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EFFECTIVENESS OF SUBOCCIPITAL RELEASE TECHNIQUE ON HAMSTRING TIGHTNESS BY USING FORWARD FLEXION DISTANCE TEST AND ACTIVE KNEE EXTENSION TEST IN YOUNG ADULTS

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INTRODUCTION

Flexibility is the ability to move a joint or a series of joints through an unrestricted pain free range of motion. It is dependent upon the extensibility of muscle which allows muscle that crosses a joint to relax, lengthen and yield to a stretch force. (1) Posterior femoral muscle includes biceps femoris, semitendinosus and semimembranosus termed as hamstrings which crosses hip and knee joint integrating coxal extension with genu flexion respectively. (2)

Being a two joint muscle hamstring play an important role in daily activities such as walking, running, jumping and controlling some movement of the trunk. (3) Tight hamstrings can increase patellofemoral compressive forces because of the increased passive resistance during swing phase of gait cycle and during running as it elicits more knee flexion than normal which produces increased patellofemoral joint reaction forces (4)

Physiological cause of reduced muscle extensibility is related to contractility of muscle cell. The activity in alpha motor neuron causes increased muscle contraction that increases force which is required to elongate the homologous muscle. By this, the muscle will have increased stiffness and decreased flexibility. (2) Limited flexibility has been shown to predispose a person to several musculoskeletal overuse injuries as there is sub maximal overload and frictional wear to a muscle resulting in inflammation and pain. (1,5) Thus muscular tightness is frequently postulated as an intrinsic risk factor for the development of a muscular injury. (5)

Hamstring tightness increases from childhood as the child attends sitting position up to the age of 40-49 years. (6) Since it is a superficial muscle they tend to become very tight leading to muscle imbalance which can rise to number of postural problems. As a two joint muscle, the ability to produce effective force at the knee is influenced by the relative position of the hip joint over which it crosses. A two joint muscle have the tendency to shorten quickly as they move both joint simultaneously and more often the action of two joint muscles is prevented at one joint by resistance from gravity. (2,7) Muscle tightness is also caused by the lack of ability of the joint surfaces to roll and slide and also by the ability of periarticular connective tissue to deform affecting the joint range of motion and an individual’s overall flexibility. (1)

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Prevalence and incidence of hamstring tightness in normal individuals is high due to limited activity and lack of regular exercise. (2)

The prevalence of hamstring tightness in male is 27.50% and that in female is 45% in the age group of 18-25 years. (8) Patni O, Saravanan M A, Juneja A, Shaikh N presented a study on student population in age group of 17-23 years. According to them, student population have a posture of sitting with hip and knee flexion at 90 degree which predisposes them to hamstring tightness.(7) Inability to achieve greater than 160 degree of knee extension with hip at 90 degree of flexion is considered as hamstring tightness.(2)

Fascia is defined as, “fibrous collagenous tissue which is part of a body wide tensional force transmission system.” Superficial back line is one such continuous fascia. (8) Fascia acts as a passive force transmitter in musculoskeletal dynamics. (8)

The superficial back line is a cardinal line that primarily mediates posture and movement in the sagittal plane. Superficial back line connects and protects the entire posterior surface of the body. When the knee is extended as in standing, the superficial back line functions as one continuous line of integrated myofascia. The superficial back line is to support the body in full upright extension that is to prevent the tendency to curl in flexion.(9) So muscles in superficial back line are interconnected in identical chains and linked through fascial structures creating a system of structure continuity.(10) These are the plantar fascia, short toe flexors, calf muscles, hamstrings, gluteus maximus, sacrotuberous ligament, erector spinae, serratus posterior, splenius, rhomboids, levator scapulae, latissimus dorsi, trapezius, sub occipital muscles which are rectus capitis posterior minor, rectus capitis posterior major, obliquus capitis inferior and obliquus capitis superior, scalp fascia, frontalis and occipitalis. The suboccipital muscles contribute significantly to regulate head posture. Among them, the rectus capitis posterior minor which has 36 muscle spindles per gram of muscle tissue contributes greatly to regulate the posture and degree of tension. (9)

NEED FOR STUDY

Due to sedentary lifestyle most of the individuals lack physical activity which becomes a major cause of reduced hamstring flexibility. The prevalence of hamstring tightness in males is 75% and females is 35% as females were found to have significantly greater range of motion than males which is attributed to the fact that men performed more vigorous physical work resulting in greater joint micro-trauma, than their female counterparts.(8,11) There are several factors which affects the hamstring flexibility like age, gender, strength, stiffness, awkward posture, BMI, occupation, physical inactivity which can cause biomechanical changes resulting into various dysfunction and postural disorders.(8) Flexibility is an important component of physical conditioning program used as an adjunct to muscle strength and endurance training. Flexibility allows the tissue to accommodate more easily to stress to dissipate shock impact and improve efficacy and effectiveness of movement that

helps in minimizing or preventing injury.(12) Suboccipital muscles and hamstring muscles are connected by one continuous line of integrated myofascia called superficial back line which connect and protects the entire posterior surface of the body.(9) The fascia comprises sheets of web like tissue surrounding muscle and joints,

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connecting different sections of the body to one another allowing the body to function as one unit.(10) Suboccipital muscle inhibition technique uses a method of relaxing the tension in the four muscles located between the occiput and axis which regulates the upper cervical vertebrae and are known to be associated with regulating body posture as well as rotation of head.(12) Pramod K Jagtap, et.al. 2015,(6) conducted a study, in which they concluded that hamstring tightness and stretch pain reduced significantly when suboccipital release was given.(6) Suboccipital release may not be choice of selection of treatment in individuals with hamstring tightness but it has proved effective with short term protocol. Therefore the purpose of the study was to see whether a treatment protocol for more number of days is more effective than a single treatment session to improve hamstring flexibility and to compare the effects achieved with one and 6 days of treatment.

