Combination effect of core stability exercise and contract relax exercise on hamstring flexibility

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Abstract. Hamstring is a muscle group that often has a reduced flexibility compared to other muscle groups. This hamstring flexibility reduction can lead as a low back pain risk factor. Nowadays, the combination effect of core stability and contract relax exercise on hamstring flexibility is still unclear. The aim of this research was to know about this exercise on hamstring flexibility. This research is experimental with 24 subjects of healthy female students who participated in the exercise program for 4 weeks consisting of 3 times per week. Subjects were randomly assigned to one of three groups: (1) core stability-CS (n=8) (2) core relax-CR(n=8), (3) core stability combined contract relax-CS+CR(n=8). The hamstring flexibility was assessed with sit and reach test using the sit and reaches box. The examinations were conducted by observers twice, prior the training program and 2 days after the last session of exercise. 22 subjects were analyzed (CS,n=7;CR,n=8;CS+CR,n=7). The paired t test analysis of each group showed significant CS (p=0.03), CR (p=0.00), CS+CR (p=0.01) in increasing of result sit and reach test was observed. There was a difference between the three groups by the ANOVA test (p=0.00). This study shows that combination of core stability and contract relax exercises can increase hamstring flexibility.

1. Introduction

Lack of physical activity is the biggest cause of reduced flexibility [1]. Flexibility is the ability to move a single joint or series of joints smoothly and easily through an unrestricted pain-free ROM [2]. Hamstring is a muscle that generally experiences adaptive shortening compared to other muscle groups. Hamstring consists of 3 hamstrings and the movements include hip extension and knee flexion [3]. Reduced flexibility of hamstring can cause risk factors for low back pain [4].

Various stretching technique are used in clinical practice to increase hamstring flexibility [5-6]. Core stability exercise is an exercise that activates deep core muscles [7]. While contract relax exercise is a stretching exercise technique of the Proposeptive Neuromuscular Fascilitation (PNF) method which uses isometric muscle contraction followed by muscle relaxation [5]. Motram and Comerford [8] and Sahrman [9] stated that the combination of static stretching and exercise stabilization efficiently in form of the correct muscle activity patterns. Contract relax stretching according to Morceli [10] stated that it is better than static stretching in increasing hamstring flexibility. Therefore, the aim of this study was to know the combination effect of core stability exercise and contract relax exercise on hamstring flexibility.

2. Materials and Method

2.1. Type and design of research

This research is a experimental research with three groups of randomized pretest and posttest group design. Ethical feasibility test has been carried out for this research by the Ethics Committee of the Health Research Faculty of Medicine, Universitas Airlangga Surabaya with the number of ethical feasibility certificate 165 / EC / KEPK / FKUA / 2018.

2.2. Research subject

Subjects who was participated in this research is 24 healthy subjects female physiotherapy students of Health Sciences Institute Bhakti Wiyata Kediri who met the following recruitment criteria: age 20-25 years, normal body mass index according to the Asia Pacific (18.5 to 22.9 kg / m2), no injuries to the lower extremities or lower back pain within 1 year last previous requiring a requirements for medical treatment. Subjects who had involved in active exercise and taking muscle relaxant drugs were not included as research subjects. Subjects who did not participate in all three exercise sessions or not replace the missed exercise excluded from the analysis (drop-outs).

2.3. Exercise program

Each group underwent a 4-week exercise program, consisting of 3 times per week. Each session started with warming up for 5 minutes, and continued with 5 mintes for exercise.

2.3.1. Core stability exercise

The program of core stability was conducted with two exercise were performed. The first, pelvic tilting exercises. Where the subject is lying on his back, knees bent and feet placed on the floor. The hand is beside the body. Subjects were instructed to tighten the abdominal muscles by pulling the stomach inward. The second exercise, supine bridging exercise was performed in a supine position with the hand is beside the body. Subjects were instructed to raise the hips upwards, so that the body was in a straight line from the knees, hips to shoulders then subjects were asked to tighten the hips. This position activated isometric contraction was contraction for 3 seconds, 3 seconds of relaxation. The exercise was repeated 10 times.

