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Effects of Neurodynamic Sliding Technique on Hamstring Flexibility among Recreational Sports Players

P. Kamalanathan*, Lanuinba Jamer, Karthick Raja MT, Sivakumar VPR
Department of Physiotherapy, SRM College of Physiotherapy, SRM University, Chennai, Tamil Nadu, India

***Corresponding author**
P. Kamalanathan

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Abstract: Hamstring tightness continues to be a risk factor for hamstring injuries among active individuals and sports players. Various interventions have been performed to find the most effective method to improve flexibility. The purpose of the study therefore, is to explore the effect of a neurodynamic sliding technique on hamstring flexibility among recreational sports players. Quasi experimental study design, pre and post study type. Male subjects within the age of 18-24 who were unable to complete finger floor test were included. Subjects with hamstring injury within the past years and multiple fractures were excluded. According to the inclusion and exclusion criteria subjects were divided into two groups: Group A and Group B. Group A received neurodynamic sliding intervention over a period of 4 weeks and group B received active hamstring stretching exercises over a period of 4 weeks. At the end of the study, significant difference between the group A and B with p value <0.05 was found. Mean values for straight leg raise test (SLR) were significantly higher for the group A when compared to the group B and while the mean values for finger floor test (FFT) were significantly lower for the group A when compared to the group B. This study concludes that the intervention of neurodynamic sliding among the recreational players increases the flexibility of hamstring more than the active hamstring stretching when measured by the straight leg raise test and finger floor test.

Keywords: Neurodynamic sliding technique, Hamstring flexibility, Straight leg raise test, Finger floor test.

INTRODUCTION

The muscles of the back of thigh are called the hamstring muscles. They are the semitendinosus, the semimembranosus, the long head of the biceps femoris, and the ischial head of the adductor magnus. These muscles are the chief flexor of the knee. These muscles are innervated by the tibial part of the sciatic nerve (L5, S1, S2). Hamstrings have variable length. Some person cannot touch the floor with their tip of the middle finger while keeping the knee straight as their hamstring muscles are rather short which restrict them from the action. Hamstring muscle injuries are very common in sports and other occupations which involves physical activity [1]. These type of injuries are in rise in our day today life and the current understanding of such injuries remains incomplete due to the high rate of recurrence [2].

Flexibility is the ability of a muscle to lengthen to its full available range of motion and also allows more than one joint to move through an available full range of motion. A decrease in the ability of a muscle to deform can be defined as the loss of flexibility [3]. Some advantages of enhanced flexibility are that it reduces the risk of injury, relieves pain and also improves the athletic performance in the field. Flexibility is dependent on the viscoelasticity of muscle, ligaments, and other connective tissues. Tools such as goniometers can be used to measure joint angles and flexibility can also be assessed [4].

Weppler and Magnusson in a recent article suggested that the change in tissue extensibility come from changes in the individual's perception of stretch or pain and not from the changes in the mechanical properties of the muscle that is being stretched. Individual who has been receiving the neurodynamic sliding intervention may adopt a "new stop point" for limitation in hamstring range of motion based on altered perceptions of stretch and pain rather than changes in the muscle structure and this leads to the increase in the point of limitation in hamstring range. Weppler and Magnusson concluded this as the "sensory theory" and increase in muscle flexibility were likely due to the modified sensation after being stretched [5].

As there is an increased participation of people in sports and other recreational activities through social changes and increased recognition that physical activity is part of a healthy lifestyle and therefore injury prevention becomes more important. Hamstring tightness or injuries are common in people who play sports and are physically active such as in football, sprinting, swimming, rugby etc. Aerobic conditioning, strength training, and flexibility are considered to be an integral component in any conditioning program by most of the medical professionals, coaches, and athletes [6]. Many predisposing factors such as insufficient warm-up [7]; poor flexibility [8]; muscle imbalance [9]; neural tension [10]; and previous injuries [11]have been suggested in the literature for hamstring injury and tightness.

Several studies have been conducted on hamstring injuries among the players in Australian football [12]. According to the Australian Rules football, it has been shown that hamstring strain injuries account 12-16% of all injuries in English and Australian professional football [13]. Inadequate extensibility within the hamstring muscle has been considered to be the most commonly accepted causes for hamstring injury among the players [14].

