IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

The Influence Of Warm –Up, Strength, Flexibility In Hamstring Muscle Injuries: Experimental Study

[1]Harinadh Konakalla, [2]Dr. Vijayaraj V, [3]Dr. Aditi D. Pansare

[1]Principal [2]Assistant Professor, [3]Senior Physiotherapist

[1]Sri Sai College of Physiotherapy,

[1]Nalgonda India

Abstract: **BACKGROUND PURPOSE:** Hamstring (HS) muscle injuries are the most common injury in sports. They are correlated to long rehabilitations and have a great tendency to recur. Hamstring muscle injury is a complex injury that probably involves more than one etiological factor. Evaluation and rehabilitation of hamstring muscle injuries should include strength and flexibility assessment. Powerful movement such as sharp pain in the thigh there might also be popping or tearing sensation, swelling and tenderness usually develop within the few hours. Some people have muscles weakness. **METHODOLOGY:** twenty-five patients with hamstring muscle injury were taken in the study and given treatment. Randomized study before and after comparison without control. Outcome measures are manual muscle grading scale and goniometer. **RESULTS:** The results in the study reveals that warm-up strengthening, flexibility shown significant improvement in hamstrings injuries whereas warmup strengthening and flexibility showed difference with p value <0.0001 in manual muscle grading scale and p value <0.001 in goniometer (in knee flexion) which is considered as extremely significant. **CONCLUSION:** This present study concludes 8 weeks of influence of warm-up, strength, flexibility in hamstring muscle injuries showed significant improvement in muscle function and strength in subjects with hamstring injuries.

KEYWORDS: Hamstring muscle strain, eccentric contraction, rehabilitation, manual muscle grading scale, goniometer.

I. INTRODUCTION

The hamstring muscle complex occupies the posterior compartment of the thigh and is comprised of three individual muscles. Together, they play a critical role in human activities ranging from standing to explosive actions such as sprinting and jumping. Hamstring injuries are common in elite and amateur sportspeople, and the treatment of such injury's ranges from conservative management to operative fixation. Uninjured hamstring tendons can be used as autografts in knee ligament reconstruction surgery.

Structure and function: The semitendinosus, semimembranosus, and biceps femoris muscles comprise the hamstring muscle group.

Biceps Femoris: Short Head

- Origin: Lateral lip of the Linea aspera
- Insertion: The fibular head and lateral condyle of the tibia
- Function: Knee flexion and lateral rotation of the tibia
- Innervation: Fibular (common peroneal) nerve
- Vascular supply: Perforating branches of the deep femoral artery **Biceps Femoris: Long Head**
- Origin: Ischial tuberosity
- Insertion: The fibular head and lateral condyle of the tibia
- Function: Knee flexion, lateral rotation of the tibia, and hip extension
- Innervation: Tibial nerve
- Vascular supply: Perforating branches of the deep femoral artery

Semitendinosus

- Origin: Lower, medial surface of the ischial tuberosity
- Insertion: Medial tibia (pes anserinus)
- Function: Knee flexion, hip extension, and medial rotation of the tibia (with knee flexion)
- Innervation: Tibial nerve
- Vascular supply: Perforating branches of the deep femoral artery

Semimembranosus

- Origin: Ischial tuberosity
- Insertion: Medial tibial condyle
- Function: Knee flexion, hip extension, and medial rotation of the tibia (with knee flexion)
- Innervation: Tibial nerve
- Vascular supply: Perforating branches of the deep femoral artery

Beginning at the pelvis and running posteriorly along the length of the femur, the majority of muscles within the hamstring complex cross both the femora acetabular and tibiofemoral joints. The short head of the biceps femoris is an exception to this rule as it originates from the lateral lip of the femoral Linea aspera, distal to the femora acetabular joint. For this reason, some argue that the short head of the bicepsfemoris is not a true hamstring muscle.

Unlike the short head of the biceps femoris, all other hamstring muscles originate from the ischial tuberosity. The proximal, long head of the biceps femoris and semitendinosus muscles are linked by an aponeurosis that extends approximately 7 cm from the ischial tuberosity. The distal hamstrings form the superolateral (biceps femoris) and superomedial (semimembranosus and semitendinosus) borders of the popliteal fossa. The gastrocnemius primarily forms the inferior border of the Popliteal Fossa.

The hamstring muscle group plays a prominent role in hip extension (posterior movement of the femur) and knee flexion (posterior movement of the tibia and fibula). Concerning the gait cycle, the hamstrings activate at the final 25% of the swing phase generating extension force at the hip and resisting knee extension. The hamstring muscles also play an essential role as a dynamic stabilizer of the knee joint. Operating in tandem with the anterior cruciate ligament (ACL), the hamstrings resist anterior translation of the tibia during the heel strike phase of the gait cycle.

The longest muscle in the hamstring group is the semitendinosus, measuring an average of 44.3 cm, followed by the long head of the biceps, which measures an average of 42.0 cm. The other two muscles in the group, the semimembranosus and the short head of the biceps, measure an average of 38.7 cm and 29.7 cm, respectively.