THE SUPERFICIAL BACK LINE

• From toe to heel

The first track runs along the under surface of the foot. It includes plantar fascia and the tendons and the muscle of the short toe flexors originating in the foot.(13)

• From heel to knee

It gets attached to the collagenous covering of the calcaneus, the periosteum and the Achilles tendon. 3 myofascial structures feed into the achilles tendon: the soleus from the profound side, the gastrocnemius from superficial side and the little plantaris in the middle. 2 larger muscle attach to achilles tendon- the soleus and gastrocnemius from superficial side.(13)

• Posterior aspect of lower limb

The myofascia is continued from the proximal gastrocnemius to hamstring provided the knee is in extended position, which takes us to the posterior side of ischial tuberosity. The dual medial hamstrings- semimembranosus and semitendinosus by single lateral hamstring- the bicep femoris. (13)

• Hip to sacrum

The gluteus maximus goes over the hamstring attachment but it clearly runs in a more superficial fascial plane. The sacrotuberous ligament arises from the back of the tuberosity as a continuation of the hamstring and passes across to the lateral border of the sacrum just above the sacrococcygeal junction. The inferior end of the ligament is continuous with the hamstring. The superior end of the ligament is likewise firmly joined to the sacrum.(13)

• From sacrum to occiput

The errector spinae arises from the layer of sacral fascia continuous with sacrotuberous ligament. Several layers of even more superficial myofascial over lie the line here in the form of the serratus posterior muscle, the splenius, the rhomboids, the levator scapulae and the superficial shoulder musculature of the trapezius and latissimus dorsi. (13)

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• The sub occipitals

There is presence of high number of stretch receptors in this tissue. There are 4 muscles of sub occipitalis which are part of the superficial back line. They run among the occiput, the atlas and the axis. They are – rectus capitis posterior minor, rectus capitis posterior major, obliquus capitis superior, obliquus capitis inferior.(13)

• From occiput to supra orbital ridge

From occipital ridge the superficial back line continues up and over the occipital as these layers blend into the galea aponeurotica or scalp fascia which includes the small slips of the occipitalis and frontalis muscles all clearly oriented in the same direction as the superficial back line. It finally come to rest at the frontal bone just above the eye socket.(13)

• The scalp

It is active area within the superficial back line and other line as several of the longitudinal line end here. (13)

There are several ways to release hamstring tightness such as static stretching by facilitation of golgi tendon organ, PNF stretching by using reciprocal inhibition to relax muscle before stretch, neurodynamic sliding technique by decreasing neural mechanosensitivity, kinesiotaping by decreasing pressure of subcutaneous nociceptors, bend leg raise by triggering neurophysiological response influencing the muscle stretch tolerance, etc.(2,5,13,14)

Flexibility of the hamstring increases as a result of an interventional targeting the suboccipital muscles. So the suboccipital muscle inhibition technique is a method of inducing relaxation to the fascia by applying a soft pressure to the suboccipital area of the patient.(15)

METHODOLOGY

INCLUSION CRITERIA

Both gender within age group of 18-25 years with hamstring tightness. (6)

• Normal healthy individual with active knee extension less than 125 degree. (6)

• Forward flexion distance test more than 5 cm. (15)

EXCLUSION CRITERIA

- Individual with herniated disc, lumbar protrusion, low back pain, neck pain, history of neck trauma in past one year. (6)
- Individual with known case of cervical ligament instability. (6)
- Individual with vertebral basilar artery syndrome in past 3 months. (6)
- Individuals with history of lower limb fracture in past 1 year.(6)
- Individuals with fractures around knee joint leading to stiffness and incomplete knee extension. (6)
- Individuals with knee ligament injuries. (6)
- Intense physical conditioning e.g. athlete, sports players. (14)

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MATERIALS USED

- Pen
- Paper
- Plinth
- Universal Goniometer
- Straps
- Measuring Tape
- Stop watch
- Wooden box

PROCEDURE

- Ethical clearance was taken from the BORS committee and ethical committee of the institute.
- A total number of 70 subjects were included in the study, following the fulfillment of the inclusion and exclusion criteria.
- Study procedure was explained to all the participants and their informed written consent was taken.
- Pretreatment assessment that is baseline was taken for hamstring tightness by using both forward flexion distance test and active knee extension test
- All the selected subjects were treated by suboccipital release technique for 6 consecutive days.
- Post intervention measurements were obtained immediately after the first treatment session as 1st, after 4 days session as 4th and after completion of study duration as 7th day, using both forward flexion distance test and active knee extension test.