2.3.2. Contract relax exercise

This program were performed with subject lying on his back with both legs straight. Then the subject was instructed to lift 1 leg to the limit of the maximum hip flexion with the knee joint held straight. Subjects were instructed to perform isometric contractions which were against resistance in the elastic band drawn by the arm of the subject. The exercise was repeated 4 times /lower extremity with contraction for 5 second and 10 seconds of relaxation.

2.3.3 Combined core stability and contract relax exercise

In this group core stability exercises were given first then contract relax exercise with a dose of exercise repetition ½ of core stability exercise and contract relax exercise.

2.4. Hamstring flexibility protocol

The flexibility of the hamstring muscle is measured by the sit and reach test using a sit and reach box of 30" x 4" x 13" in units of centimeters or inches. The examinations were conducted by observers twice, prior the training program and 2 days after the last session of exercise. The sit and reach test was carried out with the subjects sitting on the floor by straightening their knees and soles of the feet. The soles of the feet must be attached to the side of the sit and reach box. The subject is then instructed to keep the knee straight, then the arm reaches with the hand parallel to the palm overlapping as it slowly reaches forward as far as possible along the top of the box. Ask the subject to hold for 2 seconds. Aim the top of the box at the subject's fingertips. Subjects were given 2 trials and the recorded value was the best value [1].

3. Results and Discussion

3.1. Subjects characteristics

Table 1. Parameters of three groups at an initial examination after excluding data

Variable	CS n=7	CR n=8	CS+CR n=7	P level
	Mean ± SD	Mean ± SD	Mean ± SD	
Age (Years)	21,25 ± 1,16	21,50 ± 1,19	21,13 ± 1,12	0,91
Weight (Kg)	47,12 ± 3,90	44,31 ± 3,80	49,56 ± 5,05	0,57
BMI (Kg/m^2)	19,86 ± 1,36	19,70 ± 1,53	20,74 ± 1,53	0,41
Hamstring flexibility (cm)	22,71 ± 4,53	19,25 ± 4,46	20,14 ± 3,38	0,92

CS : core stability exercise

CR : contract relax exercise

CS+CR : combined core stability and contract relax exercise

Before the exercise program there were no differences between the CS, CR, CS+CR groups regarding age, weight, BMI, and hamstring flexibility.

3.2 Alteration hamstring flexibility before and after exercise

Table 2. Alteration hamstring flexibility before and after exercise program

	n	Pretest	Posttest	P level
		Mean ± SD	Mean ± SD	
CS	7	22.71 ± 4.53	25.28 ± 3.77	0.032
CR	8	19.25 ± 4.46	27.00 ± 1.92	0.001
CS+CR	7	20.14 ± 3.38	27.85 ± 2.03	0.018

CS : core stability exercise

CR : contract relax exercise

CS+CR : combined core stability and contract relax exercise

$p < 0.05$

The result obtained in this research indicate that after a 4-week exercise program increases hamstring flexibility. Although the results show that the biggest increase occurred in the CR exercise group. In contract relax exercise the reciprocal inhibition [11]. Mechanism occurs when muscle spindle releases nerve impulses, which stimulates afferent nerve fibers from the agonist muscle (quadriceps), then nerve impulses synapse with excitatory motor neurons of the agonist muscle (quadriceps) in the spinal cord and at the same time inhibits the motor neuron of the antagonistic muscle (hamstring) which prevents it from contracting [12] so that the hamstring length increases.

Lack of studies on core stability exercise about hamstring flexibility. This phenomenon is based on the anatomy of the hasmtring which has a torso of biceps femoris attached to the ischial tuberosity which is an extension of the sacrotuberous ligament whose position is crossed on the os. sacrum and attached to the thoracolumbar fascia. Through this relationship can affect tight hamstring and reduce the anterior pelvic tilt [13]. Pelvic tilting and supine bridging is an isometric activation exercise for core stabilization and activation of the gluteus maximus muscle and facilitating hip extension muscles [14] indirectly muscle lengthening in the hamstring muscle but through pelvic motion [15].