Embryology:

A significant portion of lower extremity development occurs during weeks 4 to 8 of embryogenesis. Like all other skeletal muscle tissue, the hamstring muscles form from the embryonic mesoderm. The initial limb bud originates from the lateral plate mesoderm. Migrating from the somite's during the early embryonic phase, mesodermal cells differentiate into myoblasts, which duplicate and coalesce, eventually forming functional muscle tissue. This occurs due to a complex arrayof physiological signals governing the subsequent organization and symmetry of the structures formed, for example, fibroblast growth factors, sonic hedgehog, and Wnt7a.

Bloody supply and lymphatic:

The hamstring muscle complex receives vascular supply from the perforating branches of the deep femoral artery, also known as the profunda femoris artery. The profunda femoris artery is a branch of the femoral artery. The demarcation between the external iliac artery and the femoral artery is the inguinal ligament.

In general, the deep veins of the thigh share the same name as the major arteries they follow. The femoral vein is responsible for significant venous drainage of the thigh. It accompanies the femoral artery and receives additional venous drainage from the profunda femoris vein. Like the femoral artery, the femoral vein transitions to the external iliac vein at the level of the inguinal ligament.

The lymphatic drainage of the thigh also mirrors the arterial supply and eventually drains into the lumbar lymphatic trunks and cisterna chyli.

Nerves:

The hamstring muscle complex is innervated by nerves that arise from the lumbar and sacral plexuses. These plexuses give rise to the sciatic nerve (L4-S3), which bifurcates into the tibial and common peroneal (fibular) nerves at the level of the tibiofemoral joint. The tibial nerve innervates the semimembranosus, semitendinosus, and long head of the biceps femoris muscles. The common peroneal branch of the sciatic nerve innervates the short head of the biceps femoris.

Clinical significance:

Hamstring strains are common in both elite and recreational athletes. In addition to being highly prevalent, hamstring injuries are often slow to heal and tend to recur. Nearly one-third of those who suffer from a hamstring injury are estimated to reinjure themselves within one year of returning to their sport. Most hamstring strains occur in high-risk activities such as sprinting, where rapid changes in speed or direction cause excessive muscle lengthening. The biceps femoris is the most frequently injured of the hamstrings, followed by the semimembranosus and the semitendinosus.

Typically, hamstring injuries are characterized by pain in the posterior thigh, which can be exacerbated by knee flexion and hip extension. In severe injuries, patients may also report hearing a popping sound. When evaluating a patient with a possible hamstring injury, it is important that clinicians also consider other diagnostic possibilities, such as lumbosacral radiculopathy, adductor strain, or a femoral stress fracture.

Hamstring strain injuries classify as mild (Grade I), moderate (Grade II), or severe (Grade III) based on the severity of patient symptoms. Grade I injuries are characterized by minimal pain and functional impairment, with minimal disruption to the hamstring myofibrils present. Grade II injuries are partial thickness tears to the musculotendinous fibers. Patients exhibit increased pain with definite strength loss. Grade III tears present severe pain, hematoma, significant strength loss, and a full-thickness tear to the hamstring muscle or tendon. Orthopedic consultationis the recommendation for Grade III and Grade II/III tears, which affect the distal aspect of the hamstring.

In the acute phase, hamstring injuries are initially managed with protection, rest, ice, compression, and elevation to limit inflammation and swelling. Patient pain tolerance should dictate the range of motion, as excessive hamstring stretching may lead to scar tissue formation. The role of non-steroidal anti-inflammatory drugs (NSAIDs) in hamstring injury is somewhat controversial, with some studies failing to show recovery benefits and others demonstrating possible adverse effects. However, short (5 to 7 days) courses of NSAIDs do not significantly hamper recovery and should be used primarily as analgesics. Alternative pharmacologic agents, such as platelet-rich plasma (PRP), have been explored to enhance athlete recovery. There is no strong evidence to support the use of PRP for muscle strain injury.

In patients who have healed to the point where they can begin therapeutic activities, exercise regimens that focus on eccentric contraction have been shown to shorten recovery time significantly. These regimens can be altered based on the patient's rehabilitation phase and can continue to decrease the re-injury rate. Although hamstring stretching is commonly advocated to decrease the probability of re - injury, hamstring flexibility training has not demonstrated a decrease in the incidence of hamstring re-injury.

Studies have also emphasized the importance of neuromuscular control of the lumbopelvic region. A 2004 prospective randomized study found that patients suffering from acute hamstring strain injury who were rehabilitated using a progressive agility and trunk stabilization program showed lower re-injury rates than those enrolled in a more standard progressive stretching and strengthening program. Warm-up:

Any activity which increases the body temperature by a few degrees Celsius is calledas warm up . In attaining optimum performance warm up prior to exercise playsa vital role. The effects of warm up are seen in the overall sports performance and reduction in sports injuries due to internal factors.
Warm up can be classified into active warm up and passive warm up. In active warm up, temperature is raised from the energy released from contracting muscles. External devices can be used to raise the tissue or body temperature in passive warm up. Combination of both active and passive warm simultaneously at the same time can be called as combined warm up. There are various effects of warmingup on the body which can be related to thermal and non-thermal effects.