Increasing the extensibility of the stretched muscle, fascia and its neural tissues can be done by stretching before any physical activity which may in turn decrease the chance for injury. To prevent and treat hamstring injury or tightness, the most appropriate intervention considered is hamstring stretching. Halbertsman J. P Muller explained that the hamstring stretch has been validated as an effective means of improving the hamstring flexibility [15].

The risk factor for hamstring injury remains equivocal even though various prevention of injury such as stretching and warm-up before the game is common practice in many sports [16]. Due to the alteration of neurodynamics, an individual may demonstrate a decrease range in the passive straight leg raise test with decrease in the hamstring flexibility and also decrease in the range of motion affecting the sciatic nerve, tibial nerve and common fibular nerves [17].

The concept of neurodynamics sliding or neuromobilisation is originally based on the research done by physiotherapists, Michael Shacklock and David Butler [18]. This concept of neurodynamics and neuromobilisation are used to assess mechanosensitivity of neural tissue. Neurodynamics sliding intervention are a beneficial in decreasing the mechanosensitivity of neural tissue and the addition of these intervention in the management of hamstring flexibility could be possibly beneficial and affective. Providing movement and stretching to the hamstring muscle could bring changes in the neurodynamics and modification of sensation and also helps to explain the observed increase in flexibility. Yolanda Castellote-Caballero concluded that a neurodynamic sliding intervention among the healthy subjects will increase hamstring flexibility when measured by the passive straight leg raise to some amount of degree than static hamstring stretching [19].

METHODOLOGY

Ethical approval was obtained from SRM College of Physiotherapy, SRM University. The study was performed in SRM College of Physiotherapy, SRM University, Kattankulathur. Procedure was explained clearly to the students. A total of 40 recreational sports players participated and fulfilled this study.

Male subjects within the age of 18-24 who were unable to complete finger floor test and straight leg raise <80degree were included. Subjects with hamstring injury within the past years and multiple fractures were excluded. According to the inclusion and exclusion criteria subjects were divided into two groups: Group A and Group B. Group A received neurodynamic sliding intervention over a period of 4 weeks and group B received active hamstring stretching exercises over a period of 4 weeks. Materials used were goniometer, inch tape and couch.

Fig-1: Material used

The outcome measures were straight leg raise test: The subject lays supine keeping the knee fully extended. The examiner flexes the subjects' hip until it reaches full flexion or until the subject experience discomfort as shown in the figure and then the angle of hip will be measured with the help of goniometer. Finger floor test: This test consists of asking the subjects to maintain a progressive flexion of the trunk in standing position with the knee extended and the arms and finger extended with the palms parallel. During this position, the therapist determines the distance between the distal part of the middle finger and the floor using an inch tape.

Fig-4: Straight leg raise test

Fig-5: Finger floor test

PROCEDURE

According to the inclusion and exclusion criteria, 40 subjects involved in recreational sports activities were selected. The procedures were explained in detail and informed consent form was provided to the subjects who were willing to participate in this study. 20 subjects were randomly assigned to the intervention group (Group A) and 20 subjects were randomly assigned to the controlled group (Group B). The study population comprises of young adult students between 18-24 years from SRM University. Subjects in Group A received neurodynamic sliding technique and subjects in Group B performed the active hamstring stretching exercise.

Initially a proper instruction about the procedure and benefits of the study were given to the subjects. All subjects began with a single measure of the passive straight leg raise on their dominant leg. After the application of the technique, the subjects were measured for the hamstring muscle flexibility.

GROUP A: NEURODYNAMIC SLIDING TECHNIQUE

Group A received the neurodynamic sliding technique performed in half lying position. The main aim of this technique was to provide a sliding movement of sciatic nerve structure and the adjacent tissue.

Subjects were in half lying position with their head, neck and spine supported with pillows.

Concurrent hip and knee flexion along with ankle dorsi flexion and alternated dynamically with concurrent hip extension, knee extension and ankle plantar flexion.

The therapist alternated the combination of movement depending on the tissue resistance level and was performed for 3 minutes (approximately 25 repetitions) on their dominant leg. These techniques were performed every alternate day for four weeks to the subjects.

