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The Effect of Massage on the Exhausted Aerobic Exercise-Induced Muscle Damage Indicators in Healthy Young Men

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Abstract

Background: Muscle damage and soreness caused by intense exercise are problems experienced by sedentary people whose suitable solution is an essential topic in research.

Objectives: This study aimed to evaluate the effect of massage on the response of recovery creatine kinase (CK) and lactate dehydrogenase (LDH) following exhausted aerobic exercise.

Methods: A total of 20 sedentary university male students (26.9 ± 2.7 y, BMI: 23.1 ± 1.6) participated voluntarily in the study. The subjects were randomly divided into two groups of exercise with massage group (mas, n = 10) and a control group (con, n = 10). Subjects run on a treadmill to the point of exhaustion. After that, the group had effleurage and petrissage massage for 20 min. Then, serum CK and LDH were measured, and the results were extracted using analysis of variance with repeated measures and post hoc Bonferroni test at the $P < 0.05$ level.

Results: Both groups significantly increased CK and LDH levels after the exercise session. There was no significant difference between the two groups immediately after the massage intervention ($P > 0.05$). In addition, there was a significant difference between the two groups 24 and 48 hours after massage in the control ($P > 0.05$), while there was no significant change in the massage group ($P < 0.05$).

Conclusions: Based on the results, massage intervention prevented the increase of CK and LDH levels at 24 and 48 hours after the exhaustive exercise session, which indicates the beneficial effect of massage.

Keywords: Exhausting Exercise, Muscle Damage, Massage, Recovery, CK, LDH

1. Background

Nowadays, exercise with different intensities has attracted many people. Intense and moderate-intensity exercise benefits people, such as reducing the risk of cardiovascular disease (1). However, severe or unaccustomed exercise can also cause stress and problems. The load imposed may damage muscle contractile fiber by rupturing sarcomeres (2). Subsequent damage is linked to inflammatory processes (3); the inflammatory response transfers liquid from cells to the broken tissue (4), and neutrophils and macrophages migrate and play a role in both the damage and restoration processes (5, 6). Several muscle damage biomarkers are generally measured in clinical diagnoses, including CK, aminotransferases, LDH, and myoglobin (7).

Recovery after intense activities can reduce muscle damage and fatigue. Various forms of recovery exist. The use of cold-water and warm-water immersion (8), vibration (9), stretching (10), low-intensity exercise, and massage (2, 8, 11) has become attractive after exercise, but massage is very popular (8). There are different types of massage (Petrissage, Effleurage, and Friction) for recovery to alleviate muscle injury (6). Massage can produce mechanical tension to enhance blood circulation by increasing the arteriolar pressure, accumulating muscle tissue temperature from rubbing, boosting lymph flow, decreasing edema, and minimizing pain and DOMS (6, 11, 12).

Urbaniak et al. examined the effects of massage on DOMS after weight training in karate players and observed that the DOMS decreased (13). In another study, the DOMS was reduced after 24 hours of effleurage massage post-eccentric exercise (14). In Mottaghy et al, pain and soreness lowered after massage (15). Hajizadeh-Jabdargh et al. found that CK, fatigue, and pain following kick exercise increased, but the level of CK decreased two hours after exercise in the massage group (16). Nematpour et al. examined the effects of deep and superficial massage on inflammation and muscle damage after plyometric jumping exercises and demonstrated the positive effects of massage (17). However, massage did not reduce pain, damage, or DOMS (18-21). Therefore, there are contradictory results, and the amount of effect and the exact time of massage for reducing muscle damage and pain relief are not yet proven due to the lack of well-conducted studies.

Sports massage can help to boost athletes' performance, help faster recovery, and lower exhaustion. This study may help sports players, coaches, and health staff to understand massage benefits at various times after exercise (6).

2. Objectives

This study aimed to determine the effect of massage after strenuous exercise on muscle damage changes in the pre-, post-exercise, and recovery phases (immediately, 24, and 48h).

