A comparison of stretching with ice vs stretching with heat on hamstring flexibility among physical therapy students

McBernard S. Gregorio, Ronalie L. Bernabe, Leonard Paul C. Bondoc, Jessica Rhae B. Castillo, Symon Jervis O. Chan, PTRP (Adviser)

Abstract

Introduction This study aimed to compare the effectiveness of stretching with ice and stretching with heat and their long term effect on the hamstring muscle flexibility among college students.

Methods This was a quasi-experimental study where students who were determined to have tightness of the hamstring muscle were randomized to receive hot or cold packs thrice weekly for four weeks prior to stretching the muscle. The range of motion of knee extension with 90° hip flexion (active knee extension) was measured at baseline, week 1, week 2 and at the end of the treatment period. The post-treatment range of motion was compared with the baseline within and between the two study groups.

Results Both modalities resulted in an increase in the range of motion from the initial to the week 4 determination. The final range of motion assessment was similar for the cold and hot groups. The difference between the final and initial assessment was larger in the cold group compared with the heat group (13.5° vs 9.5°) but when the mean difference was compared between the two groups, an unpaired t-test showed that the difference was significant.

Conclusion Cold therapy prior to stretching appears to be a more effective option than heat in addressing hamstring muscle extensibility problems.

Key words: Cryotherapy, hamstring flexibility, heating modality, physical therapy, static stretching

Physical therapy is a profession that deals with different modalities and manual techniques as interventions, such as stretching, for different conditions. Stretching is a technique to lengthen muscles prior to exercise or to different therapies. There are certain modalities that can help increase the lengthening of muscles. In this study, the researchers used heating and cooling modalities. The effect of a heating modality prior to stretching has already been proven to have a significant effect to the muscles, however, a cooling modality before stretching is yet to be proven whether it has a significant effect to the muscle prior to stretching. The effect of cryotherapy prior to stretching has received considerable attention. Cryotherapy is the application of cold to soft tissue for therapeutic purposes. It is an established method of treating acute soft tissue injuries. Cryotherapy is also used for post-exercise recovery.[1]

Correspondence:
McBernard S. Gregorio, College of Allied Rehabilitation Sciences, University of the East Ramon Magsaysay Memorial Medical Center Inc., 64 Aurora Boulevard, Barangay Doña Imelda, Quezon City 1113; Telephone: 027133312

Presented in the 18th Annual Research Forum, February 24, 2016, University of the East Ramon Magsaysay Memorial Medical Center, Quezon City

Increasing soft tissue temperature prior to exercise is an accepted practice.[2] This may be through warm up or local application of heat. However, there is a growing trend of recent use of cryotherapy for stretching prior to exercise. Pre-cooling has gained widespread acceptance as a method of offsetting thermal strain and fatigue and increasing aerobic and anaerobic capacity.[3,4] In spite of these early observations there is still an uncertainty whether cooling modality helps the muscle lengthen. One study suggests that supine hamstring flexibility after stretching with ice was greater than stretching with heat.[5] This study, however, only showed short term results. Hence, additional studies of the effectiveness of stretching with heating modality and stretching with cooling modality are needed to help compare which has the better effect to the lengthening of the muscles.

The purpose of this paper was to determine which modality has a better long term effect in increasing hamstring flexibility. The researchers took note of the effect of heat and ice to the muscle length. This paper hoped to show that the long term effects of stretching with ice compared to stretching with heat.

Methods

This was a quasi-experimental study[6] where students from a physical therapy school in Quezon City who were determined to have tightness of the hamstring muscle were randomized to receive hot or cold packs thrice weekly for four weeks prior to stretching the muscle. The range of motion of knee extension with 90º hip flexion (active knee extension) was measured at baseline, weekly and at the end of the treatment period. The post-treatment range of motion was compared with the baseline within and between the two study groups. The study was approved by the Ethics Review Committee.

First year BS Physical Therapy students during school year 2014-2015 were invited to participate in the study. Those who agreed were evaluated by a licensed physical therapist for hamstring muscle tightness through an active knee extension (AKE) test.[7,8] The range of motion of the knee joint was measured with a small plastic goniometer.[9,10,11] Informed consent was obtained from those with hamstring muscle tightness who agreed to join the study. The baseline range of motion was determined by a licensed physical therapist and recorded. The subjects were randomly assigned to receive a cold pack (intervention) or a hot pack (control) prior to stretching.