Fig-2: Neurodynamic sliding technique

GROUP B: CONTROLLED GROUP WITH ACTIVE HAMSTRING STRETCHING EXERCISES

The procedures were explained in detail, proper instructions and demonstration were given to the subjects about the active hamstring stretching technique.

In this group, the subject performed the active hamstring stretching exercises every alternate day for four weeks.

Four different types of active hamstring stretching exercises were demonstrated to the subjects and were advised to perform.

First stretching was done with the right leg forward stride, both arms forward flexed to 90^{o} and bend over to touch the toe.

Second stretching was done with one extended leg supported over the edge of a wooden box and with the arms flexed forward to reach the extended toe.

Third stretching was done with sitting on the floor, right knee in cross sitting and the left leg extended with both arms flexed to reach the left toe.

Fourth stretching was done with both legs two feet away from each other, trunk forward flexed with both arms extended.

Fig-3: Hamstring stretching exercise

DATA ANALYSIS

Data were analyzed by using IBM SPSS version 20.0 software. Paired t-test and student independent test was applied to assess the straight leg raise test and finger floor test.

Table-1: Pre-test and Post-test mean value of Straight leg raise (SLR) and Finger floor test (FFT) among Group A subjects trained with neurodynamic sliding technique.

	Group A	N	Mean	Std. Deviation	t-test	Significance
Pair 1	SLR PRE TEST – SLR POST TEST 1	20	-5.95000	2.5644	-10.376	.000*
Pair 2	SLR POST TEST 1 - SLR POST TEST 2	20	-4.20000	2.5256	-7.437	.000*
Pair 3	SLR POST TEST 2 - SLR POST TEST 3	20	-4.90000	3.7402	-5.859	.000*
Pair 4	SLR POST TEST 3 - SLR POST TEST 4	20	-4.60000	2.2100	-9.308	.000*
Pair 5	FFT PRE TEST – FFT POST TEST 1	20	2.30500	1.9513	5.283	.000*
Pair 6	FFT POST TEST 1 - FFT POST TEST 2	20	2.49500	1.5679	7.116	.000*
Pair 7	FFT POST TEST 2 - FFT POST TEST 3	20	3.10000	1.4473	9.579	.000*
Pair 8	FFT POST TEST 3 - FFT POST TEST 4	20	3.15000	1.8432	7.643	.000*

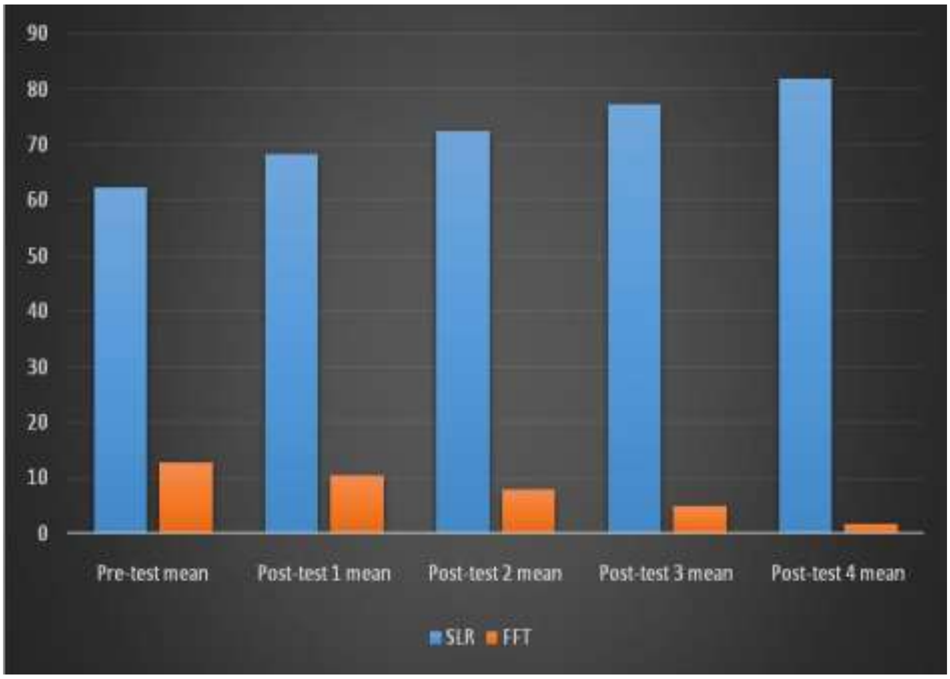
*P<0.05

Table-1 shows the pre-test and post-test Mean, Standard Deviation, t-test and p values of Straight leg raise (SLR) and Finger floor test (FFT) among Group A subjects trained with neurodynamic sliding technique.