3. Methods

3.1. Subjects

This study was conducted on 20 junior university male students (age: 26.9 ± 2.7y, BMI: 23.1 ± 1.6 kg/m^2, and height: 173.80 ± 4.8 cm) without regular exercise for at least six months. The inclusion criteria were being healthy, no massage therapy, and taking no supplements or drugs. Subjects completed the Health History form, were informed about the experimental risks and study objectives, and gave informed consent before the research. The Ethical Committee approved the protocol at the university under the Declaration of Helsinki.

3.2. Intervention

The subjects were randomly divided into the control group (n = 10) and exercise with the massage group (n = 10). The subjects were asked to complete the preliminary tests. The control group did only exercise, but the massage group did exercise, and two types of massage consist of effleurage and petrissage massage manipulation with apricot kernel oil. The average massage time was about 20 min (22).

3.3. Exercise Protocol

Subjects reported going to the laboratory at 8 o'clock after a 12-hour fasting, and they were given a 30-minute rest in an easy and resting armchair. A heart rate monitor was attached to the subject's chest to monitor rest, exercise, and recovery heart rates. The subjects did a warm-up for 5min consisting of exercise with a speed of 3 km·h^{-1} at 0% elevation. After that, the subjects continued progressive incremental treadmill running with a simultaneous change in speed (by 2 km·h^{-1}) and height (by 1%) alternatively after every 3 to reach the specific speed and grade that elicited 80% of HRmax during the semi-experimental trial. The subjects continued to exercise at that specified speed and inclination until the onset of fatigue, as indicated by volitional exhaustion (7).

3.4. Massage Program

The subject was in a supine position with arm resting by the side. Effleurage is a deep stroking movement on the skin that needs to be in the direction of venous or lymphatic flow. Massage of Effleurage, characterized by long, slow, gliding stroke, is a technique used over the centuries in different cultures as a traditional, non-pharmacological way of promoting rest and reducing stress. Petrissage is directed towards the muscles and is a more profound technique than effleurage. The fingers and closed thumbs grasp the tissues gently like tongs. This sort of massage can stimulate or relax a muscle, which depends on the amount and intensity of the pressure and stretch applied to the soft tissues (22, 23).

3.5. Muscle Damage Biomarkers

Serum CK and LDH were measured, and a blood sample of 5ml was taken from the antecubital vein at five different times just before the beginning of the exercise (baseline), immediately after cessation of exercise (post exe), after massage (post mas), at 24 (post 24h), and 48h (post 48h) after the exercise for biochemical estimation of muscle damage biomarkers and was immediately transferred from the syringe to the test tubes. It should be noted that it was allowed to clot. Then, the serum was separated by a centrifuge and poured into special tubes. CK and LDH levels were measured by enzymatic method.

3.6. Data Analysis

All Data were analyzed using the SPSS statistical software package (SPSS software version 20). The data were presented as mean ± standard deviation with a 95% confidence interval (CI). The Shapiro-Wilk test was used to test the variable's normality. Mauchly's Sphericity test confirmed the sphericity assumption.

Table 1. Characteristics of Participants (Mean ± SD)

Variables	(N = 10)	
	E	ME
Age (y)	26.10 ± 2.02	26.90 ± 1.52
Height (cm)	177.20 ± 3.85	173.80 ± 4.80
Body mass (kg)	71.30 ± 2.06	69.90 ± 3.07
BMI (kg/m^2)	22.72 ± 1.51	23.18 ± 1.60

Abbreviations: BMI, body mass index; E, exercise group; ME, massage group.

A two-way repeated-measures analysis of variance (ANOVA) with post hoc Bonferroni correction was utilized to investigate differences within and between groups for each parameter. The effectiveness of the independent variables was calculated by Effect sizes (η^2). The significance limit was considered as P-value $<$ 0.05.

