

To Compare the Effects of the Hold-Relax Technique and Foam Roller Exercise On Hamstring Muscle Tightness, Dynamic Balance and Jump Performance Among Students of Health Sciences in Jalandhar City

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Abstract: Background: Flexibility is a vital component of fitness required for desirable musculoskeletal functioning. Flexibility dysfunction is a widespread problem, especially in case of hamstring group of muscles. Tightness of hamstring may result in imbalances of muscle strength, dysfunction of anatomical kinetic chains and reduction in optimal performance. As reduced flexibility generates a vicious circle of ROM, impaired performance and pain there is a need to find an effective technique. Objective: To compare the effects of the hold-relax technique and foam roller exercise on hamstring muscle tightness, dynamic balance and jump performance among students of health sciences in Jalandhar city. Study design: Comparative design, Quasi-Experimental in nature. Method: 60 students, both male and female with age between 18-27 years, were selected for study and subsequently segregated into three groups with 20 subjects per group. Group A was given warm up. Group B was given hold-relax PNF Technique in addition to warm up and Group C received foam roller exercise in addition to warm up. Baseline data was recorded on 1st day pre-intervention, 5th day and 10th day post-intervention. 10 sessions per subject were given over 2 weeks. Hamstring muscle tightness, dynamic balance and jump performance was evaluated by Active knee extension test, Y balance test and vertical jump test respectively. Results: The result showed significant improvement in hamstring muscle tightness, dynamic balance and jump performance using Foam roller exercise. Conclusion: The present study concludes that foam roller exercise is most effective in improving hamstring muscle tightness, dynamic balance and jump performance.

Keywords: Flexibility, Hamstring Muscle Tightness, Hold-Relax PNF Technique, Foam Roller Exercise.

1. INTRODUCTION

Kisner C and Colby LA have defined flexibility as “the capability of muscle to move a single joint or series of joints smoothly and easily through an unrestricted, pain free range of motion”¹. Flexibility is a vital element of fitness required for most desirable musculoskeletal functioning and maximizing performance of physical activities. Flexibility dysfunction is a wide problem faced by common as well as sportspersons, especially in case of hamstring muscle.²

Hamstring tightness is a very common problem in students, especially those having prolonged sitting hours.^{2,5,6,7,8} Literature shows that hamstring muscle tightness affects 82% and 68%.^{2,6} The hamstring muscle tightness is present in early childhood and tends to increase with age.^{3,9} Another study also found significant increase in hamstring muscle tightness among students with less Physical Activity and more Sitting hours between age group of 18-30 years.⁵

The hamstrings muscle consists of three muscles occupying posterior compartment of thigh: semitendinosus, semimembranosus, and biceps femoris.¹⁰ Together, they form bulk of posterior of thigh.⁷ The semimembranosus and semitendinosus muscles are on medial side of posterior thigh whereas biceps femoris is on lateral side of posterior thigh. The hamstring is a biarticular muscle group, which means that it crosses hip and knee joint making it more susceptible to injury.¹¹

Hamstring muscle tightness is indicated when there is more than 30 degrees loss of knee extension as measured with femur held at 90 degrees of flexion.¹⁴ It is caused by long sitting hours at work places, lack of physical activity, hereditary predisposition and past injury to hamstring. Modern sedentary lifestyle is one of main reasons for postural abnormality. The tightness of hamstring muscles not only affects length-tension relationship of muscle but also shock absorbing capability of limb. Reduced flexibility generates a vicious circle of range reduction and results in movement dysfunction at lumbar spine, pelvis and lower limbs.^{6,17} Moreover, reduced flexibility contributes to neuro-musculoskeletal symptoms and also diminishes strength, stability, and endurance.⁶

In context to management of hamstring muscle tightness, various stretching techniques including static stretching, dynamic stretching, ballistic stretching and proprioceptive neuromuscular facilitation (PNF) have been advocated and employed to improve muscle flexibility.^{7,18} Amongst them, PNF and static stretching are two of most popular stretches used in clinical practice to improve hamstring muscle flexibility.^{4,18,19,20,21,22}

PNF are techniques commonly used in rehabilitation environments to enhance both active and passive range of motion with ultimate goal being to optimize motor performance and rehabilitation.²⁶ PNF techniques may also be helpful in building endurance and strength of muscles, increasing stability and mobility, improving neuromuscular control and coordination and establishing a foundation for restoration of function.²⁴ It is a method of flexibility training that can reduce hypertonicity, allowing muscles to relax and lengthen.²⁶

Recently, usage of foam rollers for fascia relaxation has increased in fields of exercise rehabilitation and fitness conditioning with goals of preparing for exercise and recovery of muscular functioning.^{7,16} Foam rolling is a self-myofascial release technique that works upon muscles as well as fascia of body.^{7,29} It is a multipurpose tool that can also be used to improve stability, balance, proprioception, soft-tissue mobility, body awareness, functional mobility and range of motion.³⁰ It also relaxes muscles by releasing tension and thus can influence flexibility and performance too among persons with hamstring muscle tightness.⁷

2. PURPOSE

Numerous studies and researches have been independently conducted on effectiveness of PNF and foam roller on hamstring muscle tightness but there are limited studies that have compared effects of Hold-Relax Proprioceptive neuromuscular facilitation technique and foam roller exercise on hamstring muscle tightness.

