The Effects of Intermittent Stretching Following a 4-Week Static Stretching Protocol: A Randomized Trial

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Abstract

Rancour, J, Holmes, CF, and Cipriani, DJ. The effects of intermittent stretching following a 4-week static stretching protocol: A randomized trial. J Strength Cond Res 23(8): 2217–2222, 2009—Stretching is performed in rehabilitation and sports conditioning programs. It is not known how often during a week stretching needs to be performed to maintain flexibility. Therefore, the purpose of this study was to determine the influence of intermittent stretching (i.e., 2–3 days/week) on hip range of motion (ROM) following a 4-week, daily stretching program. This study used a randomized, single-blind, test–retest design. Healthy adult subjects, age 18 to 50 years, were randomly assigned to 1 of 2 static stretching protocols: (a) standard protocol or (b) intermittent protocol. All subjects stretched their hamstrings daily for the first 4 weeks. The standard group discontinued all stretching after 4 weeks. The intermittent group continued to stretch 2 to 3 days per week for an additional 4 weeks. All subjects were measured for hip ROM weekly for the full 8 weeks. Thirty-two subjects completed the study (standard group = 14; intermittent group = 18, mean age 24.6 years). Mean hip ROM increased (p < 0.05) for both groups from before protocol (PRE) to Week 4 (standard group gain from 71.4 ± 18.5 degrees to 90.6 ± 20.5 degrees and intermittent group gain from 68.6 ± 15.7 degrees to 89.1 ± 16.8 degrees). During the final 4 weeks, mean hip ROM decreased (p < 0.05) for the standard group from 90.6 ± 20.5 degrees to 83.9 ± 20.3 degrees. Mean hip ROM for the intermittent group did not decrease during the final 4 weeks of the study (89.1 ± 16.8 degrees to 93.2 ± 14.9 degrees, p > 0.05). Intermittent stretching (i.e., 2 or 3 days/week) is sufficient to maintain ROM gains acquired from a prior static stretching program. Clinicians and trainers may educate their clients of the benefits of intermittent stretching to maintain flexibility.

Key Words: flexibility, hamstring, range of motion

Introduction

Static stretching is an integral component of rehabilitation and sports conditioning programs. Research has demonstrated that a stretching frequency of 3 to 5 times per week is sufficient to increase range of motion (ROM) (1–7,11,17,15). However, once a stretching program has been discontinued, individuals may lose all or some of the gains made during the stretching program (15,16,18). It is currently unclear as to how often a stretch needs to be performed each week, following a weekly stretching program, to maintain the flexibility gained from the initial stretching program. This is of particular interest regarding patients and clients, who presumably on discharge from therapy or a fitness program will not continue with their exercise programs at the same frequency as when supervised.

Several studies have demonstrated that ROM increases following an initial stretching program and it has been shown that ROM declines when stretching is discontinued (1–7, 9,12–16,18). A study by Willy et al. (16) examined the effects of 6 weeks of static hamstring stretching, followed by 4 weeks of cessation from stretching, and another 6 weeks of static hamstring stretching. Results indicated that ROM returned to baseline 4 weeks after stretching was discontinued. The authors concluded that there was no ROM retention following 4 weeks of cessation from stretching and that ROM gains following the subsequent stretching program were no different than those made during the initial stretching program.

Zebas and Rivera (18) performed a similar study examining 6 weeks of static stretching followed by 4 weeks of cessation from stretching. Results revealed that ROM decreased but remained above baseline following 4 weeks of cessation from stretching. The authors concluded that ROM was partially maintained 4 weeks following an initial stretching program.
Willy et al. (16) and Zebas and Rivera (18) only looked at the effects of total cessation from stretching. Neither study examined the effects of continued intermittent stretching.

The study of Wallin et al. (15) is the only one identified that examined the effects of intermittent stretching following an initial stretching program. Wallin et al. (15) examined 4 weeks of stretching, followed by 4 weeks of intermittent stretching (with groups stretching 1, 3, or 5 days per week). Results demonstrated that stretching 1 day per week was enough to maintain ROM gains, whereas stretching 3 or 5 days per week allowed for further ROM gains to be attained. Unfortunately, Wallin et al. (15) did not utilize a control group to test the effects of intermittent stretching, and the initial stretching program was only performed 3 days per week. Hence, the minimal initial gains in ROM may not have been sufficient to adequately test the effectiveness of an intermittent program.

