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Effectiveness of eccentric training Vs PNF stretching on hamstring flexibility among runners

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Abstract

Background: Muscle tightness or lack of flexibility is usually proposed as an inherent risk factor for the occurrence of hamstring injury. Good muscle flexibility will allow muscle tissue to accommodate imposed stress more efficiently and allow efficient and effective movement. So, this study identifies the best effective training method for improving hamstring flexibility. This study aims to investigate and compare the effectiveness of eccentric training and Proprioceptive Neuromuscular Facilitation stretching on hamstring flexibility.

Methodology: An experimental study of the pre-post design was implemented. The study was conducted on 60 athletes (males=27, females= 33) of 100,200- & 400-meter runners of age group 18-26 years presenting with Bilateral hamstring tightness. The selected Runners were randomly allocated into two equal groups (n=30). Interventions for two groups (PNF-CRAC stretching & eccentric training) were provided for a total duration of 3 weeks (5 sessions per week). Active Knee Extension Test, Passive Straight Leg Raise Test, and Sit and Reach Test were the pre- and post-intervention outcome measures.

Results: The results were analyzed using independent and paired t-test. The findings suggested that both groups A & B (PNF stretching and eccentric training) showed significant improvement in hamstring flexibility ($p < 0.001$). However, Group-A showed greater improvement when compared with Group-B.

Conclusion: The study concludes that both PNF-CRAC and Eccentric training are effective for improving hamstring flexibility. However, PNF stretching resulted in greater improvement when compared.

Keywords: Eccentric training, hamstring flexibility, PNF stretching, runners

Introduction

Hamstring injuries are the most common injuries in sports accounting for up to 50% of all muscle injuries and about one-third (29%) of all sports injuries (Rudisill *et al.*, 2022) [16] and are prevalent in activities encompassing running, sprinting, kicking, or jumping (Msp and Garud., 2019) [11]. Running places, a high strain on musculoskeletal systems, particularly the hamstring muscle; which is much more active than any other lower limb muscle while running. Tightening of these muscles can affect the position of the proximal and distal joints, making hamstring injuries one of the most prevalent non-contact muscle injuries in sports. Hamstring tightness can impact running kinematics, function, and injury risk (Fereydounnia *et al*., 2022) [8]. Hamstring tightness is defined as the inability to extend the knee to less than 20 degrees of knee flexion while holding the femur at 90 degrees of hip flexion while lying supine (Dasappan *et al*., 2021) [5]. Hamstring muscles typically sustain injuries when required to contract eccentrically at high velocities, such as during the terminal swing phase of running. Peak Hamstring muscle lengthening is the phase that is followed by a quick and forceful strong contraction. This is where the hamstring muscle is more susceptible to get injured especially at high running intensities like sprinting because it is frequently subjected to excessive strain that it cannot withstand (Schache *et al*., 2013) [17].

Lack of flexibility has been suggested as an inherent risk factor for hamstring strains (DePino *et al*., 2000) [6]. Flexibility is described as a muscle's ability to lengthen and permit one joint or several joints to move across a range of motion. Thus, by lengthening the musculotendinous unit, the likelihood of musculotendinous strain across the typical range of motion will be decreased (Singh *et al*., 2017) [18]. In Proprioceptive Neuromuscular Facilitation (PNF), a more advanced kind of flexibility training, the targeted muscle area is both stretched and contracted. Although PNF stretching comes in various forms, they all facilitate muscle inhibition (Nagarwal *et al*., 2010) [12]. PNF-CRAC (Contract Relax Antagonist Contract) method is accounted by two physiological mechanisms: autogenic inhibition via recruitment of the Golgi tendon organs and reciprocal inhibition, which causes inhibition of the target muscle after the opposing muscle contracts (Kotteeswaran *et al*., 2014) [10]. This mechanism reduces stretch resistance and is essential for improving ROM. Since hamstring strains frequently occur during the eccentric phase of a muscular contractions, stressing these muscles with eccentric exercise may help to prevent hamstring strains (Hibbert *et al*., 2008) [9]. It has been proven that eccentrically training a muscle throughout its range of motion reduces injury rates, enhances athletic performance, and promotes flexibility.

