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A Comparison of Two Stretching Protocols on Hip Range of Motion: Implications for Total Daily Stretch Duration

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ABSTRACT

It is theorized that the total stretch time in a day is more important than the actual single stretch duration time. The purpose of this study was to compare 2 stretching protocols, keeping total stretching time equivalent. The 2 protocols were a 10-second duration stretch and a 30-second duration stretch. Although the stretch durations differed, the total stretching time over the course of a day was held constant at 2 minutes for both protocols. Participants were randomly assigned a protocol to each of their legs: subjects stretched 1 leg with the 10-second protocol and the opposite leg with the 30-second protocol. The 10-second stretch was repeated 6 times for a total of 1 minute; the 30-second protocol was repeated 2 times for a total of 1 minute. Stretching was performed twice daily (a total of 2 minutes each day) for 6 weeks. All stretching was performed to the hamstring muscles. Hip flexion measurements were recorded at pretest, 3-weeks, and 6-weeks. Subjects demonstrated significant gains in range of motion for hip flexion over the course of 6 weeks, $p = 0.000$. No differences existed between the 2 protocols. Range of motion gains were equal between the 2 stretching protocols. The common denominator was total stretch time for a day. Regardless of the duration of a single stretch, the key to improvement was the total daily stretch time. These findings are important as they allow clinicians and individuals to customize stretching protocols to meet individual needs.

Key Words: stretching, repeated measures design, rehabilitation

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Introduction

Stretching muscles, tendons, and other soft tissue is a common practice among athletes, fitness enthusiasts, and rehabilitation professionals. The reasons behind stretching are twofold: to increase range of motion of a body segment or to restore movement to a previously injured or restricted area. In addition, athletes may use stretching to enhance athletic performance and reduce the risk of injury. Rehabilitation professionals use stretching to assist individuals to regain lost motion due to injury or immobilization. Although the evidence is inconclusive as to the injury prevention benefit of stretching, stretching can improve range of motion and flexibility in healthy and injured individuals (3, 7, 8, 10, 18).

Stretching is applied in many different forms, including multiple variations of passive and active techniques. In addition, protocols for stretching (i.e., duration of stretch, number of repetitions per session, number of sessions per day) are equally varied (4). Kisner and Colby (10) present several different protocols ranging from short duration stretches (i.e., 15–30 seconds) to long duration stretching (i.e., lasting greater than 20 minutes at a time). Short duration stretching is most common among athletes and fitness enthusiasts, whereas the longer duration protocols are common in the rehabilitation setting. Because short duration stretching is more common in the public, this study focused on the short duration protocol.

Research supports the notion that several repetitions of the short duration stretch are most effective for increasing range of motion and flexibility of the involved segment (5, 6). However, research evidence is not conclusive as to the optimal duration of a stretch. Some investigations recommend a stretch duration of at least 30 seconds, whereas others have recommended shorter duration stretches, such as 15 seconds (6, 12). For instance, Madding et al. (12) found that a 15-second stretch was equally effective to gain range of motion as 45-second and 2-minute duration stretches. However, Bandy and Orion (1) contradicted these findings by demonstrating that a 30-second stretch was more effective than a 15-second stretch. They also found that the 30-second stretch was as effective as a longer 1-minute stretch. In addition, Bandy et al. (2)

demonstrated that the 30-second stretch was superior to a dynamic range of motion (DROM) stretching program consisting of very short duration active stretches (i.e., 5-second stretches) repeated multiple times in a session. Thus based on these findings the standard stretching protocol calls for stretches that last approximately 30 seconds in length.

A difficulty with these studies examining stretching effectiveness is the fact that the total stretching time in a session differed for the different protocols. With the exception of the Bandy et al. (2) investigation of the DROM protocol, subjects in previous studies tended to spend more time stretching each day with the longer duration protocols than with the shorter duration protocols. In other words, subjects stretching for a short duration (i.e., 15 or 30 seconds) tended to stretch for less total time in a day compared with subjects stretching with a long duration stretch (i.e., 1 or 2 minutes). It is not clear whether the differences in effectiveness between the various protocols is a result of the single stretch duration or a result of the total time spent stretching in a session.

Recently, Roberts and Wilson (14) demonstrated that the total amount of time stretching in a given day may be more important than the actual hold time of a stretch. In their investigation, they compared 2 different stretch durations, 5 and 15 seconds, on active and passive range of motion in the lower extremity. Subjects were assigned to 1 of the 2 groups based on the 2 protocols. Both groups stretched for the exact same amount of time each day (i.e., 45 seconds). The group stretching for 5 seconds repeated the procedure 9 times; the group stretching for 15 seconds repeated the procedure 3 times. At the conclusion of 5 weeks, the 2 groups demonstrated comparable gains in passive range of motion. Roberts and Wilson (14) concluded that the total time stretching in a day was the important component for effective stretching protocols.