Because of the limitations of Wallin et al. (15) and the current lack of research regarding intermittent stretching, the purpose of this study was to determine the influence of intermittent stretching (i.e., 2 or 3 days per week) on hip ROM following a 4-week daily stretching program. By adding a comparison group, this study tested the effects of intermittent stretching on the range of motion gains achieved by a high-frequency (i.e., daily) stretching program. In addition, this current study obtained measurements each week, rather than at the end of a 4- to 6-week period. Hence, this current study was able to document weekly changes in ROM from the onset of the intervention.

METHODS

Experimental Approach to the Problem

This was an 8-week study, which used a prospective, randomized, single-blind test–retest design. Subjects were randomly assigned to 1 of 2 static stretching groups: A standard stretching group or an intermittent stretching group. The first 4 weeks of the study called for both groups to stretch their hamstrings on a daily basis. The final 4 weeks of the study called for the standard group to cease all hamstring stretching, whereas the intermittent group continued to stretch 2 or 3 days per week.

Subjects

Thirty-five healthy adult subjects volunteered to participate in this study. Thirty-two subjects completed the study (3 subjects did not complete the study for personal reasons). A sampling of convenience was used, with subjects consisting of Medical University of Ohio students, employees, and relatives. All subjects signed an informed consent form that was approved by the Medical University of Ohio Institutional Review Board. Subjects were included in the study if they were 18 to 50 years old and not currently involved in a hamstring stretching program. Subjects were excluded from the study if they were pregnant, had a current injury, or reported current musculoskeletal pain. Subjects were permitted to stretch their hamstrings during designated times only, but no other restrictions were placed on their activities of daily living (ADLs) or recreational activities.

Prior to the study, subjects were randomly assigned to 1 of 2 stretching groups: (a) The standard group and (b) the intermittent group. The standard group consisted of 14 subjects (9 females, 5 males), and the intermittent group consisted of 18 subjects (12 females, 6 males). Table 1 provides subject demographics. Random assignment resulted in age-matched groups in terms of mean age, minimum age, and maximum age. Random assignment further assured equal groups at baseline in terms of hip ROM measures (Table 2).

Procedures

This study used a standing one-legged hamstring stretch (3). Decoster et al. (4) found that stretching position (i.e., supine, seated, standing) did not make a difference with regard to ROM gains. The single stretch was deemed effective as a comprehensive stretching program because previous studies found that a single stretch is effective at significantly increasing ROM about a joint (1,2,4–7,15,18,20,22). All subjects were instructed on the appropriate stretching procedure prior to the start of the study. First, each subject assumed an upright posture with both feet facing forward. The leg to be stretched was extended and placed on a surface at or slightly below hip level. Subjects were then instructed to keep their back straight, while they hinged forward at their hips, until slight to moderate discomfort was felt in the back of their thigh of the leg being stretched (Figure 1). Subjects were instructed to maintain this position of discomfort throughout the entirety of the stretch.

The stretching protocol during the initial 4 weeks of the study called for both groups to stretch their hamstrings 30 seconds, rest for 10 seconds, and then stretch for another 30 seconds (1–5). This same procedure was then repeated

| Table 1. Descriptions of subject’s height, weight, and age. |
|-----------------|--------------|--------------|--------------|-----------------|
| Group           | Height (inches) | Weight (pounds) | Age (years) | Age range (years) |
| Standard group  | 67.3          | 160.9        | 24.6        | 21.0–41.0        |
| Intermittent    | 68.9          | 150.1        | 24.7        | 22.0–43.0        |
for the contralateral leg. Stretching was performed 2 times per day, with a minimum of 4 hours between stretches. The total stretching time was 2 minutes per leg per day. Stretching was performed daily (i.e., 7 days per week) for the initial 4 weeks of the study. The final 4 weeks of the study had the standard group cease all hamstring stretching, whereas the intermittent group continued the stretching protocol 2 or 3 days per week. Prior to the start of the study, subjects were instructed to keep a log of the times that they stretched to monitor adherence to the stretching program.

A hip ROM measurement of each subject was taken prior to the start of the study (PRE). Hip ROM thereafter was measured at the end of each week of this 8-week study. Hence, all subjects were measured a total of 9 times over the course of this study. Measurements of both right and left lower extremities were recorded, but only measurements of the right lower extremity were analyzed.

For the measurement process, a passive straight leg raise (SLR) was used to measure hip ROM (2). Subjects laid supine on a standard plinth with their knees bent over the edge. One investigator then applied a passive ROM force to each lower extremity (1 at a time) until a firm end feel was noted or when the subject requested to stop. A second investigator then used a standard 12-inch goniometer (Jamar, Miami, Florida) to measure hip flexion using the procedure outlined by Norkin (10) (Figure 2). Both of these investigators were blinded as to which group a subject was in. The second investigator then reported the ROM measurement to the third investigator, who recorded this value. Subjects were not made aware of their hip ROM measures. The third investigator documented all ROM measurements and had sole access to these records. All 3 investigators performed the same duties throughout the duration of this study.