MEASUREMENT OF HAMSTRING FLEXIBILITY

1. Forward Flexion Distance Test-

- It was used to test the flexibility of hamstrings muscles.(6)
- The subject was asked to stand on the box.(6)
- Then the subject would perform a maximum and progressive anterior flexion of the trunk.(6)
- The knees were maintained straight and the arms lengthening with the palms parallel and fingers extending.(6)
- With the help of a measuring tape the distance from the distal part of the fingers to the top of the box was measurement.(6)
- Measurements were taken for both limb separately

2. Active Knee Extension Test-

- It was used to measure hamstring tightness.(14)
- The participant were positioned in supine on a plinth so that the leg not being tested was flat on the plinth.(14)
- A strap was placed over the mid-thigh of this leg to eliminate any elevation of the limb. Another strap was placed in front of participants' pelvis and around the plinth to maintain pelvis in neutral position.(14)

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- The participant was then asked to flex the hip of the test leg and the thigh of opposite leg touches the plinth.(14)
- Goniometer was used to ensure 90 degree hip flexion with the axis of goniometer placed over greater trochanter and stationary arm parallel to midaxillary line of the trunk and movable arm parallel to the femur in the line with lateral epicondyle.(14)
- The participant was asked to straighten their leg at the knee as far as they can.(14)
- The axis of goniometer was then placed over lateral knee joint line, the movable arm was aligned with the lateral malleolus of the ankle and the stationary arm with the greater trochanter parallel to the femur.(14)
- The goniometer measured the angle of knee extension in degree.(14)
- The tightness was obtained by subtracting the measured angle from 180 degrees.(16)

TREATMENT TECHNIQUE

- The subject was asked to lie in supine position, the therapist was standing at the head end of the patient.(6)
- The subject was asked to close his eyes throughout the session.(6)
- Therapist placed the palms of the hands under the subjects head, head was resting on therapist hands, pads of the therapist fingers were on the projection of posterior arch of the atlas which was palpated between the external occipital protuberance and spinous process of axis vertebra.(6)
- The therapist would locate with the middle and ring finger of both hands the space between the occipital condyles and the spinous process of the second cervical vertebra.(6)
- Then with metacarpophalangeal joints in 90 degree flexion, the therapist would rest the base of the skull on hands.(6)
- The finger pads were positioned on the posterior arch of atlas.(15)
- Pressure was exerted upward and toward the subject’s nose and in the direction of the subjects head. (15)

The pressure was maintained for 2 minutes until tissue relaxation was achieved.(6)

HOME EXERCISE PROGRAMME-

Patients were given a home exercise programme to maintain the hamstring flexibility which was achieved by suboccipital release technique after the last session of treatment.

1. Hamstring stretch in long sitting-

Patient position and procedure-The patient was asked to sit on the floor by extending the knee and keeping the back straight. The patient would then reach for his ankles by extending his arms and bending forward by his hip joints. The same was repeated for opposite leg. 3 repetitions of 15 seconds hold every day to maintain hamstring flexibility achieved. (1)

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2. Bilateral toe touching-

The patient was asked to stand and place his hands on the hip joints when bending forward. To specifically stretch the hamstring muscles using forward bend method in standing, the patient was first asked to do anterior pelvic tilting to extend the spine. Patient was then asked to keep the back stable and bend only at hip joint. The patient felt stretch sensation only in the hamstring region. 3 repetitions of 15 seconds hold was asked to perform every day to maintain the hamstring Flexibility achieved (1)

METHOD OF DATA COLLECTION

Participants enrolled in the study by informed and written consent = 70

↓

Participants selected by inclusion and exclusion criteria.

↓

Participant's assessments were taken using forward flexion distance test and active knee extension test and their baseline were noted.

↓

Sub occipital muscle inhibition technique was given for 2 minutes for all participants recruited.

↓

6 treatment sessions were given for 6 consecutive days, 1session of 2 minutes per day.

↓

Outcome measures were reassessed after 1st, 3rd and 6th session of treatment.

↓

Pre and post intervention data were recorded in excel sheet excluding the drop outs. And data was analyzed using statistical test.

DATA ANALYSIS AND RESULTS

Data was analyzed using SPSS version 17. The data was entered into excel sheet, tabulated and subjected to statistical analyses. Various statistical measures such as standard deviation (SD) and test of significance were applied. The data was collected by the primary investigator and the comparison of scores were made between pre, post day 1, post day 4 and post day 7 intervals. Repeated measure ANOVA was used to see difference between the intervals. Paired t test was used to check the difference between each interval. Shapiro-Wilk test was carried out to test normality for both outcome measures.

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RESULTS

Table no.1: Age wise distribution of subjects

Age Group	Frequency	Percentage
17-20 Years	16	24.24
21-25 Years	50	75.76
TOTAL	66	100.00