Passive warm up helps in improving athletic performance by increasing flexibility, increase in oxygen release in the tissues, increase in metabolism of energy systems, increase in nerve conduction velocity, reduction in peak tension time in muscles, it can increase the temperature strain on the body and can help in increasing performance. Active warm up helps increase in blood flow, increase in baseline Oxygen consumption, it leads to breaking of actin and myosin bonds which improves flexibility . There is an increase in post-activation potential. There is increased preparation for a sports activity after active warmup.

Flexibility:

Several authors have investigated the relationship between hamstring flexibility and hamstring injury. Worrell et al and Lieman reported hamstring-injured subjects were less flexible than non-injured subjects. In contrast, Burkett reported no difference in hamstring flexibility between hamstring- injured and non-injured subjects. In addition, Ekstrand and Gill Quist reported no relationship between hamstring flexibility and hamstring injury. Burkett utilized the Wells sit-and-reach method to determine hamstring flexibility. Lieman and Ekstrand and Gill Quist utilized the straight-leg-raise method. Worrell et a1 utilized the passive-knee- extension test. Only two authors have reported reliability data to support their method of assessing hamstring muscle length. Worrell et al reported the use of a passive-knee extension test (N = 20, test-retest Pearson product moment coefficient of r = 0.98). During the passive knee-extension test, each subject is placed supine with the hip positioned at 90" of flexion. The hip is then

stabilized in this position by the sub than a group of 86 nonplayers. They reported no correlation between past injury and muscle tightness. In contrast, Worrell et al reported that the hamstring-injured group's injured extremity was significantly less flexible than the non- injured extremity ($p < 0.05$). Also, the authors
reported that both of the injured group's hamstring muscles were less flexible than the non-injured group's hamstring muscles ($p < 0.05$). It is plausible that a less flexible extremity existed prior to hamstring injury. Evidence demonstrates that areas of inflammation and adhesion occur following muscle injury. Furthermore, calcification within the hamstring muscles following muscle strain has been documented on C.A.T. Therefore, it seems possible that loss of hamstringflexibility is a possible sequela to hamstring muscle injury. Since the ability of connective and muscle tissue to absorb force is related to its resting length, the greater the resting length, i.e., flexibility, the greater the ability to absorb forces and avoid stream. Therefore, the importance of hamstring flexibility cannot be overemphasized

Goniometer:

A universal goniometer is a type of goniometer that can measure angles in multiple planes, including:

- Flexion (forward bend)
- Extension (backward bend)
- Abduction (movement away from the midline)
- Adduction (movement towards the midline)
- Rotation (turning)

It is called "universal" because it can be used to measure a wide range of movements and angles, making it a versatile tool for assessing joint mobility.

Features of a Universal Goniometer:

- Two arms, one fixed and one movable, connected by a hinge or pivot
- Angle measurements in degrees (0-360°)
- Can be used for multiple joints (e.g., shoulder, elbow, wrist, hip, knee, ankle)
- Can measure both active (patient-generated) and passive (therapist-generated) range of motion
- Often has a locking mechanism to secure the arms in place

Fig-1: Goniometer

Manual muscle testing:

Manual muscle testing (MMT) is a technique used to assess the strength and function of muscles. It involves a systematic approach to evaluating muscle strength, length, and function, and is commonly used in physical therapy, occupational therapy, and orthopedic medicine.

Principles of Manual Muscle Testing:

1. Isolation: Testing each muscle individually to assess its strength and function.

2. Standardization: Using standardized techniques and positions to ensure reliable and comparable results.

3. Gravity: Using gravity to assist or resist muscle movements to assess strength.

4. Resistance: Applying gentle resistance to assess muscle strength and function.

Techniques Used in Manual Muscle Testing:

1. Muscle length testing: Assessing muscle length and flexibility.
2. Muscle strength testing: Evaluating muscle strength through resisted movements.

3. Muscle function testing: Assessing muscle function and coordination.

Common Manual Muscle Testing Grades:

- 0-No muscle contraction

- 1-Visible muscle contraction, but no movement

- 2- Movement, but not against gravity

- 3- Movement against gravity, but not against resistance

- 4-Movement against gravity and resistance

- 5-Normal muscle strength

Normal muscle strength

Manual muscle testing is a valuable tool for assessing muscle function and identifying muscle imbalances or weaknesses. It can help guide treatment and exercise programs to address muscle dysfunction and promote optimal muscle function

STRENGTH: A voluntary activity that includes the use of weight machines, exercise bands, hand-held weights, or own body weight.

