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The Effect of Static Stretching and PNF Hold-Relax Stretching on Increasing Flexibility of Shortened Hamstring Muscle among Sedentary Living Female Students - Randomized Controlled Trial

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Abstract: ***Background and Objective: Hamstring muscle plays an important role in functional activities and relaxation. Shortened muscle may hampers the functional activities. The most widely used method for increasing muscle flexibility is stretching. The Study was design to determine and compare the effect of static stretching (SS) or PNF Hold-Relax stretching technique on improving hamstring muscle flexibility on sedentary living female population aged between 18 and 25 years. Materials and Methods: The Study id Randomized controlled trial in which 30 females of aged between 18 and 25 years living sedentary lifestyle were included with marked tightened hamstring muscles with knee extension range >20 degrees were randomly categorized into two groups named as Group 1 static stretching; (n=15), Group 2 PNF Hold-Relax stretching (n=15). Both groups were tested for 5 days a week for consecutive 4 weeks. Active knee Extension test (AKET)was used to assess the motion range of knee extension as an outcome measure in both groups. Results: Statistically, Independent t-test was used for comparison between both stretching techniques. The results showed that after 4 weeks of intervention there were a significant improvement in the hamstring flexibility after static stretching intervention for right leg and after Hold-Relax stretching intervention for left leg among sedentary living females with significance value of 0.006 (p<0.05). Conclusion: It is concluded that both, Static stretching and PNF Hold-relax Stretching are significantly effective in improving range of knee extension but on clinical determination Hold-relax revealed slightly greater effect than static stretching on increasing hamstring flexibility.***

Keywords: Static Stretching, Hold-Relax, Hamstring muscle tightness, Hamstring muscle, Flexibility, Active Knee Extension Test, knee Extension range

1. Introduction

Reduction in hamstring muscle flexibility is a very common clinical finding in young adults or it is considered as an extremely common musculo-skeletal complaint or disorder which is a root cause of functional disorders. The previous studies also stated that the disturbance in posture is due to hamstring tightness which comes from posterior tilt of pelvis because hamstring muscle has an attachment on an ischial tuberosity. “Inability to extend Knee completely when hip is flexed accompanied by discomfort or pain along the posterior region thigh or knee is attributed as hamstring muscle tightness”. [(1)] Muscle tightness is caused by reduction in the ability of muscle to get deformed, resulting in a reduce in Range of Motion (ROM) at joint on which it acts.[(1)]

Hamstring tightness can result from either increase in tension from Active or Passive mechanism. Actively, muscle can become shortened due to spasm and passively, muscle becomes shortened through postural adaptation. However, hamstring muscle is the most common muscle that goes into shortening or gets tighten either an individual is living active lifestyle or sedentary.[(2)] Hamstring tightness occurs in early age and tends to increase with age. This progressive decline in flexibility with age has been attributed to change in Elasticity and decrease level of physical activities.[(3)]Sheetal Mahadik conducted a study on prevalence of hamstring tightness in youngsters aged 18-25 years in which she concluded 82% of youngsters facing issues of hamstring tightness assessed by AKET. [(4)]

It is stated that most widely used method for increasing muscle flexibility is stretching.[(5)] The stretching is designed to enhance Neuromuscular response of proprioceptors. It has found to be effective in many conditions for instance, increasing the length of shortened muscle, strengthening the weak muscle and Increasing Range of motion of restricted joints. [(6,7)]

Two methods of stretching programme i.e., PNF- HR and SS for increasing extensibility of hamstring muscle has applied in this Study. Static stretching is defined as stationary stretch in which muscle is held to its farthest point and held to that position for certain period of time, which may lead to specific joints locked in a position that places muscle and connective tissue at their greatest possible length. [(8)] The Static Stretch takes advantage of inverse myotatic reflex, which promotes muscle relaxation and further increase ROM. [(9)] Proprioceptive Neuromuscular

Facilitation (PNF) is a most used and effective form of stretching technique that includes both the stretching and contraction of the muscle group that is being targeted. PNF stretching was originally developed as a form of rehabilitation programme. While there are several differences in PNF stretching, but they have one thing in common is that, they facilitate Muscular Inhibition. It has been shown to have a positive effect on active and passive range of motion. This stretching technique utilized to increase ROM and flexibility.[10]