On the basis of the findings of this, the researcher would be able to recommend either PNF or foam roller as an adjunct to warm up exercises for enhancing flexibility of hamstrings.

The present study aimed to compare the effects of hold-relax technique and foam roller exercise on hamstring muscle tightness, dynamic balance and jump performance among students of health sciences in Jalandhar City.

3. MATERIALS AND METHODS

3.1. Participants

60 students with age between 18-27 years, were recruited from DAV Institute of Physiotherapy and Rehabilitation, Jalandhar and Dayanand Ayurvedic College, Jalandhar for study. Inclusion criteria were (i) Subjects willing to give written informed consent, (ii) Both males and females, (iii) Age group 18 – 27 years, (iv) The subjects with hamstring muscle tightness as evaluated by Active Knee Extension test. (Greater than 30 degrees loss of knee extension). Exclusion criteria were (i) History of any recent fracture of lower limb, (ii) History

of recent surgery around low back, hip and knee joint, (iii) Present history of acute or chronic low back pain, (iv) History of any recent soft tissue injury in lower limb, (v) History of Neurological disorder affecting lower extremity

3.2. Study Design

A study Quasi-Experimental in nature with comparative design was carried out for one and half year, at the DAV Institute of Physiotherapy and Rehabilitation, Jalandhar. The sample was Conveniently divided into 3 groups: Group A was given warm up in the form of a brisk jogging of 5 minutes. Group B was given hold-relax PNF Technique in addition to warm up and Group C received foam roller exercise in addition to warm up. The baseline data was recorded on 1st day pre-intervention, 5th day and 10th day post-intervention. Total of 10 sessions per subject were given over 2 weeks i.e., 5 sessions per week.

3.3. Interventions

Ethical approval was obtained from DAV Institutional Ethical Committee (no. MPT-2021-2023)

A total of 75 subjects were approached during study. Only 60 subjects, between age group of 18-27 years, who satisfied inclusion and exclusion criteria were recruited for study. After explaining need and procedure of study, written informed consent was obtained from subjects. The dominant lower extremity was considered for assessment and intervention.

Warm up: The subjects were asked to perform 5 minutes of brisk jogging over a treadmill at 6-8 km/h speed.²³

Hold-relax PNF technique: The subjects were comfortably positioned in supine lying. The lower leg to be tested was rested on therapist's shoulder. The therapist stretched hamstring muscle by passively flexing hip with knee fully extended, allowing no hip rotation. The hamstring muscle was stretched until subjects first reported a mild stretch sensation. The subjects then isometrically contracted hamstring muscle for 5 seconds. Following, subjects were asked to relax and leg was passively stretched into new range for 10 seconds. This sequence was repeated 5 times with a rest period of 10 seconds.^{24,25}

Foam roller exercise: The subjects were positioned in long sitting, keeping their ankle relaxed and back straight. The subjects were instructed to support their trunk with their arms extended on supporting surface. The foam roller was placed over back of thigh and sliding back and forth over entire length of thigh. The protocol included three sets, each set of 1 min with 30 seconds rest between each set.¹⁵

3.4. Main Outcome Measures

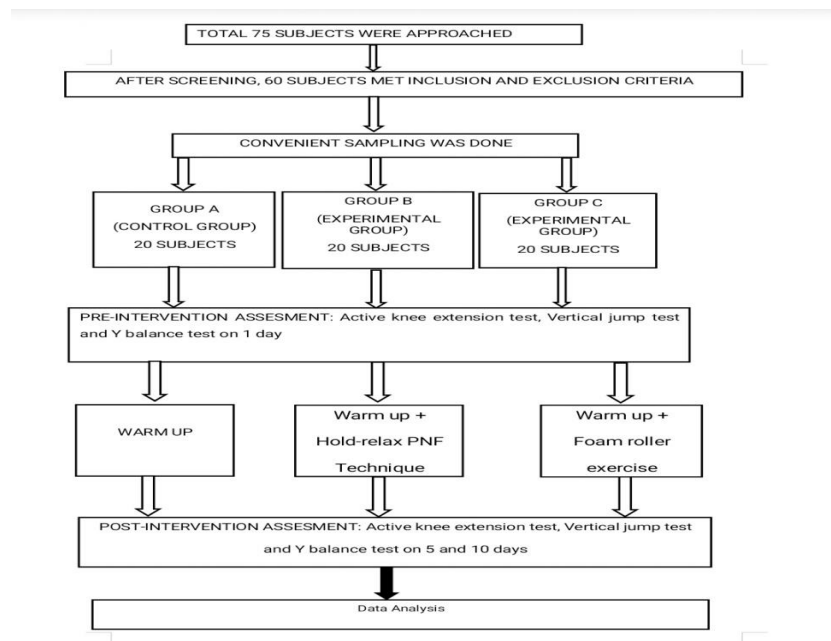
Active knee extension test: The subjects were asked to lie in supine position. The tested limb was flexed until thigh touched wooden frame, bringing hip into 90° flexion.³³ While maintaining contact between thigh and wooden frame, subjects were asked to extend their leg until they felt a strong stretch in back of thigh while keeping their foot relaxed. They were asked to hold position for about 5 seconds.⁶ While Standard universal goniometer was placed over lateral femoral epicondyle. With fixed goniometer arm is aligned along thigh in direction of greater trochanter and movable goniometer arm is aligned over leg in direction of lateral malleolus. The goniometric readings were recorded.³³ The average of three readings were calculated with one-minute rest period between two consecutive repetitions.¹²