These are hamstring strengthening exercises

- Deadlifts
- Legs curls
- Glute ham rises
- Romanian dead lifts

AIMS & OBJECTIVES

AIM

The aim of the study is to show that isometric exercise & hamstring stretching are effective in improving strength and flexibility, in patients with hamstring muscle injuries

OBJECTIVES

The objective is to improve muscle strength, reduce the pain and increase the flexibility of hamstring muscle by using warm up, strengthening & flexibility of the hamstring muscles.

MATERIALS AND METHODOLOGY

The present study was conducted as an experimental study with a sample size of 25 subjects, selected using a focusing sampling technique. The participants were recruited from Sai Venkata Physiotherapy Clinic and Moon Walk Physiotherapy Clinic, Guntur, and the study was carried out over a duration of 8 weeks. The materials used in the study included Thera bands, sandbags, a couch, a chair, dumbbells, a towel, and a yoga mat. The inclusion criteria comprised individuals aged between 20 and 40 years, of both genders, with a history of overuse or strain and diagnosed with Grade 1 or Grade 2 muscle tears. Participants with severe tears and ruptures, uncontrollable inflammatory conditions, nerve compression, deep vein thrombosis, or malignancy were excluded from the study.

PROCEDURE

WARM-UP

Passive Warm Up: Passive warm up group received moist heat as intervention. Moist heat packs were applied over hamstrings, quadriceps, gastro-soleus complex and over the gluteus muscles at the same time for a period of 20 minutes. The subjects rested in the prone position during the application. Subjects were asked not to sleep and were asked from time to time about the intensity of heat. Following passive warm up, self-stretching of the lower limb muscles was done by the subject. Hamstrings, quadriceps, gastro-soleus and gluteus muscles were stretched.

Active Warm Up: Active warm up session included exercises as the intervention. It started with five minutes of cycling on static cycle at 40 rpm followed by five leg presses with half the body weight, five squat jumps, five jump squats, five heel raises and one minute BOSU® ball balancing exercise with eyes closed and externally given perturbations. Stretching followed after active warm up exercises as explained earlier.

Combined Warm Up: Combined warm up included both passive warm up and active warm up exercises. The only difference in active warm up exercises and combined warm up was that the total duration of cycling and BOSU® ball exercise was reduced to half and other activities were reduced to three repetitions instead of five. Self- stretching of lower limb muscle followed combined warm up.

HAMSTRING STRENTHENING:

Lunge: From a standing start, each participants lunged forward so that their hip and knee are flexed to 90°, the back is upright, and there is no dynamic knee valgus. Participants are instructed to drop rapidly from the start to end position. This is a closed kinetic chain hip dominant exercise.

Single leg Roman dead-lift T-drop Standing on one leg with the knee slightly bent, each participant maintains a neutral lumbar spine and slowly flexes to end range hip flexion. The back leg remains in neutral hip flexion-extension and is moved backward as the trunk goes forward. This is a closed kinetic chain hip dominant exercise with limited knee flexion.

Kettle bell swings: A 12 kg kettle bell is used depending on ability and comfort. The participant bends forward to grip the kettle bell on the ground with both hands. The upper body at this point is parallel to the floor with the knees slightly flexed (approximately 10°–15°). The participant is required to swing the kettle bell back bridge

Participants start by lying in the supine position with arms by their side, knees bent to 90°, and feet flat on the ground. One leg is off the ground and placed over the opposite knee. The hips are lifted off the ground slowly until the knees, hips, and shoulders are in a straight line. between her legs forcefully then quickly reverse the direction with an explosive extension of the hips while swinging the kettle bell out to chest level;

at this time, the hips and knees are extended with the participant standing upright. This is a closed kinematic chain hip dominant exercise.

Hamstring bridge:

Participants start by lying in the supine position with arms by their side, knees bent, and heels on a chair. The hips are lifted off the ground slowly until the knees, hips, and shoulders are in a straight line. This position is held for 5 seconds.

Curl:

Participants stand and perform slow concentric-eccentric knee flexion-hip extension against elastic band resistance (low load, <2 kg). Stability of the hip for the weight- Bearing leg and neuromuscular control of the core is required in order to counteract the torsional forces created at the trunk. This is an open kinetic chain knee dominantexercise.

Fit ball flexion:

Participants start lying in a prone position. A fit ball is held at the position of the gluteal muscles, and the subject flexes and hits the ball with the heel. The right and left legs are alternated as rapidly as possible. One repetition is hitting the ball once with each heel. This is an open kinetic chain knee flexion dominant exercise.

Slide leg:

Participants start lying in the supine position on the floor with arms by their side, knees bent, and their heels on two pieces of rug which can easily slide over the floor. The heel on one side is used to weight-bear, with the pelvis off the ground, and the leg is straightened in a slow and controlled manner. The other leg is kept off the floor. When the knee of the working leg is straight, the leg is curled back. This is a closed kinetic chain knee flexion dominant exercise.