Graph no.1: Showing age wise distribution of subjects

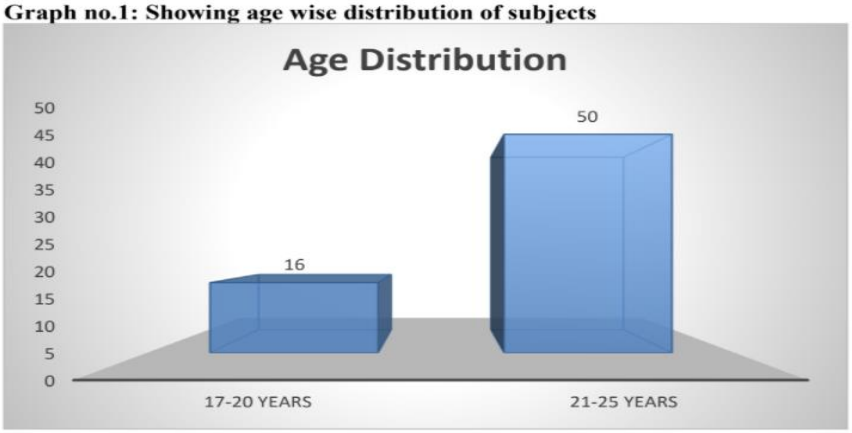

Table no. 2: Gender wise distribution of subjects

Gender	Frequency	Percentage
Male	10	15.15
Female	56	84.85
TOTAL	66	100.00

Pie chart no.1: Gender wise distribution of subjects

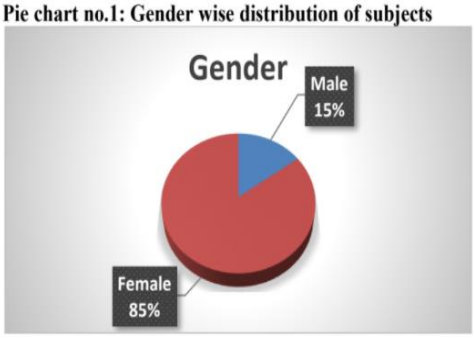

Table no.3: Normality for both outcome measures

Variable	N	Mean	SD	Shapiro Wilk Test	P-Value
Forward Flexion Distance Test (right)	66	16.76	5.76	0.709	>0.05
Forward Flexion Distance Test (Left)	66	16.84	5.85	0.675	>0.05
Active Knee Extension Test (right)	66	59.18	4.59	0.639	>0.05
Active Knee Extension Test (left)	66	59.42	4.94	0.629	>0.05

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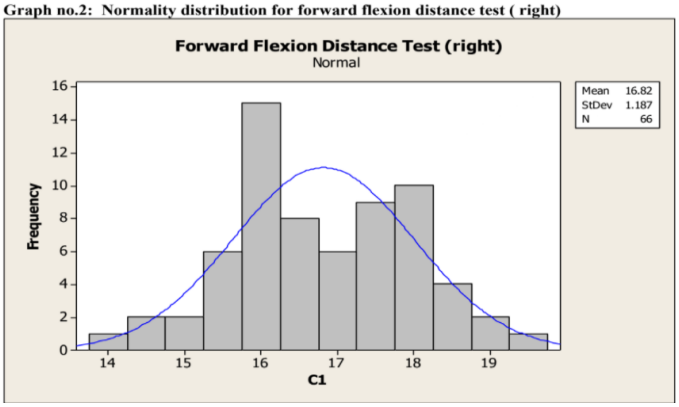
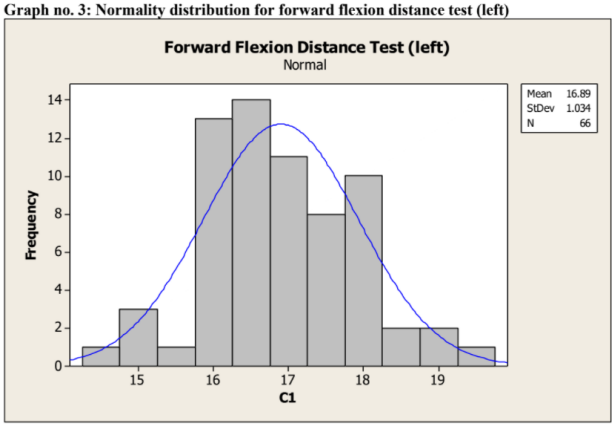
INTERPRETATION- Shapiro-Wilk Test is carried out to test Normality for outcome measures. From above table we can observe that, P-Values are greater than 0.05. Hence we can conclude that, observations are normally distributed.

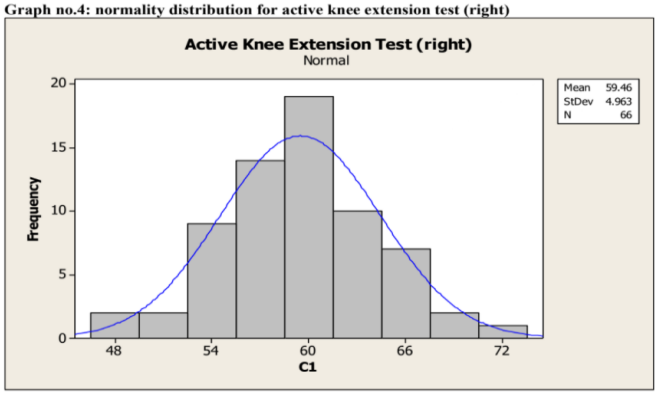
Graph no.2: Normality distribution for forward flexion distance test (right)



Graph no. 3: Normality distribution for forward flexion distance test (left)



Graph no.4: normality distribution for active knee extension test (right)



Graph no. 5: normality distribution for active knee extension test (left)

