EFFECT OF NEURODYNAMIC SLIDING AND DYNAMIC RANGE OF MOTION TRAINING ON THE FLEXIBILITY OF HAMSTRING MUSCLE-A COMPARATIVE STUDY

Dissertation submitted to

The Tamil Nadu Dr. M.G.R. Medical University

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In partial fulfillment of the requirements for the degree of

MASTER OF PHYSIOTHERAPY

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COLLEGE OF PHYSIOTHERAPY

SRI RAMAKRISHNA INSTITUTE OF PARAMEDICAL SCIENCES

COIMBATORE – 641044

CERTIFICATE

This is to certify that the dissertation work entitled **"Effect Of Neurodynamic Sliding And Dynamic Range Of Motion Training On The Flexibility Of Hamstring Muscle- A Comparative Study''** was carried out by the candidate bearing the **Register No 271650231 (May 2018)** in College of Physiotherapy, SRIPMS, Coimbatore, affiliated to the Tamil Nadu Dr. M.G.R Medical University, Chennai towards partial fulfillment of the **Master of Physiotherapy (Sports Physiotherapy).**

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Date:

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

Place:

Date:

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It is my privilege to express my deep sense of gratitude to the **ALMIGHTY** for showering his blessing and who has always been my source of strength and inspiration, throughout my life.

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ABBREVIATIONS

AKE	**-**	Active Knee Extension
PKE	**-**	Passive Knee Extension
SR	**-**	Sit and Reach
DROM	**-**	Dynamic Range of Motion
ROM	**-**	Range of Motion
PNF	**-**	Proprioceptive Neuromuscular Facilitation
SLR	**-**	Straight Leg Raise
AROM	**-**	Active Range of Motion
MFR	**-**	MyoFascial Release

ABSTRACT

Background: Muscular flexibility is an important aspect of normal human function. Decreased flexibility of the hamstring muscle predisposes to musculoskeletal overuse injuries commonly seen in sports activities and significantly affects the person's functional level. Objective of the study was to compare the Effect of Neurodynamic sliding and the Dynamic range of motion training on the flexibility of the hamstring muscle. **Materials and Methods:** 30 subjects with hamstring tightness were allocated into two groups. The outcome was measured by using AKE test and sit and reach test. Group I subjects were treated with Neurodynamic sliding whereas group II subjects were treated with Dynamic range of motion exercises. For both groups the technique was performed 5 sessions a week for total period of 6 weeks. **Results:** the results demonstrated that significant improvement in hamstring flexibility for group I subject when compared with group II at the end of six weeks. **Conclusion:** the study suggested that neurodynamic sliding technique is more effective than dynamic range of motion for improving hamstring flexibility.

Keywords : Hamstring flexibility, Neurodynamic sliding, dynamic range of motion, active knee extension test and sit and reach test.

CONTENTS

1. INTRODUCTION

Muscles contain muscle spindles as its functional unit and golgi tendon organs that determines the muscle length and function. The length of muscle tissue plays an important role in the efficacy and effectiveness of human movement which is affected by many factors like age, gender, sedentary lifestyle, genetic factors and immobilization etc [1, 2]. According to Zachezewski "muscle flexibility is the ability of muscle to lengthen, allowing one joint through a full range of motion" without any discomfort and loss of muscle flexibility decreases the ability of muscle to deform resulting in decreased ROM [2, 3]. Flexibility is one of the biomechanical property of body tissue and that determines the range of motion achievable without difficult or injury at a joint or group of joints [30].

1.1 HAMSTRING MUSCLE FLEXIBILITY

The muscle flexibility is important for prevention of injury and maintenance of full ROM. Good muscle flexibility will allow the muscle tissue to accommodate to the imposed stress and allow efficient and effective movement [21]. Hamstring extensibility that plays an important role in protecting the spine from possible risks and allowing normal daily activities and social functioning [24]. Decreased flexibility of the hamstring muscle predisposes to musculoskeletal overuse injuries commonly seen in sports activities [1, 2, 5-7] and significantly affects the person's functional level [13]. Muscle strains are commonly seen in multi joint muscles which have higher concentration of fast twitch muscle fibers and greater functional excursion. Hamstring muscles are the commonly injured multi joint muscle group in the body [1, 2]. The benefits of flexibility which includes improved athletic performance, prevention or reduction of post exercise soreness, reduced risk of injury and improved coordination [4].

1.1.1 Hamstring Injury

Ekstrand and Gillquist (1983) showed that 80% of muscle strains occurred in lower limb encountered by football players during training and or matches and 47% of those were hamstring injuries. Morgan and Oberlander (2001) reported that about 10% of major soccer players encountered hamstring muscle injury during a season [10]. 5.5-6.7% hamstring strains are the most frequent in Australian Rules football (Orchard & Seward, 2002). 11% of hamstring injuries are in British professional soccer and 12.7% in Iceland [11, 25], 11% of injuries in elite New Zealand cricketers, up to 24% of injuries in Gaelic football, 12-14% injuries in professional soccer [7]. In elite level football players are most frequent injuries (86.4 injuries per 10000 playing hours) and most time missed [27]. Hamstring injury is the most common, 12% of overall injury and a team with a 25 player-squad typically suffers about 5-6 hamstring injuries each session [28].

1.1.2 Risk Factor

Bilateral hamstring muscle tightness is caused by posterior pelvic tilt and reduced lumbar lordosis. Hamstring muscle tightness leads to decrease ROM in lumbar flexion and pelvic tilt [20].Muscle tightness results from the increased tension in active or passive mechanisms. Actively, muscles become shorter due to contraction or spasm; passively, muscles become shortened due to scarring or postural adaptation [18, 19]. Many predisposing factors for hamstring injuries are insufficient warm-up [7, 9], poor flexibility [4,7, 8, 17], muscle imbalances, neural tension, fatigue [7, 9], muscle strength deficiency [7, 9, 10], poor quadriceps flexibility [22] and previous injuries [7]. Poor flexibility has linked not only to the hamstring muscle strains but also to other conditions such as patellofemoral pain [23].

1.1.3 Neurodynamic Sliding

Neurodynamic sliding and dynamic ROM techniques are described in this literature. These techniques are used to elongate the hamstring muscle fibers. The flexibility is not only influenced by muscle elasticity but also by the extensibility of the nervous tissue. Decreased hamstring flexibility is evidenced by limited range due to altered neurodynamics affecting the sciatic and tibial nerve [12].Neurodynamics encompasses interaction between the mechanics and physiology of the nervous system. Any changes in the neural mechanics or physiology may lead to pathodynamics [13]. Mechanosensitivity of neural structures in the posterior leg, thigh, buttock, vertebral canal determines the hamstring flexibility. Protective muscle contraction of hamstring found in the presence of neural mechanosensitivity leads to hamstring tightness and subsequent muscle strain injury. Neurodynamic sliding technique is used to decrease neural mechanosensitivity and it is benefit for management of hamstring flexibility [7, 13, 26]. Sliding technique involves combination of movement result in elongation of nerve bed at one joint and reducing the nerve bed length at an adjacent joint [14].