Core stability and contract relax combination exercises in this study show that this exercise also increases hamstring flexibility. This is because if core stabilization of activated and combined with stretching, a greater stretch is obtained [16].

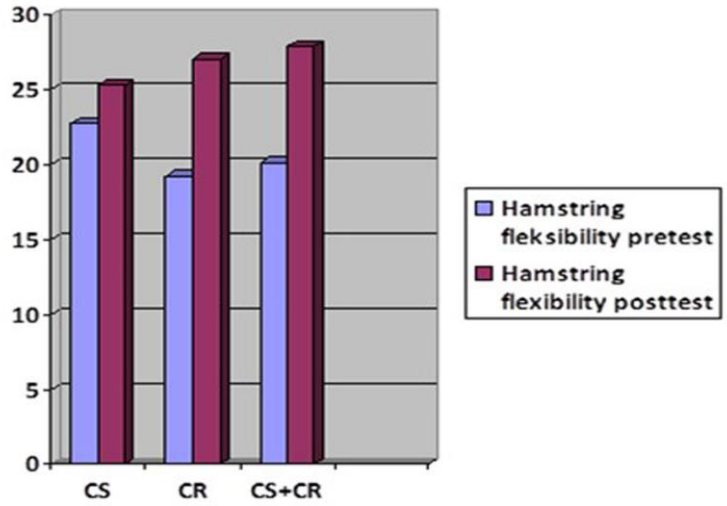

Figure 1. Bar chart hamstring flexibility. The hamstring flexibility pretest and posttest were significant increase in all exercise group CS (p = 0.032), CR (p = 0.001), and CS+CR (p = 0.018).

3.3 Differences hamstring flexibility in three group between posttest and pretest

Table 3. Differences hamstring flexibility in three group between posttest and pretest

	CS	CR	CS+cR	P level
	Mean ± SD	Mean ± SD	Mean ± SD	
Hamstring flexibility (cm)	2.57 ± 2.43	7.75 ± 4.30	7.71 ± 2.21	0.008

CS : core stability exercise

CR : contract relax exercise

CS+CR : combined core stability and contract relax exercise

$p < 0.05$

The biggest increase in the hamstring flexibility was observed in the CR exercise group (7.75 ± 4.30) and there were significant differences between all three group (p = 0.008).

5. Conclusions

This study can be concluded that the three groups core stability exercise, contract relax exercise and combination of both core stability and contract relax exercises can increase hamstring flexibility in students, as well as combination of both core stability and contract relax exercise better than core stability exercises only and as good as contract relax exercises in increasing hamstring flexibility in students.

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Comparison of sport massage and combination of cold water immersion with sport massage on decrease of blood lactic acid level

Comparison of sport massage and combination of cold water immersion with sport massage on decrease of blood lactic acid level

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Abstract. Recovery is an attempt to reduce blood lactic acid levels and make the body recover after physical exercise. The effect of cold water immersion (15°C) and sport massage combined with decreasing blood lactic acid level is still unknown. The subjects assigned to 3 groups, K1 group for recovery sport massage, K2 recovery group for combination of cold water immersion (15°C) with sport massage and K3 control group. Both groups performed sub-maximal physical exercise by doing a fast walk on the treadmill to reach (80% HRM) and then maintained for 5 minutes, followed by recovery process. ANOVA test of lactic acid level post treatment which shows there was a significant difference in the decrease of lactic acid level. The paired t-test of each group showed significant results in sports massage group (p = 0,001), combination cold water immersion (15°C) with sport massage group (p = 0,000) and a control group (p= 0,002). Recovery by soaking in contrasting waters, which result in alternating vasoconstriction and vasodilation, is considered to act in a manner similar to muscle pumping (vaso-pumping). Recovery by means of sport massage and combination of cold water immersion (15°C) with sport massage can decrease blood lactic acid levels.

1. Introduction

Sports activities have many benefits for the body including maintaining health, fitness and improving achievement in the field of sports itself. One type of sport that is common in the community is running. However, running, like other sports in general, can cause muscle fatigue. Fatigue will affect performance, especially in athletes. Rapid activation of glycolysis and increase in the concentration of hydrogen ions ($H^{+)}$ induces intramuscular acidosis which lead to decreased performance.

