



“Immediate Effect Of Neurodynamic Slide Technique On Hamstring Flexibility In Long Distance Runners.”

-AN EXPERIMENTAL STUDY

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ABSTRACT

Introduction: Muscle inflexibility is often considered to be a predisposing factor in muscle injuries. Hamstring plays a key role in running and is usually neglected by long distance runners tends to cause injury. Increased tension in the neural structures is a known causative factor for hamstring tightness for which neural mobilization has emerged as a significant adjunct to routine to other techniques. The purpose of this study was to assess the muscle flexibility and treat the hamstring inflexibility in long distance runners

Aim: To study the immediate effect of Neurodynamic slide technique on Hamstring flexibility in long distance runners by means of SLR and AKE test

Objective: To study the immediate effect of Neurodynamic slide technique on Hamstring flexibility in long distance runners by means of SLR and AKE test

Study Design: Experimental study.

Materials and Method: 74 long distance runners both males and females playing player involved in running are included in this study after taking their consent and evaluating them according to the inclusion criteria. Dominant leg Hamstring flexibility is assessed using SLR and AKE test. NDS was performed for 180 sec with subject supine lying, cervical and thoracic spine was flexed to 45 degrees and NDS concurrent movements was performed.

Results: The study demonstrated that the neurodynamic slide technique had a significant immediate effect on hamstring flexibility in long-distance runners and more ROM was observed in the NDS using SLR and AKE

Conclusion: Findings suggest that a neurodynamic sliding technique will increase hamstring flexibility in long distance runners.

Keywords: NDS, SLR, AKE

INTRODUCTION

Running has become a popular sport all around the world, and India is no exception. [1] A comprehensive research revealed that long-distance runners had a one-year injury rate of 32%, indicating that running predisposes athletes to a number of injuries. Overuse causes about 80% of running injuries, with the knee, hamstring, tibia, ankle, or plantar fascia being the most commonly affected. Ankle sprains and hamstring strains are frequent significant conditions. [2] Dysfunctional movement of the lumbar spine, pelvis, and lower limbs has been associated with the hamstring muscles. They have also been linked to irregularities in gait and low back pain. [3] During everyday activities, a decrease in hamstring flexibility may result in compensatory adjustments to posture, vertebral curvature, and pelvic motions. [4] The posterior thigh muscles known as the "hamstrings" include the semimembranosus (SM), semitendinosus (ST), biceps femoris (BF), long head (BFLH), and short head (BFSH). The long hamstring muscle group (SM, ST, BFLH) contributes to internal (SM and ST) or external (BF) knee rotation, knee flexion, and hip extension associated with concentric contractions because of its capacity to cross the hip and knee joints. The distinct anatomy of the hamstrings could be one reason for the high frequency of injuries in this muscle group. [5] The hamstring muscles are involved in 60% of the running gait cycle and serve a variety of purposes during running. They aid in knee flexion and hip extension by crossing two joints. (6) The hamstring muscles slow down knee extension and hip flexion during the swing phase. In the stance phase, these muscles help to extend the hip in response to extending the trunk and contribute in forward thrust to the body. During the terminal swing, they actively prevent knee flexion. The running phase from heel rise to toe off occurs because they flex their knees at the same moment to shorten their legs and clear their foot at takeoff. (6) Running often causes hypertrophy of hamstring muscle, which reduces their flexibility. [7] Hamstring injuries are common in sports that include a lot of high-intensity running and sprinting. High-intensity, explosive eccentric loading is repeated, strengthening and stiffening the hamstrings. [8] On the other hand, hamstring tightness is associated with these increases in strength and stiffness. [8] Strength training is thought to restrict the development of flexibility and induce muscular hypertrophy. [7] It has also been demonstrated that increasing tension in the neural structures causes the hamstrings to tighten. [9] Reduced hamstring flexibility may result from altered neurodynamics affecting the sciatic, tibial, and common fibular nerves; altered posterior lower extremity neurodynamics may also affect resting muscle length and change how stretch or pain is perceived. (10) The mechanosensitivity of neural structures in the posterior leg, thigh, buttock, and vertebral canal may contribute to hamstring muscle flexibility; protective muscle contraction of the hamstring muscles found in the presence of neural mechanosensitivity may explain hamstring tightness and thus predisposes the muscle to subsequent strain injury. Since the hamstrings

