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**Original Research Article**

# Immediate effect of dynamic oscillatory stretching vs. neurodynamic sliding technique on stretch tolerance, popliteal angle range and hamstring flexibility in apparently healthy individuals with hamstring tightness: a pre-post clinical trail

**Ganesh B. R.[1], Veedika V. Marwah[2]*, Vidhi S. Joshi[2]**

[1]Department of Cardiovascular and Pulmonary Physiotherapy, [2]Department of Physiotherapy, KAHER Institute of Physiotherapy, Belagavi, Karnataka, India

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***Correspondence:**
Dr. Veedika V. Marwah,
E-mail: vedikamarwah96@gmail.com



## ABSTRACT

**Background:** The hamstrings being postural muscles are prone to tightness which leads to muscular imbalances and inefficiency of daily living activities. Hence, the present study aims to compare two competent techniques Dynamic Oscillatory Stretching (DOS)vs. neurodynamic sliding (NDS) technique.
**Methods:** A Total of 60 subjects were recruited (31 males, 29 females). passive 90-90 knee extension test, modified v sit to reach test and NPRS scale were used to evaluate the range, flexibility and stretch tolerance in participants pre intervention and were allotted into Group A (DOS) and Groups B. The subjects were then re-assessed immediately post intervention.
**Results:** The results were obtained using the independent and dependent t-tests. Post intervention results were suggestive of a significant within group result with a p=0.0001 under all the parameters. Subjects in Group a showed a greater increase in the ROM while, Group B showed a better result in flexibility and stretch tolerance.
**Conclusions:** Both the techniques are efficient and can be incorporated in sports rehabilitation to prevent on site injury thereby improving athlete's performance.

**Keywords:** Dynamic oscillatory stretching, Flexibility, Neurodynamic sliding, Popliteal angle, Stretch tolerance, Tightness

## INTRODUCTION

The hamstring muscles are important postural muscles and help in some amount of trunk control, standing along with their other actions like walking running, jumping etc.[1]

The decrease in joint range of motion (ROM) can be produced by varied mechanisms. According to Hutton, there are four different kinds of constraints: (a) neurogenic (b) myogenic (c) joint and (d) connective tissue.[2]

As efficient as these muscles are, they are equally exposed to injuries and muscle tightness due to over activity, under activity, wrong posture etc. Making it a barrier for individuals to perform with maximum competence.

Hamstring tightness results in limitation in the extension of knee range of motion when there is limited hip flexion

with the knee extended. Tightness of hamstring can produce a large amount of knee flexion contractures and incapability of reaching full knee extension. Therefore, over activity of the hamstring muscles can cause a late swing phase and ground contact during the gait cycle. Slighter amount is associated with posterior rotation of the pelvis in standing; this thus flattens the lumbar spine and increases the risk of low back pain.[3]

The ability of a muscle to allow or lengthen a joint to move through a range of motion is known as flexibility.[4] though not all hamstring tightness Is caused by nerve entrapment or compression, it is known to be one of the leading causes.

The Dynamic oscillatory stretching (DOS) is an innovative technique which is a blend of the agonist contract-relax (ACR)of Proprioceptive Neuromuscular Facilitation (PNF), oscillatory passive physiological mobilization and static stretching. In this technique the agonist group of muscles produce a stretch in response to a contraction of the antagonist group of muscles.[5] Since our aim is to check its effect on the hamstring group, we will ask the subjects to contract their quadriceps while performing the hamstring stretch along as this will amplify the active ROM of the lower extremity using the principle of reciprocal inhibition, the DOS adds a manual oscillatory stretch of 3 seconds given by the therapist at the end range in order to help the agonist hence, the DOS consists of dynamic, oscillatory and passive stretching components. The component of oscillatory movement added in DOS has resemblance to the oscillatory physiological mobilization as described by Maitland.[6] Treatment of musculoskeletal disorders which has been shown to improve the mobility of the spinal joint. There by making the DOS a potentially good technique to increase the flexibility of the hamstring.

