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Foam Rolling on Uric Acid Levels Profile in Delayed Onset Muscle Soreness (DOMS) post 10 Km Long-Distance Running in Healthy Trained Young Men

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Abstract

Long distance running (LDR) is an exercise that has a relatively heavy load which can cause Delayed Onset Muscle Soreness (DOMS) and increase Reactive Oxygen Species (ROS) levels. Xanthine, one derivate of ROS will increase 10 times during aerobic activity which is metabolized to Uric Acid (mg/dL) (UA). Foam rolling (FR) is used for the recovery process. This study aims to determine the effect of long distance running on changes in UA levels and the effect of FR as an active recovery against changes in UA levels. This was a quasi-experiment study using a purposive sampling design, one-group repeated measure design of a sample population of young healthy males (17-25 years). The sample consisted of 10 trained young males in Semarang. The average value of UA before intervention was 4.43 mg/dL ± 0.51. In 90 minutes, it was 5.90 mg/dL ± 0.52, in 120 minutes was 5.71 mg/dL ± 0.72 and at 24 hours after intervention was 6.1 mg/dL ± 0.57. LDR has been shown to increase UA levels. FR which is done only once has not been able to reduce UA levels. The percentage of occurrence of post-LDR DOMS occurred at 24 hours.

INTRODUCTION

Sport has become a lifestyle for some people. Exercise has both positive and negative sides, the positive side are to increase self-confidence, increase muscle and bone strength, and prevent diseases. The negative side is sports injuries, which can be caused by acute trauma or stress. It can affect bones and soft tissues (ligaments, muscles, tendons). The causes of sports injuries include poor technique, accidents, inappropriate equipment, or overuse of certain body parts (Elmagd, 2016). Injuries that often occur, such as strains, muscle injuries or tearing of the muscles, are caused by excessive muscle tension. Strains are classified into three categories according to their severity, level I (mild), level II (moderate), level III (severe) (Järvinen et al., 2000; Järvinen et al., 2007).

The example of a strain level I is Delayed Onset Muscle Soreness (DOMS). It

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is a condition where the discomfort of pain and inflammation occurs in the muscles. DOMS occurs 24 hours after training, the peak is at 48 to 72 hours and will decrease after 5 to 7 days after training (Pearcey et al., 2015). DOMS can happen to anyone, whether it is a non-athlete or an untrained person who starting to train, a trained person with increased intensity, duration or volume, eccentric forms of training, resistance training, long distance running, and downhill running (Zondi et al., 2015).

Heavy loads exercises have the potential for DOMS (Pokora et al., 2014), one of which is strenuous exercise (Holub & Smith, 2017). DOMS is associated with the formation of an acute-phase inflammatory response from metabolic, mechanical, and oxidative stress (Whittle, 2007). In addition, intense muscle training or physical activity associated with skeletal muscle damage which can increase the production of Reactive Oxygen Species (ROS). ROS is already in the body and the levels will increase by several factors like heavy loads of physical activity (Berawi & Agverianti, 2017).

Oxidative stress due to ROS can cause damage to Deoxyribose Nucleic Acid (DNA) by change the chemical structure of DNA (Phaniendra & Babu, 2015). The purines in DNA are adenine and guanine. Adenosine is deaminated and will produce hypoxanthine, then hypoxanthine is oxidized to xanthine. Guanine is deaminated to xanthine. Xanthine, formed from both adenine and guanine, is oxidized into uric acid which are catalyzed by xanthine oxidase. Exercise is an aerobic activity that can increase xanthine, which leads to uric acid (Berawi & Agverianti, 2017), one of the biomarkers in inflammation (Esther et al., 2008).

Several studies already explained how to reduce DOMS, such as whole body cryotherapy (Rose et al., 2017) cold water immersion (Ihsan et al., 2016), heat therapy (Malanga et al., 2015), pneumatic compression device (PCD) (Winke & Williamson, 2018), massage (Visconti et al., 2015; Holub & Smith, 2017), acupuncture (Fleckenstein et al., 2016), non-steroidal anti-inflammatory drugs (NSAIDs) (Bryant et al., 2017), branched-chain amino acids (BCAAs) (Vandusseldorp et al., 2018), stretching (Xie et al., 2018) and foam rolling (Heiss et al., 2019; Cheatham, 2015).

Foam rolling is a self-myofascial release (SMR) technique which become recovery process in reducing acute pain (Cheatham, 2015; Lau et al., 2013). Foam rolling has been widely used in the fitness industry to increase performance and recovery. Foam rollers are also easy to use and can be done without the help of others (Kratchman & Jones, 2018). The benefit of foam rolling in reducing the degree of pain or DOMS should be examine holistically, either from a biomolecular, functional, or psychological. Therefore, research about the effect of foam rolling on reducing uric acid as biomarkers of inflammation is very necessary.