serve as a mechanical interface for the sciatic nerve, which innervates and transcends the hamstring muscle group, it has been demonstrated that abnormal nerve mechanosensitivity leads to poor hamstring flexibility. Neurodynamics may also influence hamstring flexibility (8). Michael Shacklock developed the term "neurodynamic," which describes the nervous system's combined biomechanical, physiological, and mechanical activities. Fundamentally, clinical neurodynamics is the clinical application of nervous system physiology and mechanics as they relate to one another and are combined with musculoskeletal function. Neurodynamics is a manual technique that uses posture and multi-joint movement to deliver force to nerve systems. founded on the idea that in order to maintain adequate muscle tension and promote range of motion, the neurological system should also be appropriately stretched and constricted. [11] With sliders, the neural system is subjected to movement or tension proximally, released distally, and then the sequence is reversed. [12] Many methods have been tried to improve hamstring flexibility in previous studies among these, PNF, static stretching, and active dynamic stretching were used but none of these explained about neural tissue sensitivity, Neural mobilization exercises may reduce neural sensitivity to the movement and may be useful as an addition to rehabilitation programs to increase hamstring flexibility. [9]

The need for study is the ability to propel forward and maintain a steady pace is necessary in long distance runners as their agility and endurance is at optimum level during the sport. The constant isometric contraction and overuse of the hamstring leads to impaired muscle mechanics for the future sport as well as daily activities. The hamstring flexibility in the athletic sports has been addressed in various rehabilitative strategies in the form of stretching, stabilizing and activating the hamstring muscle. In long distance runners, this muscle is of key importance and needs to be flexible enough for the athlete for his performance and daily activity. The impact of nerve biomechanics over the hamstring is an important and less explored part in rehab for hamstring flexibility. Hence, this study is to provide one adjunct for an immediate and less cumbersome technique which might be easy to administer to the runner.

MATERIAL AND METHODS

We utilize various equipment and tools to ensure effective assessment and treatment. These include wedge/pillows for patient positioning, floor mats/plinths to provide comfortable surfaces during therapy sessions, goniometers to measure joint angles, scales for monitoring weight, stopwatches to time exercises, pens for documenting progress, and consent forms to obtain patient agreement for treatments.

This study is an experimental investigation employing a randomized clinical trial design, with a duration of six months. Convenience sampling will be utilized to select a sample of 74 participants. The research will be conducted at ground sites and physiotherapy camps associated with events.

The inclusion criteria for this study are: subjects aged between 18 and 35 years, both male and female, who are willing to participate and exhibit hamstring tightness or inflexibility in their dominant leg.

The exclusion criteria for this study include: any recent lower limb injuries; a history of sciatica; previous pain or paresthesia in the lower limbs; a history of hip, pelvic, or lumbar pathology; and any shoulder girdle or neck pain or injury.

The study commenced following ethical clearance from the institutional ethics committee. Participants were screened based on predefined inclusion and exclusion criteria. Procedures were explained to participants in their native language, and written consent was obtained. Pre-intervention assessments, including the Active Knee Extension (AKE) and Straight Leg Raise (SLR) tests, were conducted. The intervention involved applying Neurodynamic slide technique (NDS) to the dominant leg of each participant for 180 seconds. Post-intervention, AKE and SLR tests were repeated. Statistical analyses were performed to evaluate the results.

The Straight Leg Raise (SLR) test is a commonly used method for assessing hamstring flexibility, demonstrating excellent interrater and test-retest reliability, with intraclass correlation coefficients 0.71

In this assessment, the subject lies supine on a mat in a relaxed state, ensuring no prior stretching or warm-up is performed, and all inclusion and exclusion criteria are adhered to. The subject is then instructed to perform an SLR of the dominant leg without compensatory movements. A universal goniometer is placed over the greater trochanter of the femur, with one arm aligned with the lateral femoral condyle and the other arm parallel to the ground or table, directed towards the midaxillary line. The tested limb is flexed at the hip while the knee remains fully extended; the contralateral limb is stabilized. The test is terminated when a strong tissue resistance is felt or pelvic rotation is observed, at which point the range of motion (ROM) achieved is measured. [10][13]



