

# Immediate effect of passive and active stretching on hamstrings flexibility: a single-blinded randomized control trial

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**Abstract.** [Purpose] This study compared the efficacy of passive and active stretching techniques on hamstring flexibility. [Subjects] Fifty-four healthy young subjects were randomly assigned to one of three groups (2 treatment groups and 1 control group). [Methods] Subjects in the passive stretching group had their knees extended by an examiner while lying supine 90° of hip flexion. In the same position, subjects in the active stretching group extended their knees. The groups performed 3 sets of the assigned stretch, with each stretch held for 10 seconds at the point where tightness in the hamstring muscles was felt. Subjects in the control group did not perform stretching. Before and immediately after stretching, hamstring flexibility was assessed by a blinded assessor, using the active knee-extension test. [Results] After stretching, there was a significant improvement in the hamstring flexibilities of the active and passive stretching groups compared with the control group. Furthermore, the passive stretching group showed significantly greater improvement in hamstring flexibility than the active stretching group. [Conclusion] Improvement in hamstring flexibility measured by the active knee-extension test was achieved by both stretching techniques; however, passive stretching was more effective than active stretching at achieving an immediate increase in hamstring flexibility.

**Key words:** Hamstring flexibility, Active stretching, Passive stretching

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## INTRODUCTION

The tightness of hamstring muscles is one of the main factors hindering performance in daily and sporting activities. Reduction in the flexibility of the hamstrings has been reported to be associated with the occurrence of back pain in adolescents and adults in cross-sectional studies<sup>1, 2)</sup>. Furthermore, reduction in the flexibility of the hamstrings has been reported to increase the risk of damage to the musculoskeletal system<sup>3, 4)</sup>. Thus, flexibility of the hamstrings is important for general health and physical fitness<sup>5, 6)</sup>.

Several studies have indicated that flexibility of the

hamstrings is improved by stretching<sup>7–11)</sup>. Indeed, many stretching techniques are used in clinical practice, including ballistic stretching, static stretching, and proprioceptive neuromuscular facilitation techniques. Among the stretching methods, passive and active stretching techniques are easy to implement and are useful as home exercises. Active stretching increases the flexibility of tight muscles while concomitantly improving the function of antagonistic muscles<sup>12)</sup>. In contrast, passive stretching is characterized by the addition of stretch stimulation on muscle contraction independent of the subject<sup>13)</sup>. Murphy detailed a new active stretching technique called the dynamic range of motion (DROM)<sup>14)</sup>. This method is as an alternative to static stretching. During DROM, a contraction by the antagonist muscle causes the joint crossed by the agonist muscle to move through the full ROM at a controlled, slow tempo<sup>14)</sup>. DROM is a technique that takes advantage of reciprocal innervation. However, Bandy et al. reported that passive stretching is more effective than DROM<sup>15)</sup>, but their study had different stretching conditions, such as different stretch elongation times, and

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**Table 1.** Characteristics of the subjects in each group

Characteristics	Active stretching group (n=18)	Passive stretching group (n=18)	Control group (n=18)
Age (years)	20.1 ± 1.2	20.3 ± 1.0	20.5 ± 1.2
Weight (kg)	61.5 ± 8.3	59.9 ± 8.2	57.4 ± 6.6
Height (cm)	167.1 ± 8.3	164.6 ± 8.2	158.8 ± 6.6

mean ± SD

was not an accurate comparison of the stretching techniques. To our knowledge, no studies have compared active and passive stretching techniques using the same method for the hamstring muscles. Thus, the purpose of this study was to compare the effect of passive and active stretching techniques using the same method on the flexibility of the hamstring muscles.

## SUBJECTS AND METHODS

### Subjects

A total of 54 healthy young subjects were randomly allocated among three groups: an active stretching group, a passive stretching group, and the control group. The subjects were paired according to gender (9 males and 9 females for each group). The inclusion criteria were as follows: limited hamstring flexibility, operationally defined as 70° by the active knee-extension test (AKET) conducted at 90° of hip flexion in the supine position<sup>11</sup>; no participation in strengthening or stretching programs for at least 1 year; and the absence of injury to the lower extremities. Institutional review board approval was obtained before recruitment of subjects. All subjects signed an informed consent form agreeing to participate in the study. This research was approved by Saitama Prefectural University's Committee of Ethics in Research (No 22705).

### Methods

Hamstring flexibility was measured before the intervention. Hamstring flexibility was measured using the AKET, which has high reliability<sup>16-18</sup>. Subjects were positioned supine with their right hip and knee flexed at 90°, and their lumbar lordosis was supported with a lumbar roll. From that position, extension of the knee was performed. The knee was extended to the point of mild resistance or just below the threshold of myoclonus, as described by Gajdosik<sup>16</sup>. The same-blinded assessor measured the knee angle (degrees from full extension) in all three sessions using an inclinometer. Subjects in the passive stretching group had their knee extended by one examiner while lying supine with 90° of hip flexion. In the same position, subjects in the active stretching group extended their own knee. Stretches were performed times in 3 sets of the assigned stretch. Each stretch was held for 10 seconds at the point where tightness in the hamstring muscles was felt, and then the leg was slowly lowered (over 10 seconds). Stretches at maximum knee extension elicited a "strong but tolerable feeling of muscular tightness" in the back of subjects' legs<sup>19</sup>. Subjects in the control group did not perform stretching.

