Passive Versus Active Stretching of Hip Flexor Muscles in Subjects With Limited Hip Extension: A Randomized Clinical Trial

Background and Purpose. Active stretching is purported to stretch the shortened muscle and simultaneously strengthen the antagonist muscle. The purpose of this study was to determine whether active and passive stretching results in a difference between groups at improving hip extension range of motion in patients with hip flexor muscle tightness. Subjects and Methods. Thirty-three patients with low back pain and lower-extremity injuries who showed decreased range of motion, presumably due to hip flexor muscle tightness, completed the study. The subjects, who had a mean age of 23.6 years (SD=5.3, range=18–25), were randomly assigned to either an active home stretching group or a passive home stretching group. Hip extension range of motion was measured with the subjects in the modified Thomas test position at baseline and 3 and 6 weeks after the start of the study. Results. Range of motion in both groups improved over time, but there were no differences between groups. Discussion and Conclusion. The results indicate that passive and active stretching are equally effective for increasing range of motion, presumably due to increased flexibility of tight hip flexor muscles. Whether the 2 methods equally improve flexibility of other muscle groups or whether active stretching improves the function of the antagonist muscles is not known. Active and passive stretching both appeared to increase the flexibility of tight hip flexor muscles in patients with musculoskeletal impairments. [Winters MV, Blake CG, Trost JS, et al. Passive versus active stretching of hip flexor muscles in subjects with limited hip extension: a randomized clinical trial. Phys Ther. 2004;84:800–807.]

Key Words: Active and passive stretching, Hip flexor muscle, Randomized trial.

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Limited hip extension range of motion (ROM) presumably due to hip flexor muscle tightness is an impairment that has been reported in subjects with lower-quarter symptoms and functional limitations,1–3 as well as in subjects without lower-quarter symptoms.4–6 Kendall et al7 have defined hip flexor muscle tightness as the inability to achieve full hip extension when in the modified Thomas test position, but they provided no evidence indicating the decrease in ROM is solely due to a lack of muscle extensibility. Although lumbar curve configuration6 and gait economy (steady-state oxygen consumption per unit of body weight required to walk or run at a specific speed)5 have been reported to be affected by the decreased ROM that is thought to be due to hip flexor muscle tightness, there are no studies that support the proposition that hip flexor muscle tightness predisposes a person to musculoskeletal injury as a result of altered lumbopelvic/hip biomechanics.1,7,8 Although the relationship among hip flexor muscle tightness, altered lumbopelvic/hip biomechanics, and injury is currently unknown, some clinicians1,6,9 have reported using stretching to manage what they believed was hip flexor muscle tightness.

Clinicians often use stretching in the management of patients with low back and lower-quarter complaints as a means of increasing ROM.1,3 Stretching also is used prophylactically in individuals without known pathology.
or impairments to prevent injury\textsuperscript{9–11} or enhance performance,\textsuperscript{5,5} although evidence for this approach is equivocal at best. A variety of stretching methods have been described, including passive, ballistic, and proprioceptive neuromuscular facilitation (PNF) stretches.\textsuperscript{12–14} Although all 3 types of stretches have been shown to increase ROM,\textsuperscript{4,13,14} recent studies\textsuperscript{9,10} do not support the use of prophylactic stretching for the prevention of lower-extremity injuries in subjects without lumbar or lower-quarter symptoms.

Muscle length is known to affect the contractile properties of muscle, and shortened or lengthened muscles may not develop maximum tension if their resting length has been altered.\textsuperscript{15,16} White and Sahrmann\textsuperscript{8} have advocated the use of active stretching as a means of increasing muscle flexibility while concomitantly improving the function of antagonist muscles. Stretching that incorporates a concomitant, active contraction of antagonist muscles may confer benefits to those muscles that are not experienced with a passive stretching program. Although active stretching is purported to improve the function of an antagonist muscle,\textsuperscript{8} it has not been demonstrated to be more effective than passive stretching for stretching the tight muscle agonist (ie, increasing ROM).\textsuperscript{17}

Previous studies\textsuperscript{4–6,14} have demonstrated the effectiveness of passive stretching for increasing hip extension ROM in subjects did not have pain that interfered with walking or running and who had presumed hip flexor muscle tightness. To our knowledge, however, no one has reported on the effect of a program of active stretching of the hip flexors for patients with pain due to disorders affecting the low back or lower quarter. The purpose of our study was to determine if there is a difference between active and passive stretching for increasing hip extension ROM in subjects who have a lower-extremity injury or low back pain and who presumably have hip flexor muscle tightness.