Ice wrapped in two layers of towel or ice towel was applied for 20 minutes to the muscle belly of the posterior thigh of the cold group. A hot moist pack wrapped in a towel with seven layers was applied for 20 minutes to the muscle belly of the posterior thigh of the heat group.[12] Stretching of the hamstring muscle was performed on both groups immediately after the application of the modalities. A 15-second stretch with 10 repetitions at 3-5 second intervals[13,14] was done by the physical therapist. The sessions were conducted three times a week for four weeks.[15-18] The range of motion of the subjects was measured right after stretching every third day of treatment of the week by another licensed physical therapist blind to the modality of treatment and was recorded by the researchers.

The subjects were given a seven day rest after the last day of treatment. No specific instructions given to the subjects for the seven day rest. After seventh day, the range of motion of knee extension with 90° of hip flexion was again measured by a licensed physical therapist to evaluate whether the subjects sustained the effect of the four week stretching intervention.

A paired t-test was used to compare the ROM of the subject's hamstrings before and after the treatment.[19] An unpaired t-test was used to compare the ROM of the hamstrings of the hot and cold groups.[20]

Results

Out of 196 students invited, 26 students agreed to be screened. Twenty-one of them fulfilled the criteria for participation and 20 students completed all sessions required.

As seen in Table 1, both modalities resulted in an increase in the range of motion from the initial to the week 4 determination. The final range of motion assessment was similar for the cold and hot groups. Interestingly, both groups showed a decrease at week 3. The difference between the final and initial assessment was larger in the cold group compared with the heat group (13.5º vs 9.5º) but when the mean difference was compared between the two groups, an unpaired t-test showed that the difference was significant (Table 2).

Table 1. Range of motion (ROM) of the subjects in the cold and hot groups per week.

	Cold	Hot	p value*
Initial assessment	65.0±5.77°	67.5±7.17°	0.21
Week 1	67.8±4.41°	69.0±11.01°	0.65
Week 2	77.0±6.75°	82.0±6.33°	0.10
Week 3	73.1±7.96°	71.9±7.56°	0.68
Week 4	81.0±7.38°	85.6±5.27°	0.20
Final assessment	78.5±7.09°	77.0±9.19°	0.59

* Unpaired t-test

Table 2. Comparative effect of hamstring flexibility with cooling modality and hamstring flexibility with heating modality.

	Cold	Hot	p value*
Initial ROM assessment	65.0±5.77	67.5±7.17	
Final ROM assessment	78.5±7.09	77.0±9.19	
Difference	13.5	9.5	0.04**
p-value	0.01*	0.07*	

* Paired t-test
** Unpaired t-test

Discussion

The physiologic effects and clinical application of heating and cooling modalities are well-documented in literature regarding their use as physical agents used in PT rehabilitation. While both modalities cause thermal sensory reactions with an initial period of thermal shock, beyond this sensory experience, heat and cold cause very different physiologic reactions. Superficial heating modalities cause localized sweating and erythema from vasodilation of the underlying vessels due to axonal reflexes and the release of dilating hormones such as histamine and bradykinin. Cold on the other hand causes blanching with piloerection, with vasoconstriction stemming from the inhibition of histamine release as an autonomic response causing a localized restriction in blood flow in an attempt to preserve heat. Heat also causes analgesia, local muscle relaxation and an increase in metabolic activity. Cryotherapy alters synaptic activity, slowing nerve conduction such that it also causes a reduction in muscle activity and analgesic effects, it conversely lowers metabolic activity in the area being treated, the complete opposite to the effect of heat.[21]

As such, both modalities have been used in increasing muscle flexibility as an adjunct to stretching or other flexibility exercises. Heat, with its properties of relaxing muscle and improving blood flow allows a muscle to lengthen more easily in addition to its analgesic properties. Cold, with its ability to inhibit stretch reflex and pain, inhibiting the protective responses of muscle spindles and golgi tendon organs, also promotes increased flexibility.[22] While decreasing spindle afferent reflex mechanism and subsequently, skeletal muscle activity may seem to predispose muscle to injury, the use of gentle passive stretching instead of high intensity flexibility exercises modulates this risk. In fact, protocols exist for improving muscle flexibility using cold as an adjunct have been shown to be safe with minimal risk of injury.[23]

Studies show conflicting results of to the efficacy of each modality in its ability to effectively increase muscle flexibility. Several studies, such as a systematic review of 36 different studies rule in favor of heat in combination with stretching as the most effective intervention.[24] As such, heat is still the modality of choice to combine with stretching, relegating cold to the treatment of acute injury. It is most useful for facilitating a reduction of pain and inflammation, resulting in a faster recovery and return to activity for both acute and chronic conditions.[25] Still other studies see no significant difference between heat and cold application, but are in agreement that either modality used in combination with stretching is more effective than stretching alone in improving muscle extensibility.[26] A 2014 study by Park, Kwon, Weon, Choung and Kim however found that the application of local cryotherapy improved both passive and active ROM in subjects with tight muscles by reducing stretch sensitivity and increasing pressure pain threshold, even without stretching maneuvers.[27]

