Effect of superficial pre-cooling on a hamstring stretching protocol

Kristin Orwig

Medical University of Ohio

Follow this and additional works at: http://utdr.utoledo.edu/graduate-projects
Effects of Superficial Pre-cooling on Hamstring Stretching Protocol

Submitted by

Kristin Orwig

Date of Presentation
June 29, 2005

In partial fulfillment of the requirements for the degree of
Master of Science in Biomedical Sciences

Academic Advisory Committee

Major Advisor
Daniel Cipriani, III, Ph.D., P.T.

Department Chairperson
Clayton Holmes, Ed.D., P.T.

Dean, College of Health Sciences
Christopher E. Bork, Ph.D., P.T.

Dean, College of Graduate Studies
Keith K. Schlender, Ph.D.
Effect of Superficial Pre-Cooling on a Hamstring Stretching Protocol

Kristin Orwig
June 13, 2005

Conducted in Cooperation with the Medical University of Ohio
Department of Physical Therapy
3000 Arlington Ave.
Toledo, OH 43614

To meet the requirements of
Masters of Science in Biomedical Sciences with a concentration in Physical Therapy

Advisor: Daniel Cipriani PhD., P.T.
**Acknowledgements**

I would like to thank Daniel Cipriani, PhD., P.T. for all of his insight and statistical calculations he provided as well as Justin Wilson and Jessica Rancour for all their time and support with measurements throughout the study. Thanks to The Medical College of Ohio Nursing School and School of Allied Health awarding us the $130.00 Research Award Grant, which enabled us to purchase the comfort gel packs from Accurate Therapeutic Supply, Swansea, S.C. I would finally like to thank, Koroshi, Inc. in Toledo, OH for the generous $6,000 grant they funded to provide one-month of free training for each subject who completed the study.
Abstract

According to past studies, only approximately 35% of patients fully adhere to their home exercise programs. Due to this low rate of compliance to home exercise programs and the importance of gaining and maintaining range of motion in order to return to functional activities after an injury, it is important for clinicians to know how long the effects of static stretching will last after the cessation of the stretching program. The purpose of this study was to compare the gains and losses in range of motion achieved by static stretching alone versus pre-cooling the muscle prior to stretching. Subjects were randomly assigned to the standard group or to the pre-cool group. Each subject performed two standing single leg hamstring stretches for 30 seconds, twice a day on each leg for a total stretching time of two minutes on each leg. Prior to stretching, the pre-cool group placed a cold gel pack on their hamstring for ten minutes. Subjects followed their assigned protocol everyday for four weeks, with cessation of the stretching program occurring during the next four weeks. Hip flexion range of motion measurements were taken once a week on each subject for nine consecutive weeks. All subjects made significant gains and losses throughout the study (p<.05). However, there was not a significant difference in range of motion between the standard and pre-cool group (p>.05). Therefore pre-cooling the muscle prior to stretching did not have a greater effect on increasing range of motion or retaining range of motion compared to stretching alone. These findings remain to be relevant in the rehabilitation setting, therefore clinicians may be advised that pre-cooling the muscle prior to stretching would be an inefficient use of valuable treatment time, increase the patient’s risk to skin irritation, and possibly decrease patient compliance if the ice makes the patient uncomfortable
Introduction

Muscle stretching is a common practice incorporated into therapeutic exercise programs for recreational or competitive athletes as well as patients in rehabilitation. Stretching is utilized to increase the range of motion of a body segment in order to reinstate function after injury or to allow for more functional movement with activities. Research supports that stretching produces an increase in range of motion (increased flexibility) at a joint by increasing stretch tolerance. Stretching has become popular among a widely diverse population due to the physical benefits it offers to both healthy and injured individuals.