METHOD

The study was a quasi-experiment using a purposive sampling design, one-group repeated measure design (Dutra & Nunes dos Reis, 2016). The subjects in this study were trained young males in Semarang. The subjects must be willing to participate in this research, declared healthy by a doctor, not currently on medication, not less than 17 years old and not more than 25 years old, active and trained student, did not have history of circulatory system or respiratory disorders, contraindications to exercise associated with muscle injury, grade III ligament injury, grade II or III muscle injury, history of surgery and fractures in the lower extremities for less than two years. Subjects who does not follow the research procedures would be excluded from this research.

The procedure in this study has received approval from the Research Ethics Commission of Universitas Negeri Semarang No. 120/KEPK//EC/2020. The research begins with subject conditioning, review of research procedures that have been submitted, giving strenuous exercise, break for 2 minutes, followed by uric acid examination (Couture et al., 2015) before and after foam rolling treatment (Berawi & Agverianti, 2017).

In previous study, the strenuous exercise treatment to induce DOMS effect was long distance uphill running, but due to the Covid-19 pandemic the treatment was replaced with a long distance running of 10 km. The results of the pilot research showed that a long distance running of 10 km is able to cause DOMS. Strenuous exercise in this research was start with warm-up for five minutes on a treadmill in walking mode, the initial two minutes with an incline of 0.0 degrees while the next three minutes with an incline of 3.0 degrees. Core exercises were using a treadmill that is set with an incline of 6.0 degrees (Rico et al., 1999; Gigli & Bussmann, 2002; Agarwal et al., 2017; Yanagisawa, 2003), distance of 10 km and intensity 70-80 % of maximum pulse. Cooling was carried out for five minutes in walking mode, the initial two minutes with an incline of 3.0 degrees and the last three minutes with an incline of 0.0.

Moderate density-soft surface foam roller was used for intervention immediately after cooling is done (Cheatham & Stull, 2018), each muscle group is given for 6 minutes with 10 rolling repetition (Su et al., 2017). In this research foam rolling was applied in five muscles (Gluteus, Quadriceps Femoris, Hamstring Femoris, Triceps surae, Tibialis Anterior) for 48 minutes (Whittle, 2007).

Capillary Uric Acid (mg/dL) was measured using Nesco Multicheck. Uric acid samples were obtained before and 2 minutes after break from strenuous exercise. Uric acid samples also collected 90 minutes, 120 minutes and 24 hours after the strenuous exercise treatment.

The summary statistics were described as means and standard deviations for continuous variable. The data were analyzed using repeated measure ANOVA test to determine and the effectiveness of the foam roller on uric acid (mg/dL) levels after strenuous exercise 10 km long distance running on treadmill.

RESULT AND DISCUSION

Characteristics from 10 subjects in this research such as age, height, weight and BMI are shown in Table 1. Average age of the subjects is 19 ± 1, height is 167 ± 5.8, weight is 64 ± 6.7 and BMI is 23 ± 2.5.

Table 1. Subject's Characteristic

Variable (n = 10)	Mean ± SD
Age (years)	19 ± 1
Height (cm)	167 ± 5.8
Weight (kg)	64 ± 6.7
BMI (kg/m^2)	23 ± 2.5

The uric acid data were analyzed using Repeated Measure Anova. Figure 1 showed that the pre-test data for uric acid which was obtained before strenuous exercise was 4.47 ± 0.51 mg/dL. Uric acid levels at 90 minutes strenuous exercise showed a significant value ($P < 0.05$) and increased by 1.43 mg/dL or around 0.31%. Measurement of uric acid at 120 minutes after strenuous exercise showed a significant value ($p < 0.05$) and increased 1.24 mg/dL or 0.27% from pre-test data of uric acid. Uric Acid levels at 24 hours after strenuous exercise treatment showed a significance value ($P < 0.05$) and increased 1.63 mg/dL or 0.36% from pre-test data of uric acid.

The measurement of uric acid at 120 minutes after strenuous exercise showed a significant value ($p < 0.05$) and decrease around 0.19 mg/dL or 0.03% compared to uric acid levels at 90 minutes after strenuous exercise. Uric Acid levels at 24 hours after strenuous exercise treatment showed a significance value ($p < 0.05$) and increased 0.39 mg/dL or 0.06% compared to uric acid levels at 90 minutes after strenuous exercise.