Several researchers have examined the effect of PNF Hold-Relax stretching and Static stretching on hamstring muscle flexibility and found these techniques to increase in hamstring flexibility. In 2008, Lehman et al concluded from his study that both static stretching and PNF Hold-relax hamstring muscle has good effect in increasing hamstring muscle flexibility. The measurement of hamstring muscle length is checked by clinical test namely, Active knee extension test (AKET). When hamstring extensibility is measured by Active Knee Extension Test (AKET) then the Hamstring muscle tightness is described as Knee Extension Angle (KEA) greater than 20 degrees when hip and knee is placed at 90 degrees of Flexion.[11] This present Study is hypothesized that both PNF Hold Relax or Static Stretching has significant effect in improving Hamstring muscle extensibility. The need of study is to determine which stretching method used in this study namely, Static stretch and PNF Hold Relax Stretch is more effective in clinical settings that would help the physical therapists to choose the most effective hamstring stretching technique to improve range of motion and to prevent hamstring muscle injuries.[12]

2. Materials and Methods

A Randomized controlled trial was conducted on 30 healthy sedentary living female population age between 18 and 25 years.. A simple random sampling method was used to allocate subjects to each group. The purpose of study was explained and written consent was taken from all subjects through that sufficient explanation of the procedure, purpose and risks/benefits was provided to all subjects. There were no dropouts in-between the treatment protocol. The recruitment of the subjects was based on inclusion criteria and exclusion criteria: Age group 18-25 years, Gender Specificity, Females, Subjects complaint of hamstring muscle tightness only was inclusion criteria while Defects in construction of Musculoskeletal and Neuromuscular System, Any surgical history on spine or lower limb from a year, Lower Back Pain or any neurological compromise in lower limb or in spine from last 3 months and those who do regular stretching or exercise or performing any exercise regime regularly was exclusion criteria.

The study was performed at Noida extension. The study was conducted in duration of 4 weeks. The subjects were recruited for unilateral hamstring tightness and were determined by Knee extension deficit (KED) by Active knee extension test. Instruments used for this study was Universal Goniometer to measure Knee extension range, Stabilizing strap to stabilize to maintain 90 degree of hip flexion and stop watch. (figure 1)

Figure 1: Materials used: Universal goniometer, stopwatch, stabilizing strap

The subjects were randomly assigned into 2 groups with each group involves 15 subjects: group 1- Static stretching group (15 subjects); Group 2- PNF Hold-Relax (15 subjects).The Ranges were noted pre-intervention, every 5th day of intervention and finally after the completion of 4 weeks of intervention to check the effectiveness of stretching intervention among both the groups (Static stretch and PNF hold-relax)

3. Procedure

Active knee extension test (AKET)-
Subjects were assessed for hamstring tightness using AKE test. The subjects were positioned in supine lying in comfortable position. The hip of tested leg is to be flexed at 90 degrees and stabilized in this position by strap because hip is stable at 90 degree of flexion and pelvic cycle does not have effect on the test and towel is placed under the spine to prevent spine cycle. The contralateral leg should be straight and stabilized by strap for the accuracy of measurement. The subject is then asked to actively extend knee to the point at which they perceived significant stretching discomfort. At this terminal knee extension ROM is measured by using universal goniometer. A full circle goniometer was used to measure angle of knee extension. The placement of goniometer parts was: The Fulcrum - lateral condyle of femur, Stationary arm- along the femur using greater trochanter as a reference, The movable arm - with lower leg using lateral malleolus as a reference. (figure 2)

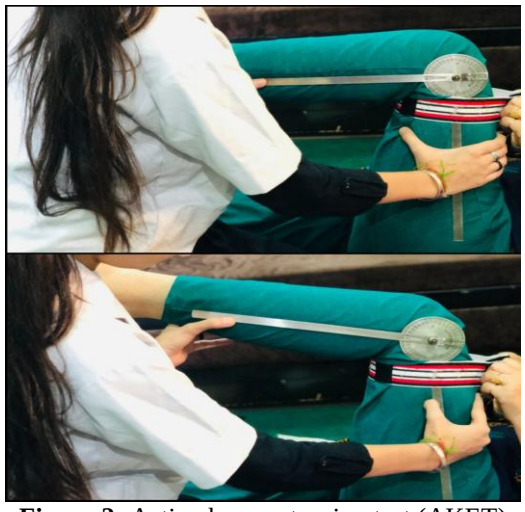

Figure 2: Active knee extension test (AKET)

4. Intervention

Group 1Static Stretching- The subject is asked to be comfortable in Supine position and concentrate on relaxing the muscles of lower extremity as much as possible. The therapist then starts the stretching protocol with passively raising (Hip flexion) the right leg to the point of muscular restriction and holds that position for 20 seconds with resting period of 5 seconds (Figure 3). While the contralateral leg i.e., right leg is placed in complete extended position which is stabilized by strap to prevent movement throughout the intervention. The stretching intervention of passive Static stretch was repeated 10 times in a set, a day. This Stretching protocol is performed 5 days in a week, for consecutive 4 weeks.