4. Results

Table 1 illustrates the mean and standard deviation of the anthropometric characteristics of the two groups. Based on the results, there was no significant difference in the average anthropometric characteristics of the subjects among the groups.

According to the results of the analysis of variance with repeated measures regarding CK, the effect of group (F = 115.83, P = 0.001, η^2 = 0.86), the effect of time (F = 33.30, P = 0.001, η^2 = 0.89), and the interaction effect of time and group (F = 110.98, P = 0.001, η^2 = 0.96) were significant. The results of Bonferroni's post hoc test related to intergroup comparisons showed before exercise, the average level of CK between the control and massage groups (P = 0.409) had no significant difference. After exercise, the average level of CK between the control and massage (P = 1.000) had no significant difference, but 24 and 48 hours after exercise, the control group was significantly more than the massage group (P $<$ 0.001, Figure 1).

The effect of group (F = 2.83, P = 0.123, η^2 = 0.182) was not significant regarding LDH, but the effect of time (F = 528.29, P = 0.001, η^2 = 0.967) and interaction effect of time and group (F = 33.97, P = 0.001, η^2 = 0.65) were significant. The results of Bonferroni's post hoc test, the average level of LDH between the control and massage in baseline, post-exercise, and post-massage (P = 0.35, P = 0.28, P = 0.41) had no significant differences, but 24 and 48 hours after exercise were significant (P $<$ 0.001). Hence, LDH increased significantly in both groups after exercise but not after massage relative to post-exe. However, LDH in the control group was significantly increased from baseline 24 and 48 hours after exercise (P $<$ 0.001), but it did not change in the massage group (P $>$ 0.05, Figure 2).

5. Discussion

This study examined CK and LDH responses after performing exercise with and without massage at different times. There was little conflicting evidence about the exact timing of massage effectiveness after exercise performance. According to the results, massage treatment affected muscle damage (CK and LDH) after a session of strenuous physical activity in young men. In other words, massage reduced muscle damage. The results of the effectiveness of massage on the level of muscle damage were very contradictory.

The results of CK indicated no difference between groups at baseline, post-exercise, and immediately after the massage. However, there was a significant change between groups after 24 and 48 h after exercise. CK increased in the control group but did not change in the massage group. Microtrauma caused by intense exercise led to delayed muscle damage and thus increased biomarkers of the injury. According to the literature, CK levels peaked within 24 - 48 hours. CK increase was observed in the control, while in the massage group, there was no CK increase. The results of most of the studies were consistent with those of the present research, reporting an increase in the CK level following intense physical activity. Moflehi et al. showed that intensity levels of aerobic exercise led to increased CK and muscle damage (24). Nematpour et al. found that deep and superficial massage after plyometric exercise effectively reduced muscle damage (17). Hajizadeh-Jabdargh et al. revealed that massage after 48 h kick exercises in taekwondo can decrease the CK level and blood lactate (16). Massage is the complementary method to reduce muscle damage after intense exercise. Post-exercise Massage could remove waste products in muscle by increasing blood flow and lymph circulation (11), decreasing muscle mass edema (16), and reducing DOMS, pain, and inflammation (13, 15-17,