From the results of the study, both groups showed a gradual increase in the post-intervention range of motion over a period of 4 weeks. Subjects sustained some degree of increased extensibility even after a one week washout period where no intervention was applied. There was however a slight drop-off during the week 3 post intervention assessment where a replacement conducted the assessment as the regular assessor was unavailable. This change can be attributed to human error as the return of the regular assessor a week later resumed the upward trend of

improved hamstring ROM. While the inter-rater and intra-rater reliability of goniometry is strong and well-documented, these findings are true for assessors with a certain threshold of experience.[12] Given that the replacement assessor had less than a year of work experience as a licensed PT, the lack of experience in utilizing goniometry may have caused some inter-rater error between measurements.

Between the application of superficial heat via hot moist packs and superficial cryotherapy via cold packs, it can be seen from the results that cold application in addition to gentle stretching maneuvers had a significant change in hamstring flexibility compared with heat application. In addition, a comparison between the overall changes in ROM between the two treatments yielded a statistically significant difference between cryotherapy and superficial heat application. From these results, it can be inferred that cryotherapy with stretching is more effective in improving hamstring flexibility.

These findings were consistent with a flexibility regimen that uses cold to improve ROM gains and recovery in acute and chronic pathologies, a technique called cryokinetics.[28] This method had been shown to be effective in regaining lost ROM early in the disease or injury process by using numbness to mask the pain and discomfort caused by the injury or pathology. The authors, however; warned that the exact nature and extent of the injury needed to be known first so as not to exacerbate the condition and to promote better patient safety. In other studies, a combination therapy has been shown to be effective. The application of a cold pack after hot moist pack application has been shown to be more effective than either heat or cold application alone in improving restricted passive knee ROM.[29] The technique, called cryostretch, uses the same principles of reducing muscular resistance to stretch by masking the pain and discomfort of the stretch by reducing the sensitivity of skeletal muscle to lengthening maneuvers.

The study showed that cold was the superior intervention. However application of cold modality and the techniques of cryokinetics and cryostretch carry with it a risk of injury if applied without caution. Due to the reduction of muscle activity and protective reflexes, there is a danger of further trauma and tissue damage. Prolonged application of cold also reduces skeletal muscle metabolism and force generating capacity, as well as a risk of frostbite and neural damage. Heat carries the same burden of causing burns and tissue damage with prolonged exposure, as well as hastening the effect of exercise fatigue and hyperthermia, its musculoskeletal and neuromuscular physiologic effects keep protective reflexes intact that prevent muscle overstretching or the muscle from generating too much tension.

Each modality comes with its own advantages and disadvantages, and based on the conflicting results of studies previously done regarding these physical agents, both can be considered equally effective. The result of thus current study indicates that the cold modality was the more effective intervention compared to heat when it comes to resolving ham-string muscle extensibility problems, although it is not without its risks and precautions. However, it should be noted that these results were drawn from subjects with no pathologic or underlying disease.

The researchers conclude that cryotherapy is more effective than thermotherapy prior to static stretching. They recommend its use on the involved muscle group prior to static stretching on non-pathologic clients between the ages of 16-18 years. This current study gives therapists and other professionals who use physical agents another different, yet effective modality to consider when treating clients who wish to regain or improve their muscle extensibility. This benefits both the professional practitioner as well as the end user of physical rehabilitation services.

References

1. Bleakley C, Davison G. What is the biochemical and physiological rationale for using cold water immersion in sports recovery? A systematic review. British Journal of Sports Medicine 2009; 44: 179-87.
2. Woods K, Bishop P, Jones E. Warm-up and stretching in the prevention of muscular injury. Sports Medicine 2007; 37(12): 1089-99.
3. Ranalli G, DeMartini J, Casa D, McDermott B, Armstrong L, Maresh C. Effect of body cooling on subsequent aerobic and anaerobic exercise performance: A systematic review. Journal of Strength & Conditioning Research 2010; 24(12): 3488-96.
4. Duffield R, Green R, Castle P, Maxwell N. Precooling can prevent the reduction of self-paced exercise intensity in the heat. Medicine and Science in Sports and Exercise 2010; 42(3): 577-84.
5. Brodowicz GR, Welsh R, Wallis J. Comparison of stretching with ice, stretching with heat, or stretching alone on hamstring flexibility. Journal of Athletic Training 1996; 31(4): 324-7.
6. Harris AD, McGregor JC, Perencevich EN, Furuno JP, Zhu J, Peterson DE, Finkel-stein J. The use and interpretation of quasi-experimental studies in medical informatics. J Am Med Inform Assoc 2006; 13(1): 16-23.