The application of superficial modalities such as ice or heat has been utilized as a common form of treatment by clinicians, trainers, and the general population. Cryotherapy, or therapeutic tissue cooling, is believed to relieve pain by inducing local analgesia to the superficial muscles and known to decrease edema, inflammation, blood flow, metabolic rate, and nerve conduction velocity. In a rehabilitation setting, cryotherapy is used to assist in alleviating musculoskeletal problems by decreasing pain, swelling, and/or muscle spasms. Cryotherapy may further be used therapeutically in combination with stretching in order to override pain impulses being sent to the central nervous system with cold impulses. This phenomenon, theoretically allows the patient to stretch to a greater degree without feeling an increase in pain. Previous research has shown that cryotherapy applied prior to stretching decreases sensory input, pain, and stretch reflex assisting patients in increasing the range of motion of a joint.
Cryotherapy has also been found to decrease muscle spindle activity which assists patients in an enhanced stretch due to the decrease in muscle spasms.\textsuperscript{7,10} This decrease in muscle spasms is thought to lessen the discomfort felt by patients to allow for a better stretch with decreased pain. Past studies have proven this decrease in muscle activity via electromyographical studies which have recorded a decrease in muscle tension with the application of a cold superficial modality.\textsuperscript{6,7}

Muscle tension can be decreased through the use of cryotherapy in order to increase muscle flexibility as well as increasing the range of motion at the joint.\textsuperscript{7,10} Prior studies have supported this finding stating that cold followed by stretch decreased the tension of the muscle.\textsuperscript{7} Lentell et al also found a further increase in shoulder range of motion when ice was used during static stretching, than just stretching alone.\textsuperscript{9}

Stretching and cryotherapy could be combined therapeutically to decrease a patient’s pain and/or muscle spasms in order to obtain a better stretch and an increase in range of motion compared to stretching alone. Patients are likely to perform stretching exercises during the time they are being monitored by a therapist. However, after their symptoms have subsided and they are discharged from therapy, many patients do not comply with part or the entire home exercise program.\textsuperscript{16} In actuality, continued compliance with home exercise programs after being discharged from therapy has been found to be as low as 35\%.\textsuperscript{16} Studies have assessed the retention of range of motion after a stretching program and found that joint range of motion declines after the cessation of a stretching program.\textsuperscript{15,16,17} One study showed that subjects returned to base-line after only four
weeks of cessation from the stretching program. However, not one of these studies considered retention after the utilization of a static stretching program in combination with cryotherapy. Hypothetically, cold inhibits pain and muscle spasms allowing a patient to reach a farther, deeper stretch and possibly longer retention in range of motion. Using cryotherapy with stretching may not only help to increase the range of motion gained at a joint, but also help to retain greater range of motion after the cessation of stretching.

The purpose of this study was to assess the effects of superficial cooling with static stretching. The researchers monitored the rate of change in range of motion during and after a stretching program in combination with ice compared to a stretching program alone. The researchers had two hypotheses. The first hypothesis was that the pre-cool group would gain more range of motion than the stretch-only group during the four-week stretching program. The second hypothesis was that the pre-cool group would retain a greater amount of range of motion than the stretch-only group after four weeks of not stretching.

**Methods**

**Subjects**

Subjects consisted of students and faculty members of the Medical College of Ohio and the general population of Toledo, OH. All subjects were free from any lower extremity injury over the past year and not already participating in a stretching program. Subjects were randomly assigned to either the standard stretching group or the pre-cool stretching
group. To allow for randomization, each subject drew a slip of paper marked “standard” or “pre-cool” and assigned to the determined stretching protocol. Prior to beginning the study all subjects signed an approved informed consent form for the Medical College of Ohio’s Institutional Review Board for Human Subjects.