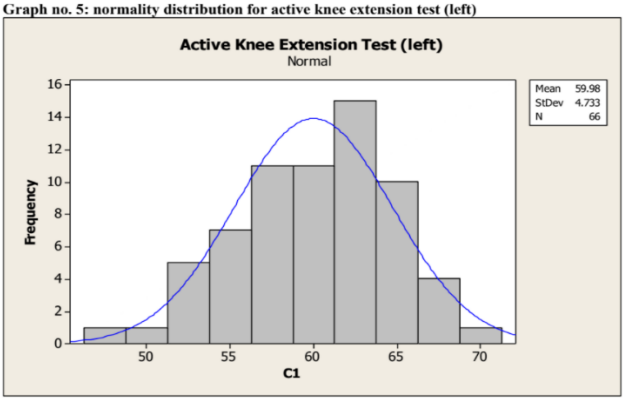


Table no 4 : Repeated measure ANOVA for forward flexion distance test (right)

Forward Flexion Right	Mean	SD	SE	% Change	F-Value	P-Value	Result
Pre	16.76	5.76	0.70	-	207.604	0.000	Sig
Post Day 1	14.68	5.65	0.69	12.39			
Post Day 4	13.03	5.24	0.64	22.24			
Post Day 7	11.35	5.16	0.63	32.28			

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INTERPRETATION: Repeated measures ANOVA is used to test significance at four follow up, From above table we can observe that, P-Value is less than 0.05. Hence we conclude that, significant change observed at four follow up is statistically significant. Mean value at pretest was 16.76 it was reduced to 14.68 at post day 1 further reduced to 13.03 at post day 4 and on post day 7 mean value reduced to 11.35.

Graph no.6: Repeated measure ANOVA for forward flexion distance test (right)

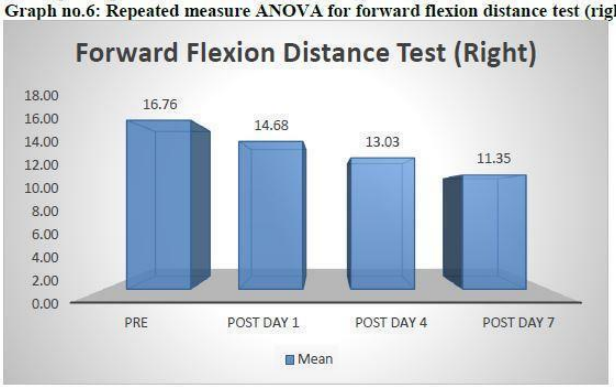

Table no. 5: Repeated measure ANOVA for Forward flexion distance test (left)

Forward Flexion Left	Mean	SD	SE	% Change	F-Value	P-Value	Result
Pre	16.84	5.85	0.71	-	233.176	0.000	Sig
Post Day 1	14.54	5.57	0.68	13.68			
Post Day 4	12.89	5.27	0.64	23.48			
Post Day 7	11.30	5.19	0.63	32.91			

INTERPRETATION: Repeated measures ANOVA is used to test significance at four follow up; From above table we can observe that, P-Value is less than 0.05. Hence we conclude that, significant change observed at four follow up is statistically significant.

Mean value at pretest was 16.84 it is reduced to 14.54 at post day 1 further reduced to 12.89 at post day 4 and on post day 7 mean value reduced to 11.30.

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Graph no. 7: Repeated measure ANOVA for Forward flexion distance test (left)

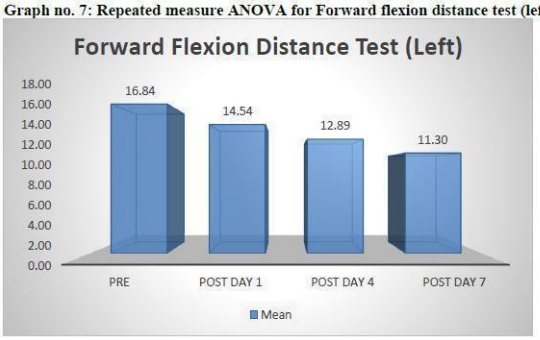

Table no.6: Repeated measure ANOVA for active knee extension test (right)

Active Knee Extension Right	Mean	SD	SE	% Change	F-Value	P-Value	Result
Pre	59.18	4.59	0.56	-	458.852	0.000	Sig
Post Day 1	52.56	4.91	0.60	11.19			
Post Day 4	47.56	5.79	0.70	19.64			
Post Day 7	42.20	6.64	0.81	28.70			

INTERPRETATION: Repeated measures ANOVA is used to test significance at four follow up, From above table we can observe that, P-Value is less than 0.05. Hence we conclude that, significant change observed at four follow up is statistically significant.

Mean value at pre test was 59.18 it is reduced to 52.56 at post day 1 further reduced to 47.56 at post day 4 and on post day 7 mean value reduced to 42.20.