The purpose of this study was to test the findings of Roberts and Wilson (14). However, we chose to compare a 10-second duration stretch with a 30-second duration stretch. The 30-second duration was chosen because it was proven to be effective in previous research (1, 2). A short 10-second duration was chosen for convenience in terms of equating total stretch time each day. As with Roberts and Wilson (14), all of our subjects stretched for an equal total time each day (i.e., 2 minutes). We had 2 hypotheses. Our first hypothesis was that no differences would exist between the 2 protocols in the total range of motion gained at the conclusion of 6 weeks of stretching. We further hypothesized that both stretching protocols would yield gains in hip flexion range of motion over time (i.e., at the end of 6 weeks).

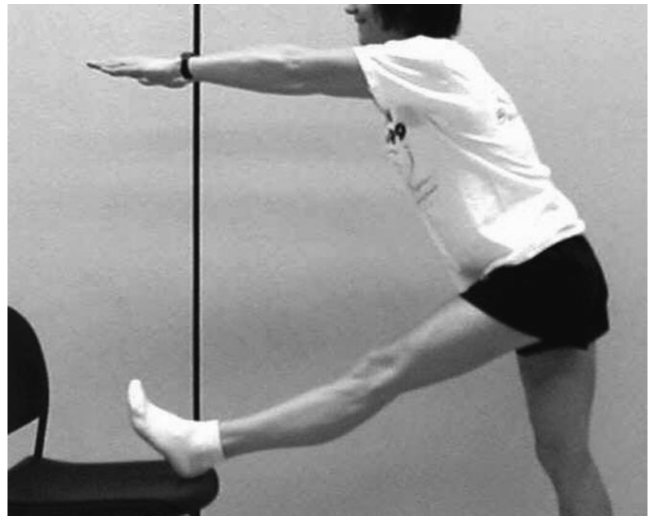

Figure 1. Single leg stretching position for both protocols.

Methods

Subjects

Thirty-five healthy individuals volunteered to participate. Subjects consisted of students and staff members of the Medical College of Ohio. All subjects were free from injury over the past 1 year. In addition, we screened all potential subjects for hip range of motion. Only subjects with hip flexion range of motion less than 70° of hip flexion, using the straight leg raising procedure (6), were included in this investigation. We excluded 12 individuals based on this criterion. Twenty-three subjects participated in this study, with 18 women and 5 men (mean age = 22.8 years, *SD* = 4.7, range = 21–43 years of age). All subjects signed an approved informed consent form for the Medical College of Ohio's Institutional Review Board for Human Subjects.

Stretching Protocols

Subjects performed all stretching exercises to the hamstring muscles of the thigh. We instructed subjects in a standing, 1-legged stretch of the hamstring. Figure 1 illustrates the stretching position. During the stretch, individuals pushed into the position until they experienced moderate discomfort in the posterior thigh. We then instructed the subjects in each of the 2 stretching protocols, the 30-second duration stretch and the 10-second duration stretch. Table 1 contains the protocols for both stretching procedures.

In each protocol, the total stretching time per session was 1 minute. Each session was repeated twice a day. The total stretching time each day was 2 minutes. The length of time for each individual stretch distinguished the 2 protocols. For the 30-second protocol, each stretch was held for 30 seconds, followed by a brief rest of 5 seconds. Subjects repeated the procedure a second time, for a total of 60 seconds of stretching. For the 10-second protocol, each stretch was held for

Table 1. Instructions to subjects for the 2 stretching protocols.

10-sec protocol	30-sec protocol
Hold the stretch for a count of 10 sec	Hold the stretch for a count of 30 sec
Repeat the stretch procedure 6 times in the same session	Repeat the stretch procedure 2 times in the same session
Relax for a count of 5 sec between each stretch	Relax for a count of 5 sec between each stretch
Repeat this procedure 2 times each day with a minimum of 4 h separating each stretching session	Repeat this procedure 2 times each day with a minimum of 4 h separating each stretching session

Figure 2. Position and technique for measuring hip joint flexion range of motion.

10 seconds, followed by a brief rest of 5 seconds. Subjects repeated the procedure 6 times, for a total of 60 seconds of stretching. The number of repetitions of a given stretch provided the equality in total stretching time for a day.