In contrast, neurodynamic sliding is a neurodynamic maneuver whose purpose is to produce sliding movement of neural structures relative to their adjacent tissues.[7] The Neural structures are usually divided in to two types a) mechanical and b) physiological primary functions are 1)nerve tension, 2) sliding of nerve and 3) compression. The slider movement has shown improvement in decrease of pain and excursion of the nerves. In order to perform a slider, the force is applied longitudinal at one end of the nerve tract and while tension is released at the other hence, in an effort to release the tension the nerve slides at the point where tension is applied or down the tension gradient.[8]

Stretch tolerance was measured in the present study. A study was conducted by Ben M, Harvey LA to evaluate if regular hamstring stretching would improve hamstring extensibility the results of this concluded that regular stretching would not help the hamstring extensibility but in turn increase the stretch tolerance which then improves the joint range of motion without really increasing the hamstring extensibility.[9]

Tightness of hamstring muscle can be defined by the knee extension angle (KEA) where in if the degree is greater than 20 degrees of knee flexion from the terminal knee extension. Popliteal angle range was measured by the passive 90-90 knee extension technique. Flexibility of the hamstring muscles was tested by using the modified sit to reach test there a son for choosing the modified sit to reach test.

These two techniques have hence proven to be efficient in releasing muscle tightness and it is our aim to compare them specifically to reduce hamstring tightness in asymptomatic healthy individuals with hamstring tightness as this yet remains a problem due to the long standing hours most professions require in today's days.

Thus, the purpose of the present study was to compare these two novel techniques in asymptomatic healthy individuals with hamstring tightness under the parameters of popliteal angle range, hamstring flexibility and the stretch tolerance in an attempt to identify the more competent technique which will help the general population lead a more proficient lifestyle.

## METHODS

The study was an experimental study using a non-probability sampling design. The ethical clearance was obtained from the Institutional Ethical Committee. All the subjects were screened based on the inclusion and exclusion criteria prior to their enrolment into the study. The demographic data was noted.

The purpose of the study was explained and a written informed consent was taken from all the subjects. 60 subjects were randomly allocated in two study Groups: Group A (dynamic oscillatory stretching) and Group B (neurodynamic sliding) to eliminate the bias with 30 subjects in each.

### *Criteria for inclusion*

- Participants of either gender
- Age 18-30 years
- BMI< 20-35 kg/m$^2$
- Sit to reach test <23 cm
- Passive 90-90 knee extension test <70 degrees
- Subjects who are willing to participate in the study.

### *Criteria for exclusion*

- Recent fracture
- History of any other neuromuscular and musculoskeletal problems
- Recent surgeries around the hip and knee joint
- Subjects having hyper mobility and inability to extend knee joint in sitting
- Recent direct trauma to hamstrings.

***Materials***

Data collection sheet, Inform consent. Standard universal goniometer, measuring tapeanda 30cm scale.

***Outcome measures***

*Stretch tolerance*

The stretch tolerance was measured using the Numeric Pain Rating Scale. This is a scale measuring 0-10 wherein 0 suggests no pain and 10 indicates excruciating pain. The patient was asked to verbally rate their pain out of this scale pre intervention when they first felt the stretch pain as the therapist performed passive conventional stretching. The stretch tolerance was measured for both the legs individually pre and post the intervention. The difference in the pain was noted which is suggestive of the alteration in the stretch tolerance.

*Popliteal angle range*

The patient was in supine lying position on the plinth with neck in neutral and arms resting on the side and hip knee $90^0$-$90^0$. The therapist stood on the side to be tested and placed the stationary arm of the goniometer parallel to the femur and the movement arm parallel to the fibula. The therapist passively performed passive knee extension and measured the range pretreatment and post treatment. (Figure 1).

**Figure 1: Popliteal angle range measurement.**

*Modified V Sit to reach test*

The patient was asked to sit in a long sitting position with the legs kept 30cms apart. Another 30cm scale was placed at the midpoint of the previous 30cm scale such that both the scales were perpendicular to each other .The scale which is parallel to the tibia was placed such that the 30cms is facing towards the patient and 0cms was placed at the midpoint of the previous scale i.e. 15cms. The patient was then asked to extend their elbow and place one hand on top of each other and lean forward to their maximum. A measuring tape was then taken to measure the length from the tip of the measuring scale till the scale below. The point coinciding on the scale was marked. All subjects who reached the length below 23cms were included in the criteria (Figure 2).