Graph no.8: Repeated measure ANOVA for active knee extension test (right)

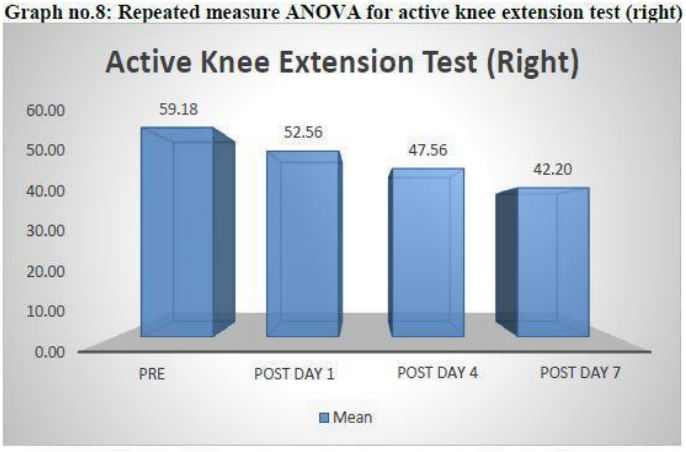

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Table no.7: Repeated measure ANOVA for active knee extension test (left)

Active Knee Extension Left	Mean	SD	SE	% Change	F-Value	P-Value	Result
Pre	59.42	4.94	0.60	-	400.819	0.000	Sig
Post Day 1	52.35	5.55	0.67	11.91			
Post Day 4	47.20	6.11	0.74	20.58			
Post Day 7	41.95	6.74	0.82	29.40			

INTERPRETATION: Repeated measures ANOVA is used to test significance at four follow up, From above table we can observe that, P-Value is less than 0.05. Hence we conclude that, significant change observed at four follow up is statistically significant. Mean value at pre test was 59.42 it is reduced to 52.35 at post day 1 further reduced to 47.20 at post day 4 and on post day 7 mean value reduced to 41.95.

Graph no.9: Repeated measure ANOVA for active knee extension test (left)

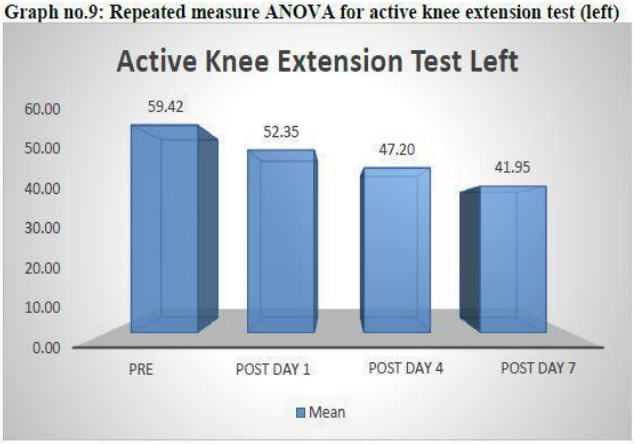

Table no 8: Paired t test for forward flexion distance test (right)

Right		**% change**	**t value**	**p value**	**Results**
	Pre - Post day 1	12.39	13.292	0.000	Significant
	Post day 1 - Post day 7	22.70	12.377	0.000	Significant
	Pre - Post day 7	32.28	17.66	0.000	Significant

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INTERPRETATION: Paired t-test is carried out to test significance between pre test – post day 1, post day 1 – post day 7 and Pre test-Post Day 7, From above table we can observe that, P-Value is less than 0.05. Hence we conclude that, significant change observed between pre test and post day 1 also between post test day1 and post test day 7 also between pre test and post day 7. Mean value at pre test was 16.76 it is reduced to 14.68 at post day 1 showing reduction in mean value of 12.39% further mean value reduced to 11.35 at day post day 7 showing reduction in mean from post day 1 to post day 7 by 22.70%.

Table no 9: Paired t test for forward flexion distance test (left)

Left		% change	t value	p value	Results
	Pre - Post day 1	13.68	13.890	0.000	Significant
	Post day 1 - Post day 7	22.28	13.559	0.000	Significant
	Pre - Post day 7	32.91	18.34	0.000	Significant

INTERPRETATION: Paired t-test is carried out to test significance between pre test – post day 1 and post day 1 – post day 7, From above table we can observe that, P-Value is less than 0.05. Hence we conclude that, significant change observed between pre test and post day 1 also between post test day1 and post test day 7. Mean value at pre test was 16.84 it is reduced to 14.54 at post day 1 showing reduction in mean value of 13.68% further mean value reduced to 11.30 at day post day 7 showing reduction in mean from post day 1 to post day 7 by 22.28%.

Table no 10: Paired t test for active knee extension test (right)

Right		% change	t value	p value	Results
	Pre - Post day 1	11.19	16.281	0.000	Significant
	Post day 1 - Post day 7	19.72	19.008	0.000	Significant
	Pre - Post day 7	28.70	27.264	0.000	Significant

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INTERPRETATION: Paired t-test is carried out to test significance between pre test – post day 1 and post day 1 – post day 7, From above table we can observe that, P-Value is less than 0.05. Hence we conclude that, significant change observed between pre test and post day 1 also between post test day1 and post test day 7.

Mean value at pre test was 59.18 it is reduced to 52.56 at post day 1 showing reduction in mean value of 11.19% further mean value reduced to 42.20 at day post day 7 showing reduction in mean from post day 1 to post day 7 by 19.72%.

Table no 11: Paired t test for active knee extension test (left)

Left		% change	t value	p value	Results
	Pre - Post day 1	11.91	17.661	0.000	Significant
	Post day 1 - Post day 7	19.86	17.042	0.000	Significant
	Pre - Post day 7	29.40	25.406	0.000	Significant

INTERPRETATION: Paired t-test is carried out to test significance between pre test – post day 1 and post day 1 – post day 7, From above table we can observe that, P-Value is less than 0.05. Hence we conclude that, significant change observed between pre test and post day 1 also between post test day1 and post test day 7.

