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The Effectiveness of Combination PNF Stretching and Cryotherapy in The Prevention of DOMS in the Lower Extremities

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***Abstract*—A person who experience DOMS will experience illness and pain in the affected muscles, decrease in Range of motion and loss of muscle strength. DOMS appears 12-24 hours after exercise, peaks between 24-48 hours and subside within five to seven days after exercise. The purpose of this study was to determine the effectiveness of pnf stretching combination and cryotherapy in the prevention of DOMS. Thirty-nine subjects between the ages of 15-17 were randomly divided into 2 groups: treatment group and control group. The treatment group was given 18 minutes of Cryotherapy and PNF stretching, which was given 2 hours after exercise. DOMS measurements are performed at 0,2 and 24 hours after exercise. The results of this study indicate that there were significant differences between treatment groups and controls on pain felt at 0, 2 and 24, post-training hours (P <0.05), significant results were also obtained between the function scale measured 24 hours after exercise between the treatment and control groups (P <0.05). The results showed that the combination of PNF Stretching and Cryotherapy was effective in minimizing the occurrence of DOMS.**

Keywords—stretching pnf, cryotherapy, delayed onset muscle soreness

I. INTRODUCTION

The problem that is often happened in sport is the occurrence of pain after exercise. Pain caused by the occurrence of Delay Onset Muscle Soreness (DOMS). DOMS occurs when a person starts exercising after a vacuum from exercise and results from increased exercise intensity [1]. DOMS is characterized by the onset of pain in the muscles a few hours after exercise, pain is felt in the dominant muscle used during exercise and the type of eccentric predominant muscle contraction [2]. Another effect of DOMS is the reduction of Range of Motion (ROM), swelling, and reduction in muscle function [3]. DOMS begins to occur within the range of 12-24 hours after exercise, peaking in the range of 24-48 hours after exercise and subside within five days to seven days after exercise [4]. DOMS is often complained by trainers and players as one of the losses experienced in the process of recovery and performance improvement [5]. If DOMS is not treated immediately, it can cause a decrease in the athlete's performance during exercise DOMS is the result of eccentric exercise that causes damage to the muscle cell membrane and triggers an inflammatory response. The factors that play a role in DOMS are muscle stiffness, speed of contraction, fatigue, and contraction angle [6]. Other factors that cause DOM are accumulation of muscle spasms, connective tissue damage, muscle damage, inflammation and the theory of enzyme efflux [1]. New training methods and excessive exercise cause muscle damage which is characterized by increased levels of Creatin Kinase (CK) in the blood. High levels of CK in the blood is one of the earliest signs of muscle damage [7].

The method that can be used to prevent and treat DOM is PNF and cryotherapy. This method aims to minimize DOM, reduce DOM time, speed up ROM recovery and muscle function. Proprioceptive neuromuscular facilitation (PNF) is designed to increase the response of neuromuscular mechanisms by stimulating proprioceptors [6]. The PNF that performed before exercise aims to prepare for flexibility and muscle strength in main training, so that in stretching practice using the PNF method affects the endorphin system in the human body. Endorphin release is a form of response from PNF stretching

Cryotherapy is defined as a therapeutic application of any substance in the body that results in a decrease in tissue temperature, Cryotherapy is widely used in sports medicine and has been shown to provide analgesic effects along with a decrease in blood flow tissue by constricting blood vessels, reduce capillary permeability decreases tissue metabolism and oxygen utilization Cryotherapy after exercise is effective in reducing CK levels in the blood resulting in muscle damage because exercise can be minimized [8]. Cryotherapy immediately after exercise is effective in reducing response inflammation and edema formation [4].

Although some interventions for DOMS management have potential, effective strategies to prevent DOMS have not been determined. Until now there has been no clarity in the literature regarding the efficiency of using cryotherapy in detecting DOMS. The purpose of this study was to determine the effectiveness of stretching PNF and cryotherapy on the prevention and treatment of DOMS.

The rest of this paper is organized as follow: Section II describes the proposed method. Section III describes the obtained result and folowing by discussion in Section IV. Finally, Section V concludes this paper.