In a previous pilot study involving 28 male soccer players, the research team was able to demonstrate that a neurodynamic sliding technique led to a short term increase in hamstring flexibility [25]. Findings from that study were limited by a small sample size, inclusion of young males only and experimental group compared to a control group. Despite that short duration study did suggest that neurodynamic treatment can significantly increase the hamstring flexibility in young male athletes [7].

1.1.4 Dynamic Range Of Motion

Dynamic range of motion (DROM) method was described by Murphy as an alternative to static stretching who suggests that DROM is a better stretch for muscle lengthening than static stretching [15]. DROM training is a technique that allows the muscle to elongate in a relaxed state. This elongation is achieved by the subject concentrically contracting the antagonist muscle to move the joint through the full available range in a slow controlled manner to stretch the agonist muscle [29]. All movements should be performed slowly and if the subject performed too quickly, a tendency to swing the extremity exists, causing the stretch reflex to be elicited at the endpoint of movement in the lengthening muscle. Antagonist muscle contraction leads to relaxation of the lengthening muscle due to the principle of reciprocal inhibition. Murphy suggests that the strength is improved when the movements had performed by the muscles that actively move the related joint. So DROM is the natural way to elongate the muscle [15].

Traditionally many more scales passive SLR, active knee extension, passive knee extension, sit and reach test and back saver sit and reach test available for measuring hamstring flexibility. According to MSA Hamid et al.

(2013) active knee extension test showed the excellent interrater and intrarater reliability for assessing hamstring flexibility in healthy adults. DM Vega et al. (2014) suggested that the sit and reach tests as a useful alternative valid tool for hamstring extensibility estimation. So the active knee extension test and sit and reach test have taken for measuring the hamstring flexibility in the literature.

1.2 NEED FOR THE STUDY

The lack of flexibility is the predisposing factor of hamstring strain. Some techniques used to increase the flexibility in muscle include static stretching, ballistic stretching, PNF stretching and eccentric training. Dynamic range of motion training may be a beneficial alternative to the more traditional stretching techniques. In addition, no research has compared dynamic ROM training with neurodynamic sliding on effectiveness of increasing hamstring flexibility. Hence this study is to determine the effect of Neurodynamic sliding and dynamic ROM training on the hamstring flexibility in healthy young male subjects.

1.3 OBJECTIVES OF THE STUDY

Determine the effect of dynamic ROM training in the decreased hamstring flexibility in the young male subjects.

Determine the effect of Neurodynamic sliding decreased hamstring flexibility in the young male subjects.

The aim of the study is to compare the effect of Neurodynamic sliding and Dynamic ROM on the hamstring muscle flexibility.

1.4 STATEMENT OF THE PROBLEM

Mechanosensitivity of neural structures in the posterior leg, thigh, buttock, vertebral canal determines the hamstring flexibility. Protective muscle contraction of hamstring found in the presence of neural mechanosensitivity leads to hamstring tightness and subsequent muscle strain injury. The purpose of the study was to find out the **"Effect of Neurodynamic sliding and the Dynamic range of motion training on the flexibility of the hamstring muscle".**

1.5 HYPOTHESIS

1.5.1 Null Hypothesis

There is no significant improvement in the **"Neurodynamic sliding than Dynamic ROM for improving hamstring muscle flexibility".**

1.5.2 Alternative Hypothesis

There is a significant improvement in the **"Neurodynamic sliding than Dynamic ROM for improving hamstring muscle flexibility".**

2. REVIEW OF LITERATURE

CM Norrish et al. (2005), conducted a study on intertester reliability of a self monitored AKE Test. 20 normal subjects selected. Subject supine lying hip and knee 90° position, the subject was instructed to extend their leg as far as possible hold it 5s. AKE was measured by standard Perspex goniometer. The AKE test when used in conjunction with goniometry manual monitoring of the test leg is a reliable measure of hamstring muscle length.

MSA Hamid et al.(2013), did a study on interrater and intrarater reliability of the AKE test among healthy adults. 14 healthy participants volunteered, two raters conducted AKE test independently with aid of a simple and inexpensive stabilizing apparatus. The finding suggests the current AKE test showed excellent interrater and intrarater reliability for assessing hamstring flexibility in healthy adults.

T Neto et al. (2014), processed a research on reliability of AKE test and SLR test in subjects with flexibility deficits. 102 participants volunteered for this study. All participants performed, in each lower limb, two trials with both AKE and SLR. The values of standard error measurement were low for both tests (2.6°-2.9° for AKE, 2.2°- 2.6° for SLR). These findings suggest that both AKE and SLR have excellent intrarater reliability.

A Schulze et al. (2013), conducted a study on active muscle extension testing of the hamstring. The AKE test performed in 119 healthy fitness athletes evaluated biometric and anthropometric data and examined joint function knee and hip activity scores. The average knee extension deficit was measured 31.6°

±12.6°. They concluded that like female gender, physical work, and sport activities for many years affect the muscle elasticity while body fat content and hip flexion are combined to female gender considered as indirect factors of hamstring flexibility.

N Malliaropoulos et al. (2015), processed a research on active knee range of motion assessment in elite track and field athletes. The AROM measured bilaterally with the AKE test during an in session period with a goniometer in 127 athletes. Male jumpers and runners had a higher mean AROM than throwers, but it was not statistically significant. Female jumpers had a higher mean AROM than both throwers and runners, but this was also not statistically significant. These finding suggest that posterior thigh muscle flexibility is associated with performance, the higher AROM, the better performance is achieved by athletes generally have high AROM, and this may be result of their increased muscle flexibility.

M Yasuda et al. (2017),did a study on the effect of active knee extension in sitting on lumbopelvic curvature in individuals with clinically tight hamstring muscles. Twenty seven individuals with tight hamstring muscles were recruited. The lumbopelvic curvature was evaluated in sitting when the right kneemoved from 90° flexion to 10° flexion on 15 occasions using a flexible ruler. Lines drawn tangential to the lumbopelvic curvature were traced at T_{12} and S_2 vertebral level and the angle between the two vertical lines was calculated. Interclass correlation coefficient(ICC) for inter-session reliability and ICC for inter-examiner reliability was 0.97 and 0.93 respectively, indicating the excellent reliability.

RJ Bonser et al. (2016), conducted a study on change in hamstring range of motion following neurodynamic sciatic sliders: A critically appraised topic. Researchers randomized 120 individuals with bilateral complaints of hamstring tightness and decreased ROM on passive SLR. Group 1 receives neurodynamic sliding, group 2 receives static stretching and group 3 receives PNF stretching. Single application of neurodynamic sliding was more effective an increasing ROM than static stretching. While others determined both neurodynamic sliding and static stretching equally increased the ROM following three sessions over one week period. Another group of researchers used three treatment session, researchers determined that both PNF and neurodynamic sliding were effective at increasing ROM.