FLEXIBILITY:

Stretching Protocol After determining the baseline value, the subjects were taken through the stretching exercise training for the duration specific for the group to which s/he belonged. The stretching exercise was carried out as follows: -

Starting Position: Subject assumed the full supine-lying position on a plinth with his two feet pointing upwards. The contra-lateral lower limb was securely strapped to the plinth using 2 slings positioned across the thigh and over the anterior superior iliac spine to stabilize the pelvis. The lower limb being stretched was passively moved into the extreme of extension, up to the limit where the subject felt a gentle stretch at the posterior aspect of the thigh. This placed the hamstring muscles at their greatest possible length. The stretch was sustained at this point for the assigned duration for each group e.g. 15 seconds, 30 seconds.

STATISTICAL ANALYSIS STATISTICAL ANALYSIS WAS PERFORMED USING SPSS SOFTWARE. THE DEMOGRAPHIC DATA LIKE STANDARD DEVIATION AND MAIN PERCENTAGE WERE CALCULATED AND PRESENTED.

WITH IN THE GROUPS: Paired t-test was performed which assessed the statistical difference withinthe groups.

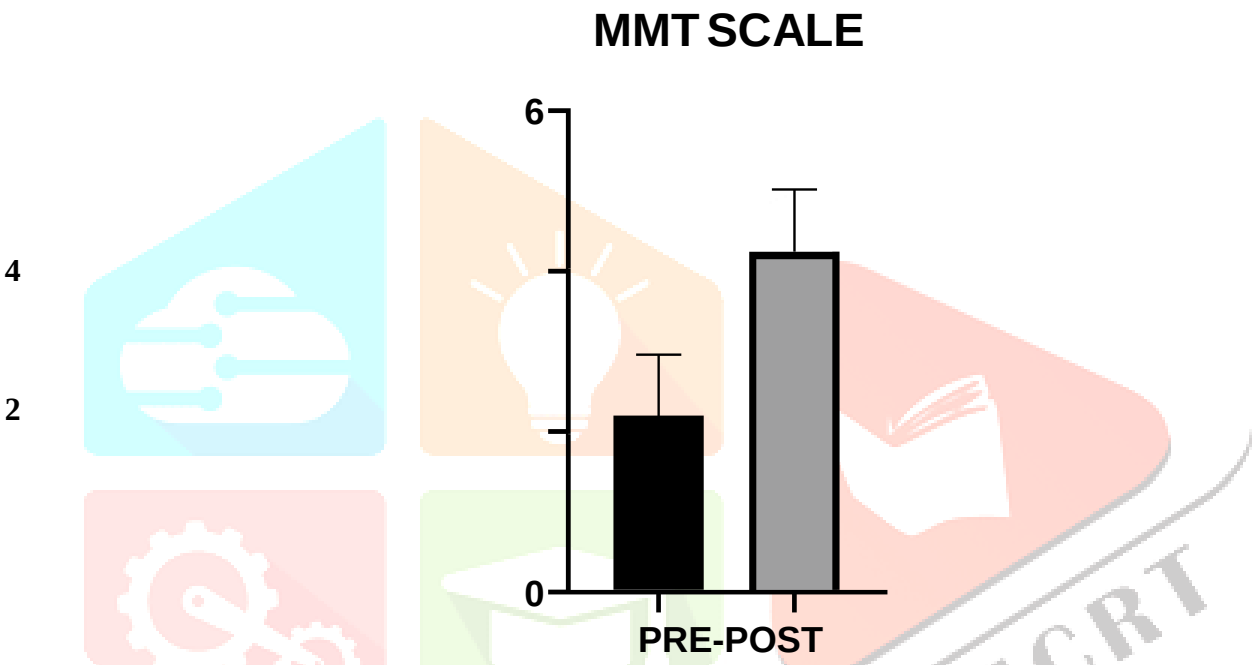
BETWEEN THE GROUPS: An Independent T-test was performed which assesses the statistical difference in mean values between the groups.

To observe the impact of treatment before and after in the groups, the analysis was carried out using statistical tests, for the outcome measures MMT scale and GONIOMETER are used. The statistical significance was set at $p < 0.0001$.

Table-1: pre and post values of manual muscle grading scale of hamstring muscle strength.

MMT	MEAN	STANDARD DEVIATION	P-VALUE	T-VALUE
PRE-TEST	2.200	0.7638	< 0.0001	9.350
POST-TEST	4.240	0.7789		

Graph-1: mean scores of pre and post values of manual muscle grading scale of hamstring muscle strength.

