Research Article

Effects of Different Stretching Times on Range of Motion in Patients with Hamstring Tightness: A Randomised Control Trial

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Abstract | Hamstring tightness is commonest cause of altered biomechanics of ankle, knee, hip and spine. Long persistent tightness results in pain, decreased range of motion and others pathologies in knee joint. Stretching techniques are used to treat muscle tightness. In clinical settings, different stretch holding times are used to treat hamstring tightness. The purpose of the study was to determine effects of different static stretch holding-times on hamstring muscles flexibility and their impacts on improving range of motion (ROM) of knee extension in adults. This experimental work was conducted on students of University of Lahore from December 2013 to March 2014. The study comprised of 60 subjects with asymptomatic tightness of hamstrings muscles and subjects were aged between 18-26 years (irrespective of their gender). Range of motion at knee joint was measured by universal goniometer before the commencement of stretching technique. Static stretching was applied to group A, B and C with 30, 60 and 90 seconds holds, respectively. Stretches were exerted at frequency of three sessions per week and three repetitions per session. Reevaluation of ROM was performed after 4 and 6 weeks. The mean values of ROM of knee extension showed gain in range after applying static stretching at 30s, 60s and 90s holding times. By applying repeated measure analysis of variance (ANOVA), the p-values were found to be statistically significant ($p<0.001$) for static stretching techniques with 30s, 60s, 90s holding times, respectively. Based on these finding, it is plausible to conclude that application of static stretching at holding times of 30, 60 and 90 seconds can significantly improve the ROM of knee extension. Stretching techniques with different holding times were equally effective in improving knee extension and gaining hamstring flexibility in adults.

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Introduction

Hamstrings are the main flexors of knee joint and tight hamstrings cause altered biomechanics, resulting in joint reaction forces during routine daily activities. Knee remains in semi-flexed position leading to gravitational falls on the anterior of the knee. The length-tension relationship of quadriceps may also disturb which further aggravate the pathology with extra tension on patellar tendon. This may result in patella-femoral dysfunction and pain syndrome.[(1)]

Tight hamstrings not only disturb the biomechanics at knee joint but also joint reaction forces and me-

chanics of hip and ankle joints. This results in abnormal gait patterns and abnormal foot loading. Planter fascia undergoes repetitive trauma that can result in planter fasciitis and heel pain.[2]

Unaffected functional activities require normal length and strength of hamstring muscle. Additionally, muscles attached on pelvic and spine control the normal curvature of spine. Therefore, hamstrings are one of the important muscles, which control pelvic movements and in turn direct spinal movements. Pelvic, lumber and thoracic spine parts are dynamically connected by various muscles. Hamstrings muscles resilience affects the thoracic and pelvic mobility when complete trunk flexion is performed with extended knees.[3]Gluteal muscle weakness is associated with hamstring tightness and it results in sacroiliac joint dysfunction.[4]

Since normal length and strength of hamstring is crucial for normal lumbar pelvic rhythm, hamstring tightness results in altered lumbar pelvic rhythm and increased load. In performing stoop lifting lumbar-pelvic rhythm, the hamstring muscle may be shortened. Delayed lumbar extension results in increased load on posterior ligament us structure leading to increased risk of spinal instability. These muscular irregularities can cause lower back complications.[5]

Low back pain causes reflex tightness of hamstring muscle and it is associated with patient's activities of daily living or its job activities or posture. Patients having low back pain usually have tight hamstrings that is not associated with work settings and sedentary life style.[6]

In normal gait cycle, terminal extension at knee requires normal flexibility of hamstring but if hamstrings are tight the person is unable to perform the terminal extension. Hamstring tightness cause altered biomechanics at knee resulting in abnormal gait pattern. Hamstring tightness is commonly seen in cerebral palsy patients. Therefore, they show abnormal gait patterns and are unable to complete the normal gait cycle.[7]

Joint range of motion (ROM)can be increased post-stretching techniques for 6 weeks with 90 sintervals despite of the frequency or the time of each individual stretch.[8] On the other hands, knee ROM with or without osteoarthritis can be improved with stretching. Stretching can play a decisive role in improving the knee ROM and can be an integral part of exercise plan in treating elderly patient with and without OA . As a mitigation plan, stretching is used as warm up exercise before performing different exercises.[9]

Static stretching is preferable improve the flexibility of muscle compared to dynamic stretches. Hamstrings strengths, both concentric and eccentric, are reduced when dynamic stretch is applied instead of static stretching. Therefore, to establish a balanced strength and length of hamstring muscle, static stretching rather than dynamic stretching is suggested. In cases, where dynamic stretching is recommended, it should be used cautiously.[10]A perfect combination of length, strength, balance and coordination is required for professional dancer. The preparation tool for training these dancers is dynamic and static stretching. Combination of dynamic and static stretching not only improves the ROM but also improves the vertical jump height and balance.[11]