Several studies have been conducted to improve flexibility, but there is lack of literature emphasizing the short-term effects of PNF stretching and eccentric training on hamstring flexibility among runners, reflecting a significant need to provide a viable protocol that can promote better performance of athletes. Therefore, the purpose of the present study was to determine the effects of PNF-Contract Relax-Antagonist Contract (CRAC) stretching and eccentric training on hamstring flexibility among runners and to compare the changes among the two groups. This can add significance to rule out the most productive training method for improving hamstring flexibility and preventing injuries concomitantly.

Materials and Methods

Participants and study design

The study was conducted at Punjabi University, Patiala, Punjab from October 2022 to April 2023. The present study was experimental in nature in which the Pre/Post-test design was implemented. The participants were selected as per inclusion criteria. A total of 60 athletes, consisting of 100,200- & 400-meter runners, both genders, of age group 18-26 years, presenting with bilateral hamstring tightness as defined by a limitation of 20 degrees or more from full knee extension were included in the study Ethical approval was taken from the Institutional Ethical Committee, Punjabi University Patiala (Ref No. 40/55/IEC/PUP/2022, Dated 13th Dec 2022). Before the start of this study, informed written consent was willingly attained by the subjects who took part in the study.

Subjects of the non-athletic population, with a history of acute/chronic low back pain, past hamstring injury in the last 6 months, Visual acute swelling in the region of the hamstring muscle, soft tissue injury and fracture, and Subjects with a history of low back, hip, knee, and ankle surgery in the last six months were excluded from the study. Standard full-circle goniometer, Sit and Reach Box, Thera band, Stopwatch, Weighing Machine, and Anthropometric Rod materials were used for the study.

Procedure

All the subjects were undergone a pre-intervention examination to assess hamstring tightness using the AKE test, PSLR test and Sit and Reach test.

Active Knee Extension Test

The subject was positioned in a supine position with the non-testing limb and pelvis strapped to the plinth to ensure stabilization. The leg to be tested was positioned with 90-degree hip and knee flexion. A universal goniometer was used, with the fulcrum centered over the lateral condyle of the femur, and the fixed arm secured along the femur shaft. The movable arm was aligned parallel to the lateral malleoli of the ankle. The participant was then instructed to extend the knee as much as possible until a mild stretch was felt over the posterior knee. This procedure was repeated three times, and the average value was taken for analysis (Biswas and Alagingi., 2018) [2].

Passive Straight Leg Raise Test

Participants were positioned in supine lying. The PSLR test was performed by two testers. One tester passively flexed the hip with the knee extended and the ankle relaxed until maximally tolerated (Feeling of resistance) range of motion (ROM) was reached and the second tester placed the fulcrum at the center of greater trochanter of femur and stationary arm with lined up with trunk, while the movable arm was lined up with the femur. The angle of motion in degrees was then recorded (Wadhwa & Garg., 2014) [19].

Sit and Reach Test

A standard sit-and-reach box (30.5 cm high) was used to position the subjects for measurement. A ruler was placed on top of the box, with the 35 cm mark representing the point where the subjects' fingertips aligned with their toes. Subjects sat on the floor with legs together and extended knees, with their feet against the edge of the box. They extended their arms forward, palms down, with one hand on top of the other. Without bending their knees, they were instructed to reach forward along the measuring line as far as possible, ensuring both hands remained at the same level. Three attempts were made, and the scores were recorded in centimeters to the nearest 0.5 cm using the scale on the left side of the reach indicator. The reading was taken after completing the three attempts (Ayala *et al*., 2011) [1].