### Method

#### Subjects

Forty-five subjects (23 male, 22 female) with lower-extremity injuries or low back pain were enrolled in the study. All subjects were recruited from the Brigade Gym patient profile program through the Physical Therapy Clinic at the Brooke Army Medical Center (BAMC), Fort Sam Houston, Texas. The profile program is for soldiers who are not able to participate routinely in army physical fitness training due to their musculoskeletal complaint. Subjects completed a questionnaire containing questions about their sex, age, height, weight, and lower-extremity pain and were screened for decreased ROM and presumed hip flexor tightness bilaterally using the modified Thomas test. Subject were classified as having tight hip flexor muscles if their thigh was above 0 degrees in relation to the treatment table. The limb demonstrated the greatest amount of decreased ROM served as the limb of interest for study purposes. If hip flexor tightness was thought to be equal bilaterally, the side of the limb of interest was chosen randomly by flipping a coin. A lower-quarter neurological screening that included manual muscle testing, sensory testing, and testing of muscle stretch reflexes also was performed at this time.

The primary inclusion criterion was the presence of what we thought were tight hip flexor muscles in the presence of a lower-extremity injury or low back pain. Decreased ROM thought to be due to hip flexor muscle tightness has been documented in patients with these disorders,\textsuperscript{1–3} and there is concern that the presence of tightness may lead to further injury.\textsuperscript{11} Our subjects also were required to be between the ages of 18 and 65 years and eligible for military health care. No subjects were excluded from the study due to neurologic abnormalities noted during the screening examination or due to an inability to correctly perform the stretching procedures used in this study.

If the subjects met the inclusion criterion, they were asked to participate in the research study. Prior to being enrolled in the study, all subjects were advised of potential study risks, which could include the development of mild muscle soreness up to 3 days, and they signed an informed consent document.

#### Design

This study was a randomized clinical trial. The independent variables in this study were group (passive and active) and time (baseline and 3 and 6 weeks after the start of the study). The dependent variable was hip extension ROM measured in the modified Thomas test position.

#### Instrumentation

All ROM measurements were obtained using a universal goniometer. Within-session interrater and intrarater reliability of hip extension ROM measurements were assessed prior to the study in a sample of 20 subjects without lumbar or lower-quarter symptoms. We chose to use asymptomatic subjects to assess reliability procedures because these subjects were easily accessible. The procedures used to assess reliability also were used in the study, and the ROM measurements were taken by the same examiners who took measurements during the study. Intraclass correlation coefficients (ICC [3,3]) for interrater and intrarater reliability were .98 and were similar to the ICCs (1,2) of .86 to .95 previously reported by Godges et al.\textsuperscript{4}
**Procedure**

Subjects were randomly assigned, using a computer-generated random number list, to either a passive stretching group (n=23) or an active stretching group (n=22). Although examiners were blinded to group assignment, the randomization list was not concealed from study personnel who made the group assignments from the list.

*Modified Thomas test.* Hip flexor tightness in the limb of interest was measured with the modified Thomas test using the following procedure: The subjects were instructed to sit as close to the edge of the table as possible. Subjects used their hands to bring their knees to their chest and then slowly rolled backward on the table. While holding this position, one lower limb was released, allowing the hip to extend toward the table while resting the ipsilateral arm on the contralateral shoulder. The leg and knee of the limb being measured were allowed to hang off the edge of the table unsupported. While the subject maintained a posterior pelvic tilt, one examiner attempted to visually ensure that the lumbar spine was flat, preventing the limb from abducting. The examiner observed and palpated the thigh in an effort to ensure that it was completely relaxed before a second examiner measured hip ROM. Hip ROM was measured 3 times, and an average value was calculated. The goniometer was reset to zero before each measurement. In our study, the scale of the goniometer was covered so as to mask the second examiner, and a third examiner read and recorded the measurements. Both the examiner who took the measurements and the examiner who read and recorded the measurements were masked to the subjects’ group assignment.

*Intervention.* Subjects received 1 of 2 different stretching procedures based on their group assignment. The passive stretching group performed the modified lunge (Fig. 1) and the prone static hip stretch (Fig. 2). For the modified lunge, each subject was instructed to assume a half-kneeling position with the ipsilateral knee on the ground. A pillow or towel was placed under the knee as needed for comfort. The subject was told to keep the trunk erect and the pelvis in a posterior tilt and to lean forward by flexing the contralateral hip and knee in order to maximize the stretching sensation in the groin of the ipsilateral limb. For the prone stretch, subjects were instructed to assume the prone position and to rest their distal thighs on a rolled towel. A pillow was used under the subjects’ pelvis as needed for comfort. Over time, the thickness of the pillow was reduced as subjects became comfortable while maintaining the posterior pelvic tilt.