Figure 3: Group 1: Static Stretching

Group 2PNF Hold-Relax- The subjects were in supine position and both the leg extended in relaxed position. However, the stretching was performed on left-leg of patient as selected by chit system. For the aim of every stretch, the therapist stretched the hamstring muscle by passively flexing the hip with knee in complete extended position and allows no rotation at hip . The lower leg was rested on the therapist right shoulder. The hamstring muscle was stretched until the subject first reported a mild stretch sensation; this position was held for 15 sec. then, the subject was asked to isometrically contract the hamstring muscle for 5 seconds by pushing her leg down towards the bed against the resistance given by the therapist. Followed by this, the subject was asked to relax the leg for 5 seconds. Again, the therapist passively stretched the muscle until a mild stretch sensationis reported. This stretch was held for 10 sec (figure 4). This sequence is performed 5 times in every repetition. The stretching was administered with 5 repetitions, a set for consecutive 5 days per week for period of 4 weeks

Figure 4: PNF Hold-Relax Stretching

Statistical Analysis

In this Randomized controlled trial, the dependent variable was Active knee extension (AKE) ROM which was used to measure hamstring flexibility. The IBM SPSS version 21.0 software programme was used for data analysis. Paired t-test was used to compare the pre/post measurement of every individual group and Independent t-test was used to compare the difference between two stretching groups. The extent of significance used was $p < 0.05$.

5. Results

The distribution of individuals according to Intervention group is shown in Table 1. The mean of demographic data (Age and weight).

Table 1: Mean and standard deviation of demographic data (Age, Weight)

Groups		N	Mean	Std Deviation	Std. Error Mean
Age (Yrs.)	Static	15	21.400	2.472	.638
	PNF	15	20.933	2.016	.520
Weight (Kgs)	Static	15	58.866	7.818	2.018
	PNF	15	62.266	8.370	2.161

*values represents Mean and Std deviation

Table 2: Paired sample tests for Group1; Static stretching

Paired Samples Statistics Group-1					
AKET Measurements		Mean	N	Std. Deviation	Std. error Mean
Pair 1	Baseline KE ROM	16.066	15	1.579	.407
	PTA Week 1	17.500	15	1.349	.348
Pair 2	Baseline KE ROM	16.066	15	1.579	.407
	PTA WEEK 2	18.900	15	1.227	.316
Pair 3	Baseline KE ROM	16.066	15	1.579	.407
	PTA WEEK 3	20.833	15	1.128	.291
Pair 4	Baseline KE ROM	16.066	15	1.579	.407
	PTA Week 4	23.100	15	0.712	.183

Table 3: Paired sample tests for Group2; PNF Hold-Relax Stretching

Paired Samples Statistics Group-2					
AKET Measurements		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Baseline KE ROM	15.933	15	2.016	.520
	PTA Week 1	18.000	15	2.138	.552
Pair 2	Baseline KE ROM	15.933	15	2.016	.520
	PTA WEEK 2	20.333	15	1.858	.479
Pair 3	Baseline KE ROM	15.933	15	2.016	.520
	PTA WEEK 3	22.633	15	1.894	.489
Pair 4	Baseline KE ROM	15.933	15	2.016	.520
	PTA Week 4	25.200	15	1.521	.392

The pre-test and post-test was performed at Baseline and at end of 1st week, 2nd week, 3rd week and 4th week and then compared to Baseline range of knee extension. Table 2 and Table 3 shows the Mean and standard deviation of Pre-stretch and post-stretch knee extension range of motion in both the stretching groups. In Group 1: the mean of baseline Knee extension ROM was 16.06±1.57, and mean of post-stretch ROM at 4th week was 23.1±0.71 While in Group 2: the mean of baseline Knee extension ROM was 15.93±2.0 and mean of post-stretch ROM at 4th week was 25.2±1.52.