II. Proposed Method

This section presents the proposed method.

A. Subjects

Thirty-nine male physically active subjects between the ages of 15-17 were required to complete a medical health questionnaire, provide informed consent and agree to refrain from any form of potentially muscle damaging resistance training or exercise before participating in the study. The criterion for subject inclusion was no previous history injury at lower extremity, absence of any current arm pain/discomfort, and ability to demonstrate full, pain-free range of motion to participation in the study. Participants were also asked to refrain from the use of non-steroidal anti-inflammatory drugs and/or alternate treatment strategies throughout the duration of the study. This study consisted of four phases: exercise to induction of DOMS, pre-test, pnf and cryotherapy treatments, and post-test. Subjects were randomly assigned to either the treatment or control groups. Nineteen subjects were assigned to the control group and twenty subjects were assigned to the treatment group.

B. Induction of Delayed Onset Muscle Soreness

Exercise to trigger DOMS using circuit training. Circuit training consists of 10 posts, including jogging and speed, skipping, plyometrics jumping, frog jump, power high knee, sideways running, shuttle run, running backward, power lunges and zigzag run, time intensity for 15 seconds, time recovery for 30 seconds (30 seconds include active recovery and move to the next post). Circuit training is carried out in 3 sets and time recovery between sets for 4 minutes (see Figure 1).

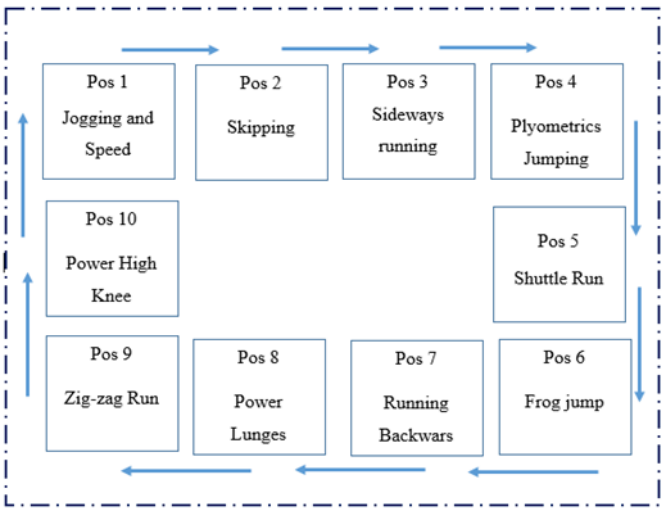

Fig. 1. Circuit Training

C. Treatment Protocols

The PNF stretching is performed on the lower extremities. There are 9 points that will be treated, each point is carried out for 30 seconds each set and carried out for 4 sets. Expressed as a set if you have stretched pnf at all points, and the second set is repeated from the beginning again. The treatment of cryotherapy was carried out for 16 minutes, cryotherapy was given after the subject do PNF stretching. There were 8 points given cryotherapy treatment, namely the gluteus, hamstring, quadriceps, iliotibial band, patella, gastrocnemius and Achilles. Subjects were given verbal directions and guidebooks for cryotherapy, cryotherapy carried out together. Only in the treatment group that received cryotherapy, the control group only rested normally without getting cryotherapy and any form of treatment that could eliminate or minimize DOMS.

D. Post-Exercise Measurements

Post-exercise measurement is done shortly after exercise, 2 hours after exercise and 24 hours after training for measuring pain scale and function scale, subjects are also asked to note the initial time of pain, the peak of pain, pain begins to disappear, and pain disappears completely. The instrument used in this study is Visual Analog Scale (VAS) for pain scale, Lower Extremity Function Scale (LEFS) for function scale. Subjects were asked to fill in the pain scale to describe the pain felt after doing the exercise and function scale to describe the function of the lower extremity. Before filling in the pain scale and subject function scale first get directions about pain scale and function scale. Pain scale consists of 0 to 10 subjects asked to circle a number that describes the level of pain felt, 0 illustrates no pain 5 illustrates moderate pain and 10 describes high level pain. LEFS consists of 20 questions, in each subject matter is asked to circle the numbers 0-4, number 0 illustrates very difficult, 1 illustrates difficulty, 2 illustrates moderate difficulty level, 3 illustrates a little difficulty and 4 illustrates without difficulty in carrying out activities.