The active stretching group did prone leg lifts with the knee bent (Fig. 3) and with the knee straight (Fig. 4).

For the prone leg lifts with the knee bent, subjects were instructed to assume a prone position with the ipsilateral knee flexed to 90 degrees, relax their hamstring muscles, and squeeze their gluteal muscles as much as possible to lift the thigh. Pillows were placed under the abdomen as needed for comfort. The same procedure was repeated for the second set of exercises, except that the ipsilateral knee was fully extended.

In the passive stretching group, both stretches were done for 10 repetitions each in a single daily session. Each stretch was held for 30 seconds, with an 8-second rest period between repetitions. In the active stretching group, both stretches also were done for 10 repetitions each in a single daily session. Each stretch was held for 30 seconds, with up to a 30-second rest period between repetitions. Subjects who were unable to hold a stretch for 30 seconds were instructed to hold each stretch as long as possible, with the goal being 30 seconds. Subjects
also were instructed to end the stretching session if they became exhausted before 10 repetitions and if they could no longer perform the stretch correctly. Subjects who used pillows at the beginning of the stretching intervention were instructed to decrease the thickness of the pillows once they could perform 10 stretches held for 30 seconds each. Because the literature remains inconclusive about optimum stretch duration and frequency, we used the guidelines of the American College of Sports Medicine (ACSM).1,9,10,18

For both active and passive stretching groups, an investigator provided subjects with written instructions that included figures depicting their respective stretches and then demonstrated each stretching procedure. The subjects then did the movements with the investigator present. The investigator observed the subjects and corrected any discrepancy in an effort to ensure consistent performance of the exercises. Subjects were asked to maintain their daily activities, with the exception of adding one session of hip flexor stretching per day.

Subjects were re-examined within 1 week after enrolling in the study and demonstrated the assigned stretching procedures. An investigator observed the subjects performing the procedures and made corrections as needed. Subjects were asked about their adherence to their stretching regimen and were reminded of its importance, but adherence was not monitored. Subjects returned after 3 and 6 weeks, and hip extension ROM measurements in the modified Thomas test position were obtained in a manner identical to that previously described.

Data Analysis

Descriptive statistics were computed for subject demographics and the hip extension ROM. Independent t tests were used to compare group baseline characteristics. To determine the significance of an interaction effect or main effects for group and time, a 2-way (2×3) mixed-model analysis of variance (ANOVA) was performed using data of subjects who completed the protocol. An intention-to-treat analysis also was conducted using a last-value-forward method.19 Post hoc tests for pair-wise differences were computed for the main effect of time using the Tukey honestly significant difference (HSD) procedure. The alpha level was set at .05 for all hypotheses. Descriptive and inferential statistics were completed using SPSS for Windows, version 9.0.*

Results

Thirty-three subjects completed the study. Fifteen subjects in the passive stretching group (mean age=24.9 years, SD=6.5) and 18 subjects in the active stretching group (mean age=22.6 years, SD=3.7) were available for measurement at baseline and 3 and 6 weeks after the start of the study. Of the 8 dropouts in the passive stretching group, 6 subjects had conflicts with job training, 1 subject moved, and another subject incurred a job-related injury and was unable to continue in the study. In the active stretching group, 2 subjects had conflicts with job training, 1 subject moved, and another subject had an unrelated injury and was unable to complete the protocol. No patients were excluded from the study due to lack of adherence.

For subjects who completed the study, there were no differences in age or weight between the 2 groups at baseline. Mean hip extension ROM measured in the modified Thomas test position at baseline was −11 degrees (SD=4) for the passive stretching group and −14 degrees (SD=16) for the active stretching group. The mean differences between groups at 3 and 6 weeks were 4 and 2 degrees, respectively. The descriptive statistics for hip extension ROM at all 3 measurement occasions are listed in Table 1. The results of the mixed-model ANOVA for the on-protocol analysis are contained in Table 2. The Mauchley test of sphericity was significant, indicating that the assumption of sphericity had been formed.

* SPSS Inc, 235 S Wacker Dr, Chicago, IL 60606.
violated. Therefore, a Greenhouse-Geisser correction factor was applied to all P values. The interaction effect (group × time) and main effect for group were not significant. The power of this study to detect a clinically meaningful effect size of 8 degrees for the interaction effect was .81. There was a main effect for time (P < .0001). The results of the mixed-model ANOVA using an intention-to-treat analysis did not differ from the results of the on-protocol analysis.