Mean value at pre test was 59.42 it is reduced to 52.35 at post day 1 showing reduction in mean value of 11.91% further mean value reduced to 41.95 at day post day 7 showing reduction in mean from post day 1to post day 7 by 19.86%.

DISCUSSION

Hamstring muscles play an important role in walking, running, jumping and controlling some movements of trunk. Prevalence and incidence of hamstring tightness in normal individual is high due to limited activity and lack of regular exercises. The prevalence of hamstring tightness in males is 75% and females is 35%. Suboccipital muscles and hamstring muscles are connected by a superficial back line which protects entire posterior surface of the body. The purpose of our study was to develop a treatment protocol for more number of days to improve hamstring flexibility and to compare these effects achieved with one and 6 days of

Treatment. 70 subjects were included in the study. There was no significant difference in baseline characteristics as gender and age distribution. Out of 70 subjects 66 completed the study, 4 subjects were dropped out as they did not complete the study. Total treatment was given for 6 consecutive days which summed up to 6 sessions. In each session a suboccipital release was performed for 2 minutes. Hamstring flexibility was measured using forward flexion distance test and active knee extension test. After completing the treatment protocol of six days the hamstring flexibility achieved by

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suboccipital release technique was maintained by a home exercise program of stretching protocol.

Shapiro-Wilk test was carried out to test the normality for outcome measures and it was concluded that, the observation were normally distributed.

Forward flexion distance test-

In our study the intergroup comparison for forward flexion distance test for each, right and left side was done using repeated measure ANOVA. For right side, as seen in table no.4 the effect observed was statistically significant with F value at 207.60 and P value less than 0.05. For left

side, as seen in table no.5 the effects observed were statistically significant with F value at 233.17 and P value less than 0.05.

As seen in table no.4 and table no.8 for right side the study showed statistically significant results between pre and post day 1 with a percentage change of 12.39, post day 1and post day 4 with percentage change of 11.24, post day 4 and post day 7 with percentage change of 12.9, post day 1 and post day 7 with a percentage change of 22.70 and pre and post day 7 with a percentage change of 32.28. P value less than 0.05.

As seen in table no.5 ad table no.9 for left side the study showed statistically significant results between pre and post day 1 with a percentage change of 13.68, post day 1 to post day 4 with a

percentage change of 11.34, post day 4 and post day 7 with a percentage change of 12.33, post day 1 to post day 7 with a percentage change of 22.28 and pre and post day 7 with a percentage change of 32.91. P value less than 0.05. As we can see the percentage change in hamstring flexibility is going on increasing from day 1 to day 7.

Observed changes in forward flexion distance test was due to reduced hamstring tightness following suboccipital release which resulted in increase of hip flexion range of motion and decrease in finger to floor distance.

Active knee extension test-

Also the inter group comparison for active knee extension for both right and left side was done by repeated measure ANOVA. As seen in table no.6 for right side, the effect observed was statistically significant with F value at 458.852 and P value less than 0.05. For left side, as seen in table no.7 the effects observed were statistically significant with F value at 400.819 and P value less than 0.05.

As seen in table no.6 and table no.10 for right side the study showed statistically significant results between pre and post day 1 with a percentage change of 11.19, post day 1 and post day 4 with a percentage change of 9.5, post day 4 and post day 7 with a percentage change of 11.26, post day 1 and post day 7 with a percentage change of 19.72, pre and post day 7 with a percentage change of 28.7value less than 0.05.

As seen in table no.7 and table no.11 for left side the study showed statistically significant results between pre and post day 1 with a percentage change of 11.91, post day 1 and post day 4 with a percentage change of 9.8, post day 4 and post day 7 with

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a percentage change of 11.12, post day 1 and post day 7 with a percentage change of 19.86 and pre and post day 7 with a percentage change of 29.40. P value less than 0.05.

As we can see the percentage change in hamstring flexibility is going on increasing from day 1 to day 7.

Previous studies have shown an immediate improvement in hamstring flexibility after giving suboccipital release in one session. In this study, our objective was to see the effect of suboccipital release in hamstring muscle for duration of 7 days. From the results we see that hamstring tightness was further decreased from 1st to 6th session of treatment. Muscle inhibition technique induces muscle relaxation by stimulating the autonomic nervous system which is the parasympathetic nervous system. Also muscle inhibition is an effective technique for muscle relaxation due to its therapeutic effects by increasing the release of beta endorphins which decreases the muscle spasm by influence on motor neuron excitability which in turn improves motor control.(17) Suboccipital muscle inhibition technique is a fascial relaxation technique that provides continuous and gentle pressure with elongation in the suboccipital region. It aims to apply a soft traction to feel the tension of the soft tissue and remove the muscle barriers by straining and relaxing the fascia and muscle.(12)

In our technique, for fascia to relax effectively a proper pressure and soft extension was applied over the suboccipital area where fascia limitation was felt.(15) Fascia is considered as a fibrous collagenous tissue that is part of the body tensional force transmission system.

This fascial relaxation occurred by the ability of fibroblast to communicate with each other via gap junctions made up of two cells known as connexons which create continuity and thus form a body wide mechanosensitive signaling system of fascia. The fibroblasts present in this fascia form the foundation of fascial continuum.