E. Statistical Analysis

Statistical analysis in this study uses two analyzes, namely parametric statistical analysis for data that meets the analysis and non-parametric prerequisite tests for data that do not meet the analysis prerequisite test. Paired sample t-test and Wilcoxon were conducted to determine differences in subject conditions at pretest and posttest in one group. Independent sample *t*-test and Mann Whitney were carried out to find out the differences in pretest and posttest conditions between All tests were carried out at a significance level of 0.05. Testing all data using a computer program through the operational application of the Statistic Packet for Social Science (SPSS) V.20.0 for windows. and control groups.

III. Results

Subjects in this study consisted of 39 men ranging in age from 15 to 17 years, with an average age of 15.92 + 0.35. The treatment group had an average age of 15.90 + 0.45 while the control group had an average age of 15.94 + 0.23 (see Table I). The height of the study subjects ranged from 157 to 174 cm, with an average age of 165 + 4.47. The treatment group had an average age of 164.95 + 4.27 while the control group had an average age of 165.21 + 4.79 (see Table II). The body weight of the study subjects ranged from 39 to 80 cm, with an average body weight of 51.79 + 9.58. The treatment group had an average body weight of 52.50 + 10.32 while the control group had an average body weight of 51.05 + 8.94 (see Table III).

TABLE I. SUBJECT AGE

No	Age	Total	Treatment	Control
		f	f	f
1	15	4	3	1
2	16	34	16	18
3	17	1	1	0

TABLE II. SUBJECT HEIGHT

No	Height (cm)	Total	Treatment	Control
		f	f	f
1	157-162	11	5	6
2	163-168	16	10	6
3	169-174	12	6	6

TABLE III. SUBJECT WEIGHT

No	Weight (kg)	Total	Treatment	Control
		f	f	f
1	39-47	17	6	11
2	48-56	11	7	6
3	57-65	7	5	2
4	66-74	3	1	2
5	75-83	1	1	0

The aim of this study was to investigate the effectiveness of stretching PNF combination and cryotherapy in the prevention and treatment of DOMS. T-test Repeated showed significant differences in interactions between treatment and control groups and time in terms of pain felt 0, 2 and 24, post-exercise hours (P <0.05), significant results were also obtained between the 24h post exercise function scale between the treatment group and the control group (P< 0,05). Results are shown in Figures 2 and 3.