YC Caballero et al. (2012), processed a research on effects of neurodynamic technique on hamstring flexibility in healthy male soccer players. 28 young male soccer players were randomly assigned to one of two groups: neurodynamic sliding or control. Each subject's dominant leg was measured by SLR test pre and post intervention. At the end of study, the groups were significantly different with more ROM in the group that received neurodynamic intervention. Findings suggest that a neurodynamic sliding technique can increase hamstring flexibility in healthy male soccer players.

S Singh et al. (2015), did a study on effect of neural mobilization and PNF stretching on hamstring flexibility in working women. 24 female with hamstring tightness as demonstrated by 20°loss in AKE and SLR less than 70° were included in study and randomly allocated to two groups. Group A received PNF stretching only and group B received PNF stretching followed by neural mobilization to hamstring muscle. Duration wasfive days per week for periods of four weeks. The study revealed that neural mobilization component when applied in combination with PNF stretching did not produce any additional benefits in terms of hamstring flexibility among working womens.

YC Caballero et al. (2014), processed a research on immediate effects of neurodynamic sliding versus muscle stretching on hamstring flexibility in subjects with short hamstring syndrome. 120 subjects short hamstring syndrome were randomized to 1-3 groups: neurodynamic sliding, hamstring stretching and placebo control. Range of motion was measured by SLR before and after intervention. Finding suggested that a neurodynamic sliding technique will increase the hamstring flexibility to a greater degree than static stretching.

S Golhar et al. (2017), conducted a study on long term effect of neurodynamic sliding technique to improve hamstring flexibility in football players. 30 male subjects with passive SLR less than 80° were divided into two groups: Neurodynamic sliding and control group. Subject were treated with neurodynamic sliding for over a week on three different days and passive SLR was re measured at end of first week, first month and second month. He concluded that neurodynamic sliding technique has a long term effect in improving hamstring flexibility.

A Perin et al. (2015), conducted a study on contribution of different body segments in sit and reach test. Subjects were 195 boys from 18-19 years, sit and reach test was evaluated with angular kinetics analysis through photogrammetry to identify the contribution of body segments in trunk flexion. He concluded that the contributions of thoracic spine, lumbar spine and hip in performing the sit and reach are 46.01 ± 7.32%, 12.68 ± 5.12% and 41.31 ± 7.19% respectively.

AP Mathias et al. (2015), processed a research on effect of warm up on hamstring flexibility using sit and reach test on young adults. 80 subjects were recruited in the study. First day just the sit and reach test was done. Second day sit and reach test was administered after three minutes of warm up. After three days the same test was repeated with five minutes of warm up. Warm up protocol divided into cycling, treadmill and general body stretching. Study showed that there is significant increase in length of hamstring muscle with and without warm up. The results also showed that there is better flexibility as the time of warm up duration increases.

AW Jackson et al. (1998), did a study on relations of sit up and sit and reach test to low back pain in adults. The sample included 2747 adults with mean age of 44.6 ± 9.8 years. The one minute sit up and sit and reach test were administered to participants as part of a voluntary clinical health and fitness evaluation between 1980 and 1990. This study does not support the validity of sit up and sit and reach test items for health related fitness batteries because they were unrelated to low back pain.

DM Cameron et al. (1993), conducted a study to determine therelationship AKE and active SLR test measurements. Twenty three subjects were tested. A 35mm camera was used to record the position of right side of pelvis and lowerlimb during performance of active SLR test on right. The camera setup was also used to record the position of right knee and pelvis during performance of AKE with the right hip flexed to 90°. These two tests suggested that both are providing an indication of the same basic phenomenon. AKE test may be useful alternative to the SLR test for providing an indication of hamstring muscle length.

JR Skaggs et al. (2015), did a study on is flexibility associated with improved sprint and jump performance? 37 high school track and field athletes performed flexibility and performance tests. Hamstring flexibility was evaluated using the sit and reach test and knee extension angle test. This study examining flexibility and athletic performance they found no evidence that flexibility is associated with improved sprint and vertical jump performance. Increased hamstring flexibility, measured by knee extension angle was associated with a decrease in vertical jump height.

PAL Minarro et al. (2009), did a comparative study on sit and reach test (SR) and back saver sit and reach test (BS) in university students. 76 men and 67 women were asked to perform three trails of SR, BS left, BS right and passive SLR right and left in a randomized order. The thoracic, lumbar and pelvis angles and forward reach scores were recorded once the subjects reached forward as far as possible without flexing the knee. The concurrent validity of forward reach score as a measure of hamstring extensibility was moderate in women (0.66-0.76) and weak to moderate in men (0.51-0.59). The concurrent validity was slightly higher in SR than BS, although no significance values were observed.

DM Vega et al. (2014), conducted a study on criterion-related validity of sit and reach tests for estimating hamstring and lumbar extensibility. The hunter schmidt's psychometric meta analysis approach was conducted to estimate population criterion-related validity of sit and reach tests. The three potential moderator variables (sex of participant, age of participants and level of hamstring extensibility) were examined by a partially hierarchical analysis. 99 correlation values across eight sit and reach tests and 51 across seven sit and reach tests were retrieved for hamstring and lumbar extensibility respectively. Generally female adults and participants with high levels of hamstring extensibility tended to have greater mean values of criterion-related validity for estimating hamstring extensibility. This study suggested that scientists and practitioners could use the sit and reach tests as a useful alternative or hamstring extensibility estimation not for estimating lumbar extensibility.

PV Askar et al. (2015), processed a research on effectiveness of eccentric training, dynamic range of motion and static stretching on hamstring flexibility muscle among football players. 88 male subjects with limited hamstring flexibility were assigned to four groups. Group 1 received eccentric training, group 2 received dynamic range of motion, group 3 received static stretching and group 4 served as a control group. All three interventions showed significant increase in hamstring length between pre and post intervention. This study concluded that eccentric training, dynamic range of motion and static stretching groups improved the hamstring flexibility.

L Deguzman (2016), processed a researchon the immediate effect of self administered proprioceptive neuromuscular facilitation, myofascial release and dynamic stretching on range of motion. 35 individuals performed each intervention on different days. Range of motion was measured before and after each intervention. The paired t tests indicated a significant increase for PNF ($t=13.3$; $p<0.001$), MFR ($t=8.9$; $p<0.001$) and dynamic stretching ($t=12.3$; $p<0.001$). These finding suggest that dynamic stretching, PNF and MFR intervention are clinically effective in increasing PKE ROM for individuals with $\geq 20°$ deficit.

WD Bandy et al. (1998), did a study on the effect of static stretch and dynamic ROM training on the flexibility of hamstring muscles. 58 subjects ranging from 21-41 years with limited hamstring flexibility were randomly assigned to one of three groups. One group performed DROM, second performed static stretch and third served as a control group. Treatment duration was five days a week for six week. Post hoc analysis of data to interpret the interaction revealed significant difference between the control group (gain 0.70°), DROM group (gain 4.26°) and static stretch group (gain 11.42°). The result of this study suggest that although both static stretch and DROM will increase the hamstring flexibility, static stretch was more effective than the newer technique DROM for enhancing flexibility.

