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Research article

EFFECT OF BODY POSITION AND TYPE OF STRETCHING ON HAMSTRING FLEXIBILITY

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ABSTRACT

Background and objective: Stretching exercise protocols, as part of outpatient treatment or home exercise programs, are used to improve muscle flexibility. So, the aim of the study was to examine the body position effect (standing and supine) and dynamic range of motion (DROM) stretching technique on hamstring flexibility. **Material and Methods:** Seventy five subjects with decreased flexibility of hamstring (defined as ≥30° loss of active knee extension, from 90°hip flexion position), participants were randomly assigned to one of three equal groups. The first group performed static stretch from standing for 30 sec. The second group performed static stretch from supine for 30 sec. The third group performed DROM stretch. The stretching procedure conducted three times per week for four weeks. **Results:** There was a significant increase in the knee extension range of motion for standing, supine and DROM stretch ($p < 0.05$). Stretch from standing and supine was significantly higher than DROM stretching ($p < 0.05$). There was no significant difference in hamstring flexibility between standing and supine stretch ($p > 0.05$). **Conclusion:** Both standing and supine stretches displayed improvement in the hamstring flexibility, and both of them produced higher improvement than DROM stretch during hamstring flexibility training

Keywords: Body position, Hamstring flexibility, Stretch

INTRODUCTION

Muscle flexibility exercises are among the exercise types most commonly used in rehabilitation and sports practice. Their aims usually include reducing the risks of injuries, minimizing late-occurring muscle pain and improving general muscle performance.[1] The muscle flexibility defined as muscle ability to lengthen, permitting one joint (or joints in a series) to freely move through a range of motion.[2]

Improvement of flexibility is postulated to prevent athletic injuries. Stretching exercises were found to benefit athletes and social exercisers in many ways, including increased

flexibility, decreased incidence of injury, and better athletic performance. [3] Low back and lower extremity injuries are strongly correlated to poor hamstring flexibility.[4,5] Hamstring stretch training significantly improved its flexibility and decreased the risk of lower extremity injuries in a sample of military trainees as compared with a control group.[4]

Hamstring stretch from standing position has been found to improve hamstring flexibility.[6–10] However, pelvic position is an important factor determining stretch efficacy;[11] therefore, proper performance must be considered. The usual static stretching technique from supine does not appear to have been investigated. It is easily taught and requires less supervision than standing stretch, thereby making the patients and athletes can perform it effectively.[12]

Dynamic range of motion (DROM) could be an alternative to static stretching; it was suggested as a better stretch technique than static stretching for increasing muscle flexibility. During DROM, the antagonist contraction allows the joint crossed by the agonist (muscle to be stretched) to move at a controlled pace through a full range of motion (ROM). All movements are performed slowly and deliberately.[13]

Dynamic range of motion includes a slow movement of the limb that starting from a neutral position toward end of range of motion, a brief hold at the end range of motion, and, finally, slow movement of the limb back to return to the original neutral position through an eccentric contraction. The antagonist contraction leads to relaxation of the agonist (lengthening muscle) as described by the principle of reciprocal inhibition. So, DROM is more natural and relaxed way of stretching, as the muscle is reflexively inhibited, and the strength is improved because the movement is performed by the muscles that move the involved joint.[13] Therefore, the aim of the current study was to evaluate the effect of static stretch from standing and supine position and dynamic range of motion hamstring stretching in increasing hamstring flexibility.

MATERIAL AND METHODS

Subjects: Seventy five subjects participated in the study, they were randomly allocated into three equal groups; supine stretch, standing stretch and DROM stretch group. Exclusion criteria are: 1) lower extremity or back injury through the last year that required medical treatment and 2) any pathological conditions that negatively affecting on hamstring flexibility. Inclusion criterion is the loss of at least 30° of active knee joint extension with the hip joint flexed to 90°.[7] Subjects agreed to maintain their physical activity level, especially level of exercise, throughout the 4 weeks of the study. Table I, presents the demographic characteristics of the participants. The study was approved by the research ethics committee of the Faculty of Physical Therapy, Cairo University.