Then the patients were randomly assigned into two groups of 30 each, using a convenient random distribution into 2 intervention groups: group A- PNF- CRAC stretching group (30 subjects) and group B- Eccentric Training group (30 subjects).

In Group A, the subjects were positioned supine with their left lower extremity secured to the table. A stopwatch was used to standardize the stretching, contracting, and relaxing time intervals. During each stretch, the investigator passively flexed the hip with the knee fully extended, without any hip rotation, to stretch the hamstring muscle until the subject reported a mild stretch sensation. This position was held for 10-15 seconds. The subject then isometrically contracted the hamstring muscle for 5 seconds by pushing their leg towards the table against the investigator's resistance. Next, the subject concentrically contracted the opposing muscle (Quadriceps muscle) by attempting to further raise the leg for 10 seconds. This sequence was repeated five times with each sequence separated by a 20-second interval. Finally, a post-test measurement was taken at the end of three weeks (Nagarwal *et al*., 2010) [12]. In Group B, the subjects were laid in a supine position with their left leg fully extended, and a Rigid Thera Band was wrapped around the heel while the subject held the ends of the band in each hand. The subjects were then instructed to pull on the Thera Band attached to the foot with both arms, bringing the right hip into full hip flexion while making sure that the knee remained locked in full extension throughout the movement. Full hip flexion was defined as the position where the subjects felt a gentle stretch. As the subjects pulled the hip into full flexion with

their arms, they were simultaneously instructed to resist the hip flexion by eccentrically contracting the hamstring muscles. Once the flexed hip position was achieved, it was held for 10 seconds, and then the extremity was gently lowered to the ground. This procedure was repeated five times with no rest between repetitions. A post-test measurement was taken after three weeks (Dasappan *et al*., 2021) [5].
Both groups received treatment 5 times a week for 3 weeks. Total 15 sessions in 3 weeks. At the end of the fifteenth session, both Groups A and B were reassessed through the Active Knee Extension Test, Sit and Reach Test, and Passive Straight Leg Raise Test. Data analysis was done using SPSS Version 20. Paired t-test and an independent sample t-test was used to find the significant difference within and between both groups respectively.

Results

Table 1: Demographic Data of the Study population

	Males			Females		
	Group-A	Group-B		Group-A	Group-B	
Parameters	Mean ±S.D	Mean ±S.D	t-value	mean ±S.D	Mean ±S.D	t-value
Age (Years)	21.8±2.85	22.28±3.09	-.382	21.17±2.78	22.12±2.52	-1.02
Weight (kgs)	56.92±9.42	60.64±10.84	-.948	52.88±2.78	51.06±4.90	1.321
Height (cms)	170.40±7.84	166.95±8.97	1.063	163.39±7.75	160.51±4.87	1.270
BMI (kg/m²)	19.54±2.38	21.58±2.10	-2.368	19.71±2.37	20.31±2.54	-.705

$p>0.05$

Descriptive statistics were used to calculate the mean and standard deviation of age, weight, height, and BMI of runners. Paired t test used showed no statistically group differences in age, weight, height and BMI of runners ($p>0.05$). The population was found to be homogenous in characteristics (Table 1).
Comparison was done both within each group (Within group) as well as in between the two groups (Between groups), so as to evaluate the intra-group and inter group effectiveness of PNF stretching and Eccentric Training which are under considerations in the present study.

