Middle East J Rehabil Health. 2014 October; 1(2): e24365 DOI: 10.17795/mejrh-24365

Published online 2014 October 20. **Research Article**

Comparative Study of Static Stretch and Hold Relax on Increasing the Motion Range of Knee Extension and Flexibility of Shortened Hamstring Muscles of Male Students in Semnan

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Received: September 3, 2013; **Revised:** November 19, 2013; **Accepted:** December 17, 2013

Background: Hamstring muscles play an important role in functional activities and relaxation and most people around the world suffer from the shortened muscles. Different methods of repairing were suggested and there were disagreements with regard to determination of one technique with high efficiency.

Objectives: This study aimed to introduce more effective method, either a static stretch or hold relax technique.

Patients and Methods: In this study, 60 male students of Semnan University of Medical Sciences (age range, 18- 25 years) who had shortened hamstring muscles were randomly categorized into three groups. One group was under test for hold relax and the other group was tested for static stretch during 4 weeks and three times a week. The third control group received no intervention. To assess these three groups, the motion range of knee extension was measured by a goniometer before and after the sessions.

Results: Results of this study showed that both methods have a significant effect on increasing the motion range of knee ($P < 0.001$). But no significant difference was observed between the static stretch and hold-relax techniques regarding increasing the motion range of knee ($P=0.246$).

Conclusions: The results of this study suggest that both techniques (static stretch and hold relax) have a significant effect on flexibility and increasing the motion range of knee. But neither is superior regarding their effect.

Keywords: Static Stretching; Hold Relax; Shortened Hamstring Muscles

1. Background

Shortness of muscles is considered as an important disorder in musculoskeletal system, which is the root of many functional disorders. Hamstring muscles are those which their shortness can have a negative effect on the spine, pelvis, lower limbs and totally, on the functional activity and general status (1, 2). The natural length of hamstring muscles plays a considerable role in efficiency of body movement such as walking and running (3) and the shortness of these muscles is widespread (4). The shortness of these muscles results in appearing types of diseases such as, waist spine disorders, neural syndromes, contractures resulting from central nervous system injuries and sports injuries. Long-term rest, due to the muscular conformity and also the nature of muscle flexion, causes shortness (5).

Two methods of extension and increasing the length of muscles proposed in Medical and Research Center of Rehabilitation are hold relax (HR) and static stretch (SS) (6). Static stretch refers to Passive stretching means the passive flexibility exercises are applied with the assistance of an external force with a special method that causes the extension of soft tissue of muscle. On the other hand, HR refers to one of the ways of facilitating nerve-muscle proprioception and active inhibition, which is used for increasing the length of muscles (7).

In 2012, Zakaria et al. performed a research investigating the effects of HR for 15 seconds and SS for 15 seconds, on the extension range of knee of young people aged between 18 and 24. The motion range of knee extension was measured by a Goniometer. The results of this study suggest that no significant difference was observed between these two techniques regarding increasing the range of knee extension (8).

In 2011, Puentedura et al. performed a research regarding the effects of both techniques (HR and SS) on flexibility and increasing the length of hamstring muscles in 13 healthy people with short hamstring aged between 22 and 37. In this study, the time period for SS and HR, was 30 seconds and 15 seconds, respectively and the range of knee extension was measured by a digital inclinometer. The researchers stated that both techniques cause a significant increase in flexibility and hamstring length and no significant difference was observed between both techniques regarding increasing length and flexibility of these muscles (9).

In 2011, Daneshmandi et al. investigated the effect of HR for 10 seconds and SS on the motion range of knee exten-

sion of 19 patients with below the knee amputation and shortened hamstring in 12 sessions. The motion range of knee in this study was measured by a Lighten flex meter. These researchers reported that, there was no significant difference between the two methods regarding increasing the motion range of knee (10).

In 2011, Nasiri et al. performed a research about comparing four methods of HR, SS, Past Isometric Relaxation and Reciprocal Inhibition on the rate of knee extension of 60 healthy individuals with short hamstring aged between 18 and 28 years old for 6 weeks. Static stretch and HR were employed for 30 seconds and 10 seconds, respectively and the motion range of knee was measured by a goniometer. The results of this study showed that SS effects can cause an increasedrange of extension compared to other three methods (11).

On the other hand, in 2010, by a study it is performed studies about the effect of HR for 5 seconds and SS for 7 seconds on the flexibility of the hamstring muscles of 80 healthy females aged between 20 and 30 years old. In this study, the motion range of active extension of knee, while the thigh joint was placed on 90 flexions, was measured by a goniometer (12). These researchers reported that the range of knee extension was significantly increased in HR groups compared to the other groups (12).

In 2006, Biddington et al. investigated the effects of SS and HR on flexibility, power and maximum extension of hamstring muscles on 32 healthy persons with short hamstring and reported that there was no significant difference between these two methods regarding increasing these indexes (13). In 2005, Odunaiya et al. compared time periods of 15,30,60,90 and 120 seconds of SS technique on the flexibility of hamstring muscles of 60 healthy individuals with short hamstring muscles for 6 weeks and reported that there was no significant difference between these time periods (14).