Y Balance test: Three lines forming a Y shape were marked on floor, two with a 90° angle between them and one positioned at a 135° angle in relation to other two lines. The subjects were instructed to stand at junction of three lines on dominant leg with great toe pointing centre. The subjects reached with contralateral leg as far as possible in anterior, posteromedial and posterolateral directions.³⁴ The subjects performed three trials in each direction with 15 sec rest period between two consecutive trials.^{13,31} Following each trial, subjects returned to starting position under control. The maximum reach distance in each direction was recorded for data analysis.³¹ The subject's leg length was measured from anterosuperior iliac spine to centre of ipsilateral medial malleolus of tibia in supine lying position

with legs 15-20 cm apart.^{13,35} The test score was calculated by dividing sum of maximum reach distances in anterior, posteromedial and posterolateral directions by three times leg length and multiplying by 100.³⁴

$$Y \text{ Balance score} = \left(\frac{\text{Anterior} + \text{Posteromedial} + \text{Posterolateral}}{3 \times \text{leg length}} \right) \times 100$$

Vertical jump test: The subjects were positioned to stand straight with their dominant side aligned with wooden board and both feet planted firmly on floor. Initially, subject's fingertip of extended hand is marked with chalk powder and recorded as a standing height.³⁶ Now, subjects were asked to bend and jump forcefully to reach highest point. This highest point is again marked by asking subjects to extend their hands against wooden board and point is recorded.¹⁶ The jump height was difference between two points marked on wooden board. The procedure was repeated three times with a minimum interval of 45 seconds between jumps and only highest jump was considered³⁶



Flow chart depicting total subjects in groups A, B & C, and description of interventions given in each group and data collection on different days for analysis

3.5. Data Analysis

Data analysis was carried out after collecting data of three outcome measures of A, B and C groups. Readings of data were taken on Active knee Extension test, Y balance test and Vertical jump test on day 1, day 5 and day 10. Data Analysis was done by using SPSS software version 18. Repeated measure ANOVA was done for intra group analysis. One way ANOVA and Post Hoc analysis by Tukey's was done for inter group analysis. Inter group analysis for AKE test, VJT and YBT on 1st, 5th and 10th day was done using Post Hoc analysis by Tukey's. The level of significance selected for study was $p < 0.05$.

4. RESULTS

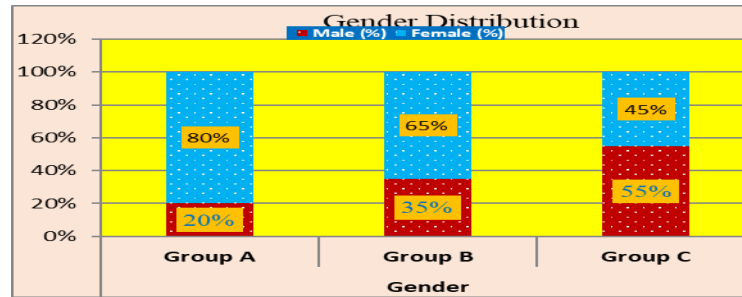


Figure 5.1: Analysis for gender variability

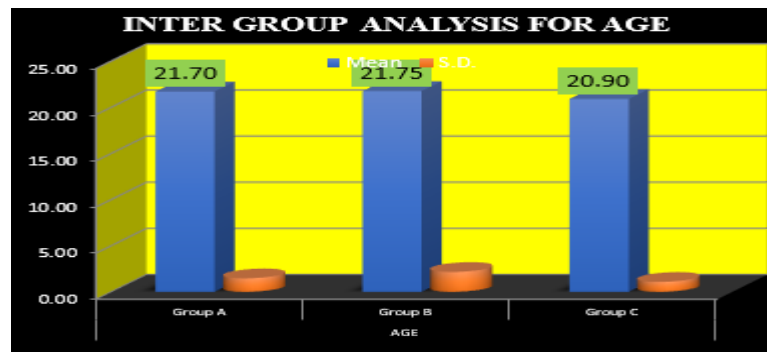


Figure 5.2: Analysis for age distribution

Intra Group Analysis



Figure 5.3: Analysis for change in AKE

Readings of Group A

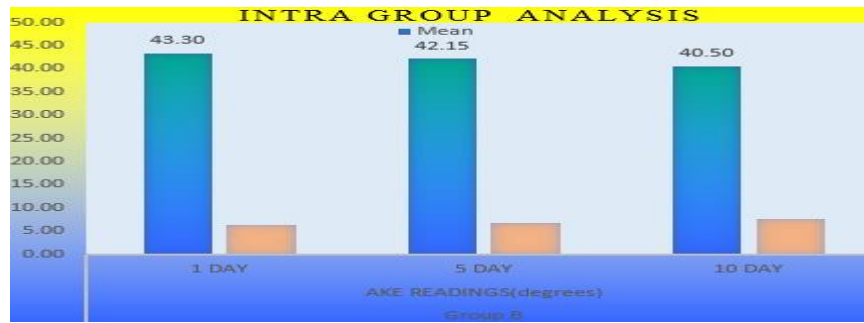


Figure 5.4: Analysis for change in AKE Readings of Group B

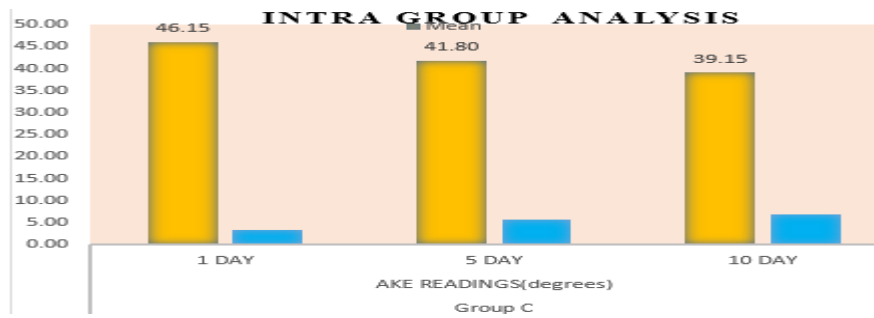


Figure 5.5: Analysis for change in AKE Readings of Group C.

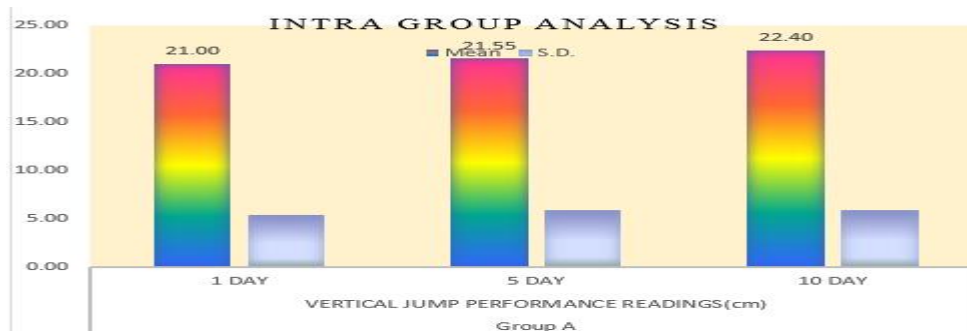


Figure 5.6: Analysis for change in VJT Readings of Group A

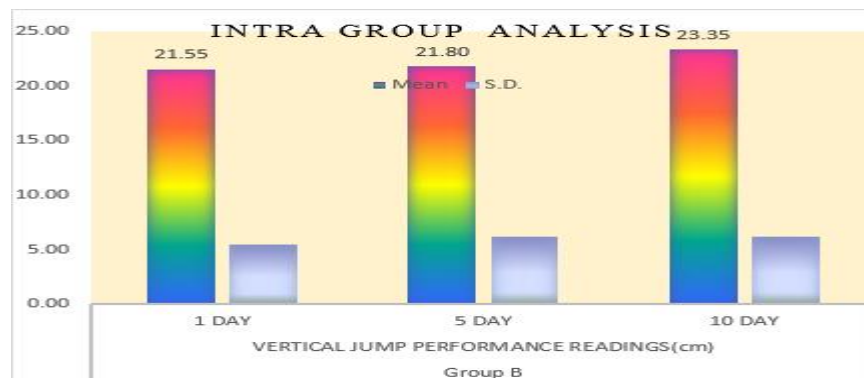


Figure 5.7: Analysis for change in VJT Readings of Group B

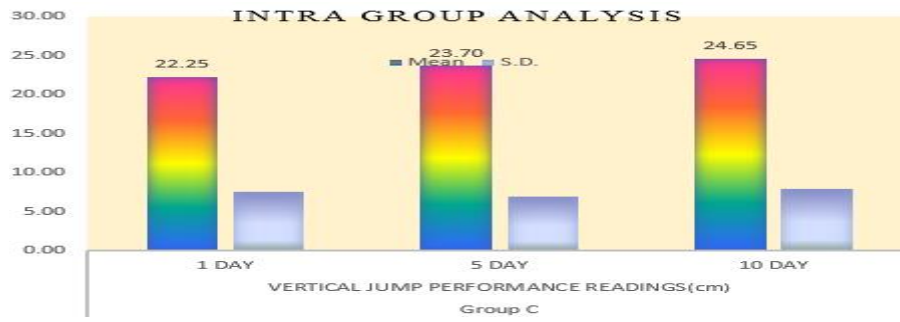


Figure 5.8: Analysis for change in VJT Readings of Group C

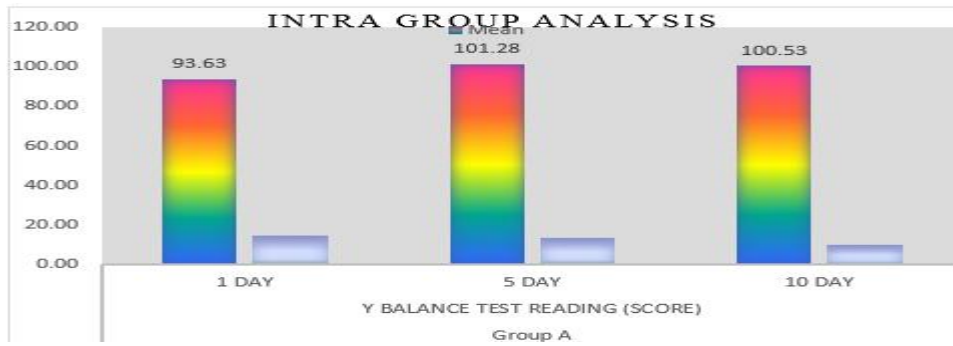


Figure 5.9: Analysis for change in YBT Score of Group A

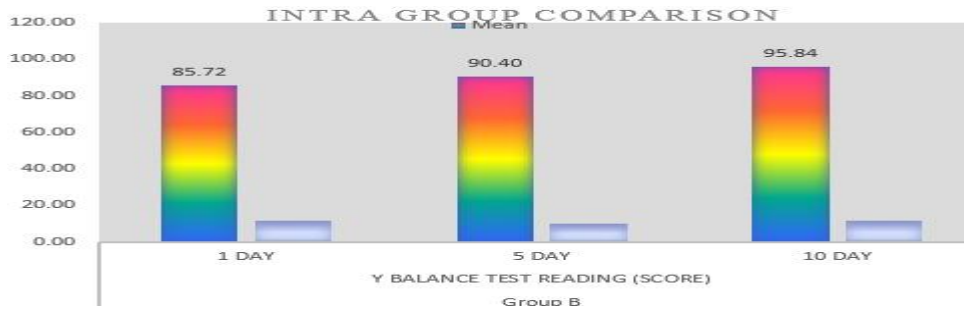


Figure 5.10: Analysis for change in YBT Score of Group B

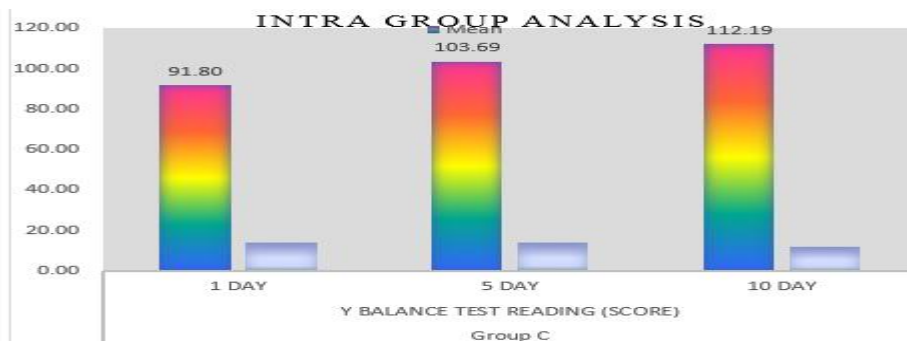


Figure 5.11: Analysis for change in YBT Score of Group C

Inter Group Analysis

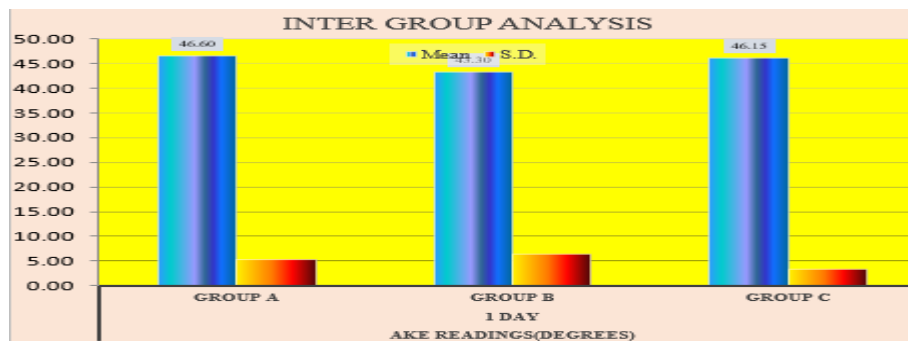


Figure 5.12: Analysis for change in AKE readings on 1st day

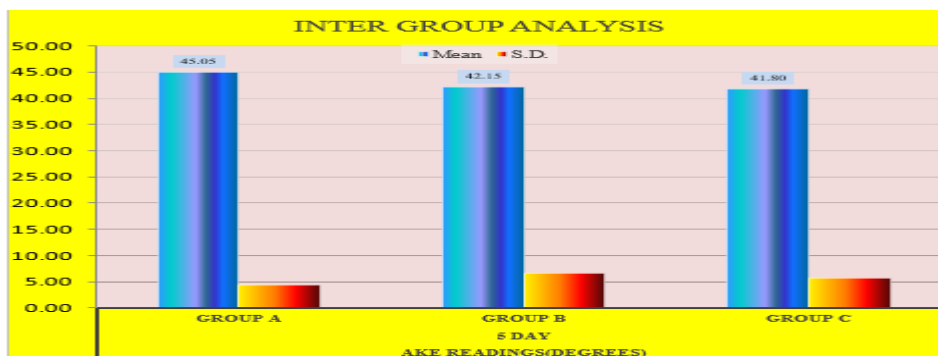


Figure 5.13: Analysis for change in AKE readings on 5th day

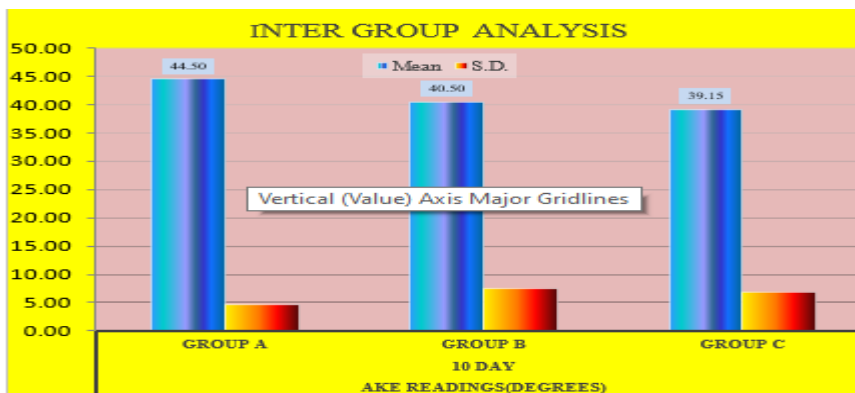


Figure 5.14: Analysis for change in AKE readings on 10th day

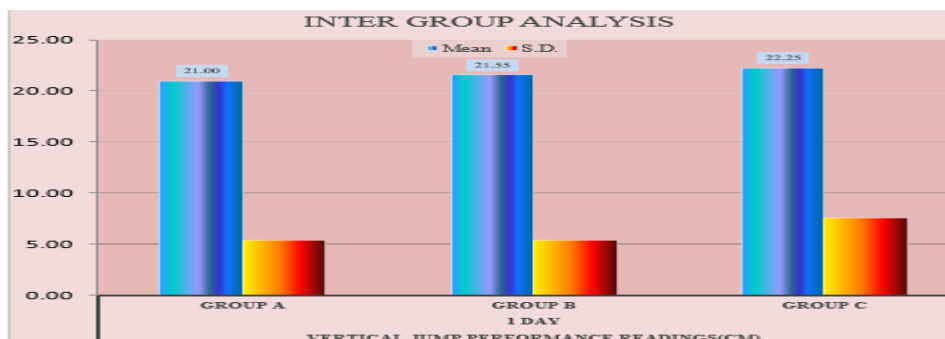


Figure 5.15: Analysis for change in VJT on 1st day

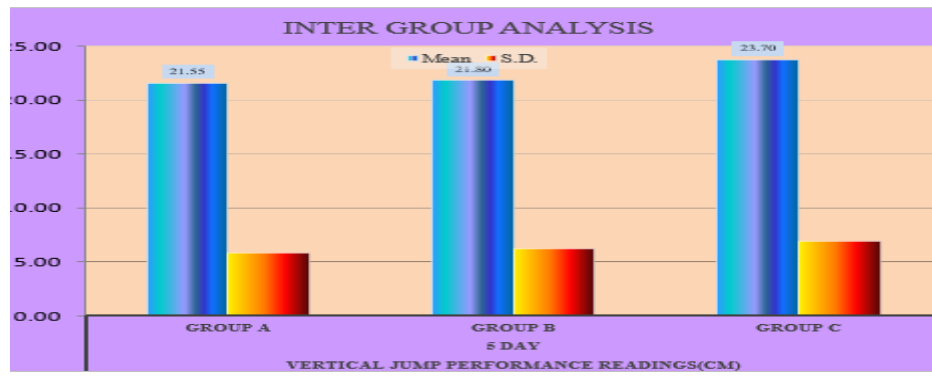


Figure 5.16: Analysis for change in VJT on 5th day

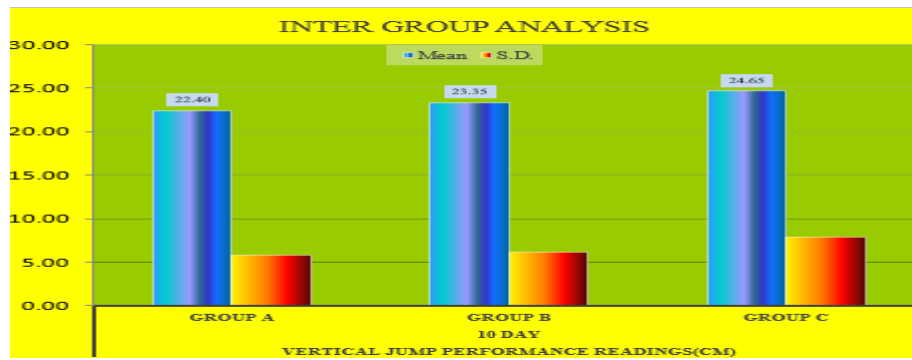


Figure 5.17: Analysis for change in VJT on 10th day

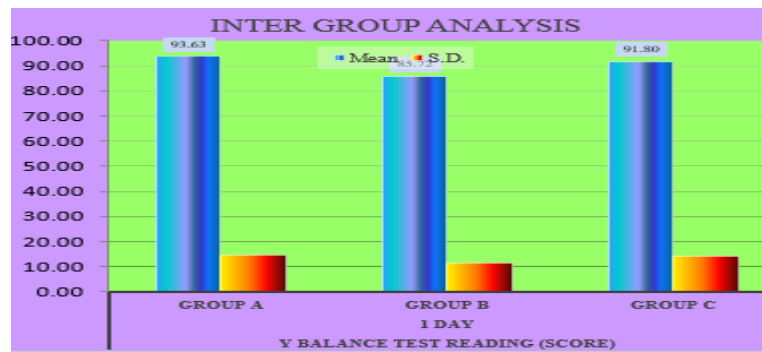


Figure 5.18: Analysis for change in YBT on 1st day

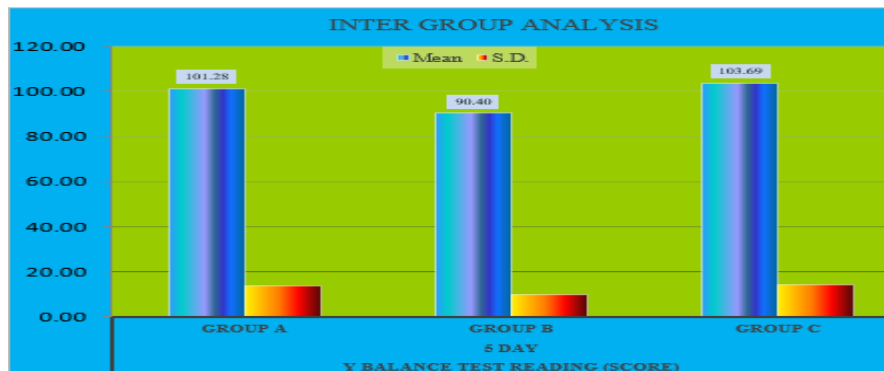


Figure 5.19: Analysis for change in YBT on 5th day

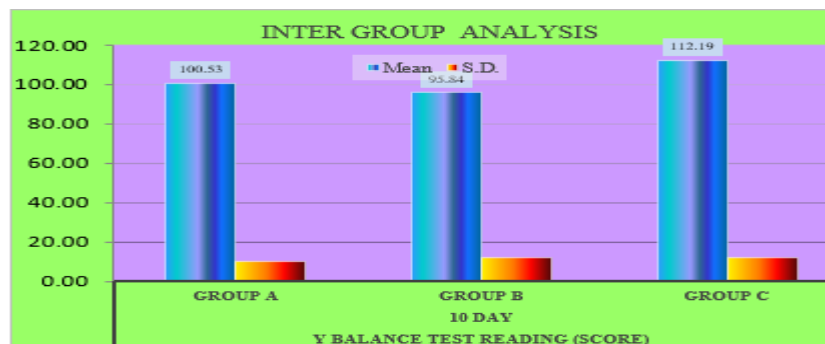


Figure 5.20: Analysis for change in YBT on 10th day

DISCUSSION

In the present study, foam roller exercise in group C was found to be effective in improving hamstring muscle flexibility, dynamic balance and vertical jump performance.

In recent years, foam rollers have gained popularity as a technique for increasing tissue length, improving tissue flexibility, and breaking fibrous adhesions in fascia.^{29,37} The physiology behind increase of active knee extension test by use of foam roller exercise is its effect on Golgi tendon organ. These are proprioceptive sensory receptor organ located at site where skeletal muscle fiber inserts into skeletal muscular tendon. The pressure exerted by a foam roller stimulates Golgi tendon organ which detect any change in muscle tension and responds by relaxing muscle spindles.³⁸ As a result, this increases flexibility of muscle fibers and improve range of motion. Moreover, foam rolling technique mechanically generates friction between foam roller and superficial and deep layers of soft tissue, stimulating mast cells and causing histamine production. Vasodilation increases blood flow to treated area and allows for a quicker and more complete diffusion of waste products from tissue to blood. It is also likely to increase intramuscular tissue temperature and blood flow, which may increase viscoelastic properties of muscle.¹⁵ Therefore, an increase in temperature of muscle, decrease in viscosity of muscle tissue, improved endothelial vascular function, reduction in arterial stiffness, and increase in blood flow may contribute to improvement in muscle flexibility.^{27,32}

A study by Zhang Q, Trama R, Fouré A and Hautier AC in 2020 identified immediate effects of Self-Myofascial Release (SMR) on Flexibility, Jump Performance and Dynamic Balance Ability between ages of 21 and 26 and concluded that there was a significant increase in flexibility and balance performance was observed following intervention. On the contrary, jumping performance was unchanged in both groups.²⁷ Another study on Immediate Effect of Dynamic Stretching and Foam Rolling on Hamstring Flexibility and Vertical Jump in College Students by Yogeshwar P and Bashir BI in 2021 concluded that foam rolling exercise and dynamic stretching increase hamstring muscle flexibility and improve vertical jump performance.⁷ A Similar study by Junker DH and Sto" ggl TL in 2015 identified role of foam roller exercise to improve hamstring muscle flexibility and concluded that foam roller improves hamstring muscle flexibility.³⁶

We also found better effects of foam roller exercise on balance. It is postulated that shortness of hamstring muscle can lead to postural disorders that can affect balance. Foam roller exercise improves hamstring flexibility, thus making it an excellent technique for improving balance by boosting muscle contraction patterns and muscle synergy adaptations. Therefore, foam roller exercise not only increases hamstring flexibility but also improves dynamic balance.³⁹ Our findings bear resemblance to observation of Zhang Q, Trama R, & Fouré and Hautier AC on immediate effects of Self-Myofascial Release (SMR) on Flexibility, Jump Performance and Dynamic Balance Ability in 2020 between ages of 21 and 26 and concluded that a significant increase in flexibility and balance performance was observed whereas jumping performance was not marked.²⁷ A similar study by Shalamzari MH, Minoonejad H, Seidi F on effect of 8-week Self-Myofascial Release (SMR) Therapy on Joint Position Sense and Dynamic Balance in Athletes with Hamstring Shortness in 2020 concluded that SMR foam rolling is not suitable for

increasing knee joint position sense accuracy of athletes with a short hamstring, but these exercises can be used to improve dynamic balance.³⁹

Although studies have used Foam Roller exercise to examine their effect on jumping performance, but limited research work has been done which explains mechanism of positive influence of a Foam Roller over vertical jump test. The literature available show that explosive power remains unchanged after foam roller exercise.^{16,27} However, the present study results explained phenomenon that effects may not only be due to stimulation of deep mechanoreceptors but also mechanical and structural changes in fascia affects jump height.⁴⁰ Our findings find support in study of Yogeshwar P and Bashir BI in 2021 on Immediate Effect of Dynamic Stretching and Foam Rolling on Hamstring Flexibility and Vertical Jump in College Students concluded that foam rolling exercise and dynamic stretching increase hamstring muscle flexibility and improve vertical jump performance.⁷ Another similar study by Pişirici P, Ekiz BM and Kulak Cİ in 2020 investigated acute effect of myofascial release techniques and dynamic stretch on vertical jump performance in recreationally active individuals between age 18 and 35 years and concluded that foam roller over hamstring, gastrosoleus and plantar fascia improve jump performance.²⁸

Thus, based on the above evidences in the present study, foam roller exercise was found to be effective on improving hamstring muscle flexibility, dynamic balance and vertical jump performance.

CONCLUSION

Therefore, the result of the study concludes that the application of foam roller exercise showed better results than Hold- Relax technique on hamstring muscle tightness, dynamic balance and jump performance among students of health sciences in Jalandhar city.

LIMITATION

The sample size for the study was small. There have been no long-term follow-ups on subjects. Environmental & work-related factors that may have predisposed to hamstring tightness were not controlled. The study was defined to limited population.

FUNDING

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CONFLICT OF INTEREST

The authors declare no conflict of interest to report

ETHICS APPROVAL STATEMENT

Obtained from DAV Institutional Ethical Committee (no. MPT-2021-2023)

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All authors Dr. Palak Mahajan (P.M.), Dr. Vijyashree Singh (V.S.), Dr. Jitendra Sharma (J.S.) participated in framing of this review study. P.M. and V.S. participated in methodology and analysis. P.M., V.S. and J.S. Contributed to conceptualization and writing. P.M. took main contribution in manuscript writing. All authors (P.M., V.S. and J.S.) took part in manuscript revision and approval final version of the manuscript

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