Table 2: Within-group comparison of mean scores of Active Knee Extension Test, Passive Straight Leg Raise Test and Sit and Reach Test of Group A and Group B

Groups	Group A (PNF-Stretching)			Group B (Eccentric Training)		
	Mean ±S.D		t value	Mean ±S.D		t value
	Pre-test	Post-test		Pre-test	Post-test	
AKE (Right)	142.5±4.89	163.7±6.99	-40.63***	142.46±4.57	157.26±4.60	-39.39***
AKE (Left)	146.6±4.84	168.9±5.86	-59.97***	145.9 ±4.22	157.26 ±4.6	-41.25***
PSLR (Right)	69.2 ±5.15	88.63 ±6.69	-45.12***	68.4 ±4.75	84 ±5.08	-43.24***
PSLR (left)	72.13 ±5.42	92.4 ±6.21	-57.03***	72 ±5.11	88.26 ±5.13	-44.19***
SRT	33.7 ±4.77	40.73 ±5.23	-36.13***	31.13 ±5.1	36.66 ±5.31	-35.22***

***$p\leq 0.001$

The data analysis revealed sig nificant differences in the Active Knee Extension Test, Passive Straight Leg Raise Test, and Sit and Reach Test of both groups at the end of three weeks. Table 2 shows the results of within group comparisons using paired t test. The obtained t value suggests that there was highly significant improvement in the hamstring muscle flexibility for both groups with a $p\leq 0.001$.

Table 3: Between-group comparison of mean difference scores (Improvement score) of Active Knee Extension Test, Passive Straight Leg Raise Test and Sit and Reach Test of both groups.

Parameters	Group-A (PNF-Stretching)	Group-B (Eccentric Training)	
	Mean ±S.D	Mean ±S.D	t value
AKE (Right)	21.2 ±2.85	14.8 ±2.05	9.95***
AKE (Left)	22.3 ±2.03	15.83 ±2.10	12.1***
PSLR (Right)	19.43 ±2.35	15.6 ±1.97	6.82***
PSLR (Left)	20.26 ±1.94	16.26 ±2.01	7.81***
SRT	7.03 ±1.06	5.4 ±0.72	6.94**

***$p\leq 0.001$

It is evident from Table 3 that the results of between group comparison of mean and S.D scores of mean difference (improvement score) post interventions showed statistically significant improvement in all three outcome measures for hamstring flexibility at $p\leq 0.001$ in both the right and left sides. On comparing the mean values of improvement score for Group-A and Group-B on all three measures showed greater improvement in Group-A than in Group-B.

Discussion

The study was aimed to compare the effects of PNF-CRAC (Contract Relax Antagonist Contract) stretching and Eccentric Training on hamstring flexibility among Runners. The demographic characteristics of the study population were homogeneous in nature in both groups. The mean age of male and female runners in group A was 21.8±2.85 and 21.17±2.78 respectively. Similarly, the mean age of male and female runners in Group B was 22.28±3.09 and 22.12±2.52, respectively. In comparison, Wan *et al*., (2021) [20] reported a mean age of 20.6±1.6 for male runners, while Ruan *et al*., (2018) [15] reported the means ± SD of age for female runners as 20.8±0.7 years. Therefore, the mean age of the runners in our study was comparable to that reported in previous studies, as this age group is known to be actively engaged in sports.
Furthermore, the mean BMI values for Group A in males and females were 19.54±2.38 Kg/m² and 20.27±2.35 Kg/m², respectively. The mean BMI values for Group B in males and females were 21.58±2.10 Kg/m² and 20.31±2.54 Kg/m², respectively, indicating that the majority of participants in both groups were within the normal BMI range of 18.5-24.9 Kg/m². For example, Chow *et al*., 2018, reported that the average mean BMI for males was 21.9 ± 1.9, and for

females, it was 21.4 ± 1.5. The findings of current and previous studies indicate that runners usually have a normal body mass index (BMI ranging between 18.5-24.9 Kg/m².