Post hoc testing for the main effect of time was significant for the pair-wise comparison between baseline and 3 weeks and between baseline and 6 weeks, but was not significant for the pair-wise comparison between 3 weeks and 6 weeks. In the active stretching group, average ROM improved by 12 degrees in the active stretching group and by 13 degrees in the passive stretching group from baseline to 3 weeks. These results are depicted in the line plots contained in Figure 5.

**Discussion**

Subjects with lumbar or lower-quarter symptoms who received either active or passive stretching for presumably tight hip flexors improved their hip extension ROM over a 6-week period. No clinically or statistically significant differences, however, were found between the 2 groups at 3 or 6 weeks. The increase in ROM observed in this study was most likely due, in our view, to the stretching. A randomized study design was used, we considered the reliability of measurements acceptable, examiners verified that subjects could perform the stretches correctly at 2 intervals during the study, and the examiner who obtained hip extension ROM measurements was masked to both the results and group assignment. Adherence to the stretching protocol, however, was not measured. Because other investigators have demonstrated that stretching is more effective than the passage of time, a no-stretch control group was not included in our study.

Increased muscle flexibility following stretching has been attributed to a number of theorized mechanisms. Tanigawa proposed that improvements made by patients using passive stretching may be the result of both autogenic inhibition and tensile stress applied to the muscle. Muscles' viscoelastic characteristics are such that when stress is applied over a constant period of time, the muscle will gradually relax and increase in length. The result is usually greater ROM in the joint the muscle crosses. With autogenic inhibition, the muscle being stretched is inhibited and is thought to simultaneously relax, resulting in an increase in length. The result is usually greater ROM in the joint the muscle crosses. With autogenic inhibition, the muscle being stretched is inhibited and is thought to simultaneously relax, resulting in an increase in length. The result is usually greater ROM in the joint the muscle crosses. 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active and passive stretching regimens in our study were equally effective in improving muscle flexibility over time.

According to Sahrmann’s movement balance system (MBS) approach, active stretching is purported to increase the flexibility of the tight muscles while concomitantly improving function of the antagonistic muscles. Our findings support active stretching as an effective method for increasing the flexibility of tight hip flexor muscles. However, we did not assess the effectiveness of stretch type on the function of the antagonist muscles (hip extensors). The claim of proponents of the MBS approach that active stretching improves muscle function of the antagonist muscles and “balances” the length and function characteristics of the hip flexors and extensors, resulting in improved patient function and decreased tissue trauma, is unsubstantiated and needs to be investigated.

Our study had several limitations. A major concern was the attrition rates in the active stretching group (18.2%) and the passive stretching group (34.8%) that could have affected group equivalency attributable to the randomization process, thereby biasing the results. The results of the intention-to-treat analysis, however, did not differ from the results of the on-protocol analysis, and this finding increases our confidence in the validity of our findings. Eight subjects, accounting for approximately 75% of the attrition rate, were self-eliminated as a result of conflicts with job training. The other 4 subjects were disenrolled due to unrelated medical problems or because they moved to another area. In all cases, the reasons for removal were unrelated to intervention. Three-week measurements were available for 5 (2 in the active stretching group, 3 in the passive stretching group) of the 12 subjects who dropped out of the study.

We examined the effects of active and passive stretching in a relatively young sample of patients with low back pain and lower-extremity injuries, and the ability to generalize our results is limited. Older patient populations, patients with primary hip disorders, and other patients with muscle tightness other than hip flexor tightness may not respond as favorably. In addition, the effects of passive and active stretching beyond 6 weeks are unknown. We were unable to locate studies describing the long-term maintenance of muscle length changes using a stretching force.

Stretching programs to increase muscle flexibility are frequently used by physical therapists in the management of patients. Therefore, if muscle stretching methods differ in effectiveness, then elucidating which methods are most effective would enable clinicians to better manage patients with muscle tightness. Based on the results of our study, we believe that both passive and active stretching are effective methods to increase muscle flexibility. Active stretching may improve the function of the antagonist muscles, although we have no data to support that assertion. We did not measure isometric muscle torque or endurance in our study. In future studies, researchers should investigate the changes in antagonist muscle function associated with active stretching, whether an active stretching regimen results in fewer subsequent injuries, and whether muscle length is maintained after the stretching program is stopped.

Conclusions

The results of our study support the use of either an active or passive stretching program to increase ROM presumably by increasing the flexibility of tight hip flexors in relatively young patients with low back pain and lower-extremity complaints. Further work is necessary to determine if the 2 methods are equally effective for improving flexibility of other muscle groups or if active stretching improves the function of the antagonist muscles more than does use of a passive stretching protocol.
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