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Effects of static stretching and neurodynamic mobilization on hamstring flexibility in elderly population- A randomized clinical trial

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Abstract
Background: Muscle tightness may be a common impact of aging caused because of cross-linking of fibers. The joints become stiffer and less flexible as we tend to age. The cartilage could begin to rub along and wear away with time. Hamstring muscle is one of the common muscle found to be tight in an individual and is the potential cause for low back issues altering the lumbopelvic rhythm in them. Various studies have compared numerous techniques to see which technique is best for increasing joint range of motion (ROM). However, there are limited studies comparing the results of static stretching and neurodynamic mobilization on hamstring flexibility in elderly.
Methods: 20 subjects aged 65-75 years with hamstring tightness were randomly allocated to two groups. Group A (n=10) received static stretching and Group B (n=10) received neurodynamic mobilization. Both the groups received 10 sessions of treatment, 5 consecutive days for 2 weeks. Passive Knee Extension (PKE) and Passive Straight Leg Raise (PSLR) measurements were measured before and after 2 weeks of intervention. Static stretching was given for 60 seconds and neural mobilization was given in form of sliders.
Results: Independent sample t-test was employed in order to verify within group analysis that showed significant improvement in hamstring flexibility after 2 weeks of intervention. Comparison between the group was done using paired t test that demonstrated non-significant differences (level of significance is $p<0.05$) in improvement score of PKE (0.06) and PSLR (0.40).
Conclusion: Static stretching and neurodynamic mobilization both were equally effective in improving the hamstring flexibility in elderly subjects.

Keywords: Static stretching, neural mobilization, hamstring tightness, elderly subjects

1. Introduction

Muscle tightness can develop from overuse injuries, trauma, stress, or illness. However, the progressive decline in flexibility with age is recognized as changes in physical property and reduced amount of physical activity [1]. Physiological changes observed with aging include muscle atrophy, reduced capability for healing, diminished capillary blood supply, and reduced amounts of mesenchymal stem cells and loss of strength and elasticity in soft-tissue matrices increased muscle and joint stiffness with accumulated amounts of fibrous connective tissue, has additionally been reported [2]. Various techniques are used to stretch the tight muscle or connective tissue like static stretching, dynamic stretching, proprioceptive neuromuscular facilitator (PNF) technique and my of ascial release technique for the same [3, 4, 5]. However, confusion persists while creating the proper selection of exercise to extend flexibility and most of the studies are targeted at the young or middle age population. Older muscles are more susceptible to contraction-induced injury, especially when the muscle is lengthened during the contraction [6] and have a diminished ability to recover from acute or repetitive musculoskeletal trauma. There is a scarcity of literature to conclude the suitable technique to increase flexibility within the geriatric population.

Neurodynamic mobilization has proven to be an efficient intervention in various musculoskeletal conditions [4]. Neural tissues involvement to hamstring flexibility has been studied in various kinds of literature. A study stated that a neurodynamic mobilization might increase hamstring flexibility more efficiently than static stretching in healthy male subjects with a tight hamstring [7]. Neurodynamic mobilization decreases the neural mechanosensitivity and may be a helpful technique in the management of hamstring flexibility.

Static stretching is widely used for measuring flexibility, which is elongating a muscle until resistance is felt and sustaining the position for a length of time [8, 9]. Active and passive stretching expand the range of motion by working on muscles, tendons, capsules and ligaments. Stretching of the muscles before an event is an extremely important factor in the achievement of optimal task performance and is also used as warming up exercise. Numerous stretching methods have proven to improve muscle flexibility, including the static stretching, contract-relax stretching, and ballistic stretching. Static stretching is done in a static state without any additional movement other than the motion of the muscle stretch, it works to improve the viscoelastic properties and stretch tolerance of the muscle [10].

Previous studies have compared the effects of Neural Mobilization and static stretch on hamstring tightness in asymptomatic subjects in young and middle age group, but less is known about the most effective method to improve hamstring flexibility in an elderly population. Hence, the present study aimed to compare the effect of neural mobilization technique and static stretching on hamstring flexibility in elderly subjects with hamstring tightness.

2. Methods

This study was a randomized experimental trial. Permission to conduct the study was granted by the Institutional Ethical Committee. A total number of participants participated in this study was 20(n=20), 10 in each group. The purpose of the study was explained to the participants in their vernacular language and a written informed consent was obtained from all the subjects. Subjects were then randomly allocated into two groups using envelope method. Both males and females were included in the study aged between 65-75 years, 20 to 50 degree knee extension loss with hip in 90 degrees of flexion, Inability to reach 70-degree hip flexion in straight leg raise test and subjects who were able to comprehend command and who were willing to participate in the study. Subjects were excluded if they had any recent episode of traumatic low back pain with any neurological symptoms. Any history of recent abdominal, back surgeries or lower limb surgeries within 6 months, subjects diagnosed with any cardiac or respiratory illness. Subjects being receiving physiotherapy treatment at the time of baseline assessment and if they had sustained any hamstring injury/soft tissue injury. The dominant side of the subjects was measured.