**Figure 2: Modified V sit to reach test.**

The intervention was given for 10-15mins after the pre-intervention evaluation was done.

**Intervention**

*Group A (dynamic oscillatory stretching)*

The patient was in supine lying position on a plinth and the therapist was standing on the side to be treated (a stepper can be used to adjust the therapists height with the patient). (Figure 3A and Figure 3B) The patient was given a passive hamstring stretch and was asked to contract the antagonist group of muscles i.e. quadriceps actively and maintain the contraction throughout the stretch. Therapist then gave a 3 second passive stretch was given with slow oscillations and the patient was asked to release the contraction as the therapist brought the leg down. This procedure was repeated 10 times in each set and 3 sets were given. Therefore, 10reps x3second hold oscillation x 3 sets were given. The therapist reached a new tolerable range with every set. The post treatment outcome measures were tested.[5]

**Figure 3A: DOS-hamstring stretch given with simultaneous instructions to the patient to contract their quadriceps muscles.**

**Figure 3B: DOS-hamstring stretch and voluntary quadriceps contraction maintained the leg is taken to the range which is tolerable. End range passive oscillations given.**

*Group B (Neurodynamicsliding)*

The subjects in group B were given the neurodynamic sliding technique wherein the patient was lying on the plinth with the cervical and thoracic spine in flexion and elbows supported on the plinth (Figure 4A and Figure 4B position for NDS) the hip and knee were flexed with ankle dorsiflexion when the proximal aspect i.e. cervical went into extension.

**Figure 4A: NDS technique.**

**Figure 4B: NDS technique.**

Hip and knee extension along with plantar flexion were performed when the cervical region went into flexion. note that the elbow was always supported on the plinth.

Thereby, allowing the sciatic nerve to slide. This combination of movements was performed for 180 seconds.[10] The subjects were re-examined post intervention and the data was noted in the data collection sheet.

***Statistical analysis***

Statistical analysis was done using Statistical Package of Social Sciences (SPSS) version 23. Kolmogorov Smirnov test was used to check for the variables of pre and post intervention i.e. for Numeric pain rating scale, popliteal angle range and Sit to reach test.

Hence, data was entered into the Microsoft Excel Sheet, tabulated and subjected to statistical analysis. Various statistical measures such as mean, standard deviation and test of significance were used.

## RESULTS

The demographic data which was inclusive of the gender (31 males and 29 females), age (mean age DOS 21.90yrs ±1.73 , NDS 22.70 yrs ±2.60), height (mean ht. DOS 165.07cm ±9.68, NDS 166.97cm ±8.59 ) weight (mean wt. DOS 63.22kgs±14.41kgs, NDS 64.33±8.9) and BMI (mean BMI DOS 23.13kg/$m^2$±3.72, NDS 23.38kg/$m^2$±3.20) was analyzed using the independent t test and was homogenous.

**Table 1: Comparison of group A and group B with respect to pretest and posttest NPRS scores in the right side by independent t test.**

| Groups | Pretest | | Posttest | | Difference | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| Group A | 5.90 | 1.30 | 3.10 | 1.42 | 2.80 | 1.19 |
| Group B | 5.47 | 1.36 | 2.72 | 1.68 | 2.75 | 1.26 |
| % of change in group A | | | | | 47.46%#, p=0.0001* | |
| % change in group B | | | | | 50.30%#, p=0.0001* | |
| t-value | 1.2645 | | 0.9537 | | 0.1580 | |
| P-value | 0.2111 | | 0.3442 | | 0.8750 | |

*p<0.05 indicates significant, # indicated applied dependent t test

Both the limbs were evaluated and significant changes in the NPRS scores post intervention within the groups were seen and both groups have a p=0.0001* though, NDS showed a greater percentage of change in both the limbs than DOS (Table 1 and Table 2).