The table shows the comparison of pre-test and post-test 1, post-test 1 and post-test 2, post-test 2 and post-test 3, and post-test 3 and post-test 4 of Straight leg raise (SLR) and Finger floor test (FFT) among Group A subjects trained with neurodynamic sliding technique.

Group A Straight leg raise (SLR) has a mean value from-5.95000 to -4.60000 between pre-test and post-test 4 and Finger floor test (FFT) has a mean value from2.30500 to 3.15000 between pre-test and post-test 4.

The table shows a significant value of Straight leg raise (SLR) and Finger floor test (FFT) from pre-test to post-test 4 of Group A subjects trained with neurodynamic sliding technique with a significant difference of P value < 0.05.



Graph-1: Pre-test and Post-test mean value of Straight leg raise (SLR) and Finger floor test (FFT) among Group A subjects trained with neurodynamic sliding technique.

Table-2: Pre-test and Post-test mean value of Straight leg raise (SLR) and Finger floor test (FFT) among Group B (controlled group with active hamstring stretching exercises).

	Group B	N	Mean	Std. Deviation	t-test	Significance
Pair 1	SLR PRE TEST – SLR POST TEST 1	20	-3.25000	3.89162	-3.735	.001*
Pair 2	SLR POST TEST 1 – SLR POST TEST 2	20	-2.45000	2.13923	-5.122	.000*
Pair 3	SLR POST TEST 2 - SLR POST TEST 3	20	-1.95000	1.79106	-4.869	.000*
Pair 4	SLR POST TEST 3 - SLR POST TEST 4	20	-2.30000	1.94936	-5.277	.000*
Pair 5	FFT PRE TEST – FFT POST TEST 1	20	1.35000	1.18210	5.107	.000*
Pair 6	FFT POST TEST 1 - FFT POST TEST 2	20	1.10000	1.41049	3.488	.002*
Pair 7	FFT POST TEST 2 - FFT POST TEST 3	20	1.10000	1.11921	4.395	.000*
Pair 8	FFT POST TEST 3 - FFT POST TEST 4	20	.50000	.51299	4.359	.000*

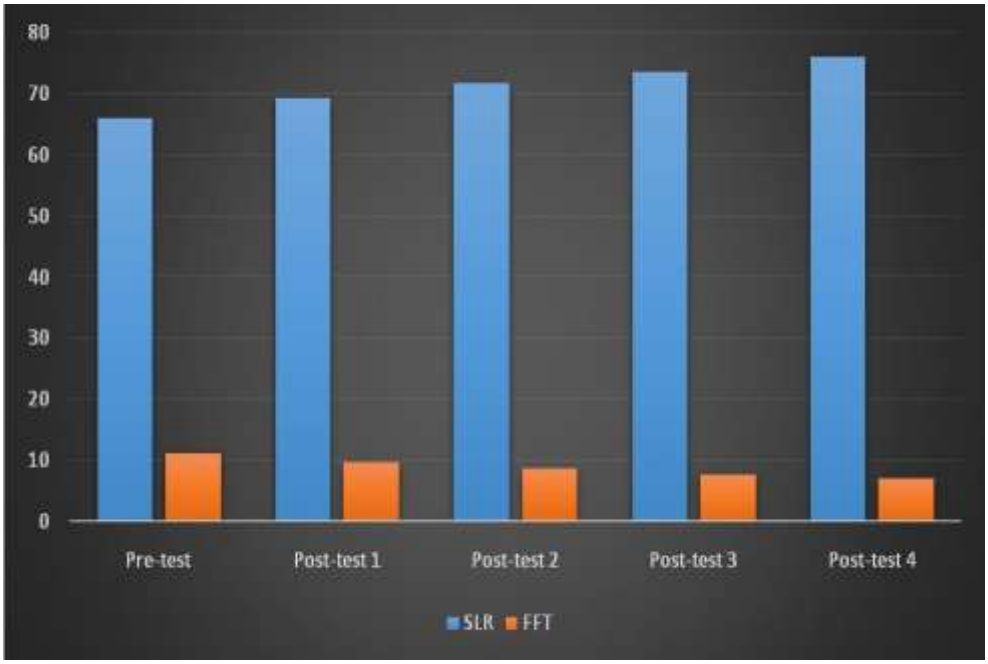
*P<0.05

Table-2 shows the pre-test and post-test Mean, Standard Deviation, t-test and p values of Straight leg raise (SLR) and Finger floor test (FFT) among Group B (controlled group with active hamstring stretching exercises).