The current study's findings demonstrate that hamstring flexibility improved significantly in both groups. The results also showed that the PNF Contract Relax-Antagonist Contract (PNF-CRAC) stretching approach produced much better improvements in hamstring flexibility than the Eccentric training technique. The isometric contraction in the stretching strategy may produce post-isometric relaxation in the muscle, resulting in reduced muscular tone in subjects who were treated to PNF - CRAC stretching. Following hamstring CRAC stretching, greater stretch tolerance and pain threshold, along with reciprocal and autogenic inhibition, promotes increased knee range of motion (ROM) and hamstring muscle length (Burgess *et al.*, 2019) [3]. Consistent with the aforementioned study, Nagarwal *et al*., 2010 [12] discovered similar physiological mechanisms contributing to the enhancement of hamstring flexibility during the application of PNF-CRAC stretching, as compared to the PNF Hold Relax (PNF-HR) stretching approach which only elicits autogenic inhibition of the target muscle.

Burgess *et al.*, 2019 [3] stated a significant increase of up to 37% in active knee extension range of motion (ROM) immediately after the application of 3 sets of PNF- CRAC stretching. However, it did not have a significant effect on agility or sprint times, suggesting that it does not negatively impact athlete performance.

Group B which received Eccentric training also showed significant differences in the AKE test, PSLR test, and SRT for hamstring flexibility at $p \leq 0.001$. O'Sullivan *et al*., 2012 [14] stated that conditioning the hamstrings with eccentric training results in neuromuscular adaptations such as an increase in biceps femoris long head fascicle length, an increase in hamstring muscle strength and/or volume, or an increase in the hamstrings' ability to generate higher levels of torque at longer muscle lengths. Sarcomerogenesis remains the most likely mechanism for increased flexibility following eccentric training. After repeated bouts of eccentric training, a substantial shift in the muscle length-tension curve occurs, indicating that muscles adapt to slightly damaging eccentric training via sarcomerogenesis. This optimizes torque generation at more extended joint positions, reducing the risk of muscle damage

Nelson *et al*., 2004 [13] claimed that while eccentric hamstring muscle training produces equal flexibility gains as static stretching after 6 weeks of intervention, eccentric training is a better functional option for flexibility training, showing structural modifications within the muscle. Similarly, Fard *et al*., 2020 [7] reported that after six weeks of eccentric training, a significant improvement was observed in test scores of the passive knee extension (PKE) test ($p < 0.05$). According to the author, eccentric training increases cortical excitability. There is spinal inhibition that lowers motor activity during eccentric training, reducing tightness.

In contrast to the previous studies, the findings of this study indicate that there is an impact of both PNF stretching and eccentric training hamstring muscle flexibility. On comparing the two groups, PNF stretching group resulted in better improvement of hamstring flexibility among runners.

Flexibility is a crucial aspect in sports as it plays a vital role in preventing athlete injuries. Considering the notable improvements in hamstring flexibility demonstrated by PNF stretching, this technique holds promise for enhancing hamstring flexibility with a reduced number of sessions. Athletes facing time constraints in their game preparation can potentially benefit from the application of this technique (Biswas *et al*., 2018) [2].

Conclusion
It was concluded that PNF stretching and Eccentric Training techniques are effective in improving hamstring flexibility among runners. PNF-CRAC Stretching resulted in Maximum improvement when compared to Eccentric training on hamstring flexibility in runners with hamstring tightness.