Means and standard deviations (SD) of the pre-inter-

vention and post-intervention AKET measurements were calculated for each group. In addition, the mean difference between pre-intervention and post-intervention AKET measurements was also calculated.

The pre-intervention and post-intervention AKET angles of the control group were used to assess the reliability of the measurement using the intraclass correlation coefficient, ICC (1,1). One-way analysis of variance (ANOVA) was used to test for significant differences between groups in the dependent variables: characteristics of each group (differences in age, height, and weight), pre-intervention AKET angle, and flexibility change (difference between post- and pre-interventions). The data were analyzed using one-way ANOVA with the Tukey-Kramer test for multiple comparisons. The level of significance was chosen as  $p=0.05$ . Statistical analyses were performed using SPSS version 15.0 (SPSS, Inc., Chicago, IL, USA).

## RESULTS

The characteristics of each group were not significantly different (Table 1). The mean values of degree of knee extension of the pre-intervention and post-intervention measurements of the control group were  $44.2 \pm 5.1^\circ$  and  $45.1 \pm 3.7^\circ$ , respectively. The ICC (1,1) value calculated for the pre-intervention and post-intervention knee extension of the control group was 0.97.

Table 2 shows the means of the pre-intervention and post-intervention measurements and the flexibility change each group. The pre-intervention AKET angle was not significantly different between the groups ( $p=0.57$ ). A comparison of each group showed a significant difference between the groups' flexibility changes ( $p=0.01$ ). Specifically, the passive stretching group showed a greater gain in flexibility than the control group.

## DISCUSSION

The present study compared passive and active stretching techniques for hamstring flexibility. The results of this study demonstrate that both active and passive stretching were effective at improving hamstring flexibility compared with the control group. In addition, the passive stretching group showed a significant improvement in flexibility compared with the active stretching group.

Winter et al. reported that passive stretching is characterized by the external addition of stretch stimulation on muscle contraction, while active stretching is characterized by a reciprocal innervation mechanism used to relax antagonist muscle contraction<sup>13</sup>. Reciprocal inhibition adjusts the

**Table 2.** Active knee extension angles in each group before and after stretching

	Active stretching group	Passive stretching group	Control group
Pre-intervention	45.9 ± 8.9°	40.6 ± 16.1°	44.2 ± 5.1°
Post-intervention	52.9 ± 8.9°	56.4 ± 15.8°	45.1 ± 3.7°
Flexibility change	7.0° #	15.8° * #	0.9°

mean ± SD

\*significant difference between the active and passive stretching groups. #significant difference from the control group.

Flexibility change: difference between pre intervention and post intervention

contraction of agonist and antagonist muscles to facilitate various movements. In this study, the subjects in the active stretching group performed stretches using this mechanism. However, the improvement in hamstring flexibility in the active stretching group was less than that of the passive stretching group. The reason for this difference may be the posture of the active stretching group during the stretch. When holding the stretch position the excitatory spinal motor neurons overcome  $\gamma$  inhibitory neuron impulses<sup>20</sup>). In this study, the final knee extension position was held for 10 seconds by subjects in the active stretching group. Consequently, there was a simultaneous contraction of agonist and antagonist muscles without antagonist suppression of the  $\gamma$  impulses. Therefore, the active stretching group did not experience antagonist muscle relaxation, suggesting that there is a difference in the degree of stretch stimulation between the active and passive stretching groups.

A recent study reported that passive stretching is harmful for movement performance<sup>21</sup>). Simic et al. reported that the results of a meta-analysis of 104 studies showed passive stretching before exercise results in a reduction of maximum muscle strength<sup>21</sup>). In contrast, active stretching has been reported to improve movement performance. Yamaguchi et al. reported that muscle strength was improved by an average of 13.3% after stretching<sup>22</sup>). In addition, Faigenbaum et al. compared motor function after different stretching techniques, and showed that active stretching improves motor function<sup>23</sup>). Thus, the effect of passive stretching and active stretching should be considered together with when the stretching occurs, e.g. before and after exercise, as this could influence the effect. The results of the current study show that passive stretching was useful for increasing the flexibility of the hamstring muscles. Previous studies reported improvements in flexibility were elicited by passive stretching conducted for patients with contracture and limited flexibility<sup>8, 13</sup>). However, passive stretching before exercise is not recommended according to another study<sup>21</sup>). Thus, passive stretching should be recommended for use when improvement in flexibility is required, for example, when there are post-exercise and range of motion restrictions, and particularly for bedridden patients, passive stretching may become one of the choices of the therapy.

The subjects of this study were young people. This study did not investigate the effects of stretching on elderly people, and only focused on immediate effects. Further studies are required. Specifically, studies using long-term interventions with greater numbers of subjects including the elderly, and

comparison of time and frequency of active and passive stretching are required. In addition, it is possible to evaluate the effect of stretching on exercise performance, not only flexibility.

In conclusion, we investigated the effect of passive and active stretching techniques on hamstring flexibility. The results of this study suggest that improvement in hamstring flexibility can be obtained by both stretching techniques. However, passive stretching may elicit greater improvements in hamstring flexibility than active stretching.

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