The table shows the comparison of pre-test and post-test 1, post-test 1 and post-test 2, post-test 2 and post-test 3, and post-test 3 and post-test 4 of Straight leg raise (SLR) and Finger floor test (FFT) among Group B (controlled group with active hamstring stretching exercises).

Group B Straight leg raise (SLR) has a mean value from-3.25000 to -2.30000 between pre-test and post-test 4 and Finger floor test (FFT) has a mean value from 1.35000 to .50000 between pre-test and post-test 4.

The table shows a significant value of Straight leg raise (SLR) and Finger floor test (FFT) from pre-test to post-test 4 of Group B (controlled group with active hamstring stretching exercises) with a significant difference of P value < 0.05.



Graph-2: Pre-test and Post-test mean value of Straight leg raise (SLR) and Finger floor test (FFT) among Group B (controlled group with active hamstring stretching exercises).

Table-3:

	Group	N	Mean	Std. Deviation	t-test	Significance
SLR POST TEST1	A	20	68.3000	10.50864	-.366	.717
	B	20	69.3000	6.23319	-.366	.716
SLR POST TEST 2	A	20	72.5000	9.20240	.314	.755
	B	20	71.7500	5.39859	.314	.755
SLR POST TEST 3	A	20	77.4000	7.54216	1.750	.089
	B	20	73.7000	5.70411	1.750	.088
SLR POST TEST 4	A	20	82.0000	6.52122	2.950	.005*
	B	20	76.0000	6.34118	2.950	.005*

*P<0.05

Comparison of Post-test Mean value of Straight leg raise (SLR) between Group A subjects trained with neurodynamic sliding technique and Group B subjects trained with active hamstring stretching exercises.

Table-3 shows the post-test Mean, Standard Deviation, t-test and p values of Straight leg raise (SLR) between Group A subjects trained with neurodynamic sliding technique and Group B subjects trained with active hamstring stretching exercises.

Group A Straight leg raise (SLR) has a post-test mean value from68.3000 to 82 and Group B Straight leg raise (SLR) has a post-test mean value from69.3000 to 76.0000.

The table shows a significant value of Straight leg raise (SLR) post-test of Group A subjects trained with neurodynamic sliding technique and Group B subjects trained with active hamstring stretching exercises with a significant difference of P value < 0.05.

Comparison of Post-test Mean value of Straight leg raise (SLR) between Group A subjects trained with neurodynamic sliding technique and Group B subjects trained with active hamstring stretching exercises.

Graph-3:

Comparison of Post-test Mean value of Finger floor test (FFT) between Group A subjects trained with neurodynamic sliding technique and Group B subjects trained with active hamstring stretching exercises.

Table-4:

	Group	N	Mean	Std. Deviation	t-test	Significance
FFT POST TEST1	A	20	10.3450	5.03268	.344	.733
	B	20	9.7500	5.87479	.344	.733
FFT POST TEST 2	A	20	7.8500	4.17102	-.511	.613
	B	20	8.6500	5.63144	-.511	.613
FFT POST TEST 3	A	20	4.7500	3.25859	-2.050	.047
	B	20	7.5500	5.16542	-2.050	.049
FFT POST TEST 4	A	20	1.6000	2.37088	-4.331	.000*
	B	20	7.0500	5.10392	-4.331	.000*

***P<0.05**

Table-4 shows the post-test Mean, Standard Deviation, t-test and p values of Finger floor test (FFT) between Group A subjects trained with neurodynamic sliding technique and Group B subjects trained with active hamstring stretching exercises.

Group A Finger floor test (FFT) has a post-test mean value from10.3450 to 1.6000and Group B Finger floor test (FFT) has a post-test mean value from9.7500 to 7.0500.