Fatigue is also influenced by the amount of Adenosine Tri Phosphate (ATP) energy and calcium [3]. During submaximal until high intensity physical exercise, the muscles contract in anaerobic conditions so that the formation of ATP occurs through anaerobic glycolysis. This results in an increase of blood and muscle lactic acid levels. Fatigue recovery is an important aspect of physical conditioning programs.

Recovery is a period of restoring the condition of the body to its pre-match state [9]. During the recovery phase, there will also be recovery of energy reserves, glycogen reserves, and myoglobin by oxygen filling, and also the removal of lactic acid from the blood and muscles [5]. Increased levels of lactic acid during strenuous exercise are caused by very high energy requirements which reach 100 times higher than during resting state. In anaerobic state, the results of metabolism are 2 ATP and the side product which is lactic acid [5].

Overcoming fatigue due to increased lactic acid can be achieved by cold water immersion (CWI) and sport massage methods. Previous studies showed that the CWI is more effective in restoring exercise with a temperature of 10° C - 15° C in a duration of 5 minutes - 10 minutes [10]. Whereas

Williams Brophy (2011) studied about the immediate effect and the slow effect of CWI after high intensity exercise for running performance, shows that soaking in cold water at 15° C for 15 minutes can reduce blood lactic acid levels.

Under cold temperature, the hypothalamus will regulate active vasoconstriction in the skeletal muscle. This will cause a person to shiver and increase the body temperature. At the same time, the adrenal glands secrete the adrenaline and noradrenaline hormones, while the thyroid gland secretes the thyroxine hormone, all of which aim to increase body temperature by increasing metabolism rate. Increased temperature in the body improve blood circulation so the demand of glucose and oxygen for muscle is met, which will help the recovery process of muscles [1].

Sport massage is a massage on certain parts by hand or special tools for blood circulation as a way of treatment or to relieve fatigue [8]. Sport massage is a massage technique that is often used by athletes before, during, and after a match or training. Because there is no consensus in recovery to reduce blood lactic acid levels yet, therefore research needs to be done to prove the effect of the combination of cold water immersion (temperature 15°C) with sports massage, and sport massage only.

2. Material and Methods

2.1 Type and design of research

The design of this research is an experimental laboratory with randomized pretest-posttest control group. This study aims to determine the comparison of recovery using sports massage and a combination of cold water immersion with sports massage to decrease blood lactic acid levels of Surabaya Indorunner community.

2.2. Research subject

This research was conducted at Atlas Sport Club Surabaya in May 2018. The population in this study was male runners aged 20-30 years who were members of the runner community (Indo Runner Surabaya). The sample size was 24 people who were randomly obtained and met the inclusion and exclusion criteria. Then, the samples were divided into 3 groups with 8 people each, where group 1 was given a sports massage as a recovery method while group 2 was given the combination of cold water immersion with sports massage as recovery method and group 3 is a control group.

3. Results and Discussion

The results of the descriptive pre-test analysis showed the mean value of lactic acid levels in group 1 (sport massage) was 3,63 with a standard deviation of 1.04. The post-test results of group 2 showed the average value of lactic acid 2,15 with a standard deviation of 0.79. Whereas in group 2 (combination of sports massage with cold water immersion) the pre-test value was 4.48 with a standard deviation of 1,12. The post test results obtained by group 2 showed an average value of lactic acid levels of 1.87 with a standard deviation of 0,41. Group 3 (control group) the pre-test value was 4,22 with a standard deviation of 0,55. The post test results obtained by group 3 showed an average value of lactic acid levels of 2,95 with a standard deviation of 0,41.