**Stretching Protocol**

Subjects were instructed on how to perform a standing, single-legged stretch of the hamstring muscles using the proper stretching technique.³ The subjects were instructed to reach with bilateral upper extremities while flexing at the hips until moderate discomfort was felt in the posterior thigh. If the discomfort reduced during the 30 seconds of stretching, the subjects were instructed to reach further forward until moderate discomfort in the posterior thigh was felt again. Figure 1 illustrates the stretching position. All individuals performed two 30-second stretches to the hamstring muscles of bilateral lower extremities with the subject taking a short five second rest in between each stretch. Stretching was repeated twice daily at least four hours apart for a total of four 30-second stretches per day to each hamstring muscle group. Both the pre-cool and standard groups followed the hamstring stretching protocol as described above. Subjects in the pre-cool group applied a 9”x 12” Comfort Gel Cold Pack (Accurate Manufacturing Supply in Swansea, SC) directly to the skin in the middle of bilateral hamstring muscle groups for ten minutes immediately preceding the standing, single legged stretch (subjects were given two gel packs one for each leg). Subjects in the pre-cool group were advised that a layer or two of paper towels could be placed between the gel pack and their skin if any skin irritation was experienced from the gel pack. All subjects in both groups
stretched seven days a week for four weeks. After four weeks of stretching, both groups (standard and pre-cool) stopped all stretching for the next four weeks. Table 1 is a summary of the protocols followed by each group. Subjects in the pre-cool and standard groups were given a monthly calendar in addition to performing the stretching protocol, in order to record stretching each day. The calendar was utilized to assess each subject’s adherence to the stretching protocol.

Table 1: Stretching Protocols for Each Group

<table>
<thead>
<tr>
<th>Standard Stretching Group</th>
<th>Pre-Cool Stretching Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stretch for 30 seconds</td>
<td>Place each cold gel pack to hamstrings of each leg for 10 minutes prior to stretching</td>
</tr>
<tr>
<td>Repeat stretch twice on each leg</td>
<td>Stretch for 30 seconds</td>
</tr>
<tr>
<td>Rest for 5 second between each stretch</td>
<td>Repeat stretch twice on each leg</td>
</tr>
<tr>
<td>Repeat protocol twice a day</td>
<td>Rest for 5 second between each stretch</td>
</tr>
<tr>
<td>Stretch 7 days a week for 4 weeks</td>
<td>Repeat protocol twice a day</td>
</tr>
<tr>
<td>Do not perform any stretching weeks 5-8</td>
<td>Stretch 7 days a week for 4 weeks</td>
</tr>
<tr>
<td></td>
<td>Do not perform any stretching weeks 5-8</td>
</tr>
</tbody>
</table>

Figure 1: Single-Legged Stretch Method
Measurement

Hamstring range of motion was measured using a straight-leg raise position (Figure 2). Each subject was measured in the supine position on an Adapta Treatment Table (Chattanooga Cooperation in Chattanooga, TN). Bilateral lower extremities of each subject were measured for straight leg raise range of motion at the hip by a physical therapy student who was previously instructed on the proper measurement by a licensed physical therapist. Measurements were obtained using a standard 12-inch Jamar Goniometer (Jacksonville, FL). The same individual performed all measurements for both groups and was blind as to which group each subject belonged. The measurer took an initial measurement of each subject prior to beginning the study to serve as a base line for each subject. Eight additional measurements were taken, one for each week of the study. Past research suggests that the time of day can affect muscle length differently, therefore hip range of motion measurements were taken on the same day each week and at approximately the same time.³⁵ The subject’s leg being measured was raised and held into position by another physical therapy student. The same student raising the leg being measured, also stabilized the leg not being measured, on the treatment table, to allow for the proper positioning of bilateral lower extremities. The measurement position was based on obtaining a firm end feel or by a verbal report from the subject to stop. Only measurements of the right lower extremity were utilized due to bilateral similarities possessed by individuals (the researchers found no significant difference between right and left lower extremity range of motion). Degree measures were recorded by a third physical therapy student.
Statistical Analyses

The reliability of the data analysis was performed by a blinded investigator and was calculated utilizing the intraclass correlation coefficient (ICC), using the pretest measurements of the subjects. The ICC (2,1) was found to be .95 with a 95% confidence interval (CI95=.91, .97). A two-factor (9x2) ANOVA was used to determine if an interaction existed between time and intervention. In addition, separate simple repeated measures ANOVA were used to test the main effect of time for each group (p-value <.05).