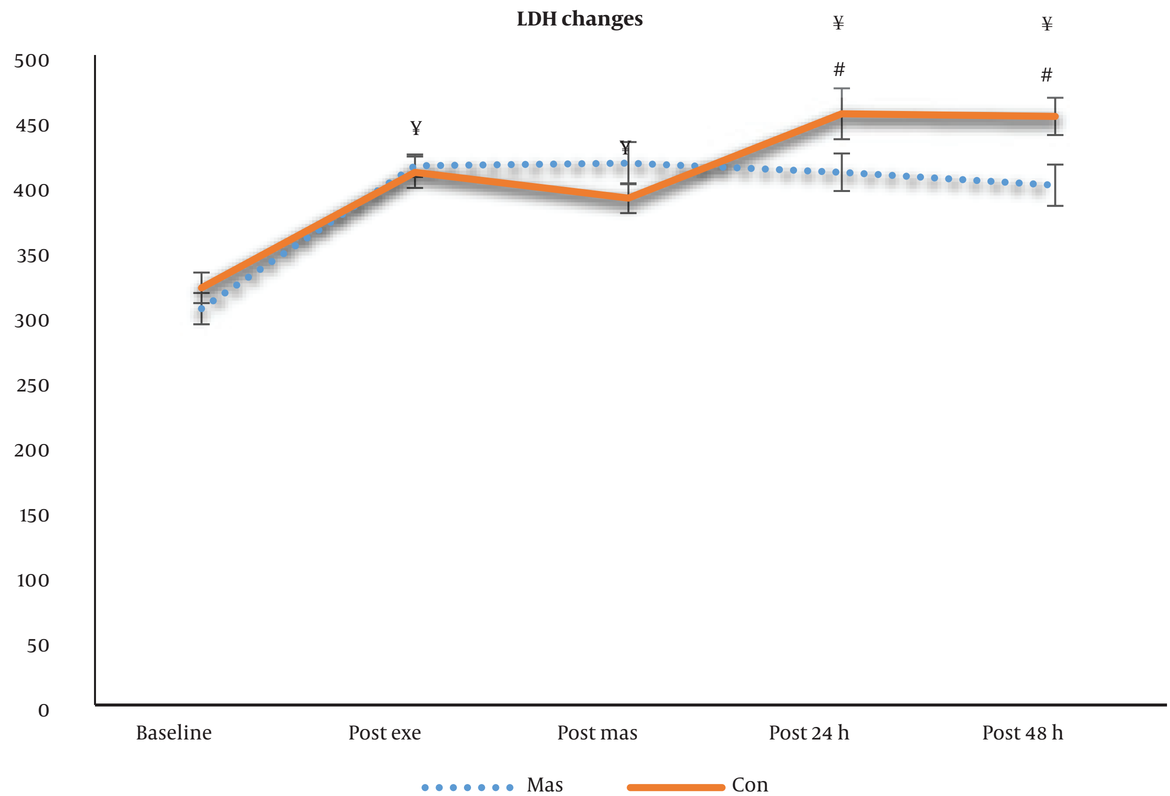

Figure 1. Changes in CK levels in control and massage groups. # Significant difference between control and massage groups. ¥ Significant difference from baseline for the control group

25). However, the results did not align with a few studies, showing no soreness sensation change after 24 h after exercise and massage (18, 20).

The results of LDH indicated that LDH increases significantly after exercise in both groups, but after massage, there was no significant difference between the groups. The two groups showed a significant difference 24 and 48 hours after the massage. The control group's LDH increased during recovery, while the massage group's remained unchanged. Ramezani and Sarhaddi found a significant increase in LDH in middle-aged women after moderate-int aerobic exercise for 30 minutes (26). Nematpour et al. showed that LDH significantly increased after plyometric exercise, but it significantly decreased after massage and 24 hours, and the effect of deep massage was more significant (17). Ilbeigi et al. observed that LDH did not change significantly after exercise but significantly decreased 24 and 48 hours after the massage (27). Moazzeni et al. observed that massage after football-specific training reduced the LDH of football players (28). When the mechanical stress increases in the muscle, metabolic muscle breakdown is generated. Therefore, LDH, an enzyme, is released from the cytosol (29). Exercise-related metabolic factors, such as free radicals and excessive calcium accumulation, cause cell damage. The destruction resulting from the attack of free radicals led to the leakage of intracellular components into the extracellular space. The level of lactic acid in the body increased with the continuation of strenuous physical activity. The LDH enzyme converts lactic acid to pyruvic acid to get rid of it. The transfer of LDH from the injured muscle to the blood circulation through the lymph fluid increased with massage (30).