The results of the modified v sit to reach test also

suggested a significant increase within the groups with a p=0.0001*. However, NDS showed an increased percentage of change than DOS (Table 3).

The popliteal angle range also showed a significant increase within both the groups with a p=0.0001* though, DOS showed an increased percentage of change than NDS in both the limbs (Table 4 and Table 5).

**Table 2: Comparison of group A and group B with respect to pretest and posttest NPRS scores in the left side by independent t test.**

| Groups | Pretest | | Posttest | | Difference | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| Group A | 6.02 | 1.15 | 3.03 | 1.81 | 2.98 | 1.43 |
| Group B | 5.43 | 1.50 | 2.72 | 1.60 | 2.72 | 1.00 |
| % of change in group A | | | | | 49.58%#, p=0.0001* | |
| % of change in group B | | | | | 50.00%#, p=0.0001* | |
| Z-value | 1.6904 | | 0.7189 | | 0.8381 | |

*p<0.05 indicates significant, # indicated applied dependent t test

**Table 3: Comparison of group A and group B with respect to pretest and posttest sit to reach test scores by independent t test.**

| Groups | Pretest | | Posttest | | Difference | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| Group A | 18.32 | 3.70 | 23.45 | 4.93 | -5.13 | 5.99 |
| Group B | 17.69 | 3.21 | 23.07 | 3.10 | -5.37 | 4.51 |
| % of change in group A | | | | | -28.03%#, p=0.0001* | |
| % of change in group B | | | | | -30.37%#, p=0.0001* | |
| t-value | 0.6965 | | 0.3603 | | 0.1753 | |
| P-value | 0.4889 | | 0.7199 | | 0.8614 | |

**Table 4: Comparison of group A and group B with respect to pretest and posttest popletial angle range scores in right side by independent t test.**

| Groups | Pretest | | Posttest | | Difference | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| Group A | 48.20 | 9.64 | 57.67 | 9.11 | -9.47 | 7.51 |
| Group B | 45.97 | 11.20 | 54.40 | 12.89 | -8.43 | 4.69 |
| % of change in group A | | | | | -19.64%#, p=0.0001* | |
| % of change in group B | | | | | -18.35%#, p=0.0001* | |
| t-value | 0.8281 | | 1.1337 | | -0.6393 | |
| P-value | 0.4110 | | 0.2616 | | 0.5251 | |

*p<0.05 indicates significant, # indicated applied dependent t test

**Table 5: Comparison of group A and group B with respect to pretest and posttest popletial angle range scores in left side by independent t test.**

| Groups | Pretest | | Posttest | | Difference | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| Group A | 49.37 | 9.60 | 58.13 | 8.61 | -8.77 | 6.33 |
| Group B | 47.30 | 6.94 | 55.47 | 8.00 | -8.17 | 4.09 |
| % of change in group A | | | | | -17.76%#, p=0.0001* | |
| % of change in group B | | | | | -17.27%#, p=0.0001* | |
| t-value | 0.9556 | | 1.2423 | | -0.4360 | |
| P-value | 0.3432 | | 0.2191 | | 0.6645 | |

*p<0.05 indicates significant, # indicated applied dependent t test

## DISCUSSION

The results from the statistical analysis of the existing study support the alternative hypothesis that dynamic oscillatory stretching and neurodynamic sliding both will have an immediate effect on the popliteal angle range, hamstring flexibility and stretch tolerance in asymptomatic healthy individuals with hamstring tightness.