3. MATERIALS AND METHODOLOGY

3.1 MATERIALS

Stop watch

Wooden couch

Pillow

Universal Goniometer

Ruler

Paper

Pen

3.2 METHODOLOGY

3.2.1 Study design:

A comparative study

3.2.2 Study sampling:

Convenient sampling.

3.2.3 Sampling size:

30 subjects were assigned into the group I and group II. 15 subjects in each group.

3.2.4 Study setting:

Sri Ramakrishna College of Physiotherapy

3.2.5 Study duration:

The study was carried out by aperiod of 6 months.

3.2.6 Treatment frequency

5 sessions in a week for period of 6 weeks.

3.3 CRITERIA

3.3.1 InclusionCriteria

Age 20-30

Hamstring muscle tightness

Male

3.3.2 ExclusionCriteria

Hamstring injury within past year.

Exceeding 70° in the initial AKE test

Who performing the regular lower extremity stretching

History of neck trauma

Neck symptoms

History of fracture in any part of the body

History of neurological or orthopaedic disorder

History of growth disorder

Diagnosis of herniated disc

Lower limb discrepancy

3.4 TREATMENT TECHNIQUES

A total of 50 hamstring tightness young male subjects selected as a sample. 20 subjects were excluded for various reasons. 30 subjects were assigned into the group I and group II.

3.4.1 Group I

The subjects in this group received Neurodynamic sliding.

3.4.2 Group II

The subjects in this group received Dynamic ROM exercise.

3.5 TREATMENT PROCEDURE

In neurodynamic sliding group subjects is positioned in high sitting in the treatment couch. Subjects sat with their trunk in thoracic flexion(slump) and while maintaining the posture, they performed alternating movements of knee extension/ankle dorsiflexion with cervical extension and knee flexion/ankle plantarflexion with cervical flexion.The dynamicROMgroup subjects is positioned supine with their hip held at 90˚flexion and subject actively extended the leg (5sec), held the leg at the end of knee extension for (5 sec) and then slowly lowered the leg (5 sec).

3.6 TOOLS USED IN THE STUDY

1. Active knee extension test

2. Sit and reach test

3.7 OUTCOME MEASURE

Hamstring muscle flexibility.

3.8 STATISTICAL TOOLS

Independent 't' test

The independent 't' test was used to compare and analyze the post test values between the two groups for improvement of flexibility in hamstring muscle tightness.

$$t = \frac{\overline{X_1} - \overline{X_2}}{S} \sqrt{\frac{n_1 \, n_2}{n_1 + n_2}}$$

$$S = \sqrt{\frac{\sum (X_1 - \overline{X_1})^2 + \sum (X_2 - \overline{X_2})^2}{n_1 + n_2 - 2}}$$

$\overline{X_1}$ = Mean of Group I.

$\overline{X_2}$ = Mean of Group II

n_1 = Number of subjects in Group I

n_2 = Number of subjects in Group II

S = Standard deviation

4. DATA ANALYSIS AND RESULTS

The Study was conducted with the two groups, Group I and Group II.

Group I: The subjects received the Neurodynamic sliding.

Group II: The subjects received the Dynamic range of motion.

Pre test and post test values were taken and the improvement on the flexibility of hamstring muscle was evaluated in following parameters.

1. **Active Knee Extension test**
2. **Sit and Reach test**

GROUP I

NEURODYNAMIC SLIDING (AKE TEST VALUES)

S.no	Pre test	Post test	Difference	$X_1-\bar{X}_1$	$(X_1-\bar{X}_1)^2$
1	143	162	19	-0.87	0.75
2	145	163	18	0.13	0.02
3	143	161	18	-1.87	3.48
4	142	164	22	1.13	1.28
5	144	165	21	2.13	4.55
6	146	163	17	0.13	0.02
7	145	162	17	-0.87	0.75
8	142	164	22	1.13	1.28
9	144	163	19	0.13	0.02
10	143	162	19	-0.87	0.75
11	145	164	19	1.13	1.28
12	146	163	17	0.13	0.02
13	144	162	18	-0.87	0.75
14	145	161	16	-1.87	3.48
15	144	164	20	1.13	1.28

Mean 162.87°

Standard deviation 1.15

GROUP II

DYNAMIC ROM (AKE TEST VALUES)

S.no	Pre test	Post test	Difference	$X_2-\bar{X}_2$	$(X_2-\bar{X}_2)^2$
1	145	155	10	-1.47	2.15
2	146	156	10	-0.47	0.22
3	144	155	11	-1.47	2.15
4	144	157	13	0.53	0.28
5	146	156	10	-0.47	0.22
6	147	155	8	-1.47	2.15
7	151	164	13	7.53	56.75
8	148	157	9	0.53	0.28
9	144	156	12	-0.47	0.22
10	145	157	12	0.53	0.28
11	146	155	9	-1.47	2.15
12	145	157	12	0.53	0.28
13	144	156	12	-0.47	0.22
14	144	155	11	-1.47	2.15
15	143	156	13	-0.47	0.22