Subjects drew a slip of paper marked either ''right = 30'' or ''right = 10.'' This process allowed for a random assignment of the 2 stretching procedures to each subject's legs. Thus if an subject drew ''right = 30,'' this subject performed the 30-second stretch to the right leg and the 10-second stretch to the left leg. All subjects stretched both legs, using a different protocol on each leg. All subjects stretched the right leg first, regardless of the protocol. Subjects stretched the appropriate legs over a course of 6 weeks. In addition to the stretching, subjects kept a daily log of their stretching activities. We used the log as a means of assessing compliance.

Measurement

Figure 2 illustrates the measuring position for hip range of motion. We measured both legs of each subject for straight leg raise range of motion at the hip. We obtained measurements using a standard 12-inch goniometer. The same individual, a licensed physical therapist, performed all measurements. The physical therapist took measurements on 3 occasions: pretest, 3 weeks, and 6 weeks. The physical therapist was blind as to the condition for each leg. In addition, the physical therapist repeated the measurements on 10 randomly selected subjects to investigate measurement reliability. Force of the movement to obtain the measurement position was based on obtaining a firm end feel or a report by the subject to stop.

Statistical Analyses

We estimated the reliability of the goniometry measurements, with the single physical therapist, using the intraclass correlation coefficient (ICC; 15). The ICC for the pretest measures was 0.96, which is excellent intrarater reliability.

In addition, this investigation involved a 2×3 (protocol $\times$ time) mixed model repeated measures design. Subjects served as their own controls in this study. We first examined potential interactions between the treatment condition and time. In addition, we examined the main effect for treatment and the main effect for time. We used the multivariate approach to repeated measures analysis (11, 13, 16). In case of any main effects for the time variable, we used pairwise comparisons with the Bonferroni adjustment procedure (9, 17). Finally, we used polynomial contrasts to examine the time trend of the data.

Results

The combined means for hip range of motion values for both protocols across 3 times were 54.43° (SD = 11.29, range = 25–69°); 70.36° (SD = 15.28, range = 41–112°); and 80.50° (SD = 16.56, range = 46–115°) for the pretest, 3-week, and 6-week measures, respectively. An interaction between methods and time was not statistically significant (exact $F = 0.54$; $df = 2{,}41$; $p = 0.5889$). In addition, the main effect for method was not significant (exact $F = 0.13$; $df = 1{,}42$; $p = 0.7221$). The main effect for time was significant (exact $F = 99.51$; $df = 2{,}41$; $p = 0.0001$). Table 2 contains the mean values for each of the measurement conditions, along with the overall mean for each time period (e.g., pretest, 3-week, and 6-week).

Polynomial contrasts revealed a significant quadratic trend for time ($F = 6.21$; $df = 1{,}42$; $p = 0.0167$),

Table 2. Mean values of range of motion for the hip over 3 measurement time periods.

	Pretest		3-Week		6-Week	
	Mean	*SD*	Mean	*SD*	Mean	*SD*
10-sec stretch	54.0	11.4	71.4	15.6	82.0	15.4
30-sec stretch	54.8	11.5	69.3	15.2	79.0	17.8
Groups combined (time effect)*	54.4	11.3	70.4	15.3	80.5	16.6

* Group outcomes were significantly different ($p < 0.05$) for each time period.

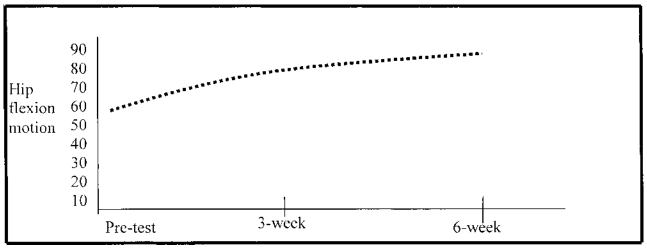

Figure 3. Significant quadratic trend of data over time ($p < 0.05$).

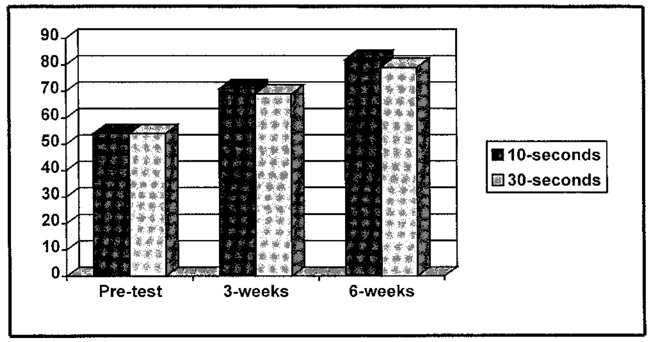

Figure 4. Mean range of motion values for each protocol over time (no differences between stretching protocols).