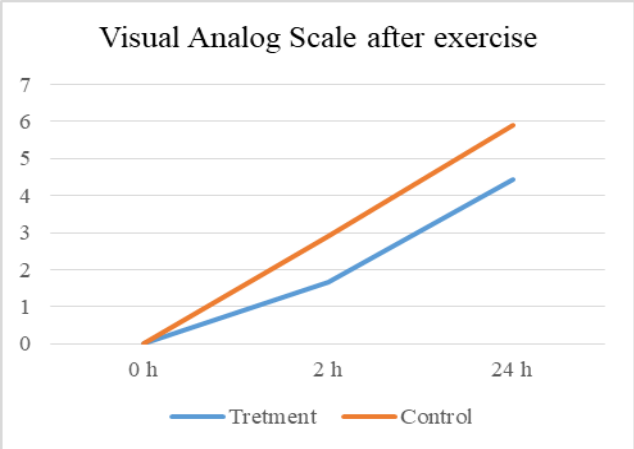

Fig. 2. Visual Analog Scale

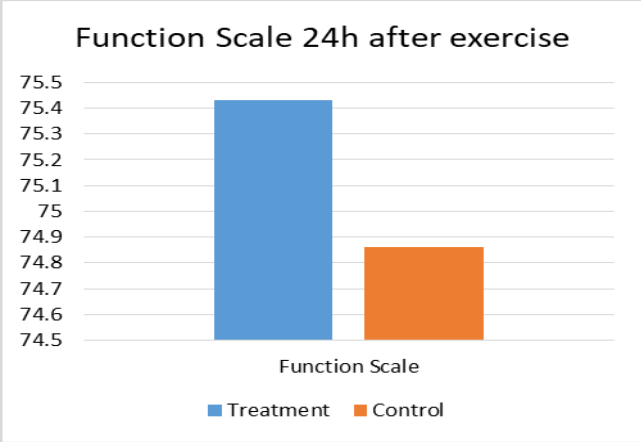

Fig. 3. Function Scale

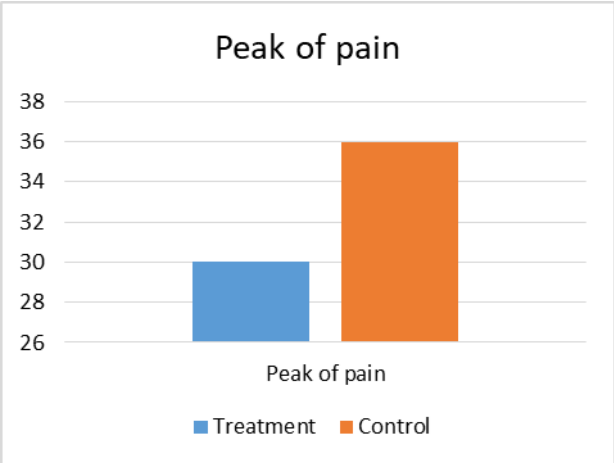

Fig. 4. Peak of pain

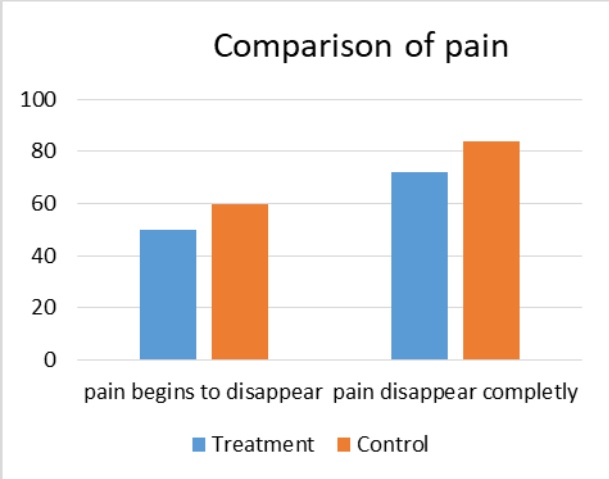

Fig. 5. Comparison of pain

The pain that arose after training between the treatment group and the control group was significantly different, at 2h post training and 24h after exercise. The control group felt more pain compared to the treatment group. The results of the scaling function measured 24h after exercise also showed a significant difference. From Figure 4 the treatment group experienced less function than the control group. From the results of this study that stretching PNF and effective cryotherapy in relieving DOMS.

IV. Discussion

This study aims to determine the effectiveness of the combination of PNF stretching and cryotherapy to prevent the occurrence of DOMS. The results showed that the two groups experienced DOMS after exercise, this can be seen from the pain scale and function scale in each group after exercise. The pain scale in each group increased (see Figure 5), but in the control group there was an increase in pain that was higher than the treatment group. This indicates that muscle damage that occurs due to exercise occurs more in the control group. The cold skin stimulus generates afferent neural impulses that are conveyed by large, myelinated nerve fibers at a much faster velocity than that of pain impulses conveyed by smaller unmyelinated nerve fibers, which inhibits transmission of pain impulses within the spinal cord and which suppresses the stretch reflex. The subjective nature of pain sensations has made the analgesic effect of cryotherapy difficult to study [10]. Similar results occur at the function scale, the function scale in the control group is lower than the function scale in the treatment group. The result of LEFS measurement is that the treatment group function scale is better than the control group, this shows that the treatment group's muscle function is better than the control group. The results of measuring this function scale cannot be separated from the results of pain scale measurement. Muscles that experience damage at the tissue level will cause the appearance of pain in response to the damage, when the muscle feels pain will affect its function. The more pain a muscle will also decrease the muscle function.