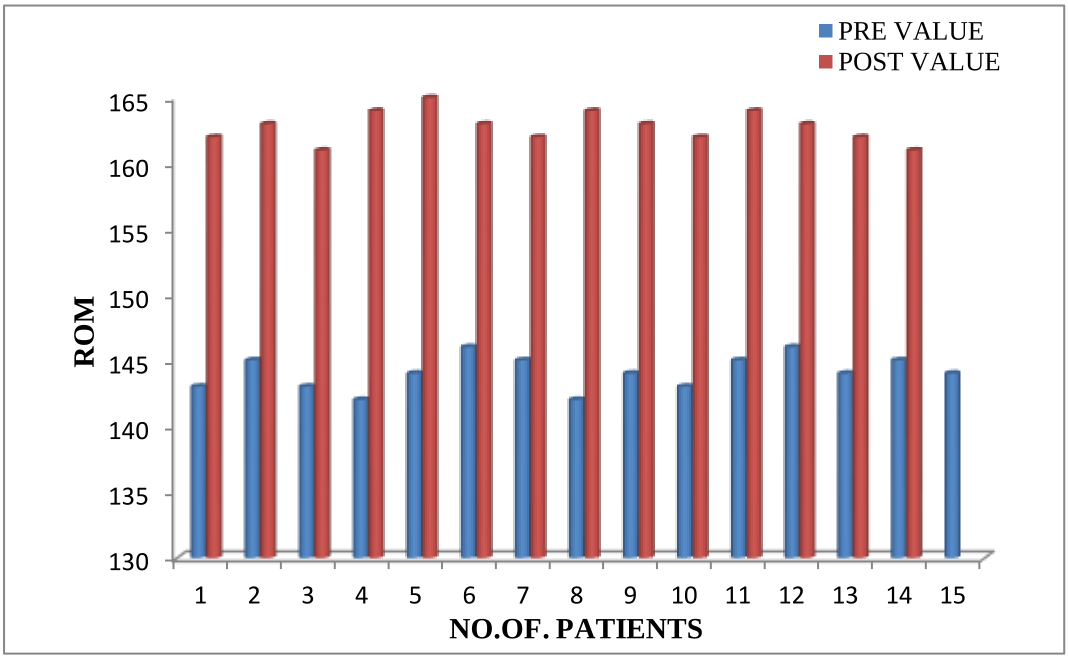
Mean 156.47°

Standard deviation 2.16

t value 9.80

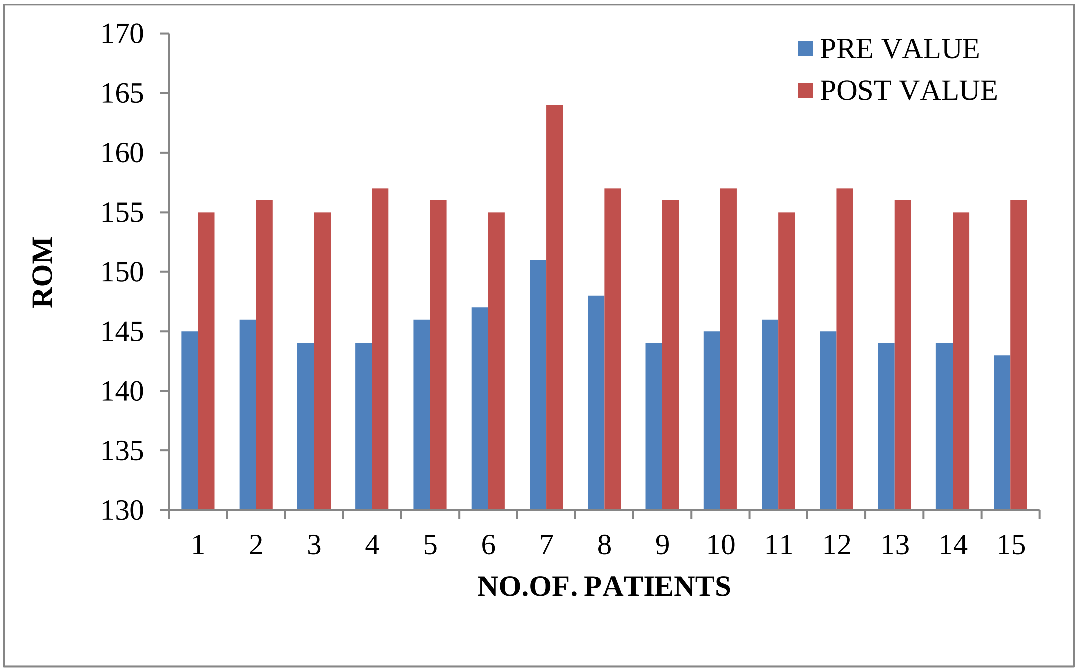
GROUP I

NEURODYNAMIC SLIDING
(AKE TEST- PRE AND POST VALUES)



GROUP II

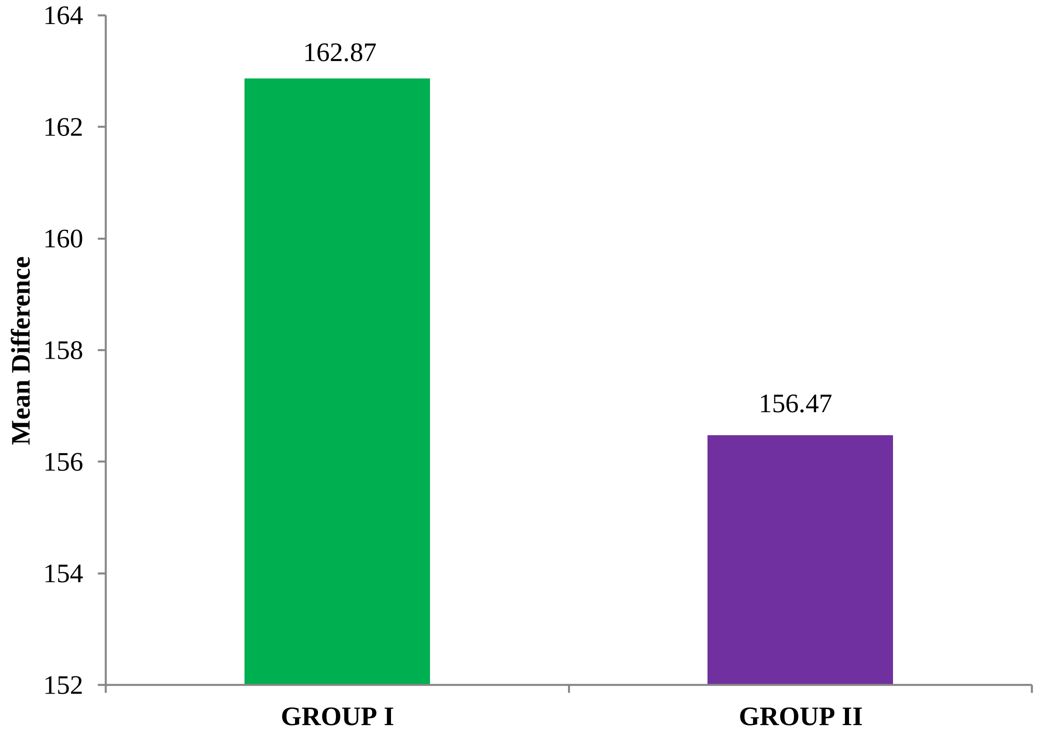
DYNAMIC ROM (AKE TEST- PRE AND POST VALUES)



Post test values of both Group I and Group II- independent 't' test (AKE test)

Test	Mean	Standard deviation	Calculated 't' value	Table 't' value	P value
GROUP I	162.87	1.79	9.80	2.048	0.00001
GROUP II	156.47				

Post test mean values of both Group I and Group II (AKE test)



GROUP I

NEURODYNAMIC SLIDING (SIT AND REACH TEST VALUES)

S.no	Pre test	Post test	Difference	$X_1-\overline{X}_1$	$(X_1-\overline{X}_1)^2$
1	7	20	13	-0.47	0.22
2	6	19	13	-1.47	2.15
3	8	21	13	0.53	0.28
4	5	22	17	1.53	2.35
5	8	20	12	-0.47	0.22
6	6	21	15	0.53	0.28
7	7	22	15	1.53	2.35
8	5	19	14	-1.47	2.15
9	9	20	11	-0.47	0.22
10	5	21	16	0.53	0.28
11	7	22	15	1.53	2.35
12	6	20	14	-0.47	0.22
13	8	19	11	-1.47	2.15
14	9	20	11	-0.47	0.22
15	5	21	16	0.53	0.28