The average value of blood lactic acid levels in all groups measured in this research can be seen from table 1. The mean value of blood lactic acid levels 5 minutes after physical exercise (pre-test) in the recovery of sport massage group was 3.63 ± 1.0 mMol / L, while the combination group of cold water immersion 15°C with sports massage was 4.48 ± 1.12 mMol / L. The results prove that there is an increase in blood lactic acid levels as a result of anaerobic metabolism after the subject performed submaximal physical exercise by running on a treadmill to reach 80% of the maximum HR. The results of the normality test of each group, K1 = 0.789, and K2 = 0.447 was greater than 0.05 ($p > 0.05$), so that the data is normally distributed. High intensity physical exercise can increase lactic acid levels up to 15-25 mM when measured 3-8 minutes after exercise. These very high levels of lactic acid indicate the occurrence of ischemia and hypoxia [7].

From the results of table 3 the results of the effect test for lactic acid levels showed a P value <0.05 can be concluded, 1) recovery with cold water immersion of 15ºC can reduce blood lactic acid levels, 2) recovery with sports massage can reduce the blood lactic acid level. The value of blood lactic acid levels shows decrease in all groups in this research after the recovery phase (table 1). The blood lactic acid level of recovery phase in the sport massage group was 2.15 ± 0.79 mMol / l and in the combination of cold water immersion 15°C with sport massage group was 1.87 ± 0.41 mMol / l. This result shows that after being given a different form of recovery treatment, namely recovery sport

massage, or combination of cold water immersion 15°C with sport massage from the same submaximal physical exercise (80% maximum HR) and same duration of recovery time, a decrease was measured in value of blood lactic acid levels in each group. The results of the normality test for each group, K1 = 0.508 and K2 = 0.675, means the value is greater than 0.05 (p> 0.05), so the data are normally distributed. After physical exercise, the amount of blood lactic acid increases. Therefore, efforts are needed to accelerate the decomposition of lactic acid so that the body recovers quickly. The recovery phase is a condition that is needed by the body to return to the state before the exercise or match.

Table 1. Average and Standard Deviation Lactic Acid Result

Variable	K1 (8)	K2 (8)	K3 (8)
	Mean ± SD	Mean ± SD	Mean ± SD
Lactic Acid Level (*pre test)*	3.63 ± 1.04	4.48 ± 1.12	4.22 ± 0.55
Lactic Acid Level (*post test)*	2.15 ± 0.79	1.87 ± 0.41	2.95 ± 0.66
Lactic Acid Level (delta)	1.48 ± 0.75	2.61 ± 0.78	1.26 ± 0.45

The data are assumed normally distributed if the value of p> 0,05. Based on table 2 the results of the normality test showed that the variables of pre-test and delta lactic acid levels were normally distributed with a value of p> 0,05.

Table 2. Test the normality of the lactic acid

Variable	K1 (8)	K2 (8)	K4 (8)
	P value	P value	P value
Lactic Acid Level (*pretest)*	.789*	.447*	.968*
Lactic Acid Level (*post test)*	.508*	.675*	.003
Lactic Acid Level (delta)	.310*	.200*	.155*

Table 3. Paired T-test

		Mean ± SD	P value
Pair 1	PreK1_PostK1	1.48 ± 0.86	0.001
Pair 2	PreK2_PostK2	2.61 ± 0.85	0.000
Pair 3	PreK3_PostK3	1.26 ± 0.46	0.002

Based on the results of this study, the decrease in blood lactic acid levels in the combination of CWI with the sports massage group was more significant than sports massage group. Recovery of CWI combination with sport massage is the same as a recovery in contrast water (hot-cold) where there will be alternating phases of vasodilation and vasoconstriction. Recovery of CWI combinations with sports massage is better than sport massage because alternating vasoconstriction and vasodilation are thought to act in a manner comparable to muscle pumping (vaso-pumping), increasing blood flow and removing metabolites so as to improve recovery [4]. Increased circulation will increase the supply of oxygen which will help recycle lactic acid into an energy source.

4. Conclusion

Based on the results of the research and the results of data analysis that has been carried out, it can be concluded that recovery using massage can reduce blood lactic acid levels. Recovery of combination massage with CWI can reduce blood lactic acid levels and recovery of combination massage with CWI is better to reduce blood lactic acid levels than recovery massage after submaximal physical exercise.

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