Results

Thirty-one healthy individuals volunteered for the study with twenty-nine subjects participating in the study. Two subjects were dropped from the study. One subject was dropped due to non-compliance with the stretching protocol and the other subject was
dropped due to a pre-existing back injury with no relation to the stretching program. Fourteen subjects were assigned to the standard group, with 9 female and 5 male (mean age = 24.6 years, SD = 5.4, range = 21-41 years of age). Fifteen subjects were assigned to the pre-cool group, with 8 female and 7 male (mean age = 25.1 years, SD = 7.3, range = 18-48 years of age).

The mean values for both individual stretching protocols for the pre-stretch measurement and at each week are displayed in Table 2. The hamstring range of motion values were examined from the pre-stretching measurement to the end of the stretching protocol (week 4). The standard group increased from 71.36° to 90.57° for a mean difference of 19.21°, and the pre-cool group increased from 71.47° to 91.80° for a mean difference of 20.33°. From week 4 to week 8 after the cessation of both stretching protocols, the standard group declined in range of motion from 90.57° to 83.93° for a mean difference of 6.64°, and the pre-cool group declined in range of motion from 91.80° to 85.00° for a mean difference of 6.80°. A two-factor (9x2) ANOVA was used to determine if an interaction existed between time and intervention. The pre-test measurements from the two groups were not significantly different (p >.05), which is expected with a randomized study. After finding no problems with the normality of the data, separate, simple repeated measures ANOVA were utilized to test the main effect of time for each group. The analysis showed that both groups had significant gains and losses in ROM (p <.05), but the changes occurring in hip range of motion were not dependent of each other (F = 1.708, df = 8, 20, p >.05). Figure 3 displays the weekly measurement comparison.
between the pre-cool and the standard stretching group. The figure shows similar gains and losses in hip range of motion between the two groups.

Table 2: Mean Values According to Stretch Method

<table>
<thead>
<tr>
<th>Type of Stretch</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>71.35</td>
<td>18.57</td>
<td>14</td>
</tr>
<tr>
<td>Pre-cool</td>
<td>71.46</td>
<td>22.26</td>
<td>15</td>
</tr>
<tr>
<td>WEEK1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>76.71</td>
<td>17.14</td>
<td>14</td>
</tr>
<tr>
<td>Pre-cool</td>
<td>78.80</td>
<td>21.68</td>
<td>15</td>
</tr>
<tr>
<td>WEEK2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>82.35</td>
<td>21.22</td>
<td>14</td>
</tr>
<tr>
<td>Pre-cool</td>
<td>81.47</td>
<td>22.05</td>
<td>15</td>
</tr>
<tr>
<td>WEEK3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>83.71</td>
<td>19.12</td>
<td>14</td>
</tr>
<tr>
<td>Pre-cool</td>
<td>90.47</td>
<td>21.67</td>
<td>15</td>
</tr>
<tr>
<td>WEEK4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>90.57</td>
<td>20.47</td>
<td>14</td>
</tr>
<tr>
<td>Pre-cool</td>
<td>91.80</td>
<td>20.96</td>
<td>15</td>
</tr>
<tr>
<td>WEEK5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>88.57</td>
<td>20.48</td>
<td>14</td>
</tr>
<tr>
<td>Pre-cool</td>
<td>88.80</td>
<td>18.16</td>
<td>15</td>
</tr>
<tr>
<td>WEEK6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>85.93</td>
<td>18.65</td>
<td>14</td>
</tr>
<tr>
<td>Pre-cool</td>
<td>89.07</td>
<td>19.89</td>
<td>15</td>
</tr>
<tr>
<td>WEEK7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>84.79</td>
<td>18.99</td>
<td>14</td>
</tr>
<tr>
<td>Pre-cool</td>
<td>88.93</td>
<td>19.54</td>
<td>15</td>
</tr>
<tr>
<td>WEEK8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>83.93</td>
<td>20.30</td>
<td>14</td>
</tr>
<tr>
<td>Pre-cool</td>
<td>85.00</td>
<td>19.38</td>
<td>15</td>
</tr>
</tbody>
</table>
Figure 3: Weekly ROM Measurements