7. Norris CM, Matthews M. Inter-tester reliability of a self-monitored active knee exten-sion test. Journal of Bodywork and Movement Therapies 2005; 9(4): 256-9.
8. Norkin C, White DJ. Measurement of Joint Motion: A Guide to Goniometry. 4th ed. Philadelphia, PA: Margaret Biblis; 2009.
9. Hsieh CY, Walker JM, Gillis K. Straight-leg-raising test: Comparison of three in-struments. Phys Ther J 1983; 63(9): 1429-33.
10. Adams PS, Keyserling WM. Three methods for measuring range of motion while wearing protective clothing: A comparative study. Int J Industrial Ergonomics 1993; 12(1): 177-91.
11. Rothstein JM, Miller PJ, Roettger RF. Goniometric reliability in a clinical setting: Elbow and knee measurements. Phys Ther J 1983; 63(10): 1611-5.
12. Taylor BF, Waring CA, Brashear TA. The effects of therapeutic application of heat or cold followed by static stretch on hamstring muscle length. JOSPT 1995; 21(5): 283-6.
13. Kisner C, Colby LA. Therapeutic Exercise. 6th ed. Philadelphia: Margaret Biblis; 2013.
14. Odunaiya NA, Hamzat TK, Ajayi OF. The Effects of static stretch duration on the flexibility of hamstring muscles. African J Biomed Res 2005; 8(1): 79-82.
15. Decoster LC, Cleland J, Altieri C, Russell P. The effects of hamstring stretching on range of motion: A systematic literature review. J Orthop Sports Phys Ther 2005; 35(6): 377-87.
16. Guissard N, Duchateau J. Effect of static stretch training on neural and mechanical properties of the human plantar-flexor muscles. Muscle & Nerve 2004; 29(2): 248-55.
17. Harvey L, Herbert R, Crosbie J. Does stretching induce lasting increases in joint ROM? A systematic review. Physiotherapy Research International 2002; 7(1): 1-13.
18. Knudson D, Magnusson P, McHugh M. Current issues in flexibility fitness. President's Council on Physical Fitness and Sports Research Digest 2000; 3(9): 1-8.
19. Wilkerson S. Application of the paired t-test. Xavier University of Louisiana's Undergraduate Research Journal 2008; 5(1): 1-5.
20. McCluskey A, Lalkhen AG. Statistics IV: Interpreting the results of statistical tests. BJA: CEACCP 2007; 7(6): 208-12.
21. Hecox B, Mehreteab TA, Weisberg J. Integrating Physical Agents in Rehabilitation. 2nd ed. Upper Saddle River, NJ: Pearson/Prentice Hall; 2005.
22. Behrens BJ, Michlovitz SL. Physical Agents: Theory and Practice. 2nd ed. Philadelphia: F. A. Davis Company; 2005.
23. Pinto J. A comparative study on the effectiveness of cryotherapy with that of the superficial heat in combination with electrical stimulation and stretching in reducing spasticity of plantar flexors in children with spastic cerebral palsy. Retrieved from: http://14.139.159.4:8080/jspui/bitstream/123456789/7480/1/Jyothi%20CD%20Document%20final%20final.pdf. [Accessed August 2014].
24. Bleakley CM, Costello JT. Do thermal agents affect range of movement and mechan-ical properties in soft tissues? A systematic review. Arch Phys Med Rehab 2013; 94: 149-63.
25. Swenson C, Sward L, Karlsson J. Cryotherapy in sports medicine. Sc and J Med Sci Sports 1996; 6(4): 193-200.
26. Khan S, Shamsi S, Alyaemni A. A Comparison of superficial heat, deep heat and cold for improving plantar flexors extensibility. Middle-East J Sci Res 2013; 13(4): 477-82.
27. Park K, Kwon O, Weon J, Choung S, Kim S. Comparison of the effects of local cryotherapy and passive cross-body stretch on extensibility in subjects with posterior shoulder tightness. J Sports Sci Med 2014; 13: 84-90.
28. Cameron MH. Physical Agents in Rehabilitation: From Research to Practice. 4th ed. St. Louis, Missouri: Elsevier; 2012.
29. Lin Y H. Effects of thermal therapy in improving the passive range of knee motion: comparison of cold and superficial heat applications. Clin Rehab 2003; 17(6): 618-23.