A combination of PNF stretching and cryotherapy can minimize the time of doms. this can be seen from the difference in peak pain and pain begins to subside. At peak times pain and loss of pain the treatment group has a shorter duration than the control group. Peak pain in the treatment group 30 hours after exercise while the control group was 36 hours after exercise. The pain began to disappear in the treatment group 50 hours after exercise and disappeared completely 60 hours after exercise, while in the control group the pain began to disappear 72 hours after exercise and disappeared a total of 81 hours after exercise. these results are in line with the theory revealed by Cheung the intensity of discomfort increases within the first 24 hours following cessation of exercise, peaks between 24 and 72 hours, subsides and eventually disappears by 5–7 days post exercise [1]. This indicates that the role of combination pnf stretching and cryotherapy has an effect in minimizing the occurrence of DOMS.

The results of this study are reinforced by the theory expressed by Day & Ploen which states that Cryotherapy shortly after exercise is effective in reducing the inflammatory response and edema formation [4]. Isabell, *et al*. did not find significant differences in their criterion indicators of DOMS resulting from the use of ice massage [9]. However, we felt that their mode of cryotherapy treatment was less effective than other forms of ice application, and that the treatment time was too short. Our study addressed these weaknesses by changing the mode of ice application to the use of an ice bag for treatment, and by increasing the treatment time from 15 minutes to 30 minutes. Stretching using the PNF method influences the endorphin system in the human body. The release of endorphins is a form of response due to stretching of PNF.

V. Conclusion

This study found that the PNF stretching combination and cryotherapy cannot prevent the occurrence of DOMS, but the PNF stretching combination and cryotherapy is effective in reducing pain that occurs after exercise and reducing the duration of DOMS.

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References

[1] K. Cheung, P. A. Hume, and L. Maxwell 2003. Delayed onset muscle soreness: Treatment strategies and performance factors. *Sport. Med*., 33, 145–164.

[2] Z. Zainuddin, M. Newton, P. Sacco, and K. Nosaka 2005. The effects of massage on delayed onset muscle soreness. *J. Athl. Train.*, 40, 174–180.

[3] P. Barlas, J. A. Craig, J. Robinson, D. M. Walsh, G. D. Baxter, and J. M. Allen 2000. Managing delayed-onset muscle soreness: Lack of effect of selected oral systemic analgesics. *Arch. Phys. Med. Rehabil*., 81, 966–972.

[4] M. Day and E. Ploen 2010. The Effectiveness of Cryotherapy in the Treatment of Exercise- Induced Muscle Soreness. *J. Undergrad. Res*., 8, 1–6.

[5] P. D. Glasgow, R. Ferris, and C. M. Bleakley 2014. Cold water immersion in the management of delayed-onset muscle soreness: Is dose important? A randomised controlled trial. *Phys. Ther. Sport.*, 15, 228–233.

[6] A. Kalaiselvan, K. M, And S. M.V 2017. Effect of proprioceptive neuromuscular facilitation versus Muscle energy technique in improving muscle Function in delayed onset muscle soreness In recreational players. *Int. J. Pharma Bio Sci*., 8, 3.

[7] M. F. Baird, S. M. Graham, J. S. Baker, and G. F. Bickerstaff 2012. Creatine-kinase- and exercise-related muscle damage implications for muscle performance and recovery. *J. Nutr. Metab.*, 2012, 1-13.

[8] E. Hohenauer, J. Taeymans, J. P. Baeyens, P. Clarys, and R. Clijsen 2015. The effect of post-exercise cryotherapy on recovery characteristics: A systematic review and meta-analysis. *PLoS One*, 10 1–22.

[9] Isabell, W.E., E.Durrant, W.Myrer, and S.Anderson. 1992. The effects of ice massage, ice massage with exercise, and exercise on the prevention and treatment of delayed onset muscle soreness. *J Athl Train*., 27, 208-217.

[10] Synder, J.G., Ambegaonkar, J.P., Winchester, J.B. 2011 Cryotherapy for Treatment of Delayed Onset Muscle Soreness. *International Journal of Athletic Therapy and Training*, *16*(4), 28–32.