The Active Knee Extension (AKE) test is a reliable method for assessing hamstring flexibility, with reliability intraclass correlation coefficients (ICC) 0.71. In this assessment, the subject lies supine and relaxed. The dominant limb, previously assessed using the Straight Leg Raise (SLR) test, is now tested using the AKE method. The procedure involves flexing the hip and knee of the dominant limb to 90 degrees. The subject is then instructed to actively extend the knee while the contralateral limb is stabilized. A standard universal goniometer is positioned over the lateral femoral condyle, with one arm aligned along the thigh towards the greater trochanter and the other arm aligned over the leg towards the lateral malleolus. Knee extension continues

until myoclonus occurs, at which point the range is noted. The subject is then asked to slightly flex the knee until the myoclonus stops, and the range is recorded again. [10][13]



The Neurodynamic Sliding (NDS) technique involves positioning the subject supine with support under the neck and thoracic spine to maintain a forward-flexed posture. This technique combines simultaneous movements of hip and knee flexion with ankle dorsiflexion, as well as hip and knee extension with ankle plantarflexion. The therapist adjusts these movement combinations based on the subject's level of tissue resistance. The NDS technique is applied to the dominant lower extremity for a duration of 180 seconds.



OUTCOME MEASURE

The active-knee-extension test (AKE) and the straight-leg-raise test (SLR) is used to assess hamstring flexibility

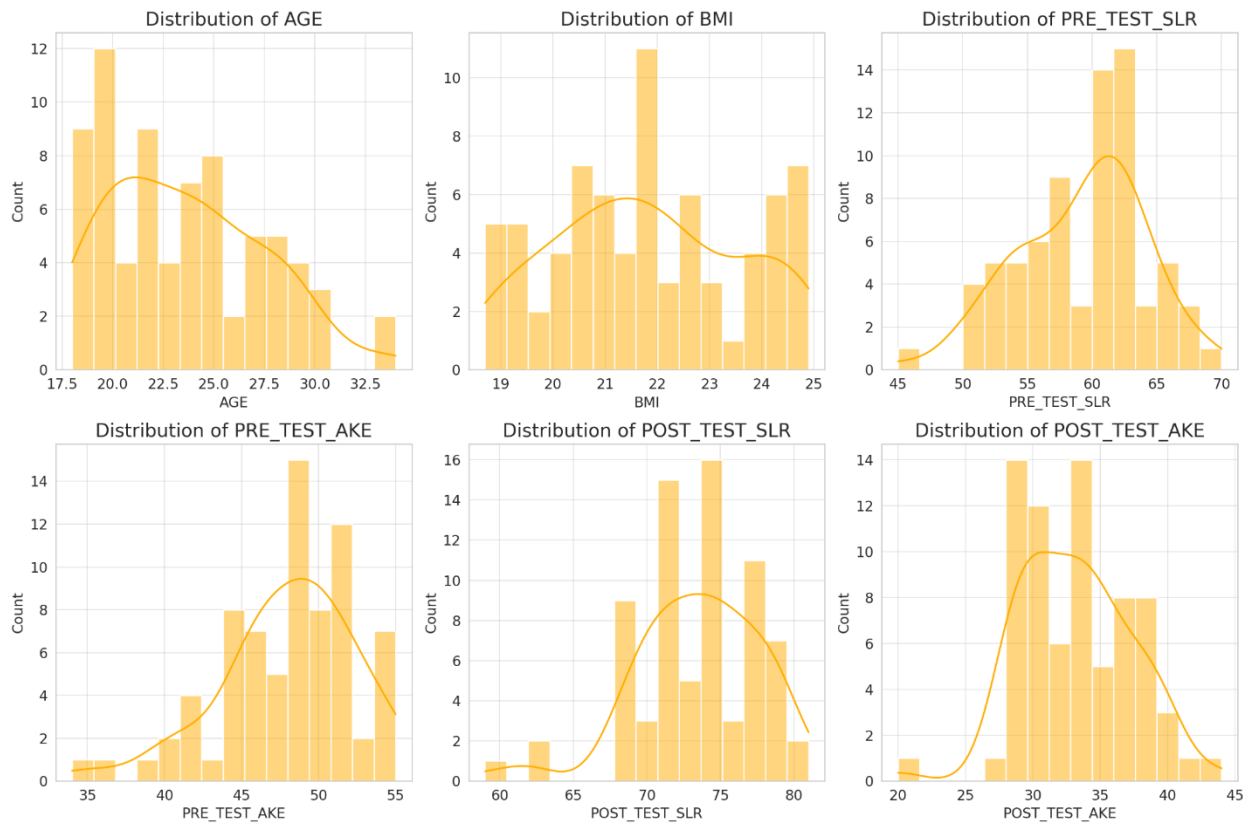
STATISTICAL ANALYSIS

Paired t-tests (Pre-Test vs. Post-Test) showed significant improvement in SLR p-value <0.0001 with t-statistic of -32.41.