In order to increase the length and flexibility of hamstring muscle, different stretching techniques are applied. Most commonly used stretching techniques are dynamic and static stretching. Both stretching techniques improve flexibility and ROM, however, improving flexibility is static stretching is the most fruitful technique.[12]Normal extensibility and flexibility of hamstring muscle affects biomechanics (both static and dynamic) of spinal curvatures. Spinal curvature deviations and correction of increased thoracic kyphosis can be achieved by static stretching of tight hamstring that results in immediate improvement in spinal curvature in median plan. Static stretching of hamstring improves the anterior pelvic tilt with knee in full extension. Additionally, trunk and lumber forward flexion can also be improved when hamstring flexibility is practiced.[13]

Given variability in time and nature of static stretching in clinical cases, the objective of this study was to compare the effects of 30, 60 and 90 seconds of holding times in static stretching of hamstrings muscles in adults between the ages of 18-26 years. The cumulative results of presented finding propose the most suitable and appropriate practices to alleviate the pressure on hamstrings muscles.[14]

Material and Methods

It was an experimental study (randomized control tri-

al) involving 60 students, aged between 18-26 years from University of Lahore, Pakistan. Subjects were selected from December 2013 to March 2014 by systematic random sampling; in group A (1st, 4th, 7th, 10th… subjects were included), in group B (2nd, 5th, 8th, 11th …. subjects were included) where as in group C (3rd, 6th, 9th, 12th…were included).

The data was collected after approval of the research protocol by the ethical review board of University of Health Sciences, Lahore, Pakistan. All participants involved in the research study filled the informed consent form. Asymptomatic tight hamstring muscles in students between the ages of 18-26 years with limited extension equal to or greater than 15 degrees were included in the study. Students with hyper mobility or having history of hamstrings tears, any surgery (spine or lower extremity joints), and neurological diseases or with athletic background were excluded. Necessary data was taken from 60 subjects who met the selection criteria; they were divided into three groups A, B and C and each composing of 20 students. Systematic sampling was used for allocation of students in three different groups:

$$k=N/n,\ k=60/20$$

k=3for systematic sampling there for k is 3. 1st, 2nd and 3rd for groups A,B and C.A valid and reliable Goniometer was used to measure and make the record of the degrees of tightness (decreased ROM) before treatment and then re-evaluation was conducted4 and 6 weeks after treatment.[2]

Knee extension ROM was measured with 90/90 SLR in which hip joint is placed in 90 degrees flexion position and knee extension is performed through full range or up to the point when person have the feeling of stretch. Static stretching technique was applied to group A, B and C with holding time of 30, 60 and 90 seconds, respectively. Frequency of the stretches was three and stretches were given three times per week. A rest-time of 20 seconds was given in between three stretches. The data was analyzed by using statistics software SPSS22 and the p-value was set as 0.05 (p-value less than 0.05 ($p<0.05$) was considered significant). Change in ROM was measured at the end of fourth and sixth week as main variable. The quantitative data was presented in the form of means and standard deviations. The qualitative data was presented in form of frequencies. The data had showed normal distribution, there for erepeated measure ANOVA and multivariate tests were used to reveal the difference of study population over different follow-up studies in three groups.

Results and Discussion

The means (± standard deviations) of ROM of knee extension showed gain-in its range at 4 and 6 weeks after providing static stretching at different holding times as compared to values at baseline (Table 1). This showed improvement in ROM of knee extension after static stretching. The significant p-values ($p<0.001$) were found for static stretching techniques with 30s, 60s, 90s holding-times, respectively).

Table 1: *Descriptive statistics and comparison of means ± S.D of ROM of knee extension in three groups over different follow-up (n=20 in each group).*

	Before treatment	After four week	After six week	p-value
Group A	-40.10±12.49	-23.80±14.58	-10.25±11.83	<0.001
Group B	-45.65±15.26	-25.10±15.23	-9.70±11.15	<0.001
Group C	-51.10±12.97	-29.15±14.04	-11.65±12.99	<0.001
Overall	-45.62±14.14	-26.02±14.56	-10.53±11.84	<0.001

**ROM: Range of motion, p-value ≤0.05 statistically significant. Negative mean values shows that it is the degrees of limitation in range of knee extension, as the ROM of knee extension is from 135-0°. Overall repeated measure one way ANOVA showed statistically significant difference (p-value <0.001).*

(I) time	(J) time	Mean Difference (I-J)	Std. Error	p-value
Group A	Group B	-19.60	0.74	.000
	Group C	-35.08	1.35	.000
Group B	Group C	-15.48	0.93	.000

Linear graph showed that mean values of ROM of knee extension are increasing in equal proportion in all groups at the end of the treatment. This graph showed a gradual increase in ROM at 4th and 6th week in three groups (Figure 1).

Hamstring muscle is more prone to tightness, which can be reduced by static stretching techniques. The purpose of this study was to compare the effects of static stretching with 30, 60 and 90 seconds holding-times to improve the range and flexibility at knee joint.

