: Comparison results of the average 100-meter swimming record of the three groups

	100m swimming record (seconds)		p
Groups	Pre-test mean± Standard deviation	Post-test mean± Standard deviation	
Control	64/3±1/64	63/1±3/94	./51
Q10	63/6±3/96	62/7±3/1	
Vitamin C	64±3/7	61/1±3/7	

Table 3: mean± Standard deviation of research variables

variable	Group	stage	mean± Standard deviation	P
Creatine kinase	Control	Pre-test	148± 6/8	0/001*
		Post-test1	178/7±6/9	
		Post-test2	228/3±7/9	
	Q10	Pre-test	169/3±1/2	
		Post-test1	136± 5/4	
		Post-test2	184/5± 1/2	
	Vitamin c	Pre-test	190/1± 1/2	
		Post-test1	298± 1/8	
		Post-test2	320/6± 1/3	
lactate dehydrogenase	Control	Pre-test	355/1±3/3	0/125
		Post-test1	360/9±3/8	
		Post-test2	353/5±3/6	
	Q10	Pre-test	355/7±7/9	
		Post-test1	306/7±3/4	
		Post-test2	298/8±3/3	
	Vitamin c	Pre-test	360/3±5/8	
		Post-test1	356/1±4/9	
		Post-test2	329/6±7/1	
AST	Control	Pre-test	31/6±9/7	0/598
		Post-test1	32/7±9/2	
		Post-test2	33/7±9/3	
	Q10	Pre-test	31/8±9/1	
		Post-test1	29/6±7	
		Post-test2	26/7±4/3	
	Vitamin c	Pre-test	38/3±9/2	
		Post-test1	31/2±5/8	
		Post-test2	28/6±4/8	

*= significant difference

4. Discussion

The results of the present study showed that coenzyme Q10 consumption significantly reduced creatine kinase in water polo boys after fourteen days of supplementation compared to the other two groups. High levels of creatine kinase after exercise can be caused by damage to skeletal muscle tissue (19). Evidence suggests that due to fatigue of muscle fibers, membrane resistance decreases and potassium duct activity increases with increasing internal free calcium ions (19). Another structure of localized muscle tissue damage is sarcoma damage due to fragmentation of the Z lines, which intense exercise can damage this muscle structure and increase creatine kinase (5). Elevation of total serum creatine kinase following resistance activities occurs mainly due to rupture of muscle sarcolemma (17). While the increase in serum concentration of this enzyme is due to more aerobic and endurance activity due to leakage due to loss of energy and instability or damage due to peroxidation of cell membrane phospholipids (17). It is essential to take nutritional antioxidant supplements to prevent injuries from strenuous exercise(9) .Coenzyme Q10 reduces peroxidation of membrane fats and reduces damage to phospholipid membranes by removing free bases and increasing the body's antioxidant capacity, thus preventing the leakage of intracellular enzymes into extracellular fluids(20). In khanevari et al.'s study (2020), creatine kinase decreased after 14 days of coenzyme Q10 supplementation and a period of strenuous exercise in inactive men, which was consistent with the results of the present study (12) .

However, it was inconsistent with the results of Nejatmand et al (2014) that coenzyme Q10 consumption could not prevent the increase of creatine kinase after exercise (21). This discrepancy may be due to the method of supplementation (type of supplement, purity, amount and time of use), different exercise protocol (intensity, duration and type of activity). The stresses of intense exercise compared to moderate-intensity exercise may be such that coenzyme Q10 supplementation cannot prevent leakage of protein and intracellular enzymes into extracellular fluids (22). Also in the present study, consumption of vitamin C caused a significant increase in serum creatine kinase in stages 2 and 3 of blood sampling compared to the control group. Changes in vitamin C concentrations during exercise are possible; indicates its redistribution between plasma antioxidant stores and tissues (18). Consumption of antioxidants can increase their storage in tissues and increase their release into the bloodstream (18). Azizi et al (2011) showed that taking antioxidant vitamin supplements reduced CK and AST indices in elite female swimmers after strenuous swimming training (17), which is inconsistent with the results of the present study. It seems that the daily dose of 500 mg supplementation in the present study is not enough to show the positive effects of vitamin C and should be consumed in larger amounts or days.