Paired t-tests (Pre-Test vs. Post-Test) showed significant improvement in AKE p-value<0.0001 with t-statistic of 30.12.

RESULT

1. Distribution plots of variables



2. Data Overview

The dataset consists of 12 variables, including demographic information (AGE, GENDER, BMI), pre-test and post-test scores, and other relevant measures. The data has been cleaned and formatted appropriately for statistical analysis.

Variable	N	Mean	Std Dev	Min	Q1	Median	Q3	Max
AGE	74	23.61	3.84	18	20	23	26.75	34
PRE_TEST_SLR	74	59.15	4.96	45	55	60	62	70
PRE_TEST_AKE	74	47.96	4.39	34	46	48.5	51	55
POST_TEST_SLR	74	73.43	4.25	59	71	74	77	81
POST_TEST_AKE	74	33.16	4.15	20	30	33	36	44

HEIGHT_cm	74	169.07	11.29	150	160	169	176.75	189
WEIGHT_kg	74	62.64	9.93	44.6	54.15	61.9	69.25	84
BMI	74	21.82	1.8	18.7	20.45	21.7	23.08	24.9

3. Distribution Analysis

The distributions of the key numeric variables were visualized using histograms with kernel density estimation (KDE).

- AGE appears normally distributed.
- BMI has a slightly right-skewed distribution.
- Pre-Test and Post-Test Scores indicate improvement after intervention.

4. Paired t-tests (Pre-Test vs. Post-Test)

To determine whether there is a significant improvement in test scores after intervention, paired t-tests were conducted:

Variable	t-statistic	p-value	Conclusion
SLR Test	-32.41	<0.0001	Significant Improvement
AKE Test	30.12	<0.0001	Significant Improvement

Since the p-values are extremely low, we conclude that there is a statistically significant improvement in both SLR and AKE test scores after intervention.

5. Gender-Based Comparisons

We compared key variables between males and females using descriptive statistics and independent t-tests.

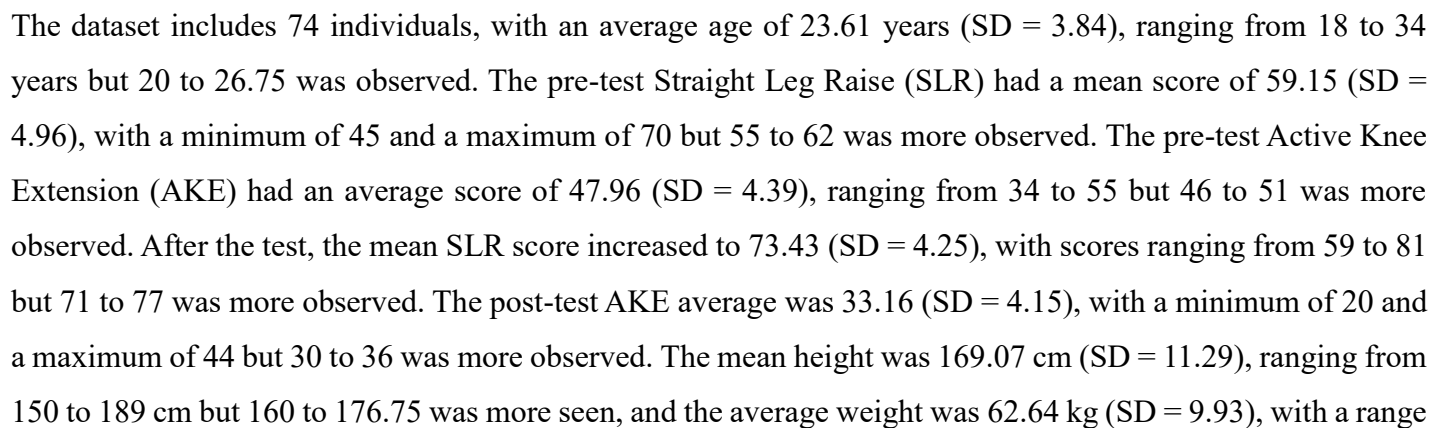
Variable	Males (Mean $\pm$ SD)	Females (Mean $\pm$ SD)
AGE	23.89 $\pm$ 4.07	23.14 $\pm$ 3.45
BMI	21.75 $\pm$ 1.82	21.93 $\pm$ 1.79
PRE_TEST_SLR	59.13 $\pm$ 5.10	59.18 $\pm$ 4.80
PRE_TEST_AKE	48.24 $\pm$ 4.67	47.50 $\pm$ 3.92
POST_TEST_SLR	73.04 $\pm$ 4.55	74.07 $\pm$ 3.69
POST_TEST_AKE	33.22 $\pm$ 4.53	33.07 $\pm$ 3.52