On reviewing the literature relating to hamstring tightness occurring in asymptomatic healthy individuals the incidence of hamstring tightness has been shown to be high in individuals with either long standing professions and also with students who have along extended sitting posture hence, the age group of 18-30years was taken to be relevant.[11] Similarly, another study advocates that the incidence of hamstring tightness is seen to be more in the age group of 20-25years as a consequence of increased physical stress.[12]

Flexibility of the hamstring muscles was tested by Davis DS, Quinn RO et al on concurrent validity of four clinical tests which included knee extension angle, the straight leg raise test, the sacral angle and the sit to reach test. In this the reliability of the classic sit to reach was reported to be 0.98. In the present study the modified v-sit to reach test is been taken with an added advantage of it being portable and convenient for people across the globe to perform this test as it does not require the specifics it to reach box that is usually used to perform the sit to reach box test.[13] The results shows that there was a better result shown in the group B and not much of difference in the group A

A conducted by Ben M, Harvey LA to evaluate if regular hamstring stretching would improve hamstring extensibility concluded that regular stretching would not help the hamstring extensibility but in turn increase the stretch tolerance which in turn improves the joint range of motion without really increasing the hamstring extensibility.[9] In the present study conducted had shown increase in the stretch tolerance in the inter group in the Group B and not much of results in the Group A.

Study done by Shakya NR, Manandhar S in the physiotherapy students in Nepal in which the passive knee extension technique is considered to be reliable as it assesses the hamstring muscle length.[14] Hence, it was used in the present study.

A similar study was done by Vidhi S et al, the aim of this study was to compare 2 techniques of stretching: Proprioceptive Neuromuscular Facilitation (PNF) and Neurodynamics (NDS) for hamstring tightness. In this study they took a sample size of 60 asymptomatic subjects having an extension lag of more than 200 degrees. The "contract relax" PNF technique was used in comparison to butlers technique of neurodynamic sliding. The results of this study show that there was significant improvement in the hamstring flexibility with PNF as well as the NDS technique, however the improvement was more with PNF technique whereas, the present study compares the agonist-contract relax technique of PNF using the reciprocal inhibition concept in comparison to Shacklocks technique of neurodynamic sliding suggesting an almost equal significance of improvement.[15] The difference in the results suggests that the neurodynamic sliding of Shacklock's technique could be as effective as the contract relax technique of PNF.

The physiology behind dynamic oscillatory stretching is based on the concept that because of the of contraction of the antagonist muscle ,the agonist muscle is able to go in a state of comparative relaxation and hence the passive stretching is more effective now as it allows the therapist to reach a higher ROM and the oscillations given at the end range add the mobility component there by making this technique an efficient one. Let us now discuss the effect of DOS on the individual outcome measures according to our opinion a) stretch tolerance, the pain during the stretch had reduced by nearly 50% in all the subjects and this might be due to the fact that since the concentration of the subjects was in holding the quadriceps into contraction they allowed the hamstrings to be relaxed and hence the therapist could give a better sustained stretch which helped in reducing the pain. b) sit to reach test, since the subjects were able to tolerate a better stretch the effect of the stretch was better which indirectly allowed to achieve better flexibility. c) Range of motion ,there was again an appreciable increase in the range of motion due to all the components of DOS ,the contraction of the quadriceps allowed a good relaxation of the hamstrings, the stretch tolerance improved and the oscillations at the end helped break the adhesions allowing increase in range of motion in totality.

It's now a known fact that the tightness can be caused not only by inflammation of the surrounding structures but also by the nerves[7]This is why the sliders help in relieving the surrounding adhesions. The present study supports the previous hypothesis given which suggests that there can be alterations in the viscoelastic properties and MECHANO sensitivity due to the sliding which lead to the improvement in stretch tolerance again by nearly 50%.The surrounding adhesions were released with the help of the sliding techniques which lead to an increased range of motion and hence increase in the flexibility too. NDS has shown to give relief to an additional component and that's the pain along the nerve course so if applied to patients with hamstring tightness caused due to neural pain it will be more effective.

## CONCLUSION

In conclusion, DOS is said to have a more significant effect on hamstring tightness with muscular origin. similarly, NDS showed a better effect in subjects with hamstring tightness caused due to neural origin. Both the techniques have a secondary effect on the quadriceps

muscle and hence play a role in increasing its strength in long term. Thus, both the techniques can be incorporated in sports rehabilitation to prevent on site injury thereby improving the athletes or subjects performance. Hence, stretching on a day to day basis should be practiced in young adults to be injury free.

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