Table 4: Independent t-Test, Comparison of both stretching groups

Independent samples test									
	Levene's Test for Variance Equality		t- test for equality of Means						
	F	Sig.	t	df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	95% CI	
								Lower bound	Upper bound
Baseline AKEROM between 2 groups	1.346	0.256	.202	28	0.842	0.133	0.661	-1.221	1.488
PTA WEEK-1 between 2 groups	4.738	0.038	-0.766	28	0.450	-0.500	0.652	-1.837	0.837
PTA WEEK-2 between 2 groups	2.226	0.147	-2.493	28	0.019	-1.433	0.575	-2.611	-0.255
PTA WEEK-3 between 2 groups	4.314	0.047	-3.162	28	0.004	-1.800	0.569	-2.966	-0.633
PTA WEEK-4 between 2 groups	8.822	0.006	-4.842	28	0.000	-2.100	0.433	-2.988	-1.211

Table 4: Independent t-test showed the significant difference in hamstring muscle flexibility in 3rd and 4th week mainly when compared between static stretch and PNF Hold-Relax stretching 4 post treatment measurements. The significant of t-value of week1 = -0.766 ($p<0.05$), t-value of week2 = -2.493 ($p<0.05$), t-value of week3 = -3.162 ($p<0.05$), t-value of week4 = -4.842 ($p<0.05$)

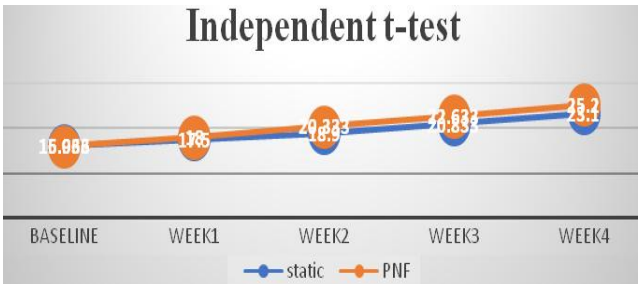

Figure 5: Plot of independent t-test

Figure 5; shows mean comparison of pre-test and post-test AKET measurement at baseline, week-1st, week-2nd, week-3rd, week-4th between Static stretch(G-1), PNF Hold-Relax(Group-2).

Table 4 has showed the p value 0.04($p<0.05$) post-stretch on week 3rd and p value 0.006($p<0.05$) post-stretch on week 4th in both the stretching groups which showed the statistically high significant in week 3rd and 4th while in figure 5, plot shows the mean of both the groups individually which showed the effectiveness of either group on clinical basis.

6. Discussion

The aim of the present study was to compare the effect of Static stretching or PNF Hold Relax stretching technique on improving hamstring muscle flexibility. In the present study, both Hold-relax and Static stretching techniques have significant effect on recovery of hamstring muscle flexibility and increasing the Extension range of knee. But according to clinical determination and plot of Independent t-test (shown in figure 5) PNF Hold-Relax stretching reported a slightly more effective than Static stretching.

In 2014, Abdolhamid haji et al, performed HR and SS on individuals for 3 days in a week for consecutive 4 weeks and found the significant effect on increasing flexibility and range of knee motion but neither is superior regarding their effect whereas In this study HR and SS is performed 5 days a week for consecutive 4 weeks and analysis revealed both are effective in increasing knee extension range and HR shows slightly greater effect than static stretch in clinical determination

In 2008, Lehman et al. Compared HR and SS regarding increasing flexibility of muscles and concluded that both methods have significant effect on increasing flexibility and reported no significant difference in the results, of course, in the present study, it is stated that both stretching method are effective but Hold relax shows slightly greater effect on increasing flexibility and increasing motion range of knee.

7. Conclusion

The study concluded that there is no significance difference found in Range of Knee extension in the initial weeks (1st and 2nd) as shown in table 4. Both the stretching manoeuvres were effective for improving hamstring muscle flexibility as measured by AKE test and are almost equal in their effectiveness for improving hamstring flexibility (seen in week 3rd and 4th) and either of the techniques may be used in clinical practice for improving hamstring flexibility.

Although, the study also stated that PNF Hold-Relax stretching technique is slight more effective than static

stretching technique for improving hamstring flexibility on clinical basis (as seen in figure 5 - plot chart).

8. Limitations of Study

Study was restricted to female subjects only. Research was done among particular Age group between 18 and 25 years. Sample size taken was small (n=30)

9. Scope for Future Research

Further investigation of this study may overcome limitations of study by:

Using larger sample size.Varying the Age limit, Comparing effectiveness of stretching methods among both male and female, Another scope could be designing a follow-up study which could examine for how long the gain in hamstring flexibility lasted after 4 weeks of stretching intervention.

10. Acknowledgment

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Competing interests: None

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