In 2003, Nachtwey et al. investigated the direct and indirect effects of HR for 15 seconds on the flexibility of hamstring muscles and motion range of thigh joint of 27 healthy individuals with short hamstring measured by a goniometer and reported that the direct effects of this technique is considerably more efficient than the indirect effects (15). In 2002, Carrie et al. performed a research regarding the effects of HR and SS on the shortened hamstring muscles of participants. In this research, it was reported that SS technique causes flexibility and the length of this muscle and motion range of thigh increase compared to HR (16). Comparing the effects of HR, SS, Ballistic Stretch and Passive Stretch on flexibility and increasing the length of shortened muscles of participants, in 2002, Draper et al. reported that HR is the most effective method compared to the other methods regarding increasing the length of hamstrings. Need to mention that SS is the second effective method following GR (17).

Different studies show that various and paradoxical results about the effectiveness of HR and SS for increasing the flexibility of hamstring muscles and motion range of knee have been reported. In this research, the test of passive knee extension was used, contrary to the previous studies which used Straight Leg raising (SLR), pelvic cycle does not damage the tests and results and it shows more accuracy to investigate the shortness of hamstring muscles and motion range of knee compared to the old methods.

2. Objectives

We sought to perform this study regarding the effectiveness and to compare these methods on the flexibility of muscles and motion range of knee so that we can take steps toward recognizing and choosing a more useful and important method.

3. Patients and Methods

The clinical trial study was approved by the Ethical Committee of Semnan University of Medical Sciences and was performed on 60 male students of Semnan University of Medical Sciences aged between 18 to 25 (mean age, 21/22 years)using the random sampling. The participants who had shortened hamstring muscles on lower limbs were randomly allocated into the three HR, SS and control groups. Those with defects in construction of musculoskeletal and neuromuscular systems and operation history on spine and lower limbs, those who do regular exercise, participate in matches and exercise programs, take medicines effecting on extension or sports and those who suffer from pain effecting on the shortness of hamstring muscles were excluded from the study. Volunteers with shortened hamstring muscles were selected in this study using the 90-90 test. They read the form of research data, and then filled out the consent form of participation. The participants with maximum compatibility were categorized into three groups for intervention, regarding the confounding variables, by means of HR, SS and control groups. Demographic data such as age, gender, weight, height and body mass index were registered.

To assess the tests of extension range of knee, the participants attended at test location in specific time; the 90-90 test was performed to assess the length of hamstring muscles of below limbs on the participants' right leg. Because hip is stable in flexion 90 degree and pelvic cycle does not have effect on the test, passive knee extension or 90-90 test needs more precision than other tests regarding checking the shortness of hamstring muscles (18-20). The participants are asked to lie down on the bed and bend their hip and knee for 90 degrees. For patients with short hip flexor muscles, a towel below the other knee was placed in order to prevent from pelvic cycle. Also, to prevent from spine cycle, a towel was placed under their spine. Then, the extension range of knee was measured by a goniometer (21).

These cases were assessed by the first assessor and the second assessor measured the motion range using the goniometer. Goniometer has two arms; its stable arm is

on the external line of truck parallel to bed. The dynamic arm is on the leg and trochanter. The reliance point of goniometer is placed on Tibiofemoral joint. The participants were asked to relax their legs and the assessor moves the legs toward the knee extension inactively until the person feels extension. When the legs are placed in flexion 20 degrees or more, it is regarded as shortness (22-24).

The SS method was exercised on lower limbs in form of a non-stopping 30second stretch with 5 times in each session and 15 seconds relaxation. In this method, in order to report the feeling of light stretch at the back of thigh, the patient's legs were raised in a manner of SLR (4). HR was exercised on the lower limbs with a 10 second Isometric Contraction and 3 second break time and three times in each session. In this method, lower limbs were extended inactively toward the range of extension and then the thigh joint was extended inactively toward complete range of flexion. Following this action, isometric contraction of hamstring muscles and after the contraction, the muscle relaxed for 3 seconds and this exercise was redone (5).

The number of sessions for all of the participants in both intervention groups was arranged for 4 weeks/three times a week (12 sessions). Control group has done the test during that time interval like as treatment group, but the intervention has not been done. It is noteworthy to mention that the participants of this study ran on the spot for 5 minutes and favorite pace before starting the treatment methods which causes warm up before employing these techniques (12, 14).

Statistical review: the number of samples was selected based on the study of Daneshmandi et al. in 2011 (10) and the formula of sample number. The data were analyzed using SPSS-16. The normality of data was confirmed by Kolmogorov-Smirnov. Then, ANOVA and Tukey test were used to examine the effect of SS and HR on the range of knee extension and compare their effects. The Sig was considered $P < 0.05$ for all of these tests.