Mean 20.47cm

Standard deviation 1.02

GROUP II

DYNAMIC ROM (SIT AND REACH VALUES)

S.no	Pre test	Post test	Difference	$X_2-\overline{X}_2$	$(X_2-\overline{X}_2)^2$
1	6	16	10	-0.93	0.87
2	9	18	9	1.07	1.14
3	7	16	9	-0.93	0.87
4	8	17	11	0.07	0.00
5	7	16	9	-0.93	0.87
6	6	17	11	0.07	0.00
7	9	18	9	1.07	1.14
8	8	18	10	1.07	1.14
9	7	16	9	-0.93	0.87
10	6	16	10	-0.93	0.87
11	9	18	9	1.07	1.14
12	7	16	9	-0.93	0.87
13	6	17	11	0.07	0.00
14	7	17	10	0.07	0.00
15	8	18	10	1.07	1.14

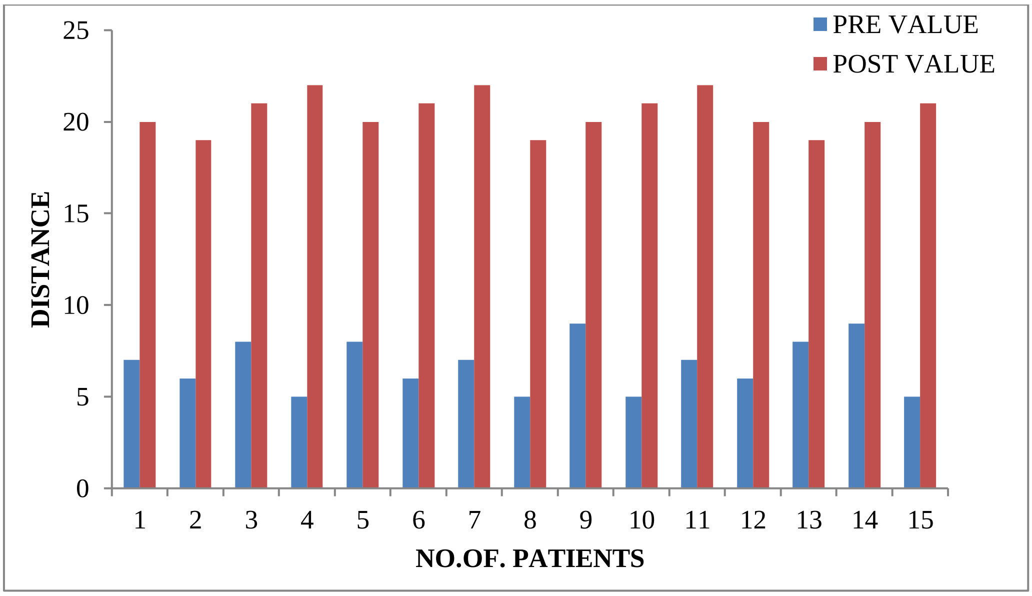
Mean 16.93cm

Standard deviation 0.73

t value 9.90

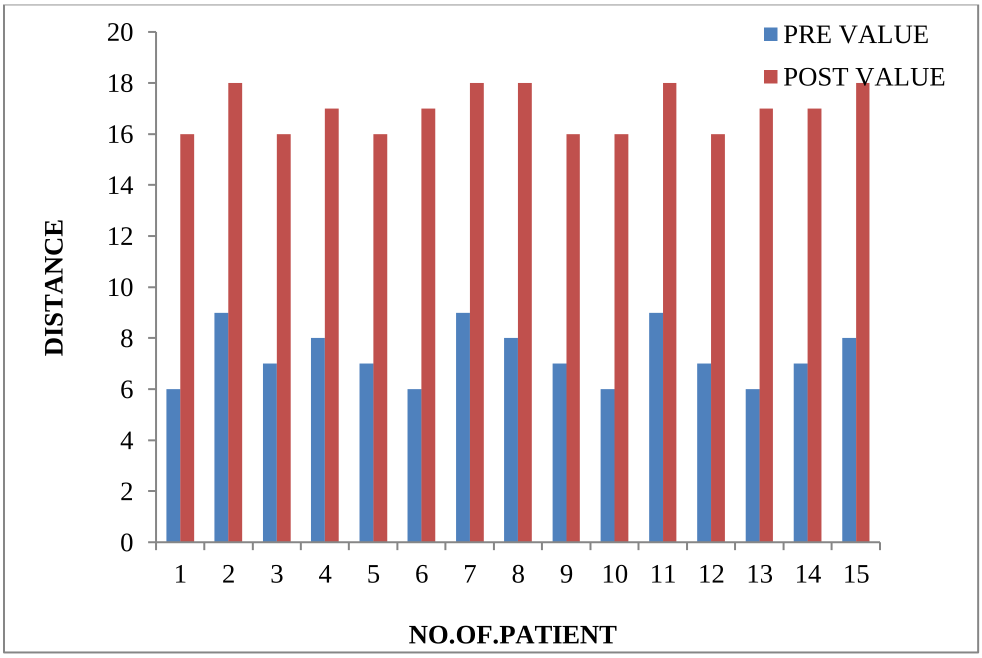
GROUP I

NEURODYNAMIC SLIDING (SIT AND REACH TEST- PRE AND POST VALUES)



GROUP II

DYNAMIC ROM (SIT AND REACH TEST- PRE AND POST VALUES)



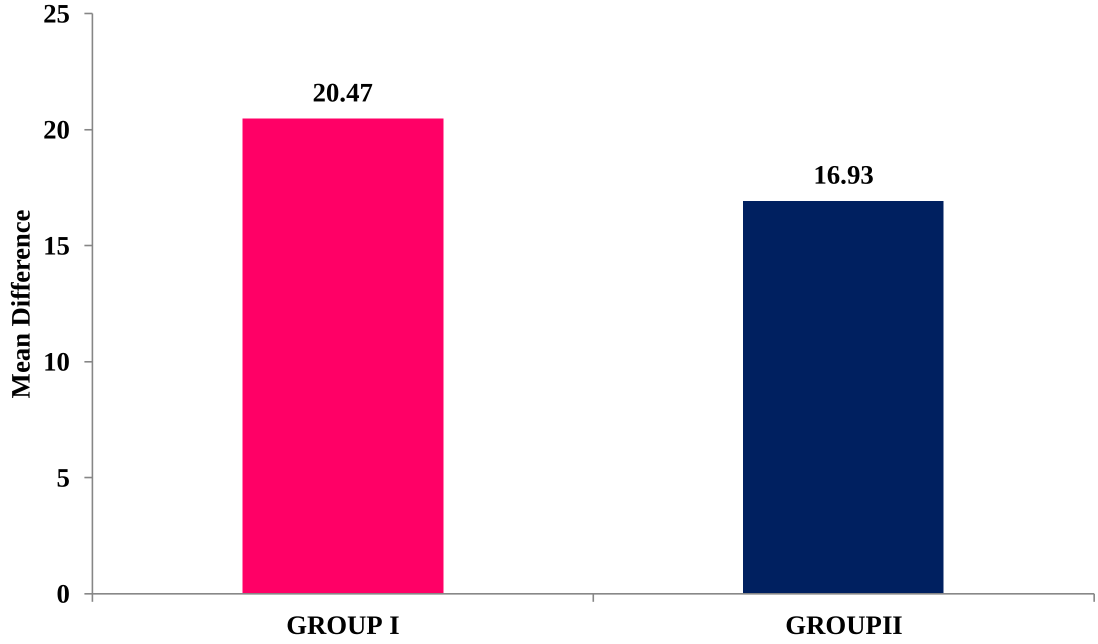
Post test values of both Group I and Group II-

independent 't' test (Sit and Reach test)