5.1. Conclusions

Based on the results, increased CK and LDH levels in sedentary men after the exercise session probably led to skeletal muscle cell damage. The control group increased 24 and 48 hours after the massage, but there was no significant change in the massage group. On the other hand, massage significantly prevented the increase of CK and LDH after 24 and 48 hours, which indicated the benefit

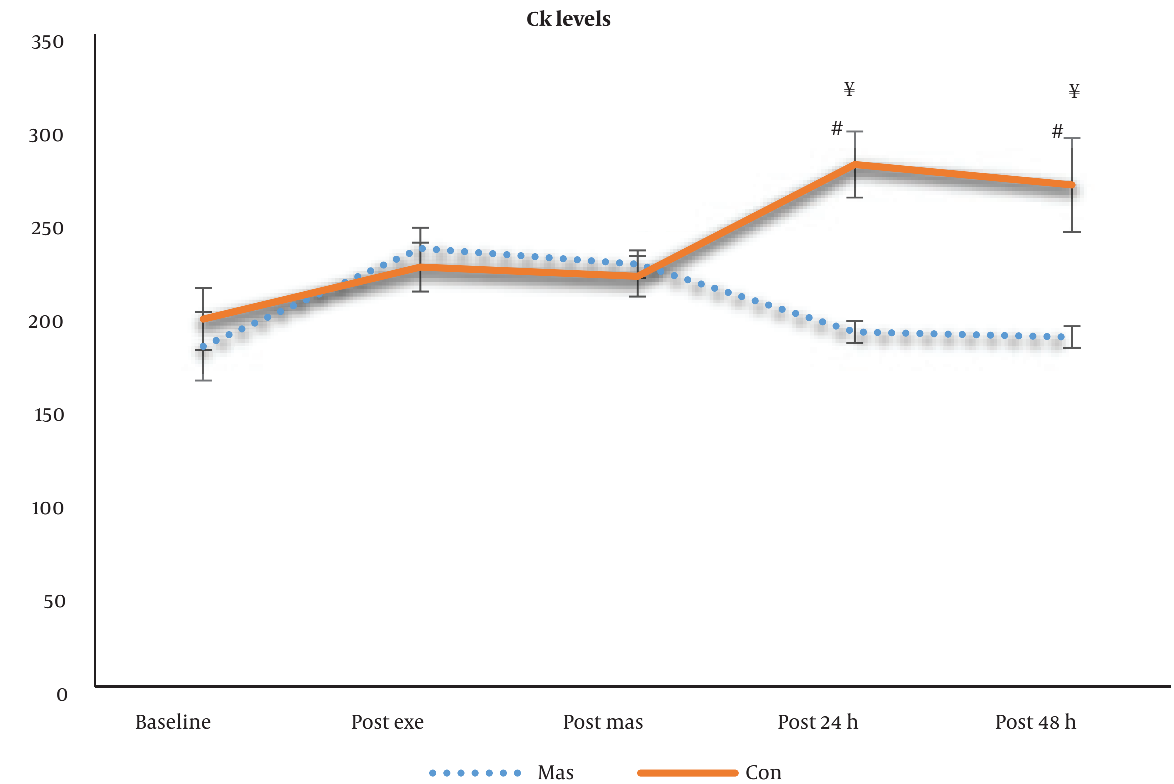

Figure 2. Changes in LDH levels in control and massage groups. # Significant difference between control and massage groups. ¥ Significant difference from baseline for control and massage groups

of massage in young men after intense physical activity. Although there is complete proof of this claim, several studies should be conducted with different intensities, ages, and a more significant number of subjects.

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Footnotes

Authors' Contribution: Gholami. M. conceived and designed the evaluation and drafted the manuscript.

Conflict of Interests: There is no conflict of interest in this study.

Data Reproducibility: The dataset presented in the study is available on request from the corresponding author during submission or after publication.

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Informed Consent: The research objectives were explained to all participants, and written informed consent was obtained.

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