Table 3. Pairwise comparisons with Bonferonni adjustment, 99% confidence intervals.

	Mean difference (*SD*)	Lower limit	Upper limit
Pretest vs. 3-wk*	−15.932 (1.637)	−21.026	−10.838
3-wk vs. 6-wk*	−10.136 (1.303)	−14.191	−6.082
Pretest vs. 6-wk*	−26.068 (1.829)	−31.760	−20.376

* The mean differences are significant, $p < 0.01$.

suggesting a decreasing effect of the stretching effects over time. Figure 3 illustrates the trend of the data.

Pairwise comparisons for the main effect over time revealed significant differences among all pairwise comparisons, using 99% confidence intervals for differences. Significant differences existed between the measures taken at pretest compared with the measures taken at 3 weeks ($p < 0.01$). In addition, there was a significant difference between the measures taken at 3 weeks compared with the measures at 6 weeks ($p < 0.01$). Finally, comparing the measures at pretest with the measures at 6 weeks revealed a significant difference ($p < 0.01$). Thus significant gains in hip range of motion continued to occur over the duration of the 6 weeks of this study. Table 3 contains the mean difference scores, *SD,* and the upper and lower bounds for the 99% confidence limits.

Discussion

Stretching is an important component to exercise and physical activity. In addition, rehabilitation professionals rely on stretching as a method for restoring lost motion and function. Although the literature supports various stretching protocols (3–5, 7, 8, 10, 18), complete consensus does not exist as to the most effective method, particularly for short duration stretching. The results of our investigation support the notion that the total time stretching in a given day may be more important than the actual duration of a single stretch repetition. As with Roberts and Wilson (14), the overall time duration appears to be a key factor influencing stretching effectiveness. Regardless of whether a stretch is held for 10 or 30 seconds, equal gains in range of motion can be achieved with either technique provided the individual stretches for the same total time over the course of a day. In this investigation, total stretch time was 2 minutes each day. A comparison of the mean range of motion values for both stretching protocols revealed no significant differences between the 2 methods. However, both protocols resulted in significant gains in the range of motion at the hip (Figure 4).

In addition to the gains obtained over the course of this investigation, the significant quadratic trend for time indicates that rate of gain decreased over time. This is evident by looking at the gain scores from pretest values to the 3-week values compared with the gain scores from the 3-week values to the 6-week values. Subjects improved hip range of motion by approximately 16° from the beginning of the stretching program until the 3-week measurement time. Subjects gained approximately 10° from the time of the 3-week measurement to the 6-week measurement time. This polynomial trend suggests that range of motion gains are more rapid in the first 3 weeks of a stretching program and that the rate of gains gradually decreases over time. Further research is needed to see if this trend continues or if a linear trend resumes. Extrapolation of further gains is not possible at this time.

Although all subjects performed both stretching protocols (i.e., 1 protocol was assigned to each leg), we do not feel that a crossover effect occurred. We were not able to find sufficient evidence that performing a single plane motion stretch to 1 side of the body has any appreciable effect on the contralateral side.

The findings of this investigation, regarding the 2 different stretching protocols, may be useful for the clinician (e.g., athletic trainer, physical therapist, personal trainer) or coach when developing an exercise program for an athlete, client, or patient. Clinicians and coaches can design the stretching component of the exercise program to suit the needs and abilities of each individual. For individuals who tolerate long duration–type stretching, the 30-second or longer protocol may be best. However, for individuals who do not tolerate the sensation of stretching, a shorter duration, more frequent approach may be best suited for them. In addition, the shorter duration approach may be more effective for individuals who do not tolerate stretching well. These individuals may inadvertently reduce the stretching tension during long duration stretches in an attempt to reduce the discomfort. With the short duration stretch, individuals may be less likely to reduce the intensity of the stretch. These suppositions are purely theoretical and must be tested empirically with a patient population.

Practical Applications

The purpose of this study was to test whether the total stretching time in a given day was the key element for effective stretching. We compared 2 stretching approaches, a 10-second protocol to a 30-second protocol. The common element between these 2 protocols was the total time individuals stretched each day, namely 2 minutes. The results of this investigation support the notion that effective gains can be achieved with either stretching approach provided the total stretching time in a day was 2 minutes. Clinicians and athletes are advised to consider using shorter duration stretching approaches for individuals who do not tolerate the sensation of stretching.

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