4. Results

Regarding the random classification of the participants in this study, both treatment groups and the control group were compared regarding demographic indexes such as age, weight, height using K-S and T test and the results showed no significant difference among these three groups. Also, no significant difference was found regarding the range of knee extension between the groups under study (Table 1). In order to assess the repeatability of motion range of knee via goniometer, Pearson's coefficients test was used in a specific time for 2 successive days. The results of this study showed the considerable repeatability (0.935) with Sig of $P < 0.001$ regarding the mean and SD of first (4.6 and 73.6) and second tests (5.9 and 72.7) (Table 2).

Comparing the mean of knee extension range in both hold relax and static stretch compared to the control group showed a significant difference in recovery of motion range of knee extension ($F = 0.01$ and $P < 0.001$) in the participants, which shows the effectiveness of both methods (Table 3). Comparing the mean of changes in extension range of knee between hold relax and static stretch groups after the intervention revealed no significant difference between both groups regarding recovery of motion range of knee extension (Table 3).

Table 1. Mean and SD of Registered Indexes in Groups Before The Intervention [a]

Index	Group			P Value
	Control (n = 20)	Hold Relax (n = 20)	Static Stretch (n = 20)	
Age, y	21.22 ± 2.5	22.4 ± 2.2	22.12 ± 1.8	> 0.05
Height, cm	163.2 ± 5.9	157.8 ± 8.5	162.6 ± 6.7	> 0.05
Weight, kg	65.3 ± 13.3	70.4 ± 15.3	68.4 ± 12.8	> 0.05
Range of knee extension, degree	62.4 ± 6.2	62.8 ± 6.8	64.1 ± 6.1	> 0.05

[a] Data are presented as Mean ± SD.

Table 2. Mean, SD and Correlation Coefficient Repeatability of Results From Assessing the Motion Range of Knee Extension

Test	Range of Knee Extension, degree [a]	Correlation Coefficient	P Value
First test	73.6 ± 4.6	0.935	< 0.0001
Second test	72.7 ± 5.9		

[a] Data are presented as Mean ± SD.

Table 3. Comparing the Mean and SD of Knee Extension Range Between Treatment Groups and Control Group After the Intervention

Group	Knee Extension Range [a]	95 % CI	F	P Value
Hold relax (n = 20)	27.1 ± 2.03	-0.616-2.416 (P = 0.333)	0.01	< 0.001
Static stretch (n = 20)	26.2 ± 2.28	23.34-26.37 (P < 0.001)		
Control (n = 20)	1.34 ± 1.6	24.24-27.27 (P < 0.001)		

[a] Data are presented as Mean ± SD.

5. Discussion

The results of this study suggest that both HR and SS methods have a significant effect on recovery of hamstring short tissue flexibility and increasing the extension range of knee. But there was no significant difference between these two methods, and it was clinically determined that SS method, with respect to increasing the motion rate , is slightly more effective than HR method and the shortened tissue showed more flexibility and better function. In research by Puenteduraet al. in 2011 and Draper et al. in 2002, the same issue was stated and the significant difference was not shown between these methods (9) which approve these results.

In 1997, Madding stated that there is no significant difference between time periods of 30 and 60 second Pasio Static Stretches and both times cause the flexibility of hamstring muscles and extension range of knee to increase, which in this study the 30 second stretch has been used and has a significant effect on the recovery of hamstring muscles (5). Moreover, in the study by Bonnar et al. in 1998, it was determined that we can use 6 and 10 second HR technique for isometric contraction which shows no significant difference, and in this study, 10 second isometric contraction was used (25).

In 2010, it is investigated the effect of HR and SS on the flexibility of Hamstring muscles and reported that the range of knee extension has been considerably increased in HR compared to the other group (11) which is not consistent with the results, the number of weeks of intervention in this study and using SLR test may effect on the results of this study. In 2002, it is performed a research regarding the effects of HR and SS on the shortened hamstring muscles of participants. In this research, it is reported that SS technique causes more flexibility and increase the length of this muscle and motion range of thigh compared to HR (15). The small number of samples and difference in mean age of the participants in abovementioned study may affect the results of this study.

In 2008, Lehman et al. compared HR and SS regarding increasing the flexibility of muscles and concluded that both methods have a significant effect on increasing flexibility and reported no significant difference in the results, of course, in the present study, it is stated that both methods are effective (26). The results of this study showed that both SS and HR techniques have a significant effect on recovery of flexibility and increasing the motion range of knee, but neither of them is prior regarding the effect and both of them can be employed. Static can decrease the maximum extension and muscular power due to the changes in elastic viscoelastic properties in muscles and tendon. Also, this extension causes changes in factors effecting on neuromuscular systems like number and frequency reduction of active motion units which justifies the reasons of effectiveness (27).

It is noteworthy to mention that as the flexibility and motion range depend on different factors like age, gender and occupation (28) and the number of samples; due to the small number of samples in this study, we cannot reach certain results, we should have large number of samples and a lot of time for doing techniques to reach a decisive conclusion for these techniques. Regarding the results of this study, it is recommended to compare both techniques with large number of samples and various stretch times.

Acknowledgements

Finally, we would like to acknowledge the research and education officials of the rehabilitation faculty of Semnan University of Medical Sciences and Tabatabaei physiotherapy clinic in Semnan.

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