Pre-cool Stretching vs. Standard Stretching on Hip Flexion ROM

Discussion

Previous studies have shown that static stretching can increase the range of motion at a moveable joint.\textsuperscript{3,16} Data obtained from this study further supports this finding with the focus of motion at the hip joint. Week four measurements from the two groups showed improved hip range of motion with the standard group increasing by 19.21° and the pre-cool group increasing by 20.33°, but no significant difference between the two protocols was found after examining the simple, repeated measures ANOVA (F= 1.708 and p >.05). This reinforced the findings that static stretching increases range of motion at a moveable joint. However, since there was no significant difference between the groups at week four, our hypothesis that superficial pre-cooling would increase hip range of motion greater than the standard group was not supported. Similar findings stating that superficial pre-cooling did not significantly increase the range of motion gained by static stretching were reported by Taylor, Waring, and Brashear.
When comparing the two stretching methods from week 4 to week 8, the two groups declined at similar rates with changes in range of motion not being dependent on which group the subject was in (F= 1.708 and p >.05). Therefore the second hypotheses stating that pre-cooling the muscle will slow the loss of range of motion of the hamstrings, were also not supported.

The data obtained did not agree with previous studies done on increasing range of motion via pre-cooling and static stretching. This variance in findings may be due to the stretching regimen utilized. The stretching protocol used was very vigorous with the subjects performing two 30 second static stretches twice a day. The subjects were also instructed that if there was a decrease in discomfort during the stretch, they needed to reach further forward into a deeper stretch until the moderate discomfort in the posterior thigh was experienced again.

Even though neither hypothesis was supported, this study remains to be relevant especially in the rehabilitation setting. Because the results show that pre-cooling the muscle before stretching did not have a greater effect on increasing ROM or retaining ROM than the standard stretch group, clinicians may be advised that pre-cooling the muscle prior to stretching would be an inefficient use of valuable treatment time, increase the patient’s risk to skin irritation (i.e. if ice left on too long or patient is hypersensitive to cold), and possibly decrease patient compliance if the ice makes the patient uncomfortable.
Future studies should focus more on subjects that have increased pain with stretching and how pre-cooling the muscle prior to stretching affects the subject’s pain. In theory, the cryotherapy is used as a local analgesia in order to override the pain impulses being sent to the central nervous system with cold impulses thus decreasing the subject’s pain. If this study was completed and yielded an accepted hypothesis, this could be of great clinical relevance for post-operative orthopaedic patients experiencing increased pain following surgery. Pre-cooling prior to stretching the painful area will therefore allow the patient to experience a more comfortable stretch and possibly increase the patient’s compliance with a home stretching program. Cryotherapy can also assist in decreasing edema and inflammation to the post-operative area and aid in the recovery process. Future research needs to be completed to determine the relevance of this focus area.

**Conclusion**

Overall, range of motion can be increased at a moveable joint by static stretching alone or in conjunction with cryotherapy. However, using ice in conjunction with static stretching yielded no better results than stretching alone. By not utilizing ice prior to a static stretch, clinicians can avoid using valuable treatment time inefficiently, avoid any possible irritation to the patient’s skin, and/or avoid using ice on a patient who is hypersensitive to cold temperatures. Future research should be done on the benefits of ice prior to stretching focusing on whether cryotherapy can assist in decreasing a patient’s pain prior to stretching allowing for a more comfortable stretch.
References