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References
1. Ayala F, de Baranda PS, Croix MD, Santonja F. Criterion-related validity of four clinical tests used to measure hamstring flexibility in professional futsal players. Physical Therapy in Sport. 2011 Nov 1;12(4):175-81.
2. Biswas S, Alagingi NK. Compare the effectiveness of static stretching and muscle energy technique on hamstring tightness among student population. Compare. 2018 Mar;3(2).
3. Burgess T, Vadachalam T, Buchholtz K, Jelsma J. The effect of the contract-relax-agonist-contract (CRAC) stretch of hamstrings on range of motion, sprint and agility performance in moderately active males: A randomised control trial. South African Journal of Sports Medicine. 2019;31(1):1-5.
4. Chow TH, Chen YS, Wang JC. Characteristics of plantar pressures and related pain profiles in elite sprinters and recreational runners. Journal of the American Podiatric Medical Association. 2018 Jan 1;108(1):33-44.
5. Dasappan S, Kumar RR, Sharad KS. Effects of eccentric training and static stretching to imrpove hamstring flexiblity among physiotherapy students. 2021.
6. DePino GM, Webright WG, Arnold BL. Duration of maintained hamstring flexibility after cessation of an acute static stretching protocol. Journal of athletic training. 2000 Jan;35(1):56.
7. Fard Mehregan A, Hadadnezhad M, Letafatkar A. Effect of eccentric training on knee strength and hamstring flexibility in active females with hamstring tightness: A clinical trial study. Journal of Gorgan University of Medical Sciences. 2020 Dec 10;22(3):19-27.
8. Fereydounnia S, Shadmehr A, Salemi P, Amiri S. Comparison of ROM, perceived tightness, and kinetic variables during balance, walking, and running tasks in athletes with and without hamstring tightness using sensor insoles. Sport Sciences for Health. 2022:1-7.
9. Hibbert O, Cheong K, Grant A, Beers A, Moizumi T. A systematic review of the effectiveness of eccentric strength training in the prevention of hamstring muscle strains in otherwise healthy individuals. North American journal of sports physical therapy: NAJSPT. 2008 May;3(2):67.

10. Kotteeswaran K, Snigdha JO, Alagesan JA. Effect of proprioceptive neuromuscular facilitation stretching and dynamic soft tissue mobilization on hamstring flexibility in subjects with low back ache-single blinded randomised controlled study. Int. J Pharm Bio Sci. 2014;5:228-33.
11. Msp G, Garud P. To Compare The Immediate Effects Of Eccentric Training Versus Hold Relax Propriocetive Facilitation On Hamstring Flexibility In Male Football Players Of Age Group 15 To 21 Years. Age. 2019;15(21yrs):1.
12. Nagarwal AK, Zutshi K, Ram CS, Zafar R, Hamdard J. Improvement of hamstring flexibility: A comparison between two PNF stretching techniques. International journal of sports science and engineering. 2010;4(1):25-33.
13. Nelson RT, Bandy WD. Eccentric training and static stretching improve hamstring flexibility of high school males. Journal of athletic training. 2004 Jul;39(3):254.
14. O'Sullivan K, McAuliffe S, DeBurca N. The effects of eccentric training on lower limb flexibility: a systematic review. British Journal of Sports Medicine. 2012 Sep 1;46(12):838-45.
15. Ruan M, Li L, Chen C, Wu X. Stretch could reduce hamstring injury risk during sprinting by right shifting the length-torque curve. Journal of Strength and Conditioning Research. 2018 Aug;32(8):2190.
16. Rudisill SS, Varady NH, Kucharik MP, Eberlin CT, Martin SD. Evidence-based hamstring injury prevention and risk factor management: A systematic review and meta-analysis of randomized controlled trials. The American Journal of Sports Medicine. 2022 Apr 6:03635465221083998.
17. Schache AG, Dorn TW, Blanch PD, Brown NA, Pandy MG. Mechanics of the human hamstring muscles during sprinting. Medicine & science in sports & exercise. 2013 Apr 1;44(4):647-658.
18. Singh AK, Nagaraj S, Palikhe RM, Neupane B. Neurodynamic sliding versus PNF stretching on hamstring flexibility in collegiate students: a comparative study. Int. J Phys Educ Sports Health. 2017;1(1):29-33.
19. Wadhwa G, Garg C. Comparison of Sit and Reach test, Back Saver Sit and Reach test and Chair Sit and Reach test for measurement of hamstring flexibility in female graduate and undergraduate physiotherapy students. National editorial advisory board. 2014 Oct;8(4):4230.
20. Wan X, Li S, Best TM, Liu H, Li H, Yu B. Effects of flexibility and strength training on peak hamstring musculotendinous strains during sprinting. Journal of sport and health science. 2021 Mar 1;10(2):222-229.