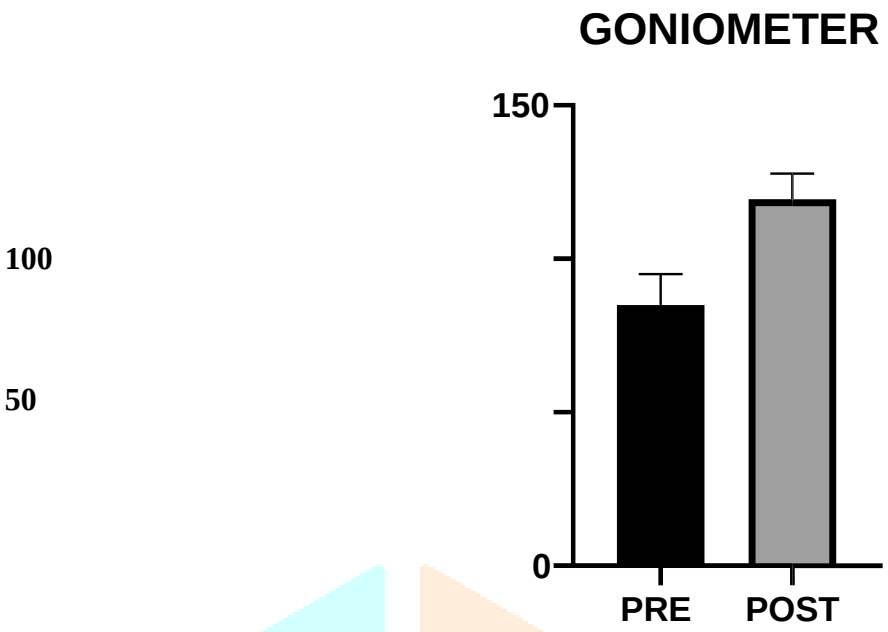


RESULT: The above table and graph show mean values changes within the SARA from pre-test and post-test were found to be statistically significant. ($p<0.0001$).

Table-2 pre and post values of goniometer of knee flexion.

GONIOMETER	MEAN	STANDARD DEVIATION	P-VALUE	T-VALUE
PRE-TEST	84.92	10.07	< 0.0001	13.19
POST-TEST	119.4	8.332		

Graph-2: mean scores of pre and post values of goniometer of knee flexion.



RESULT: The above table and graph show mean values changes within the BBS from pre-test and post-test were found to be statistically significant. ($p<0.0001$).

RESULTS:

The results in the study reveals that warm-up strengthening, flexibility shown significant improvement in hamstrings injuries whereas warmup strengthening and flexibility showed difference with p value <0.0001 in manual muscle grading scale and p value <0.001 in goniometer (in knee flexion) which is considered as extremely significant.

DISCUSSION

The purpose of this is to find that isometric exercises & hamstring stretching are effective in improving strength, flexibility, and it's possible to improve muscle strength, reduce the pain and increase the flexibility of hamstring muscle by using warm up, strengthening & flexibility of the hamstring muscles.

In this study 25 patients were taken to treat hamstring muscle injury with warm-up, strength, flexibility exercises in hamstring muscle. There is a significant improvement shown in strengthening and flexibility exercises.

In patients with hamstrings muscle injury there is aa improvement in strength of hamstring muscle in manual muscle grading scale from pre mean 2.200 to post mean 4.240 and in patients with hamstrings muscle injury there is aa improvement range of motion of hamstring muscle in goniometer from pre mean 84.92 to post mean 119.4.

Xiangqi Wan, The results of this study partially support our first hypothesis that 8 weeks of hamstring flexibility exercises significantly increase hamstring optimal musculotendinous lengths and decrease peak musculotendinous strains during sprinting for male recreational athletes. Specifically, our results showed that the optimal musculotendinous lengths of both the semimembranosus and biceps long head significantly increased following the 8 weeks of flexibility training. Furthermore, we showed that the peak musculotendinous strains of all 3 bi- articulated hamstring muscles during sprinting significantly decreased after 8 weeks of flexibility training. In the same group, sprinting speed, step length, and frequency were not significantly changed over the 8 weeks of flexibility exercises. Taken together, these results suggest that the decreases in peak musculotendinous strains of the semimembranosus and biceps long head were due mainly to the increase in optimal musculotendinous lengths of these 2 muscles.

Considering the *p* values and effect sizes, although the increase in the optimal musculotendinous length of semitendinosus after 8 weeks of flexibility training was not statistically significant, it still appears to be the most likely explanation for the decrease in the peak musculotendinous strain of this muscle during sprinting.
Our second hypothesis was that 8 weeks of strength training would increase the optimal musculotendinous lengths of the 3 bi-articulated hamstring muscles, while decreasing the peak musculotendinous strains of these muscles during sprinting. Once again, this hypothesis was partially supported by our findings. Optimal musculotendinous length for all 3 muscles significantly increased after 8 weeks of a strength training intervention, which included concentric as well as eccentric strengthening exercises, while peak musculotendinous strains for all 3 muscles significantly decreased. Interestingly, sprinting speed, step length, and frequency were not significantly changed over the 8 weeks. These results suggest that in this cohort of male recreational athletes, decreases in peak hamstring musculotendinous strains during sprinting were due mainly to the increases in the optimal length of the tissues.