Table.1: Demographic data for supine, standing and DROM stretch groups

Groups	Supine stretch group, (n = 25) Mean ± SD	Standing stretch group, (n = 25) Mean ± SD	DROM stretch group, (n=25) Mean ± SD
Age, years	25.54 ± 3.72	23.92 ± 3.87	24.20 ± 4.19
Weight, kg	75.44 ± 6.73	77.34 ± 7.84	76.34 ± 7.77
Height, cm	172.8 ± 5.07	170.88 ± 5.61	173.24 ± 6.53

SD: standard deviation

Procedures

Hamstring muscle flexibility was measured with a transparent plastic goniometer marked off in 1-degree increments. Each subject was lying supine with the right hip and knee joint flexed to

90 degrees. The greater trochanter, lateral epicondyle and lateral malleolus of the right lower extremity were then marked with a felt-tipped pen for later goniometric measurement. Ninety degrees of hip flexion was maintained by one researcher, while the tibia of the knee was passively moved to the terminal position of knee extension by the second researcher. The terminal position of knee extension was defined as the point of range of motion at which the subject complained of a feeling of discomfort or tightness in the hamstring muscles or the experimenter perceived resistance to stretch. Once the subject reached the terminal position of knee extension, the second examiner measured the degree of knee extension range of motion with the universal goniometer.[14] All measurements were performed in the same way before and after the stretching techniques (4 weeks), without warm-up before measurement.

All participants received a handout describing the ideal way the three types of stretch technique. They randomly assigned to the three groups by using a computer-generated number table. First group (standing stretch), subjects stands facing the table of evaluation with the heel placed on the table edge, then the subjects instructed to bend forward, the subjects maintain a flat back with the pelvis move in the direction of anterior rotation, they must maintain a neutral position of the head and maintains the stretched leg in full extension as shown in figure (1). The second group (supine stretch) subjects positioned in supine lying on the floor with the stretching leg elevated on the cupboard or wall and the other leg straight on the floor, the subjects adjust the distance from the wall to feel a hamstring stretch. When the supine stretch position cannot produced a stretching sensation to the hamstring, the examiner instructs the subject to slide their body closer to the cupboard or the wall[12], as shown in figure (2).

Fig.1: Standing stretching procedure for hamstring

Fig.2: Supine stretching procedure for hamstring

The third group (DROM stretch) the subjects lying supine on the evaluation table with the hip joint maintained in 90° of flexion. The subjects extended the knee joint actively (5 sec), maintain the leg at the end of the knee extension for 5 sec, and then slowly move the leg to flexion (5 sec), which was considered one repetition. The DROM stretching movement was repeated for six times. DROM stretch performed for six repetitions of 5 sec each allowed 30 sec of actual stretching duration, which is equal to the stretching duration performed by the first and second groups[13]

The three stretching techniques were performed 3 times/week for 4 weeks, at the same time of day. Each stretching session consisted of 3 times stretching for 30 sec. Subjects rested for 15 sec between stretches, for the supine stretch group the subjects removed their leg from the wall, for standing stretch group the subjects move their leg

down from the table, from DROM stretch group the subjects take the sitting position. No warm-up exercise was performed before stretching sessions. One of the researchers supervised the stretching sessions to ensure that stretching techniques were being performed in the same way. If a subject missed 2 stretching sessions during stretching program would be excluded. Two days existed between the last bout of stretching procedure and final measurement. To eliminate bias effect the 2 researchers who recorded the measurements did not review the initial flexibility measurement values.

Statistical analysis

Data were analyzed by using a Statistical Package for Social Sciences (SPSS) for Windows version 16.0. (SPSS, Inc., Chicago, Illinois). Dependent t-test was used to compare between pre and post values of each group. One-way ANOVA was used to investigate the effect of the training program on hamstring flexibility. Least significant difference (LSD) test used to locate the source of differences. Level of significance was set at 0.05 for all tests.

RESULTS

The descriptive statistics of the pretest and posttest values of the supine, standing and dynamic range of motion stretch groups were illustrated in Table II. Paired t-test of the pre and post values of the three groups revealed that there was significant improvement in the knee extension ROM of knee joint of the three groups (p=0.00).

One-way ANOVA of the pre values of the supine, standing and dynamic range of motion stretch groups revealed no significant difference between the three groups (p > 0 0.05). One-way ANOVA of the post values of the supine, standing and dynamic range of motion stretch groups revealed that there was no significant difference between post values of supine and standing stretch (p = 0.929), the improvement of supine stretch group was significantly higher that dynamic range of motion stretch group (p = 0.006), the improvement of standing stretch group was significantly higher that dynamic range of motion stretch group (p = 0.007).

Table.2: Knee-extension measurements pre and post stretch of the three groups

	Supine	Standing	DROM
	Extension ROM	Extension ROM	Extension ROM
Pre test	138.24 ± 6.11	137.12 ± 7.81	136.48 ± 7.07
Post test	145.56 ± 5.34	145.40 ± 7.99	140.44 ± 5.32
Gain (difference between pretest and posttest)	7.32 ± 1.80	8.28 ± 1.93	3.96 ± 2.32

Finally, to summarize the data, a one-way ANOVA on gain values of the three groups was calculated, it revealed a significant difference between groups (p < 0.05). Post hoc analysis using LSD test indicated the gain of the supine and standing stretching groups was significantly higher than the gain of the DROM stretch group (p = 0.000), as well as no significant difference in gain of the standing and supine stretch groups (p = 0.980).

DISCUSSION

This study was conducted to compare the effect of standing, supine and DROM stretch on hamstring flexibility. The musculotendinous units have the properties of creep and stress relaxation. Creeping is known as muscle lengthening due to an applied constant load. Stress relaxation is defined as decrease in force that necessary to hold a tissue at a particular length over time.[15] The musculotendinous unit lengthens as it is being stretched and goes

through elastic deformation followed by plastic deformation before complete failure.[16] The proprioceptors located within the muscle fibers and tendons relay information about muscular tension to the central nervous system. The two proprioceptors related to stretching are muscle spindles and Golgi tendon organs. Muscle spindles are located in the intrafusal fiber of the muscle, and responds to any changes in length.[17,18]

Hamstring static stretching from standing position allowing trunk flexion with knees extended that produced a greater degree of lumbar spine flexion and anterior pelvic tilting with lower degree of thoracic spine kyphosis. So, hamstring stretching is recommended before sport activities required trunk flexion with both knees maintained in a full extension position to obtain a higher degree of hamstring flexibility.[19]

The groups that performed standing and supine stretch illustrated significantly greater gains in hamstring extension ROM than the third group that performed dynamic range of motion stretching. This is consistent with the results of Bandy et al.[6] who compared the effects of 30 sec of static stretching with dynamic range of motion, the gain of static stretching was 11.42° but the gain of dynamic stretching was only 4.26°, the gains of the current study were 7.32° for the supine hamstring stretching group, 8.28 ° for the standing hamstring group and 3.96 ° for the dynamic stretching group, these results appear to be less than that reported by Bandy et al.[6], the reason may be due to the short duration of the present study (4 weeks) in comparison to the study conducted by Bandy et al.[6], which conducted through 6 weeks of stretch training.

Many factors contribute to the clinical success of a stretching program. The frequency, intensity, and duration are critical to achieve plastic deformation of the tissue and lasting gains in range of motion.[20] The time frames for a stretch program used in the previous studies[11,21] ranging from 2 to 8 weeks of stretching programs. The participants of the current study performed stretching 3 times per week for 4 weeks, which is consistent with the duration and frequency used by previous studies.[6,7,21,22] Moreover, stretching exercises performed three times a week were sufficient to improve flexibility and range of motion compared to subjects exercised five times a week.[23] Moreover, Cipriani et al.[24] stated that stretch training produces the same results, whether the subjects conducted daily or 3 times per week.