Independent t-tests for Gender Differences

Variable	t-statistic	p-value	Conclusion
AGE	0.84	0.4016	No Significant Difference

None of the p-values indicate significant differences between males and females in any of the measured variables.

in plot



from 44.6 to 84 kg but 54.15 to 69.25 was seen. The average Body Mass Index (BMI) was 21.82 (SD = 1.8), with a minimum of 18.7 and a maximum of 24.9 but 20.45 to 23.08 was more seen.

DISCUSSION

The purpose of this experimental study was to investigate the immediate effects of the neurodynamic slide technique on hamstring flexibility in long-distance runners. The neurodynamic slide technique is commonly utilized to mobilize and improve the flexibility of the nervous system, especially in the context of muscle tightness and restricted mobility. This study aimed to evaluate whether such a technique could have a measurable effect on the hamstring flexibility of long-distance runners, who often experience muscular stiffness due to prolonged physical exertion.

This aligns with previous Castellote-Caballero et al. in 2014 compared the NDST with static muscle stretching, finding that a single neurodynamic intervention resulted in a higher instantaneous increase in passive SLR range of motion. The authors suggest that this result may be attributed to Weppeler and Magnusson's "sensory theory," which suggests that perceptions of stretch and pain (sensation) have a greater impact on muscle flexibility and its response to rapid stretching than biomechanical effects on the muscle tissue itself. A study by Cyanna Joseph D'souza et al. in 2024 showed that neural tensioning was more effective than neural sliding in improving hamstring length on both measures, however this difference was negligible. Within-group analysis demonstrated that the mean post-test scores on the AKET test and SRT were significantly greater than the pre-test scores in both groups ($p < 0.05$).

One key finding in this study was that subjects who underwent the neurodynamic slide technique showed an improvement in their range of motion, with their hamstrings exhibiting greater flexibility post-treatment. This suggests that the neurodynamic slide technique can be an effective intervention for addressing neural restrictions that impact hamstring flexibility, particularly in long-distance runners who frequently deal with hamstring inflexibility as a result of repetitive motions.

These mechanisms could explain the immediate improvements seen in hamstring flexibility, as the technique could potentially influence both the neural and muscular components contributing to flexibility.

The underlying mechanism, explaining the greater increase in hamstring flexibility after neurodynamic sliders, could be attributed to several possible theories. First of all, sliders might affect the extra neural interface where adhesions between neural and surrounding tissue may limit the neural tissue excursions within the mechanical interface and may lead to increased tension and apprehension during passive stretch. Neurodynamic sliders provide linear excursion of the sciatic nerve which could prevent or modify these adhesions, thus leading to a decrease in neural mechanosensitivity and an increase in neural tissue viscoelasticity, thus increasing hamstring mobility.

Another potential explanation for the observed flexibility gains might be the reported analgesic effect of neurodynamic mobilization, which would delay the onset of pain sensation and therefore the associated protective muscle contraction. The neurodynamic slide technique may not only stretch the neural tissues but also help in resetting the neurophysiological responses related to muscle tone and stiffness. This mechanism could explain the immediate improvements seen in hamstring flexibility.

CONCLUSION

From the result and statistical analysis, we can conclude that. There is significant improvement in both SLR and AKE test scores after intervention also Pre-test and post-test scores are strongly correlated, but BMI does not show strong correlations with performance and There are no significant differences between males and females in age, BMI, or test scores.

FUTURE SCOPE

This study only focuses on an immediate effect, in future a long- term effect is needed to improve runner performance. Hamstring tightness/inflexibility could lead to decreased performance. Long distance running put significant load on hamstring and lead to fatigue and tightness. Due to muscle imbalance quadriceps more get involved leading to reduced mobility in hamstring. Repetitive impact and overexertion can lead to strain in back muscles and hence can change lower spine biomechanics. Due to Hamstring tightness runners may experience imbalance and incorrect posture and can put extra stress on spine. Assessing these changes and alterations will be required to plan a patient centric approach for rehabilitation.

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