Feng Liang, in this study, Effects of eccentric training on hamstring muscle strength levels for dance students, possessing good muscle strength is crucial for enhancing their performance and preventing injuries. The daily training and performances of dance students involve multidimensional and multi-form posture changes, as wellas comprehensive movement states such as walking, running, and jumping.
Techniques such as high leg lifts, jumps, and flips all necessitate substantial muscle strength. Following intervention training, the NHE&SLD group demonstrated significant improvements in both concentric and eccentric muscle strength levels in the dominant leg, with a particular increase in eccentric muscle strength. There were no significant modifications in the levels of concentric and eccentric muscle strength in the FBE&SLL and CG groups. This is likely because inthe NHE&SLD group's eccentric training, the muscles underwent resistance stretching whilst sustaining substantial contractile tension to counteract the body’s weight, thereby enhancing muscle strength. Early studies on animal muscles32 have indicated that eccentric training provides an essential mechanical stimulus for amplifying the number of rat muscle fibers after downhill running. This increase in the number of serially connected muscle fibersencourages faster contraction speed and increased muscle strength during muscle contraction. Chronic eccentric training appears to be associated with modifications in the length-tension curve of muscles39·40. Research involving humans has shown that eccentric training significantly stimulates the longitudinal growth of muscle fibers. For instance, a 14% increase in the length of quadriceps
muscle fibers were observed after 10 weeks of isokinetic eccentric training at the knee joint. The FBE&SLL group's stretching training, consisting of simple static stretching without resistance, elongated the muscles and enhanced flexibility, but it did not augment muscle strength. The CG group only completed the basic training content of the course, and because there was no special strength training, there was no significant change in the strength performance area.

CONCLUSION

This present study concludes 8 weeks of influence of warm-up, strength, flexibility in hamstring muscle injuries showed significant improvement in muscle function and strength in subjects with hamstring injuries.

SUMMARY

The purpose of the study is to find out the influence of warm-up, strength, flexibility in hamstring muscle injuries. A total number of 25 subjects of hamstring muscle injuries. Subjects were assigned to one group. 25 subjects were selected in one group. This group was treated with seven types of strengthening exercises. The treatment duration time was about 10 minutes for each exercise. The warmup duration is about 10 minutes. Total treatment of stretching is about 10 minutes. The total treatment was done in 60 sessions (Daily in a week for 8 weeks). Total 25 subjects have improvement in joint range of motion, improvement in muscle strength and which was assessed by joint range of motion (Goniometer) andto measure the hamstring muscle strength we used the manual muscle grading scale.

LIMITATIONS AND RECOMMENDATIONS

1. A small sample size was taken.

2. It was run over a short time frame.

3. Only two outcome measures were used in this study.

4. Risk of re-injury.

5. Pain and discomfort due to unable do ADL activities properly.

6. Participants were not followed up for a longer period.

RECOMMENDATIONS

1. A large sample size can be selected.

2. Study duration should be more with more sessions.

3. Compression and elevation should be advised.

4. Long term outcome should be known by further studies.

5. Supportive kinesiology taping or bracing.

6. Moist heat therapy.

REFERENCES:

- Agre I: Hamstring injuries. Sports Med 2:2 1-33, 1985
- Arnheim D: Modern Principles of Ath- letic Training, p 583. St. Louis: Times MirrorlMosby College Pub., 1985
- Bohannon R: Cinematographic analy- sis of the straight-leg-raising test for hamstring muscle length. Phys Ther 62(9): 1269- 1274, 1982
- Bohannon RW, Cajdosik R, LeVeau BF: Contribution of pelvic and lower limb motion to increase in the angle passive straight leg raising. Phys Ther 65(4):4 74-4 76, 1985
- Brubaker C, lames S: Injuries to run- ners. I Sports Med 2: 189- 198, 1974
- Burkett L: Causative factors of ham- string strains. Med Sci Sports 2(1):39-42, 1970
- Christensen C, Wiseman D: Strength: The common variable in hamstringstrain. Athl Train 7(2):36-40, 1972
- Coole W, Gieck I: An analysis of ham- string strains and their rehabilitation.I Orthop Sports Phys Ther 9(2):77-85, 1987
- Dorman P: A report on 140 hamstring injuries. Aust 1 Sports Med 4:30-36,1971
- Duncan P: Muscle Rehabilitation. In: Malone T (ed), Muscle Injury and Re- habilitation, p. 63. Baltimore: Williams & Wilkins, 1988
- Ekstrand I, Cillquist I: The frequency of muscle tightness and injuries in soccer players. &n I Sports ~ e d 10(2):75-78, 1982
- Ekstrandl, Cillquist I, Moller M, Oberg B, Liljedahl SO: Incidence of soccer injuries and their relation to training and team success. Am I Sports Med 1 1
(2):63-69, 1983
- Ekstrand 1, Wiktorsson M, Oberg B, Cillquist I: Lower extremity goniomet- ric measurements: A study to deter- mine their reliability. Arch Phys Med Rehabil63: 17 1 - 175, 1982