The Table shows a significant value of Finger floor test (FFT) post-test of Group A subjects trained with neurodynamic sliding technique and Group B subjects trained with active hamstring stretching exercises with a significant difference of P value < 0.05.

Comparison of Post-test Mean value of Finger floor test (FFT) between Group A subjects trained with neurodynamic sliding technique and Group B subjects trained with active hamstring stretching exercises.

Graph-4:

RESULTS

Table 1 and Graph 1 shows that the Group A has shown some change in the mean value from -5.950 to -4.600 between the pre-test and post-test 4 of Straight leg raise (SLR) and Finger floor test (FFT) has a mean value from 2.30500 to 3.15000 between pre-test and post-test 4 among Group A subjects trained with neurodynamic sliding technique.

The table shows a significant value of Straight leg raise (SLR) and Finger floor test (FFT) from pre-test to post-test 4 of the Group A subjects trained with neurodynamic sliding technique with a significant difference of P value < 0.05.

Table-2 and Graph-2 shows that the Group B has shown some change in the mean value from -3.25000 to -2.30000 between the pre-test and post-test 4 of Straight leg raise (SLR) and Finger floor test (FFT) has a mean value from 1.35000 to .50000 between pre-test and post-test 4 among Group B (controlled group with active hamstring stretching exercises)

The table shows a significant value of Straight leg raise (SLR) and Finger floor test (FFT)from pre-test to post-test 4 of the Group B (controlled group with active hamstring stretching exercises) with a significant difference of P value < 0.05.

Table-3 and Graph-3 shows that the Group A has shown some changes in the mean value of Straight leg raise (SLR) from 68.3000 to 82 and Group B Straight leg raise (SLR) has a post-test mean value from 69.3000 to 76.0000.

The table shows a significant value of Straight leg raise (SLR) post-test of Group A subjects trained with neurodynamic sliding technique and Group B subjects trained with active hamstring stretching exercises with a significant difference of P value < 0.05. This shows that the group A has significantly improved than Group B within the Straight leg raise (SLR) comparison.

Table 4 and Graph 4 shows that the Group A Finger floor test (FFT) has a post-test mean value from 10.3450 to 1.6000 and Group B Finger floor test (FFT) has a post-test mean value from 9.7500 to 7.0500.

The table shows a significant value of Finger floor test (FFT) post-test of Group A subjects trained with neurodynamic sliding technique and Group B subjects trained with active hamstring stretching exercises with a significant difference of P value < 0.05. This shows that the group A has significantly improved than Group B within the Finger floor test (FFT) comparison.

The result thus shows that the groups were significantly different. The mean value for straight leg raise test (SLR)were significantly higher for the group A when compared to the group B and while the mean value for finger floor test (FFT) were significantly lower for the group A when compared to the group B. Therefore, it shows a significant effect of using neurodynamic sliding technique on hamstring flexibility.

DISCUSSION

The purpose of this study was to find out the effectiveness of neurodynamic sliding technique on hamstring flexibility among recreational sports players. The result shows that there is a significant difference in group A when compared to group B. Therefore, at the end the results showed a significant difference among the two groups in which the neurodynamic intervention was greater with regard to the active hamstring stretching exercise.

Hamstring injuries are common factor among sports players and also active individuals which is often due to inadequate warm up, poor flexibility and neural tension. M. R. Safran, W. E. Garrett Jr., R. R. Glisson, and B. M. Ribbeck suggested that warmup plays an important role in the muscular injury prevention [7].

Many researches done on increasing the hamstring flexibility has been mainly focused on the changes of stretching, such as static stretching by [20, 21]; research on proprioceptive neuromuscular facilitation (PNF) done by [20, 22]; study on plyometric stretching and ballistic stretching done by [23]. Differing stretch intensities [24] and frequencies were also been compared by [25]. Some few studies have been done on the effects of neurodynamic sliding technique on hamstring flexibility and the results of this study showed that there is limitation in the SLR with further points added to the evidence for the role of neural tissue mechanosensitivity.