Reliability of the measurement procedure was estimated prior to the beginning of this study. The measuring investigators, prior to the start of the study, measured right lower-extremity hip ROM on a sample of healthy individuals (n = 15). Hip ROM was measured twice in the same day to determine intrarater reliability. The second measurement occurred in a random order, approximately 20 minutes after the initial measurement. Intraclass correlation coefficients (ICC) (2,1) were determined and demonstrated that the investigators provided reliable data with this technique (ICC = 0.95, CI95 = 0.91, 0.97).

### Table 2. Mean hip range of motion (ROM), in degrees, and standard deviation from the PRE measurement through week 8.

<table>
<thead>
<tr>
<th>Week</th>
<th>Standard mean hip ROM (SD)</th>
<th>Intermittent mean hip ROM (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE</td>
<td>71.4 (18.6)</td>
<td>68.6 (15.7)</td>
</tr>
<tr>
<td>Week 1</td>
<td>76.7 (17.1)</td>
<td>76.1 (18.9)</td>
</tr>
<tr>
<td>Week 2</td>
<td>82.3 (21.2)</td>
<td>78.6 (17.9)</td>
</tr>
<tr>
<td>Week 3</td>
<td>83.7 (19.1)</td>
<td>86.4 (17.8)</td>
</tr>
<tr>
<td>Week 4*</td>
<td>90.6 (20.5)</td>
<td>89.1 (16.8)</td>
</tr>
<tr>
<td>Week 5</td>
<td>88.6 (20.5)</td>
<td>91.6 (17.6)</td>
</tr>
<tr>
<td>Week 6</td>
<td>85.9 (18.7)</td>
<td>91.6 (16.1)</td>
</tr>
<tr>
<td>Week 7</td>
<td>84.8 (18.9)</td>
<td>92.4 (16.1)</td>
</tr>
<tr>
<td>Week 8†</td>
<td>83.9 (20.3)</td>
<td>93.2 (14.9)</td>
</tr>
</tbody>
</table>

*Significant difference when compared to PRE measures, independent of group, p < 0.05.
†Significant difference between groups, p < 0.05.
Statistical Analyses
Descriptive statistics were generated for subject details. To test for the possible interaction between stretching protocol and time, a 2-factor analysis of variance (ANOVA) was used. The 2 factors included time (repeated factor of 9 time points) and condition (i.e., standard stretch and intermittent stretch). In the absence of any interaction, the main effects were then tested with ANOVA. If the interaction was significant, separate paired t-tests were run to compare group differences. Planned contrasts were used to test for differences between each time period (e.g., Week 1 to Week 2, Week 2 to Week 3, etc.) for the 2 groups. A p-value of 0.05 was established as the criteria for statistical significance.

RESULTS
The 2-way ANOVA found a significant interaction between group and time, with the hip ROM values of the intermittent group and standard group diverging during the final 4 weeks of the study (Figure 3). Mean hip ROM significantly increased (p < 0.05) for both groups from the PRE measurement to Week 4. The mean hip ROM of the standard group increased from 71.4 ± 18.5 degrees to 90.6 ± 20.5 degrees. The mean hip ROM of the intermittent group increased at a similar rate from 68.6 ± 15.7 degrees to 89.1 ± 16.8 degrees. The hip ROM at Week 4 was not different between the 2 groups (p > 0.05). During the final 4 weeks of the study, mean hip ROM significantly decreased (p < 0.05) for the standard group from 90.6 ± 20.5 degrees to 83.9 ± 20.3 degrees. However, the mean hip ROM for the intermittent group did not decrease during the final 4 weeks. In fact, the intermittent group demonstrated a trend toward increasing ROM from 89.1 ± 16.8 degrees to 93.2 ± 14.9 degrees (Table 2). Finally, the intermittent group's hip ROM was significantly greater than that of the control group (p < 0.05) by the end of Week 8.

Figure 3 illustrates the rate of gain and loss in ROM between the 2 groups over the 8-week period. A consistent weekly gain in ROM is noted during the first 4 weeks; however, the change from week to week was not statistically significant when tested with the planned contrasts. A significant change is not detected until a comparison is made between PRE and Week 4. In addition, during the final 4 weeks of the study (i.e., cessation time and intermittent time), the change in ROM for the standard group (cessation) was not significant on a week-to-week basis until comparing Week 4 with Week 8.