Test	Mean	Standard deviation	Calculated 't' value	Table 't' value	P value
GROUP I	20.47	0.98	9.90	2.048	0.00001
GROUP II	16.93				

Post test mean values of both Group I and Group II

(Sit and Reach test)



5. DISCUSSION

This study is aimed to assess the "**Effect of Neurodynamic sliding and Dynamic ROM training on the hamstring flexibility".**

The study involved 30 subjects selected on the basis of convenient sampling.Neurodynamic sliding technique were given in group I subjects for 1 minute, 5 sets in a day, 5 sessions in a week for a period of 6 weeks. Group II subjects were treated with dynamic range of motion exercises treatment duration and sessions were same as group I. At the end of the last session at 6^{th} week post values were measured by using AKE test and SR test.

Data collected through this study showed improvement in the flexibility of hamstring muscle in the young males in both groups. This result supports the studies of S Golhar et al. (2017), in which they concluded neurodynamic sliding technique has a long term effect in improving hamstring flexibility. A study on effect of neurodynamic sliding technique on hamstring flexibility in healthy male soccer player (Y Caballero et al. 2012) was carried out to compare the short term effect of a neurodynamic sliding technique vs controlled condition. At the end of the study, the groups were significantly different more ROM in the group that received the neurodynamic interventions. A study on effectiveness of eccentric training, dynamic range of motion exercises and static stretching on flexibility of hamstring muscle among football players (PV Askar et al. 2015) was showed the significant improvement in the flexibility of hamstring muscle in group that received DROM.

Increasing hamstring flexibility suggested as an important factor in the treatment and prevention of lower extremities overuse injuries. Many research on increasing hamstring flexibility focused on the varying modes of stretching such as PNF, static stretching, plyometric stretching and ballistic stretching. They also have compared different stretch intensities and frequencies. Very few studies have examined the effect of neurodynamic sliding intervention on hamstring flexibility.Results from this study showed that the neurodynamic sliding intervention provides a greater improvement in the hamstring flexibility measured by AKE test and SR test.

The Statistical analysis performed **between Group I and Group II** showed the following outcome in AKE test with a mean improvement of**18.8°**and**11°** respectively for Group I and Group II. The value of the **standard deviation** for Group I and Group II are**1.15** and **2.16**respectively. The "**t**" value for the **independent 't' test** calculated between the groups is **9.80** which is significant at the level **0.05%** at **28** degrees of freedom . In sit and reach test with a mean improvement of**13.73cm** and **9.73cm** respectively for Group I and Group II. The value of the **standard deviation** for Group I and Group II are **1.02** and **0.73** respectively. The "**t**" value for the **independent 't' test** calculated between the groups is **9.90** which is significant at the level **0.05%** at **28** degrees of freedom.

The results of this study demonstrate a mean increase in AKE range for the neurodynamic group 18.8° which compares favourably with other studies.Castellote-caballero et al. reported mean increases in SLR of 9.86°

following similar neurodynamic sliding technique. Mendez-Sanchez et al. reported mean increases of only 3.7° in the right SLR and 2.2° in left SLR after sustained hamstring stretching intervention and when they added a neurodynamic sliding with sustained hamstring stretching they found greater mean increase of 6.2° in the right SLRand 6.3° in the leftSLR. S Singh et al. reported that mean increase in AKE range 20.42° after PNF stretching and when they added a neurodynamic sliding with PNF they found mean increase in AKE range 23.48°.

Both groups showed the significant improvement. Yet, analyzing the statistics and clinical outcomes, it shows **Group I** is better than **Group II**.

The results confirmed our alternative hypothesis that there is a significant improvement in the**"Neurodynamic sliding than Dynamic ROM for improving hamstring muscle flexibility".**

6. CONCLUSION

The finding of this study showed that a 6 week neurodynamic sliding technique received subjects with hamstring tightness significantly improves the hamstring flexibility in AKE test and SR test than compared with the dynamic ROM.

The results of the statistical analysis showed significant improvement in both the groups. Comparing the post-test values of both groups, Group I had significantly more improvement than Group II in AKE test showed the independent 't' value **9.80** and in sit and reach test showed the independent 't' value **9.90**.The Statistical analysis performed **between Group I and Group II** showed the following outcome in AKE test with a mean improvement of **18.8°** and **11°** respectively for Group I and Group II. In sit and reach test with a mean improvement of **13.73cm** and **9.73cm** respectively for Group I and Group II.

Hence we reject the null hypothesis and accept the alternative hypothesis which is stated as there is **significant improvement in the "Neurodynamic sliding than Dynamic ROM for improving hamstring muscle flexibility".**

LIMITATIONS

1. The study is conducted for only 6 weeks.

2. Small sample size 30 subjects were taken into the study.

3. Only the young male subjects included in the study.

4. The follow up is not done.

RECOMMENDATION

1. More research is needed to further explore the real benefits of neurodynamic sliding.

2. Further studies including large sample sizes with in randomized clinical trial should be considered.

3. The female subjects can be taken.

4. Hamstring injury is commonly seen in sports activities. So players can be taken as a sample for the study.

5. Follow up need to assess the long term improvement in effect of treatment.

6. Neurodynamic sliding can be compared with PNF and other traditional stretching.

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APPENDICES

APPENDIX – I

ASSESSMENT

Date:

Name:

Age:

Gender:

Occupation:

Address:

Chief Complaint:

History:

Present History:

Pain History:

Duration of symptoms

Type of pain

Aggravating and Relieving factors

Past History:

Bronchial Asthma

Blood Pressure

Diabetes

Cardiac Problems

Enquiry made for any accidental injury

Personal History:

Cigarette

Alcoholic

Socio-Economic History:

Medical History:

On Observation:

General Condition of patient – Poor, Good, Fair built

Wasting

Oedema

Any bandages, Scars – Area Extent

Attitude of the Limbs – Supine, Sitting, Standing

Type of gait

Bony contours

Deformities

On Palpation:

Tenderness

Tissue tension and texture

Temperature variation of skin

Spasm

Type of skin – Dry or Excessive moisture

Scar – Adherent / Non Adherent

Swelling

Comes on soon after injury – **Blood**

Comes on after 8 to 24 hours – **Synovial**

Boggy, spongy feeling – **Synovial**

Harder, tense feeling with warmth – **Blood**

Tough, dry – **Callus**

Leathery thickening – **Chronic**

Soft fluctuating – **Acute**

Hard – **Bone**

Thick, slow-moving – **Pitting oedema**

On Examination:

Vital Signs

Motor Assessment

Muscle power

Range Of Motion (ROM)

Hip

Flexion

Extension

Abduction

Adduction

Medial rotation

Lateral rotation

Knee

Flexion

Extension

Ankle

Plantarflexion

Dorsiflexion

Muscle Girth Measurement:

Thigh- right and left side

Sensory Assessment :

Superficial Sensations - Pain, Temperature, Light touch, Pressure

Deep Sensations - Movement sense, Position sense

Limb Length Discrepancies

Apparent Length

True Length

Special Tests :

Active knee extension test

Sit and reach test

Gait Assessment :

Type of gait

Stride length

Step length

Investigations:

Clinical Impression:

Goals:

Short Term

Long Term

Treatment Plan:

Neurodynamic sliding

Dynamic range motion

Home Programme:

APPENDIX II

NEURODYNAMIC SLIDING

Neurodynamic is a mobilization and pain control technique that acts directly on the nerves of the body. Neurodynamic innovative management tools involve conservative decompression of nerves various neural mobilizing techniques and patient education techniques.

In neurodynamic sliding group subjects is positioned in high sitting in the treatment couch. Subjects sat with their trunk in thoracic flexion (slump) and while maintaining the posture, they performed alternating movements of knee extension/ankle dorsiflexion with cervical extension and knee flexion/ankle plantarflexion with cervical flexion. The subjects performed these movements for 1 minute, 5 sets in a day, 5 sessions in a week for the period of 6 weeks.

Mechanosensitivity of neural structures in the posterior leg, thigh, buttock, vertebral canal determines the hamstring flexibility. Protective muscle contraction of hamstring found in the presence of neural mechanosensitivity leads to hamstring tightness and subsequent muscle strain injury. Neurodynamic sliding interventions are thought to decrease neural mechanosensitivity and inclusion of these interventions in the management of hamstring flexibility could be beneficial.

The subject was doing the alternative movements of knee extension/ankle dorsiflexion with cervical extension and knee flexion/ankle plantarflexion with cervical flexion.

APPENDIX III

DYNAMIC RANGE OF MOTION

The dynamicROM group subjects is positioned supine with their hip held at 90˚flexion and subject actively extended the leg (5 sec), held the leg at the end of knee extension for (5 sec) and then slowly lowered the leg (5 sec). The subjects performed these movements for 1 minute, 5 sets in a day, 5 sessions in a week for the period of 6 weeks.

Dynamic range of motion (DROM) method was described by Murphy as an alternative to static stretching who suggests that DROM is a better stretch for muscle lengthening than static stretching. DROM training is a technique that allows the muscle to elongate in a relaxed state. This elongation is achieved by the subject concentrically contracting the antagonist muscle to move the joint through the full available range in a slow controlled manner to stretch the agonist muscle. All movements should be performed slowly and if the subject performed too quickly, a tendency to swing the extremity exists, causing the stretch reflex to be elicited at the endpoint of movement in the lengthening muscle.

The subject actively extended the leg (5 sec), held the leg at the end of knee extension for (5 sec) and then slowly lowered the leg (5 sec)

APPENDIX IV

ACTIVE KNEE EXETENSION TEST

The active knee extension test designed and studied by Gajdosik and Lusin is a method of measuring the hamstring musculotendinous length. All the subject were undergone a pre-treatment examination to assess hamstring tightness using AKE test. The subject was in supine lying with hip and knee in 90° position. The testing was done on right lower extremity and subsequently the left lower extremity and the pelvis were strapped down the table to stabilize the pelvis and control any accessory movements. Landmarks used to measure hip and knee range of motion is greater trochonter, lateral condyle of the femur and the lateral malleolus which were marked by a skin permanent marker. The AKE range was measured by using the universal goniometer. The fulcrum of the universal goniometer was centered over the lateral condyle of the femur with proximal arm secured along the femur using greater trochonter as a reference. The distal arm was aligned with the lower leg using the lateral malleolus as a reference. Then the subject asked to extend the right lower extremity as far as possible until a mild stretch sensation was felt. Three repetitions were performed and an average of the three will be taken as the final reading for knee flexion range of motion (hamstring tightness).

Measuring knee extension by using universal gonimeter

APPENDIX V

SIT AND REACH TEST

The sit and reach test is a common measure of flexibility, and specifically measures the flexibility of lower back and hamstring muscles. This test is important because tightness in this area is implicated in lumbar lordosis, forward pelvic tilt and lower back pain. This test was first described by Wells and Dillon (1952) and is now widely used as a general test of flexibility.

TEST PROCEDURE

- **Equipment Required:** sit and reach box (or alternatively a ruler can used, and a step or box)

- **Procedure:** theprocedure for **presidents challenge** version requires that the box is made with 9 inches (23 cm) at the level of feet. Subject sitting on the floor with legs stretched out straight ahead. Shoes should be removed. The soles of the feet are placed flat against the box. Both knees should be locked and pressed flat to the floor- the tester may assist by holding them down. With the palms facing downwards and the hands on the top of the each other the subject reaches forward along the measuring line as far as possible. Ensure the hands remain at the same level, not one reaching further forward then the other. After some practice reaches, the subject reaches out and holds that position for at 1-2 sec while the distance is recorded. Make sure there are no jerky movements. The score is recorded to the nearest centimeter as the distance reached by the hand.

- **Advantage:** the SR test is a common test of flexibility and is an easy and quick test to perform.
- **Disadvantage:** variation in the arm, leg and trunk length can make comparisions between individuals misleading. This test is specific to the range of motion and muscles and joints of the lower back and hamstrings, and may not be relevant to other parts of the body

Performing sit and reach test- Presidents Challenge version

APPENDIX VI

INFORMED CONSENT FORM

I ___________________________________ agree to take part in the project study, conducted by_________________________, post graduate student (MPT), Sri Ramakrishna Institute of Paramedical Sciences, College of physiotherapy, Dr.MGR University.

I acknowledge that the research study has been explained to me and I understand that agreeing to participate in the research means that I am willing to,

- Provide information about my health status to the researcher.
- Allow the researcher to have access to my medical records, pertaining to the purpose of the study.
- Participate in the analysis program.
- Make myself available for further analysis if required.

I have been informed about the purpose, procedures and measurements involved in the research and my queries towards the research have been clarified.

I understand that my participation is voluntary and can withdraw at any stage of the research.

Signature of the patient/care giver:

Contact Address:

Signature of investigator: Date: