Foam rolling reduced total creatine kinase in acute muscle inflammation following long-distance running

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Foam rolling reduced total creatine kinase in acute muscle inflammation following long-distance running

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ABSTRACT

Strenuous physical activity is able to cost muscle damage. In urban society, ten kilometers running has become a modern culture. It induces acute inflammation as a normal physiological response. Conversely, a foam roller is known as a self-myofascial release (SMR) technique which can be done individually. Previous studies stated that foam rolling (FR) could increase flexibility, and reduce muscle pain sensation. However, there is still a limited supply of scientific evidence to prove its positive effects, especially through biomarkers such as creatine kinase (CK). This study aims to elucidate the beneficial effects of a foam roller in CK concentration after 10 kilometers of running which induces DOMS. A quasi-repeated measures design was elected as an approach to conducting this study. The purposive sampling technique was used to obtain the subjects (n= 10). Creatine kinase measurements were performed before 10 km running and 3 days post running by using the COBAS INTEGRA 400 Plus Test (the UV-test concept). Repeated Measures ANOVA was used to determine the effect of FR on CK. Ten kilometers of running increased Total CK concentration, pre-test data was 146.2 ± 36.3 (U/L), and 24 hours was 452.3 ± 216.5 (U/L). Creatine Kinase decreased at 48 hours (300.6 ± 117.6 (U/L), and 72 hours (238.4 ± 67.5 (U/L) post-application of foam rolling. We conclude that long distance running increased significantly total CK, and foam rolling might decrease CK concentration in the blood.

Keywords: Physical therapy; muscle damage; endurance exercise

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INTRODUCTION

Lengthening muscle contraction while running for 10 km can cause damage to the muscle fibers because the muscles are working continuously (Ryu et al., 2016). Acute muscle inflammation, such as delayed-onset muscle soreness (DOMS), is known as a response that occurs post-physical workout. DOMS is related to the

soreness feeling; it will reach a peak at 24 hours and last for 48 hours, and this can last until four days after exercise (Heiss et al., 2019). DOMS is categorized as muscle damage due to sports (new exercise models, long contractions, eccentric contractions). It is counted as the light trauma that causes functional disturbances in the biomotor (Mueller-Wohlfahrt et al., 2013). Symptoms of DOMS are soreness, stiffness, decreased range of motion, flexibility, muscle strength, and mobility. However, these symptoms will gradually disappear day by day until day five, but it can be faster with active recovery (Cheung et al., 2003; Ryu et al., 2016).

Damaged muscle post-physical exercise can be described as the metabolic adaptation levels, which can be evaluated using a biomarker named Creatine Kinase (CK) and lactate dehydrogenase (Brancaccio et al., 2006). Other indicators that can be used to evaluate training adaptation include the level of leukocyte, monocyte, blood lactate, and range of motion (Hui et al., 2014; Jajtner et al., 2014; Larkin-Kaiser et al., 2015; Manojlović & Erčulj, 2019; Nikolaidis, 2017; Rossato et al., 2015).

Creatine kinase can be found in three different tissues of our body, such as skeletal muscle, the heart, and a small amount in the brain (Schmidt J., 2018). This enzyme is responsible for the energy metabolism of phosphocreatine. CK is normally found in small amounts in the bloodstream as a result of a metabolism side effect, and the amount can be increased due to damage, injury, or diseases such as myopathies and muscular dystrophy (Guimarães-Ferreira, 2014). Foam rolling is one of the independent therapy techniques that can be performed before physical exercise at the stages of warming up and cooling down (D'Andrea et al., 2017). Skeletal muscle is the target of foam rolling activity by doing the rolling movement to the targeted muscles, and body weight can be manipulated as the bearing to the muscle (Mayer et al., 2019). Foam rolling is also known as a tool for myofascial release (MR) (Behm et al., 2020). It refers to the manual massage technique to release muscle fascia and skin tissue, muscle, and bone (Beardsley & Škarabot, 2015).

Previous research indicates that myofascial release technique is significantly lowering pain and improving functional movement in patients with trapezius muscle myofascial pain syndrome (Sulistyaningsih & Putri, 2020). Further, the joint range of motion (ROM) increases significantly after foam rolling, but muscle force does not decrease in performance (Kalichman & David, 2017). Additionally, foam rolling activity could increase flexibility, reduce muscle pain sensation, and increase sprint performance (Wiewelhove et al., 2019).

Although foam rolling is easy to perform independently without any assistance from a professional practitioner, a foam roller is portable media that can be carried anywhere, and the establishment of the benefits of foam rolling is well known as far as the functional, yet there is no scientific evidence supporting the advantages of foam rolling from biomarkers such as creatine kinase. From the bottom of the evidence presented, we presume that foam rolling can help reduce the increase in CK (U/L) in DOMS after a 10-kilometer run. Therefore, the aims of this study are to evaluate the effect of 10 km long-distance running on changes in total CK and CK response to foam rolling.

METHOD

The study is a quasi-experiment with a one-group repeated-measures design. In this study, the independent variable is a foam roller, and the dependent variable is creatine kinase (U/L) as a barometer of muscle damage (acute muscle inflammation stage) (Lau et al., 2013).

This study's population consists of trained young males. Purposive sampling was used to obtain the subjects (n= 10) with the following inclusion criteria: aged 17-25 years, smoke-free individuals, not on medication, and never perform foam rolling. The exclusion criteria, on the other hand, are as follows: resign as a volunteer and be unwilling to do the whole study protocol, according to medical history-having health problems such as cardiovascular diseases, pulmonary disease, back pain, fractures less than two years old, and having a contradiction related to muscle-ligament injuries.

All volunteers were asked to abstain from engaging in any physical activity for at least seven days prior to the 10 km run, but they were still permitted to do their everyday activities as usual. We did ask them to concentrate on the finish line, not their turnaround time. Meanwhile, some research assistants were stationed at various places to motivate subjects. The intensity (70%-80% of MHR) during the 10 km run was tracked using the Xiaomi Mi Band 3. 10 kilometer running was done outside on the Sumurboto public sports facility, Jatingaleh, Semarang, Indonesia.

The foam roller is a self-therapy instrument that is thought to reduce muscle tiredness and soreness while increasing muscle flexibility and performance (Wiewelhove et al., 2019). A high-density foam roller made of EVA foam was chosen, and it was applied to the quadriceps muscle group for 45 seconds of rolling and 15 seconds of rest, three times, for a total duration of 6 minutes for both legs. The technique of foam rolling presented here is a mix of those of Dr. E, "Master of Muscle", and Matthew "Casall". Foam rolling was given after 2 minutes of cooling down, the next day at 24 hours, and 48 hours later.

Biochemical Measurement, the standard protocol from Cito Clinical Laboratory, was used to draw the blood sample, extracting the plasma. Blood was collected four times: before the 10-kilometer run, twenty-four hours later, forty-eight hours later, and seventy-two hours later. The COBAS Integra 400 Plus Test (clinical chemistry analyzer) was used to measure the total amount of creatine kinase (U/L) in the plasma. It is the UV-test concept, which is recommended by the German Society for Clinical Chemistry and the International Federation of Clinical Chemistry, that is used to determine CK with activation by acetylcysteine (NAC).

The research protocol has been approved by the Universitas Negeri Semarang's institutional health research ethics committee (number letter: 120/KEPK/EC/2020). This research is divided into three stages: 1) The starting stage includes instrument checking, inspecting the venue, data mining, professional laboratory technicians, and subjects prior to actually explaining a clear study protocol to all subjects on what suggested and what prohibited acts throughout data collection and how to perform physical treatment (10 km running). Additionally, runners were instructed not to engage in any physical activity for 7 days prior to the run. 2) Execution stage, study protocol repetition, validation that all subjects were hydrated, afterwards pre-data mining: blood collection (creatine kinase), ensuring that all subjects had total creatine kinase between 35 and 175 (U/L), warming up before 10 km running, and cooling down; the first foam rolling treatment was given 2 minutes post-cooling down. 3) The finishing stage, after the intervention and data mining, subsequently data analysis and display, then data explanation, discussion, and closure drawing.

As a prerequisite, normality and homogeneity tests were carried out. The repeated measures An ANOVA test with a significant value of p 0.05 was used to evaluate the effect of foam rolling on changes in total CK after 10 km of running. It was used to assess the data changes on an interval basis. All data analyses were carried out using IBM SPSS Statistics 26.

RESULTS AND DISCUSSION

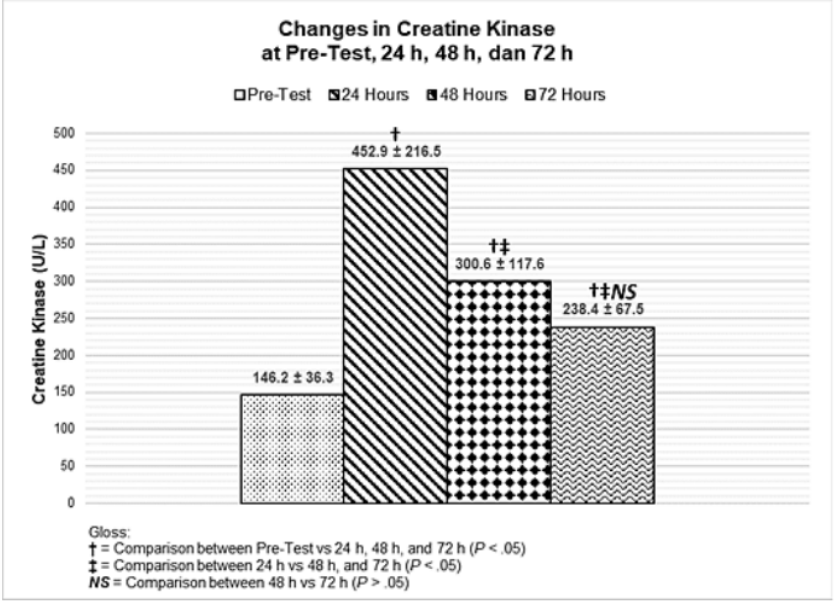
Data collection was held for four days from June 27th until June 30th, 2020, at Sumurboto Soccer Field and at Karangrejo Selatan Street, Tinjomoyo, Banyumanik District, Semarang city. Blood drawing and CK measurement were assisted by a laboratory assistant from Klinik CITO. Subjects' characteristic data, including sex, age, body weight, height, and body mass index, were obtained before 10 kilometers of running.

Demographical data shows that 10 males voluntarily signed up as subjects. Average age is 19 1 years old; body weight is 64 6.7 kg; height is 166.8 5.6 cm; and body mass index (BMI) is 23 2.5 kg/m2. According to the World Health Organization, subjects had a normal BMI. See Table 1.

Table 1. Subject's Demography

Criteria	Mean ± SD
Sex	Males (n= 10)
Age (y.o)	19 ± 1
Body Weight (Kg)	64 ± 6.7
Height (cm)	166.8 ± 5.6
BMI (Kg/m^2)	23 ± 2.5

Total creatine kinase was significantly increased (306 U/L) from 146.2 36.3 (U/L) pre-running data to 452.3 216.5 (U/L) after 24 hours post-10 Km running as P 0.05. Although after 48 hours (300.6 117.6 (U/L)) it was decreased significantly (152 (U/L) as P 0.05 compared to 24 hours data, and the decrease in CK 214 at 72 hours (238.4 67.5 (U/L)) is significant compared to 24 hours (P 0.05), but not to 48 hours. Unfortunately, these decrements were still higher compared to pre-running CK. Detailed data can be seen in Graph 1.



Graph 1. Changes in Total Creatine Kinase Due to Running and Foam Rolling Treatments

In a healthy adult, factors such as gender, race, and physical activity could be affecting the serum CK level, but the normal range is 22 to 198 (U/L). Elevated serum CK levels may indicate muscle damage caused by chronic disease or acute muscle injury (Baird et al., 2012). The increase in CK 24 hours after running 10 kilometers proved that it is strenuous physical training that causes muscle damage.

This phenomenon is consistent with Ryu's previous research in 2016, which stated that various long-distance running events, including 10 km, 21 km, and 42 km, can cause a creatine kinase increase in the 24 hours following the event (Ryu et al., 2016). Not only the duration of performed physical exercise but also the intensity itself seems to be another factor affecting the increase in CK after a 24-hour workout with 80% of VO2Max intensity in running mode on the treadmill (Callegari et al., 2017). Generally, muscle damage can be caused by the stretch-shortening cycle mechanism in physical exercise (Siqueira et al., 2009).

The release of CK and lactate dehydrogenase (LDH) in the bloodstream as a response to a change in membrane permeability after prolonged physical exercise such as long-distance running occurred right after the activity stopped, and it has been evaluated (Ryu et al., 2016). Eighty percent of VO2Max intensity is considered too heavy, and it leads to fatigue (Callegari et al., 2017). An increase in intensity and volume of training related to tension stress in aerobic training methods also causes changes in the hormone and immune systems (Simpson et al., 2015).

The peak increase of creatine kinase in this study was at 24 hours after 10 kilometer running, then it gradually decreased at 48 hours and 72 hours after foam rolling treatment. Foam rolling is considered an active recovery or independent self-massage that can accelerate the bloodstream (Pearcey et al., 2015). The clearance of total CK in the bloodstream can accelerate muscle recovery post-physical training (Guo et al., 2017). The foam rolling treatment in this study was given 2 minutes post-cooling down (the day of 10 km running), 24 hours, and 48 hours after 10 km running. Interestingly, this data was different compared to a previous study, which stated that creatine kinase gradually decreased at 24 hours post foam rolling treatment (Moradi & Monazzami, 2020). It is highly assumed that the studies have different targeted muscles, different physical training, and different foam rolling techniques. Dr. E, "Master of Muscle" and Mathew "Casall" foam rolling techniques are currently being used in this study.

At this point, our findings can be considered additional scientific evidence that the foam rolling benefits have been exposed by changing CK levels as a biomarker of muscle damage after 10 kilometers of running.

Therefore, it can be an alternative option for recovery tools after heavy exercise. Supporting the study novelty, a study by Hendricks et al. (2020) states that foam rolling (90-120 seconds for each muscle group) should be performed before a training session, along with active warming up and dynamic stretching, to lower muscle stiffness and increase ROM post-physical training (Hendricks et al., 2019). Furthermore, foam rolling significantly reduced post-exercise fatigue. In the implementation of the training session, this reduced feeling of fatigue leads to chronic performance improvement by allowing participants to increase the duration and volume of acute workouts (Healey et al., 2014).

CONCLUSION

Based on the current data, we conclude that long-distance running significantly increases total creatine kinase (U/L) concentration in the blood, and foam rolling is considered to have a positive effect by significantly decreasing CK concentration. The foam rolling technique used by the subjects in this study may differ in terms of rolling speed and muscle width. Running 10 kilometers focuses solely on mileage rather than time. Furthermore, an individual's ability to perceive pain affects their soreness level evaluation. However, the number of subjects must be limited due to COVID-19 issues, according to the government's appeal. We realized that we did not evaluate the relationship between participant performance and CK levels, and we did not collect nutrition information from participants. Finally, this study might be more beneficial with a control group as a comparison across different sexes, different age groups, and different physical fitness statuses. Thus, further research may consider the conditions above.

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CONFLICT OF INTEREST

The authors have declared that we have no conflicts of interest regarding the authorship and/or publication of this article.

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