- Cajdosik RL, LeVeau BF, Bohannon RW: Effects of ankle dorsiflexion on active and passive unilateral straight leg raising. Phys Ther 65(lO): 1478- 1482, 1985
- Cajdosik RL, Lusin C: Hamstring mus- cle tightness: Reliability of an active-knee- extension test. Phys Ther 63(7): 1085- 1090, 1983
- Carrett WE, Califf IC, Bassctt FH: His- tochemical correlates of hamstring in-juries. Am I Sports Med 12:98-103, 1984
- Carrett WE, Rich FR, Nikolaous PK, Volger IS: Computed tomography of hamstring strains. Med Sci Sports Exerc 2 1 (5):506-5 14, 1989
- Carrett WE, Safran MR, Seaber AV, Clisson PR, Ribbeck BM: Biomechan- ical comparison of stimulated and nonstimulated skeletal muscle pulled to failure. Am I Sports Med 15(5):448- 454, 1987
- Cross C: Gray's Anatomy of the Hu- man Body (29th Ed), pp 502-503. Phil- adelphia: Lea and Febiger, 1981
- Heiser T, Weber I, Sullivan C, Clare P, lacobs R: Prophylaxis and manage- ment of hamstring muscle injuries in intercollegiate football players. Am I Sports Med l2:368-370, 1984
- lnman V, Ralston H, Todd F: Human Walking, pp 1-2 1. Baltimore: Williams & Wilkins, 1981
- Konnberg C, Lew P: The effect of stretching neural structures on grade one hamstring injuries. 1 Orthop Sports Phys Ther 1 O(1 2):48 1-487, 1989
- Lieber RL, Friden I: Selective damage of fast glycolytic muscle fibers with eccentric contraction of the rabbit ti- bialis anterior. Acta Physiol Scand 133:587- 588, 1988
- Liemohn W: Factors related to ham- string strains. / Sports Med 18:71-76, 1978
- Lysholm, 1, Wiklander 1: Injuries in run- ners. Am 1 Sports Med 15:168-171, 1987
- Mann RA: Biomechanics in running. In: Mack R (ed), American Academy of Orthopaedic Surgeon's Symposium on the Foot and Leg in Running Sports, pp 1- 19. St. Louis: C.V. Mosby, 1982
- Mann RA, Sprague P: A kinetic analysis of the ground leg during sprinting. Res Q Exerc Sport 5 1 :334-348, 1980
- McMaster W, Walter M: Injuries in soc- Journal of Orthopaedic & Sports Physical Therapy® Downloaded from www.jospt.org at on July 20, 2024. For personal use only. No other uses without permission. Copyright © 1992 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved. cer.Am I Sports Med 6(1):293- 299, I986
- Nikolaous PK, MacDonald BL, Glisson PR, Seaber AV, Carrett WE: Biome- chanical and histological evaluation of muscle after controlled strain injury. Am 1 Sports Med l5(1):9- 14, 1987
- Paton RW, Crimshaw P, McCregor 1, Noble I: Assessment of the effects of significant hamstring injury: An isoki- netic study. I Biomed Eng 1 1:229- 230, 1989
- Puranen I, Orva S: The hamstring syn- drome: A new diagnosis of gluteal sciatic pain. Am I Sports Med 16(5):5 17-52 1, 1988
- Roy 5, lrvin R: Sports Medicine, pp 303-304. Englewood Cliffs, Nl: Pren- tice- Hall, 1983
- Safran M, Carrett W, Seaber A, Clisson R, Ribbeck B: The role of warmup in muscular injury prevention. Am I Sports Med 16: 123- 128, 1988
- Stanton P, Purdam C: Hamstring inju- ries in sprinting-The role of eccentric exercise. 1 Orthop Sports Phys Ther 10(9):343-349, 1989
- Stauber WT: Eccentric action of mus- cles: Physiology, injury, and adapta- tion. In: Pandolf KB (ed), Exercise and Sport Sciences Reviews, pp 165- 1 72.Baltimore: Williams & Wilkins, 1989
- Sutton C: Hamstrung by hamstring strains: A review of the literature. I Orthop Sports Phys Ther 5(4):184- 195, 1984

- Wood C, Marshall R, Strauss C: Elec- tro-musculomechanicaI action of the lower limb in sprinting- Insights into hamstring injury potential. Presented at the fourth meeting of the European Society of Biomechanics, Davos, Swit- zerland, September, 1984
- Worrell TW, Denegar CR, Armstrong S, Perrin DH: Effect of body position on hamstring muscle group average torque. I Orthop Sports Phys Ther 1 1(10):448- 452, 1989
- Worrell TW, Perrin DH, Cansneder B, Cieck I: Comparison of isokinetic strength and flexibility measures be- tween hamstring injured and nonin- jured athletes. I
Orthop Sports Phys Ther 13(3): 1 18- 125, 199 1