According to the statistical analysis, Group A has shown some changes in the mean value of Straight leg raise (SLR) from 68.3000 to 82 and Group B Straight leg raise (SLR) has a post-test mean value from 69.3000 to 76.0000.The table shows a significant value of Straight leg raise (SLR) post-test of Group A subjects trained with neurodynamic sliding technique and Group B subjects trained with active hamstring stretching exercises with a significant difference of P value < 0.05. This shows that the group A has significantly improved than Group B within the Straight leg raise (SLR) comparison.

Group A Finger floor test (FFT) has a post-test mean value from 10.3450 to 1.6000 and Group B Finger floor test (FFT) has a post-test mean value from 9.7500 to 7.0500.The table shows a significant value of Finger floor test (FFT) post-test of Group A subjects trained with neurodynamic sliding technique and Group B subjects trained with active hamstring stretching exercises with a significant difference of P value < 0.05. This shows that the group A has significantly improved than Group B within the Finger floor test (FFT) comparison.

The increase in the flexibility of the hamstring muscle is due to the change in the individual's perception of stretch or pain and not from the changes in the mechanical properties of the muscle that is being stretched. Individual who has been receiving the neurodynamic sliding intervention adopts to a "new stop point" for the limitation in hamstring range of motion based on altered perceptions of stretch and pain rather than any change in the muscle structure and this leads to the increase in the point of limitation in hamstring range of motion. Weppler and Magnusson [5] in a recent article suggested that the change in tissue extensibility come from changes in the individual's perception of stretch or pain and not from the changes in the mechanical properties of the muscle that is being stretched.

Although both the interventions were effective in increasing straight leg raise (SLR) and the finger floor test (FFT), the neurodynamic sliding technique provided more difference. This technique provided less force on the nerves and adds more sliding and is therefore more effective in providing greater amount of flexibility on the hamstring. Michael Shacklock and David Butler [18] originally coined the concept of neurodynamics sliding or neuromobilisation. The results showed that a neurodynamic sliding technique provided a greater amount of improvement in hamstring flexibility, assessed by passive straight leg raiwhen compared to the active hamstring stretching exercises.

Increasing the hamstring flexibility has been suggested as an important factor in the prevention of lower extremity injuries. Witvrouw, Danneels, Asselman, D'Have, and Cambier [8] suggested that due to poor flexibility of the muscle, it may lead to hamstring injury. Halbertsma, Mulder, Goeken, and Eisma [15]; Hartig and Henderson [26]; Ross [27] suggested that increasing the extensibility of the stretched muscle, fascia and its neural tissues can be done by stretching before any physical activity which may in turn decrease the chance for injury. Safran, Garrett, Seaber, Glisson, and Ribbeck [28] also suggested that insufficient warm-up may also lead to hamstring injury.

The results showed that the neurodynamic sliding technique has greater effect in increasing the hamstring flexibility when compared to active hamstring stretching. Yolanda Castellote-Caballero *et al*., [29] Concluded that a neurodynamic sliding intervention among the healthy subjects will increase hamstring flexibility when measured by the passive straight leg raise to some amount of degree than static hamstring stretching.

This study was conducted for a short period of time hence further studies can be done fora longer term results and also can be done by assessing the effect of combining neurodynamic techniques with other interventions or techniques.

Following the neurodynamic sliding technique, the subjects in the group A also saw greater improvements in finger-floor test. The study suggests that neurodynamic sliding technique can significantly increase the straight leg raise and finger floor test more than active hamstring stretching exercise among the recreational players.

CONCLUSION

This study concludes that the neurodynamic sliding technique has a great effect in increasing hamstring flexibility when measured by the passive straight leg raise compared to the active hamstring stretching among the recreational players even though both the group A and group B were effective in increasing straight leg raise. Following the neurodynamic sliding technique, the subjects also showed greater improvement in the finger floor test in group A when compared to group B which received active hamstring stretching exercise.

LIMITATIONS AND RECOMMENDATIONS

LIMITATIONS

- Sample size was smaller.
- Only males were included.
- Age limitation between 18-24years.
- Normal people were assessed.
- Only the tightness of the hamstring muscles were assessed.
- Long term follow up was not conducted.

RECOMMENDATIONS

- Athlete's subjects can also be included
- Longer duration of study
- Comparison of both gender can be recommended.
- Further studies can be done on longer term results and can be done by assessing the effect of combining neurodynamic techniques with other interventions or techniques.

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