3. Outcome Measurements

Measurements of hamstring flexibility were obtained using the passive knee extension (PKE) test and passive straight leg raise (PSLR).

The Passive Straight Leg Raise (PSLR) was used to measure hamstring flexibility [11], while the subject lying supine on the examination table with the other limb secured by a Velcro strap. Subject's lower extremity is lifted up passively by maintaining the knee extended, to the point where the subject can tolerate the resistance or stretch in the posterior part of the thigh. The examiner palpates the anterior rim of the pelvis to note the point at which the pelvis begins to posteriorly tilt because of hamstrings tightness. Measurements were taken with the help of goniometer. Optimal muscle length will permit degrees of flexion around 60-70 degree.

Measurement of passive knee extension was obtained with the subject lying supine with the opposite lower extremity extended and the lower extremity being measured positioned at 90 degrees of hip flexion. The greater trochanter and the lateral epicondyle of the femur and lateral malleolus were landmarks during measurement. Hip flexion maintained at 90 degrees while the assistant moved the tibia into the terminal position of knee extension, which was the point at which the subject reported a feeling of discomfort. The goniometric value was then recorded. The PKE is the most reliable test for measuring hamstring tightness [12].

4. Intervention

Group A: Static stretching was given in form of passive stretching of hamstring muscle. The subject was in supine lying, therapist passively positioned the subject into hip flexion, knee in extension and ankle in neutral without pain or discomfort to the point where resistance to the movement was first noted. This position was then maintained for 60 seconds[2] and repeated thrice with 10 seconds interval. Treatment was repeated 5 times a week for two weeks.

Group B: Neurodynamic level 2 distal sliders which is a standardized level for subjects with mild to moderate tightness were performed with 30 repetitions of 3 sets with 10 seconds break after each repetition. The technique is given by placing the patient in supine lying position followed by flexion of the leg to 70 degrees SLR with dorsiflexion of the ankle. This includes a passive hip/knee/ankle slider in supine. Treatment repeated 5 times a week for two weeks.

4.1 Data Analysis

Standard descriptive statistics were calculated for all variables. Comparison of physical characteristics (mean age, height, and weight) and baseline values of PKE and PSLR values between the participants of both group showed non-significant differences indicating homogeneity of groups as shown in table 1. The normality of the data was determined using the Kolmogorov-Smirnov test procedure. The level of significance was set at (p=0.05) for all comparisons and all analyses were performed using SPSS version 23. The Student's paired t- test was applied to compare pre and post values of PKE and SLR within the groups, while independent t-test was used for between group analysis to compare mean difference values of PKE and SLR.

5. Results

Independent samples t-test was employed in order to verify the difference between two sample means assuming equal variances and results were presented in the table2 below. The treatment related to a respective group does not show any statistical difference. However, a significant difference was noted in group A (Static Stretching) and group B (Neurodynamic Mobilization) when the test was done to compare pre-post analysis. Within the group, comparison demonstrated that the PKE and PSLR values significantly increased from baseline values on the 10^{th} day, in both groups suggesting both interventions were effective in increasing hamstring flexibility (table 2, table 3).

Table 1: Comparison of physical characteristics and baseline values of participants of group A (Static Stretching) and group B (Neurodynamic Mobilization).

Baseline data	Group A (Mean±SD)	Group B (Mean±SD)	'p' value
Age (years)	68.4±3.59	66.2±1.322	0.26
Height (cm)	176.50±4.70	176.21±3.53	0.90
Weight(kg)	77.29±5.25	78.93±4.60	0.30
PKE	31.03±3.50	35.02±2.83	0.20
PSLR	59.05±6.86	57.40±2.470	0.20

Table 2: Comparison of PKE values at baseline and 10th day within group A and group B.

	Baseline PKE scores (Mean±SD)	Day 10TH PKE scores (Mean±SD)	't' value	'p' value
Group A	31.03±3.50	28.01±3.37	16.43	0.00*
Group B	35.02±2.83	27.41±2.33	19.00	0.00*

*$P<0.05$= level of significance

Table 3: Comparison of PSLR values at baseline and 10th day within group A and group B.

	Baseline PSLR scores (Mean±SD)	Day 10th PSLR scores (Mean±SD)	't' value	'p' value
Group A	59.05±6.86	61.65±6.74	-5.46	0.00*
Group B	57.40±2.470	63.90±2.80	-6.10	0.00*

*$p<0.05$=level of significance

Table 4: Comparison of mean difference values of PKE and PSLR values between group A and group B (pre-post difference)

Variable	GROUP A (Mean±SD)	GROUP B (Mean±SD)	't' value	'p' value
PKE	3.02±1.53	7.62±1.15	1.96	0.06
PSLR	2.6±3.04	6.5±1.81	1.51	0.40

$P<0.05$= level of significance

6. Discussion

The present study was designed to compare the effects of neurodynamic and static stretching in improving hamstring muscle flexibility. Results revealed that both interventions significantly improve hamstring flexibility, and there was no significant difference between the groups in improving hamstring flexibility.