Limitation in performing terminal extension at knee

joint is usually caused by tight hamstrings. Normal gait requires normal biomechanics and normal length, and strength of hamstring is prerequisite for normal biomechanics in lower extremity. Flexibility of hamstring is questionable when terminal extension at knee is limited. This result in altered swing phase pattern of gait. [7]Decreased flexibility can be improved by applying stretching techniques on shortened muscle. Also, stretching improves flexibility and in turn ranges of motion at joints. Static stretching is one of the most common types of stretching used to improve flexibility. [15]

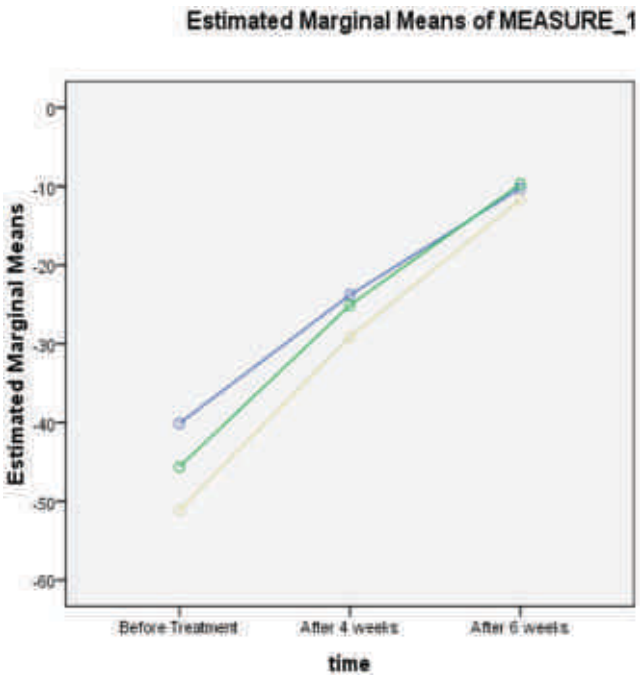

Figure 1: *showing comparison between three groups.*

Bandy WD and Irion JM have conducted a study and found that the static stretch of 30 and 60 seconds are more effective than static stretch of 15 seconds hold on hamstring flexibility. Comparing the results of 30 and 60 seconds hold static stretching techniques, both holding times showed equal improvement in flexibility of hamstring muscle and range of motion. [16]Our study also showed that 30s, 60s and 90s holding times for stretch are equally effective in gaining range and improving flexibility in youngsters.

Feland JB et al have concluded similar studied in late ages where 60 seconds hold of static stretching was more beneficial to bring greater changes in the range of motion and flexibility. Among two static stretch holding times 30 sec and 60 sec, longer static hold during stretching of the hamstring muscles showed greater and more sustained increase in joint mobility in old age patients. In young population holding times of 30 seconds and 60 seconds of static stretching produces equal gains which are different from the older patients. [17] Our study also provided same evidences that in young age group, stretching of different holding times produce same effects. No significant difference was found among the groups.

Different studies were carried out on young population to observe and measure the effects of different static stretch times, repetition and number of treatment session per week for gaining the range of motion at different joints. It was noticed that static stretching when applied in form of 2 x 15-, 6 x 30-, and 4 x 45-seconds durations of static stretching produce same effects in increasing hamstring resilience when frequency is 3 days per week for 12 weeks in young adults. [18]

Hamstrings muscles flexibility and extensibility is greatly improves by stretching. Combine therapy of Static stretching with stabilization exercises not only improve the hamstrings flexibility and trunk forward bend in healthy 10 to 13 years old children it also improves the strength, which is measured by different test performances like gains in the straight leg raise, improvement in popliteal angle and finger-to-floor test results. Post isometric relaxation provides similar measureable results; gained straight leg raise range, improved popliteal angle and finger-to-floor test. If simple stretching is applied, it only improves the straight leg raising (SLR). [19]

Studies were conducted to measure the difference in improvement when stretching exercises were performed three and five times a week. It was found that 3 times per week were sufficient to improve flexibility and range of motion same as 5 times per week. Same gains were observed with stretching exercise either these were performed three times or five times per week. [20]

This study was conducted on young population to observe the effects of 30, 60 and 90 seconds of static stretch. All three different holding times 30,60 and 90 seconds of static stretch were applied with three repetitions and frequency of three times per week. Same gains in hamstring resilience and knee extension range of motion were observed in all three groups. All three reading of ROM of all three groups

were analyzed. It revealed that same gains in range of knee extension regardless of different holding times 30, 60 and 90 seconds. Therefore, it is time and energy saving to use 30 seconds holds stretching time rather than longer durations.

Conclusions

From the results of this study, it can be concluded that there is significant improvement in ROM of knee extension and flexibility in hamstring muscles after applying 30, 60 and 90 seconds hold of static stretching in all the three groups. The significant p-values found for static stretching techniques with 30s, 60s, 90s holding times ($p<0.001$) showed that stretching for 30 seconds hold is as effective as for 60 and 90 seconds holding times. All the different holding times are equally effective in gaining range of knee extension in young population between ages of 18-26 years. There was no significant difference within groups using multiple comparison tests (post-hoc test).

This study showed the effectiveness of static stretching technique in improving range of knee extension in youngsters, commonly limited by the tightness of hamstrings.

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