DISCUSSION
The results of this study, which are similar to those found by Wallin et al., indicate that intermittent stretching (i.e., 2 or 3 days/week) will maintain ROM gains made during an initial stretching program. Both of our groups (standard and intermittent) gained similar ROM during the first 4 weeks of the study. However, the intermittent group maintained ROM and demonstrated a possible trend to gain ROM during the final 4 weeks of the study. The standard group lost significant motion during the final 4 weeks. At the conclusion of the 8 weeks, the intermittent group demonstrated
significantly greater hip ROM than the control group (Figure 4). Our study differs from that of Wallin et al. in that our standard group ceased all stretching, whereas all groups in the Wallin et al. study continued stretching, even during the intermittent period. Hence, our study demonstrates that, in the absence of at least intermittent stretching (i.e., 2–3 days/week), ROM gains will be lost when stretching is discontinued.

Stretching can cause viscoelastic changes to occur in muscles. Elastic changes occur following a single stretch. However, these changes are temporary, and the muscle will return to its original length once the stretching load is removed (11). This may account for why ROM decreases following a single stretch (5,6,13). Willy et al. (16) noted that following several weeks of stretching, increases in musculotendinous length and stretching tolerance can occur. These increases may be a result of the plastic elongation of tissues. Plastic changes are hard to achieve but can lead to permanent elongation of tissues (11). Thus, the muscle will not return to its original length once the stretching load has ceased (14). This may explain the accumulative effects of stretching and demonstrate how ROM may be maintained following a stretching program. Intermittent stretching may therefore help to prevent ROM from decreasing by keeping the muscles in the plastic elongation state.

Our study also examined the weekly changes in ROM during a stretching program. Although we found significant gains at the end of a 4-week stretching program, the weekly gains, although notable, were not significant on a week-to-week basis. Only after a full 4 weeks were we able to document a significant change in motion. The same is noted for the cessation period. During this time, the standard group lost a significant amount of ROM by the end of the 4-week cessation period. However, the week-to-week changes were not statistically significant. This indicates that the rate of gain/loss over a 4-week stretching program and subsequent 4-week cessation period likely occurs consistently over the time period. Our limited sample size likely contributed to the lack of significance between weeks.

From a clinical and practical perspective, the results of this study are pertinent because patients/clients may be more likely to adhere to their stretching exercise programs if they are educated that they will be able to begin a maintenance program (i.e., intermittent) once their ROM goal is attained. Patients/clients also may be more likely to adhere to their maintenance stretching program because this program will not be as time consuming as the initial program but will still be as effective. In the case of patients, this in turn may lead to a decreased risk of reinjury following discharge from therapy. Athletes may also benefit from this knowledge, especially during the off-season, when ROM gains need to be maintained. However, it is essential for clinicians and coaches to educate their patients and athletes on the potential benefits of intermittent stretching.

Several limitations were associated with this study. This study used a sampling of convenience to recruit subjects, and all subjects were healthy and free of injury. Future studies might attempt to recruit a more diverse subject population including those with specific musculoskeletal injuries/dysfunction and subjects of different age. Finally, collection of all subject stretching logs, although attempted, was not feasible. The intermittent group stretched either 2 or 3 days per week during the final 4 weeks; however, we do not have an accurate account of the final percentage of days stretched.

Future multiweek studies are needed to study the effects of intermittent stretching, following an initial stretching program, because there is a current lack of research in this area. Future studies may also look at a strictly intermittent stretching program rather than a daily program. The effects of intermittent stretching for durations longer than 1 month should be assessed to determine whether ROM gains continue to be maintained. Different muscles may be studied to see if there are any differences between muscle groups. Finally, our study used healthy individuals, aged 18 to 50 years old. Therefore, the results can only be applied to this population of individuals.

**Practical Applications**

The results of this study indicate that, following a daily stretching program of 4 weeks duration, the gains made during this program can be sufficiently maintained with an intermittent stretching (i.e., 2 or 3 days/week) program. Once ROM goals have been attained with a daily stretching program, ROM can be maintained, provided the individual continues to stretch 2 to 3 days per week. These findings may help to increase adherence to home exercise programs and maintenance programs. With this potential increased rate of adherence, this may lead to a decreased rate of reinjury following discharge from therapy. This may also allow athletes to maintain their ROM gains, during the off-season, which may help to prevent injury as well. Clinicians, coaches, patients, and athletes can consider the use of intermittent stretching to maintain ROM gains following an initial stretching program.

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**References**


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