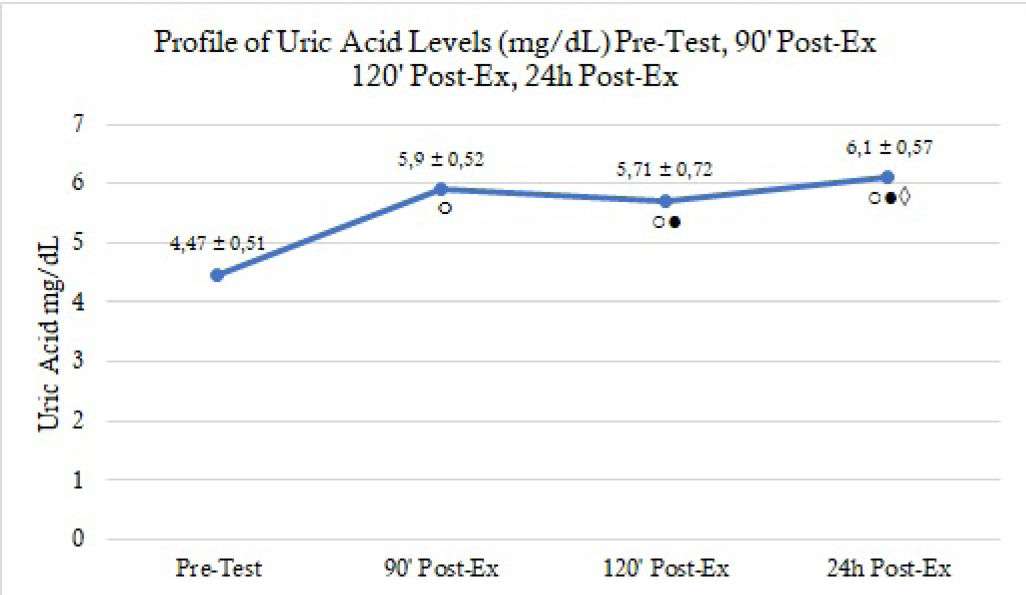

Figure 1. Uric Acid Levels On Pre Test, 90 Minutes, 120 Minutes and 24 Hours Post Exercise

○ = Comparison between pretest and 90 ’post ex, 120’ post ex and 24h post ex ($P < 0.05$)

● = Comparison between 90 ’post ex with 120’ post ex, and 24h post ex ($P < 0.05$)

◊ = Comparison between 120 ’post ex and 24h post ex ($P < 0.05$)

The results of this study indicate that there is an increase in Uric Acid after 10 km running. Ten km running is a form of strenuous exercise and is classified as aerobic activity that can increase oxidative stress, ROS and uric acid levels (Berawi & Agverianti, 2017). Previous studies showed that, besides increasing uric acid levels, there are other anti-oxidants that were increased during exercise such as vitamin E and vitamin C (Rietjens et al., 2007). In this study, all subjects did not do physical activity for 7 days before the intervention and the average of uric acids was of 4.47 mg/dL that was categorized as normal value. The reference of normal uric acid levels in men is 3.6 - 8.2 mg/dL while in women is 2.3 - 6.1 mg/dL.

In this study, there was an increase in uric acid levels to 5.90 mg/dL at 90 minutes after exercise. This happened because 90 minutes after exercise is the minimum duration of acute response to physical activity (Berawi & Agverianti, 2017). This is in line with previous research (Nikolaidis et al., 2007) which states that an increase in uric acid after exercise is marked by an increase in total anti-oxidant capacity also an increase of oxidative stress in the blood. Exercise in hot conditions can also acutely increase uric acid levels due to induction from hyperthermia and dehydration which includes hypokalemia and hyperuricemia (Schlader et al., 2017).

Uric acid levels decreased in 120 minutes after exercise to 5.71 mg/dL or decreased by 3.2% compare to measurement in 90 minutes after exercise, the decrease occurred because 120 minutes is the maximum duration of acute response after physical activity (Berawi & Agverianti, 2017). Previous research stated that uric acid is the strongest antioxidant of human serum, which prevents oxidative inactivation of endothelial enzymes and maintains the ability of the endothelium to mediate vascular dilatation of oxidative stress. Uric acid levels can be decrease if physical activity with moderate intensity can be done regularly, this happened due to the lower exposure of tissue structures to endogenous oxidants (Chrzczanowicz et al., 2012).

Furthermore, at 24 hours after exercise the uric acid level increased to 6.10 mg/dL or 6% compare to measurement in 120 minutes after exercise. The increase was due to the ATP damage induced by exercise, as well as the activation of xanthine oxidase which was formed other than oxygen. However, the results of this study explained that uric acid levels increased due to physiological mechanisms to counteract the increased of radical production by exercise (Rietjens et al., 2007). This study also found that foam rolling treatment after exercise has not decreased the uric acid levels in 24 hours after exercise. Whereas DOMS began to occur 24 hours after exercise then increased at 48 hours to 72 hours after exercise (Pearcey et al., 2015).

The difference in scrolling speed of foam rolling become the limitation of this study. Although all subjects use moderate density-soft surface foam roller but the scrolling speed could be different. These are factors can affect the effectivity of foam rolling to reduce uric acid levels.

CONCLUSION

The occurrence of DOMS after a long distance running of 10 km occurred on the first day (24 hours). Long distance running of 10 km is proven to increase uric acid levels at 90 and 120 minutes after running and increase more in the next day. Foam rolling that is done only once after exercise has not been able to reduce uric acid levels significantly. Based on the results, foam rolling could be used as a recovery method for athletes after training and to reduce the level of uric acid, foam rolling could be done for multiple times during the DOMS phase.

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