Elderly population begins slowing down their movements and even gives up their regular routines to avoid injury and falls as their bodies get weaker [13]. The hips and knees are especially prone to cartilage depletion and goes into muscle shortening [13].

Stretching exercises are used extensively in the rehabilitation planning, whereas injury or disease may have resulted in a restricted range of motion specific to given joints, and the goal is to regain "normal" range of motion. Stretching of muscles and joints helps to relax the muscles and increase the range of motion [14].

Static stretching is a familiar long-established technique applied to stretch tight muscles. The musculoskeletal system has an inherent, built-in protective device made up of the muscle spindle and golgi tendon organ (GTO), which are highly sensitive receptors acting to prevent overstretching of the passive joint structures and muscle/tendon unit, respectively. Tension applied on the tendon and GTOs on muscle contraction. The GTOs record the change and rate of change in tension. When this tension exceeds a certain threshold, it triggers the lengthening reaction via spinal cord connections to inhibit the muscles from contracting and cause them to relax [15, 16]. In addition, muscle contraction can induce reciprocal inhibition or the relaxation of the opposing muscles [17]. Another theory proposed by Weppler and Magnusson stated that possible mechanism of improvement can be related to the sensory theory proposed by who stated flexibility and its response is attributed to pain perception rather than biomechanical effect. They suggested that the restriction in hamstring range might increase, not because of changes in the anatomy of the muscle. The stretching may adopt a "new stop point" for limitation in hamstring range based on altered perceptions of stretch and pain [18].

Neurodynamic mobilization is an effective treatment modality, although support of this suggestion is primarily unreliable. This technique used to regain the movement and elasticity of nervous system by reestablishing the axoplasmic flow thus, restoring nerve tissue homeostasis, which could be the possible mechanism of improvement in Neurodynamic solution [19]. Current evidence suggests altered posterior lower extremity neurodynamics (integrated biomechanical, physiological and morphological functions of the nervous system) influence resting muscle length and increase mechanositivity [20]. A study was done to observe the effects of neurodynamic mobilization on fluid dispersion within the tibial nerve at the ankle suggested that passive neural mobilization induces dispersion of intraneural fluid [18, 21]. Few studies have examined the effects of the neurodynamic intervention on hamstring flexibility and the result of this study can be seen as adding further evidence for the potential role of neural tissue mechanosensitivity in hamstring tightness [6. 17].

Studies were done on to compare the effects of NDS and static stretching most of them concluded NDS intervention to be better than static stretching [6, 17]. However, the results of this study are in contrary to previous studies as both the intervention group is equally effective in improving hamstring muscle flexibility in elderly subjects. The apparent reason for obtaining similar results could be the difference in duration of static stretching used in this study. In the present study, subjects received 60 seconds of static stretching which was the dose adopted from a study done by J Brent Feland on effect of duration of stretching of the hamstring muscle group for increasing range of motion of hamstring muscle in people aged 65 years or older which stated that longer hold times during stretching of the hamstring muscles achieved greater ROM and a more sustained increase in ROM in elderly subjects. Whereas the previous study applied static stretching for 30 seconds[17]. Although in the present study both the groups showed significant improvement in hamstring flexibility in elderly, results of PKE outcome were clinically significant in both the groups when compared to PSLR. Lee Herrington et.al studied the effect of different neurodynamic mobilization techniques on knee extension range of motion in the Slump position [20]. It's objective was to investigate the effects of two neural mobilization techniques (sliders and tensioner) on knee range of motion. The findings of this study indicate that both the tensioner and slider techniques have a positive and significant effect on improving knee extension range of motion in the slump position. This could decrease the sensitivity of the sciatic nerve and the neuromeningeal structures to mechanical load.

Exercise program provides significant benefits to aging population [21, 22]. It is important to provide an evidence-based prescription for older adult exercise programs and highlight areas of research requiring further investigation in order to maximize these benefits. There is relatively little research on the potential benefits of flexibility-specific training interventions for this population in that context. This study helps clinicians to prescribe an alternative method to stretch tight hamstring muscle in elderly with an adjunct to static stretching. Limitation of the study is small sample size and lack of control group.

7. Conclusion

Present study concludes that both the groups were equally effective in elderly population and Neural mobilization can be prescribed to elderly population as a home programme as it's easily applicable and is not as aggressive as static stretching which involves holding limb in one position for set period of time.

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