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Comparison of Heat and Cold Therapy and Exercise Treatment on Exercised Induced DOMS: A Pilot Study

1st Pradchayakorn Arayasompho
Department of Health and Sport Science
Faculty of Education, Mahasarakham University
Mahasarakham, Thailand
pradchayakorn13@gmail.com

2nd Thanarat Sripongngam
Department of Health and Sport Science
Faculty of Education, Mahasarakham University
Mahasarakham, Thailand
thanarat.s@msu.ac.th

Abstract*— Delayed onset muscle soreness (DOMS) is usually caused by repeated exposure to eccentric muscle contraction or unfamiliar exercises. Eccentric exercise causes muscle cells damage leading to loss of muscle strength, increase muscle pain, muscle weakness, stiffness and swelling resulting in decreased physical performance and psychological distress. The purpose of this study was to compare the effects between heat and cold therapy and exercise on DOMS symptoms and functional capacity. Twelve healthy male participants were divided into two groups: Heat and Cold therapy (HCT) group (6 persons) and Exercise (E) group (6 persons). The experiment was performed on 2 times included post-induced DOMS and after getting recovery treatment. This study found that pain was significantly decreased ($p<0.05$) in both groups but not significantly different between-group comparison. Conclusion, HTC therapy and E treatment could decrease immediate muscle pain after induced DOMS, And may be a guideline for further studies and additional experiments.

***Keywords*— DOMS, Heat therapy, Cold therapy**

I. INTRODUCTION

Delayed Onset Muscle Soreness (DOMS) occurs frequently when beginning to exercise such as heavy exercise or playing sports in wrong manners or intensively doing unfamiliar activities or eccentric exercise. It leading to limited mobility and .reduced muscle performance [1, 2].

The symptoms of DOMS include muscle soreness that occurs within 1-3 days in maximum. It is found that the secretion of creatine kinase (CK) increases while the muscle strength is reduced, within 48 hours in peak. The reduction of range of motion (ROM) and swelling occur within 3-4 days after exercise. DOMS symptoms severely increase between 24 - 48 hours after exercise [3]. These symptoms affect both physical fitness and the duration of time to recover the symptoms depends on the individual's potential [3,4,5].

The previous study demonstrated that exercise is an effective method to reduce DOMS. Tufano studied showed that aerobic exercise at a moderate intensity for 20 minutes after heavy exercise could reduce DOMS when compared to normal resting [6]. Olav Olsen studied the effects of warm-ups and cool-downs by using a 20-minute of cycling. They concluded that the warm-up could prevent muscle pain and the cool-downs could relieve pain. Thus, exercise is another way to effectively alleviate DOMS because during exercise, it supports blood circulation, movement degrees, and endorphin secretion, which result in more disposal of waste produced after exercise and the reduction of muscle soreness [3, 6, 7].

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At present, there is an implementation of heat and cold for muscle recovery because it is simple and convenient. Jerrold Petrofsky and coworker studied the effect of 20 minutes of dry heat and wet heat, after 24 hours of exercise. They found that both heat and cold could reduce pain. Eisuke Hirumalnshowed that a 40-degrees Celsius of Hot pack for 20 minutes could increase the temperature on muscle tissue, improved blood circulation and decreased pain. It can be seen that heat also causes the connective tissue to expand, increases blood circulation, supports the degree of movement, and stimulates A-beta that causes substantia gelatinosa cells to inhibit the transmission cells (transmission; T cell) resulting in reduced pain and increase in tear resistance of the tissue. Thus, heat can prevent and reduce DOMS symptoms [6, 9].

Also, cold therapy is widely used because it could decrease pain after heavy exercise [4] demonstrated that cold water immersion at 10 degrees Celsius for 10 minutes by using at 1, 24 and 48 hours after exercise. They found that cold therapy could reduce muscle pain and increased muscle strength. This study corresponds to Ascensao , they found that cold water could reduce muscle pain and support muscle recovery after a football match. Cold therapy could reduce pain due to the cold affecting nerve transmission of pain perception through adrenergic nerve fiber [8, 7, 10, 11].

From the previous study, the researcher's interest to studied the effects of heat to prevent DOMS by applying heat before exercise and then used the cold after exercise to reduce

DOMS compared to active exercise to reduce pain, reduce swelling, increase ROM, increase muscle strength, and functional capacity after induced DOMS.