Results of the present study showed that consumption of vitamin C and coenzyme Q10 decreased lactate dehydrogenase in Premier League water polo boys after fourteen days of supplementation and 24 hours after the last training session compared to the control group, but this reduction was not significant. Researchers believe that coenzyme Q10 supplementation may reduce the increase in lactate dehydrogenase after exercise, this decrease may be due to an increase in plasma coenzyme Q10 and potentiation of mitochondrial enzyme and activation of the aerobic metabolic pathway, which limits lactate production by accelerating the consumption of fatty acids and the production of adenosine triphosphate (23) .Nejatmand et al (2014) reported in a study that taking 30 mg of coenzyme Q10 supplementation had no significant effect on lactate dehydrogenase in male athletes, which is consistent with the results of the present study (21) .The results of Demiri et al.'s (2014) study on the sports performance of skiers are inconsistent with the results of the present study (24). Existing contradictions may be due to several factors such as the period and amount of supplementation before the activity, the size and speed of absorption of supplements during the activity, the diet of the subjects before and during the study and the training status of the participants and a combination of the above factors. It can affect the effect of antioxidant supplements on the response of oxidative markers (10, 13). Research shows that taking vitamins C and E at the same time increases the levels of antioxidant enzymes in the body (17). One possible mechanism for this increase could be an increase in adenosine levels as a result of adenosine triphosphate intake, which reduces oxidative stress and ultimately reduces muscle damage (17).

Taghiyar et al (2012) in a study entitled The effect of taking E and C supplements on muscle injury index and oxidative stress in female athletes found that reactive oxygen species (ROS) are effective in causing muscle damage and taking vitamin supplements may It can play a role in reducing the indicators of muscle damage caused by aerobic exercise in women (16). ROS is a major source of oxidative stress and the resulting muscle damage and plays a major role in the onset and progression of muscle fiber injury after exercise (16). Intense exercise with increased free radicals increases lipid peroxidation, DNA damage and to a lesser extent protein oxidation, which means cell damage and leads to oxidative stress and muscle damage (25) .Antioxidant supplements such as vitamins C, E, A, carotenoids and flavonoids can counteract free radicals or delay oxidative stress and muscle damage caused by exercise (25) .

Results of the present study showed that consumption of vitamin C and coenzyme Q10 decreased AST of Premier League water polo boys after fourteen days of supplementation and 24 hours after the last training session compared to the control group, but this decrease was not statistically significant. Coenzyme Q10 is the predominant form of ubiquinone in the human body (10). It is produced as an enzymatic exogenous cofactor in all living human cells and acts as a catalyst for proton / electron transport in mitochondria and lysosomes Protects against free radical damage (10, 11). Recent evidence suggests that coenzyme 10 may re-circulate or regenerate alpha tocopherol and ascorbate and may inhibit the peroxidant effects of alpha-tocopherol (26). Coenzyme Q10 acts as an antioxidant in lipid membranes by direct collection of reactive oxygen species and prevents lipid peroxidation (26).

It also prevents the oxidation of lipoproteins by regenerating vitamin E. Coenzyme Q10 is a potent reductant that reacts immediately with plasma proteins to directly reduce disulfide groups (10, 26). It can also regenerate known antioxidants such as ascorbate, tocopherol and glutathione by converting the oxide form to reduction (26). This coenzyme increases the ratio of reduced glutathione to oxide in the liver and by reducing the levels of reactive oxygen species, increases the activity of mitochondrial electron transfer chain complexes and reduces the effects of oxidative stress (27). Changizi et al (2014) reported that coenzyme Q10 intake following a session of resistance exercise had no effect on serum AST concentration and delayed muscle bruising in male student-athletes, which is consistent with the results of the present study (14). Emami et al. (2017) also showed in a study that the short-term effect of coenzyme Q10 supplementation significantly reduced the AST of elite swimmers (13).

5. Conclusion

The results of the present study showed that coenzyme Q10 supplementation reduced muscle damage indices in coenzyme Q10 group compared to the control group, which was significant in creatine kinase index. Vitamin C supplementation also reduced lactate dehydrogenase and AST in the vitamin C group compared to the control group, which was not significant. Vitamin C supplementation caused a significant increase in serum creatine kinase index in the vitamin C group compared to the control group. Therefore, considering the possible effects of Q10 supplementation in significantly reducing muscle injury index, water polo players are recommended to use coenzyme Q10 supplementation in their training to prevent muscle injury.

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Author contributions

Conceptualization: P.A., A.I., M.S.; Methodology: P.A., M.S.; Software: P.A., A.I., M.S.; Validation: A.I., M.S.; Formal analysis: A.I., M.S.; Investigation: P.A., A.I., M.S.; Resources: P.A., A.I., M.S.; Data curation: P.A., A.I.; Writing - original draft: P.A., A.I., M.S.; Writing - review & editing: P.A., M.S.; Visualization: P.A., A.I., M.S.; Supervision: P.A., A.I., M.S.; Project administration: P.A., A.I., M.S.; Funding acquisition: P.A., A.I., M.S.;

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Compliance with ethical standards

Conflict of interest: None declared.

Ethical approval: the research was conducted with regard to the ethical principles (Thesis Code: 137783).

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