The standing hamstring stretch is common and has been considered as valid and effective method of increasing hamstring flexibility,[6,7,10] the present study proved that supine stretching is equally effective as standing stretch. During standing stretch the subject can achieve an adequate stretch by bending his trunk forward without flexing the spine, so the pelvic position is very important during standing stretch.[7,11] In contrast, during supine lying stretch the pelvic position was free, for this reason it is preferable to use the supine lying stretch in unsupervised settings, such as group therapy, home exercise programs or during athletic training. Moreover, supine lying stretch isolate the hamstring muscles during stretching, so it is safe and comfortable for people suffering from low back pain which will improve the relaxation during stretch.[12]

The duration of static stretch (standing and supine) used during this study was 30 sec that in accordance with the study of Bandy et al. [7] indicated that a 30 sec stretch duration was more effective than a 15 sec stretch and its effect is equal to 60 sec stretch. Moreover, the 30 sec of stretch and the procedure of DROM stretch repeated for three times that was trial to overcome the problem facing Bandy et al.[6] during conduction of their study, they stated that the stretching activities of DROM group were higher than that performed in standing and supine static stretching groups. In spite of this increment in the total duration of stretch of the DROM group, the groups of standing and supine stretching for 30 sec (3 repetitions) increased

hamstring flexibility to a significantly greater than the DROM group (3 repetitions), that is coincident with the study conducted by Bandy et al.[6], who proved that the standing static stretch is more effective in improving hamstring flexibility than DROM.

However, Guissard and Duchateau [17] reported that active dynamic stretching results in length changes similar to passive static stretch, the major advantage to active dynamic stretching compared to passive static stretching is its effect on the nervous system, and elastic properties of the muscle during a stretch. As stated earlier, the nervous system regulation of tension and length is performed by a golgi tendon organ and muscle spindle, respectively. When a muscle is repeatedly stretched, a muscle spindle records the change in length, thus activating the stretch reflex and causing a change of the muscle length through a muscle contraction. As a direct result of an increase in muscle spindle activity, a fast, dynamic stretch will increase a stretch reflex response causing an agonist muscle to contract with greater force. So, the dynamic range of motion stretch is more effective in increasing the muscle power and performance which did not evaluated during this study.

Perrier et al.[25] proved that flexibility was greater after both static stretch and dynamic stretch compared to after no stretch, with no difference in flexibility between static stretch and dynamic stretch. Athletes in sports requiring lower-extremity power should use dynamic stretch techniques in warm-up to enhance flexibility while improving performance.

The result of the current study was against the findings of Meroni et al.[26] who found that active stretching of hamstring produced a greater increase in the active knee extension range of motion, and the improvement of hamstring flexibility was maintained 4 weeks after finishing the training. However, the maintaining effect of static stretch is less than active stretching. So, active stretching was more efficient than static stretching in producing positive effects on hamstring flexibility.

This study was limited by the following: First, the study was restricted for the male subjects and female subjects not represented in this study. So, the reader must be careful during generalization of the results of this study on all populations. Second, the sample of the current study was young. So, the results of the present study will be more suitable for a similar age group and further research evaluates the effects of the three methods of stretching in individuals in other age groups would be interested. Third, no warm up activity applied before stretching which may increase the ROM gains, that is in agreement with the findings of O'Sullivan et al.[27], who stated that the hamstring flexibility increased by warm-up exercise, static stretching, however dynamic stretching did not. Finally, there is no control group in the design of the present study that is due all the previous literature[6,7,21,28] proved that no changes in the knee extension ROM of the control group as they did not perform any type of stretch.

CONCLUSION

In conclusion, the results of the study proved that standing, supine and DROM stretching increases the hamstring flexibility. Moreover, standing and supine stretch is significantly higher than DROM stretching, as well as there is no significant difference between supine and standing stretch in increasing the hamstring flexibility. Supine stretch requires less instruction and supervision. So, it is effective for home exercise programs or during athletic training.

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