II. MATERIAL AND METHOD

A. Participants

Twelve healthy male students aged between 18-25 years were divided into two groups, heat and cold therapy group and exercise group. The participants who exercise at least 3 days per week, there is no injury to the ligaments, muscles, and joints. They all have been selected by the test of leg muscle strength by using the Leg Dynamometer

B. Procedure and Protocol

The participants who in HCT groups, they received a 40°C hot compress with a silica gel pad for 20 minutes at the front thigh, quadriceps muscle, which is the largest and most active muscle bundle . After that, they received an exercise to induced DOMS. All of them step up and down on 50 cm. height box for 10 minutes. The speed of step was set at 140 beats per minute by using metronome. A 14°C cool compress with a silica gel pad for 20 minutes at the same muscle was applied after exercise.

In the exercise group, the participants received A 20 minute of moderate exercise by using a mechanical treadmill at a level of 60-70% of the maximum heart rate was measured by using a running watch polar M430. Then, they received the same method to induced DOMS, after that, they received moderated exercise to reduced DOMS.

C. Outcome Measurement

Pain, swelling, muscle strength, ROM, and functional capacity were measured after induced DOMS and after the intervention (heat and cold therapy or exercise). Visual analog scale (VAS) was used to assess quadriceps muscle pain, which it consists of a 0-10 scale, 0 means no pain and 10 means severe pain [12]. Quadriceps muscle swelling was measured by using taping at 15 cm above patella bone in a supine lying position [13] Quadriceps muscle strength was measured 2 times by using leg dynamometer and the best value was used to analyze [14]. Knee flexion and ankle dorsiflexion were measured by using goniometer in a supine lying position [15]. Six-minute walk test (6MWT) was used to assess functional capacity by the participants walk as fast as possible in 6 minutes [16].

D. Data Analysis

The data were presented as mean ± SD. Kolmogorov-Smirnov test was used to verify normal distribution. Wilcoxon Sign Rank-Test was used to compare the outcome variables of after induced DOMS and after the intervention within a group. Mann Whitney U-Test was used to compare outcome variables between groups. Statistical significance was set at the $p<0.05$.

III. RESULT AND DISCUSSION

This study showed that pain was significantly decreased in both groups when compared within-group ($p<0.05$) but it did not differ between-group comparison. It showed that heat and cold therapy could reduce pain like exercise, which is a standard technique for improved DOMS. Olsen O. studied about 20-minutes of cycling for improved DOMS. They found that the warm-ups could prevent muscle pain and the cool downs could relieve pain.

Mover, cold therapy could reduce pain because cold transmit nerves of pain perception through adrenergic nerve fiber leading to decreased pain. This study corresponds to Bailey, they found cold-water immersion at 10 degrees Celsius for 10 minutes, using immediately after exercise for 1, 24 and 48 hours [17]. They found that cold water could reduce muscle pain.

Heat and cold therapy and exercise could not change swelling, ROM, muscle strength, and functional capacity may be due to this study is a pilot study, witch a small number of participants

Swelling, ROM, muscle strength, and functional capacity were not changed when comparing within the group and were not differ between-group comparisons.

TABLE I. COMPARISON ON ALL VARIABLES BETWEEN AFTER INDUCED DOMS AND AFTER EXERCISE

Outcome	**Group 1**	
	After induced DOMS mean±SD	***After exercise treatment mean±SD***
Pain	8.5±0.54	4.5±1.048*
Swelling (L)	44.6±6.18	44.7±6.60
Swelling (R)	44.95±6.79	45.16±7.42
Knee flexion (L)	127.66±6.83	127.33±7.47
Knee flexion (R)	127.33±9.52	126.66±7.65
Ankle dorsiflexion (L)	6±5.36	5±3.94
Ankle dorsiflexion (R)	5.5±7.39	6.66±8.35
muscle strength	141±14.93	154.66±21.23
Functional capacity	442.96±121.18	438.03±101.56

Note: DOMS= delayed onset muscle soreness, L=left, R=right
*Significant difference at p-value <0.05

TABLE II. COMPARISON ON ALL VARIABLES BETWEEN AFTER INDUCED DOMS AND AFTER HEAT AND COLD THERAPY.

Outcome	**Group 2**	
	After induced DOMS mean±SD	***Afterheat and cold therapy mean±SD***
Pain	8±0.89	3.16±1.47*
Swelling (L)	44.68±5.57	45.25±6.04
Swelling (R)	45.3±5.25	45.88±6.09
Knee flexion (L)	131.66±5.53	132.5±5.99
Knee flexion (R)	133.83±7.05	132.83±6.27
Ankle dorsiflexion (L)	9.33±5.50	9.83±6.24
Ankle dorsiflexion	13.5±10.91	12.166±9.66

(R)		
muscle strength	181.33±49.80	173.58±39.85
Functional capacity	422.66±128.93	426.16±123.20

Note: DOMS= delayed onset muscle soreness, L=left, R=right
*Significant difference at p-value <0.05

IV. CONCLUSION

The present study demonstrated that both heat and cold therapy and exercise could reduce pain after induced DOMS.

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