These fibroblast adapt to metabolic and mechanical stimuli present and therefore allow real time communication among distant areas of the whole body. These junctional structures facilitate the conveyance of mechanical information and electrical activity.

There is also the presence of nanotube tunnels that differ from connexons as they allow continuation of the membrane even when it is far from the original cell. So this nanotube composed of F-actin and myosin facilitate a rapid transmission of metabolic and electrical information. (18)

This integrating function of fascial continuity is analogous to that of the nervous system.(19) Suboccipital muscle inhibition technique improved hamstring flexibility as the tone of the suboccipital muscles falls, the tone of hamstring muscles also reduces as this myofascia relaxes by stimulating the densely packed muscle spindles under suboccipital area.

This can be associated with the hamstring and suboccipital muscles being part of this continuous link of the neural system which passes through the dura mater which is the superficial back line.(4) This myofascial bridge between the suboccipital and hamstring muscles passes through the rectus capitis posterior minor muscle to the posterior aspect of the bodies of the thoracic, lumbar, posterior longitudinal ligaments and

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sacrotuberous ligament to the hamstrings. So they get connected through this superficial back line.(9) The suboccipital muscles are the proprioceptor monitors that contribute significantly to regulate the head posture. Also the rectus capitis posterior minor muscle has high number of muscle spindles that is 36 muscle spindles per gram muscle fiber which when compared to gluteus maximus has only 0.7 muscle spindles per gram muscle fiber.(20)The restoration of length of myofascia takes the pressure off the sensitive structures and restores the performance and mobility of joints and muscles. This thus helps in reducing tightness present in hamstring muscles.(21) The study showed that this manual technique improved the overall function of the superficial backline as the released tension relaxes the tissue in a way that allowed more movement throughout the entire fascial line by reducing the fascial tension. Sung Hak in 2015 did a study on, “The comparison of the immediate effects of application of the suboccipital muscle inhibition and self –myofascial release technique in the suboccipital region on the short hamstring.” Suboccipital release technique was given for 2 minutes to group 1 and self myofascial release was given for 5 minutes to group 2 His study resulted in immediate increase in flexibility of the hamstring and it was confirmed that suboccipital muscle inhibition was more effective than self myofascial release.(15) Pramode K. Jagtap in 2015 did a study on, “The effect of suboccipital muscle inhibition technique on hamstring tightness patients.” In this study suboccipital inhibition technique was given for 2 minutes for 5 days. The study concluded that hamstring tightness and stretch pain reduced significantly when suboccipital release is given. This study is in accordance to what our study have found. Similarly, Ushaben Mahendrakumar Prajapati in 2020 did a study on, “Effects of suboccipital muscle inhibition technique on hamstring tightness in healthy adults- An interventional study.” The study included 52 subjects between the age group of 18 to 25 years. Group A received

suboccipital release technique of 2minutes with static stretching and group B received only static stretching. Treatment was given for 6 days a week for 2 weeks. The results showed marked improvement in both groups but when compared between both groups, suboccipital technique had showed more improvement. This study proved the efficacy of the treatment of suboccipital muscle inhibition technique in increasing the length of hamstring muscles in healthy adults. Hence other studies support the results of our study done on hamstring flexibility using suboccipital muscle inhibition technique.

However other techniques to reduce hamstrings have showed better results than suboccipital release, as in a study conducted by Rooju Vachhani in 2021, in which he compared muscle energy technique with suboccipital inhibition technique.

He found that both techniques were effective in improve hamstring tightness however, muscle energy technique showed better results. In muscle energy technique, Knott and Voss proposed that golgi tendon organ is a nerve receptor found in the tendons that fires when tension increases in the tendon. When the golgi tendon organ fires a signal is sent to the spinal cord causing the agonist muscle to relax. Likewise, a study done by Razouvohu and Sarravana in 2017 on hamstring tightness, they compared suboccipital inhibition technique with neurodynamic sliding and found that both were effective in improving hamstring flexibility but neurodynamic sliding was more

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effective. This may be due to mechanosensitivity of the neural structures in the posterior leg, thigh, buttock and vertebral canal which determine the flexibility of the hamstring muscles. Neurodynamic technique reduce this mechanosensitivity by providing movements and stretching which helps to increase hamstring flexibility. Shrikrishna Shinde et.al. Conducted a study in 2021 where he compared static stretching for hamstring muscles with suboccipital release. In his study both groups were equally effective statistically and improved hamstring flexibility however clinically static stretching was found to be more effective in increasing popliteal angle post treatment. Thus we can see that hamstring flexibility is going on increasing from post day 1, post day 4 and post day 7 of treatment. So it is better to give treatment for 6 days rather than1 day to increase the flexibility of hamstrings. Stretching exercises shown to the subjects can help maintain the increased flexibility.

CONCLUSION

The study concluded that suboccipital release technique improves hamstring tightness after one, three and six days of treatment. Also a protocol of 6 days is more effective than a single treatment to improve hamstring flexibility.

LIMITATIONS

1. The sample population was not divided equally as there were more females and less males.
2. The sample size is small
3. The duration was a short duration for the study.

Further recommendations

Future studies can be carried out with equal numbers of males and females as subjects, for a longer duration and for other populations from different professions.

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