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Effect of ballistic stretching versus PNF hold-relax stretching on hamstrings flexibility in non-athletic young adults

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ABSTRACT

To assess the effect of Ballistic stretching versus PNF Hold Relax stretching on hamstrings flexibility in non-athletic young adults. Study design included pre-post control and experimental group design. Participants were 43 non-athletic healthy young adults between age groups of 20-30 years. Purposive sampling was done and the subjects were randomly allocated in 2 groups. Group I received hot pack and therapist-applied PNF stretching. This group received 3 repetitions of PNF Hold Relax in each session. Group II received hot pack and self-stretch ballistic stretching. This group received 3 exercises which were performed for 3 sets, 30 seconds each. Outcome measures included 90–90 Straight Leg Raising Test measured by Universal goniometer. Each group received stretching on 5 consecutive days. Intragroup analysis showed that both techniques were statistically extremely significant (<0.0001). The Intergroup analysis showed that difference between effectiveness of both techniques were not statistically significant bilaterally (Right- 0.0706 and Left- 0.6251). This study concluded that though there is no significant difference between PNF Hold-Relax stretching and Ballistic stretching on hamstrings flexibility in healthy young adults, both are effective treatment methods.

Keywords: 90-90 Straight Leg Raise test, Hamstrings tightness, Bilateral, Non-athletic.

INTRODUCTION

In the literature, the terms “flexibility” and “muscle length” are often used synonymously when referring to the ability of muscles to be lengthened to their end range. Flexibility is the total range of motion of a joint or group of joints. The structural characteristics of the joints and the mechanical properties of the connective tissues of the muscle tendon structures have been known to affect the

extent of movement around a given joint. The specificity of movement that a person performs in regular physical activities and stretching methods used, define the development and improvement of the body's range of motion [1]

A reduction in muscular flexibility reduces functional level and may cause damage to the musculoskeletal system due to overuse. Such damage mainly occurs in multi-joint muscles which have large functional excursion and high

percentage of fast twitch muscle fibres; the hamstring muscle has been reported to be the multi-joint muscle which is most frequently injured in the human body. Reduced hamstring muscle flexibility has been deemed a cause in lumbar spine dysfunction and showing strong positive correlation between decreased hamstring flexibility and low back pain². A previous study reported that flexibility is important to general health and physical fitness, and hamstring flexibility exercise has been successfully prescribed for relief of low back pain [3].

Stretching is a form of physical exercise in which a specific skeletal muscle (or a muscle group) is deliberately lengthened to its fullest length in order to improve the muscle's felt elasticity and reaffirm comfortable muscle tone. The result is a feeling of increased muscle control, flexibility and range of motion. Stretching has been promoted for years as an essential part of fitness program.

Stretching is also used therapeutically to alleviate cramps. The flexibility of the hamstring muscles is important in the prevention of injury, muscular and postural imbalance and maintenance of full range of joint movement, optimal musculoskeletal function and enhanced performance in day to day activities. Stretching techniques can be categorized as static, ballistic, slow active and Proprioceptive Neuromuscular Facilitation¹. A study by Sady, S.P., M. Wortman and D. Blanke, establish PNF techniques as more efficacious treatments than traditional static stretching exercise for range of motion or flexibility enhancement. The goal of all stretching programs is to optimize joint mobility without affecting joint stability. Concern should always be focused on the systematic, safe and effective application of the range of motion techniques utilized [1].

Due to subject's increasing tolerance to stretching maneuvers, the prior use of cryotherapy requires attention in the act of stretching so as not to exceed a patient's physiological limits. Thermotherapy is another modality that has been extensively investigated as a factor enhancing the results of the stretching, since it effectively changes conjunctive tissue's viscoelastic properties [4].

Brasileiro JS, Faria AF, et al. have attempted to establish the effects of thermotherapy combined with stretching, but most of them have sought to

elucidate the effects of thermotherapeutic modalities associated with static stretching and few have evaluated their association with PNF stretching [4].

Proprioceptive neuromuscular facilitation techniques used for stretching (PNF stretching), also referred to as active stretching or facilitative stretching, integrate active muscle contractions into stretching maneuvers purportedly to facilitate or inhibit muscle activation and to increase the likelihood that the muscle to be lengthened remains as relaxed as possible as it is stretched [5].

Hold-Relax is a type of PNF stretching. Practitioners in the clinical and athletic training settings have reported that the HR and CR techniques appear to make passive elongation of muscles more comfortable for a patient than manual passive stretching [5].

Ballistic Stretching is a rapid, forceful intermittent stretch- that is, a high-speed and high-intensity stretch. It is characterized by the use of quick, bouncing movements that create momentum to carry the body segment through the ROM to stretch shortened structures [5].

This type of stretching has proven effective in improvements in power production relative to vertical jump and sprint performance, in a study by Fletcher I, Jones B, et al. This is stretching, by bouncing into (or out of) a stretched position, using the stretched muscles as a spring which pull you out of the stretched position. (eg. Bouncing repeatedly to touch your toes). It sometimes causes them to tighten up by repeatedly activating stretch reflex [6].

Stretching protocols are the focus in the treatment of hamstrings tightness. Most studies have compared the effect of PNF or Ballistic stretching with the effect of static stretching. Some of these studies have observed significant differences between static and PNF whereas others have observed no differences. Ballistic stretching is frequently used for athletes, with its effectiveness well documented. But, its effectiveness in non-athletic healthy young adults is not adequately proven.

PNF Hold-Relax stretching is a therapist-assisted stretching whereas ballistic is a form of self-stretching, which, if proven beneficial can be effective and can be administered by the patient himself. This study is intended to evaluate if a self-administered technique like ballistic stretching can

be more effective than a therapist-assisted technique like PNF Hold Relax. Hence the aim was to assess the effect of Ballistic stretching versus PNF Hold Relax stretching on hamstrings flexibility in non-athletic young adults.

METHODOLOGY

Study design was a comparative study done using purposive sampling. 43 subjects were taken according to the inclusion criteria. The subjects selected were from MAEER's Physiotherapy College, Sneh Girls Hostel, Talegaon Dabhade. The subjects were allocated in two groups randomly. Inclusion criteria was Healthy adults between the ages of 20 and 30 years with bilateral hamstring muscle flexibility of more than 20 degrees (inability to achieve greater than 160° of knee extension with hip at 90° of flexion is considered hamstring flexibility). Both male and female subjects were included. Subjects who were excluded were those with any lower limb surgical history, history of any lower limb musculoskeletal disorders, individuals with acute low back pain, acute or chronic hamstring injury, herniated intervertebral disk, cruciate ligament damage, radiation or tingling or numbness, recent fractures around hip and knee, adults who practice sports/ gymnastics on a daily basis.

Hamstrings flexibility was measured of bilateral lower limbs before the study began. Each subject in the Ballistic group received hot pack for 10 mins, followed by Ballistic stretching. Participants will perform 3 stretching exercises that target the hamstrings. Hamstring exercises are sitting toe touch, semi-straddle, and lying hamstrings. Sitting Toe Touch- Participants sit on the floor with their legs extended out front. Their right hand is placed on top of their left, and they reach forward toward

their feet as far as possible while keeping their knees flat. Semi-Straddle- Participants sit on the floor with their right leg extended out front and their left knee flexed and hip abducted. Their right hand is placed on top of their left, and they reach forward as far as possible while keeping their right knee flat. Same is then done with left. Standing Hamstrings- Participants stand in stoop standing with palms facing the ground. They are asked to bend downwards just beyond their stretch point. Ballistic stretching was performed by moving back and forward through their maximal ROM for 3 sets of 30 seconds with 15-second rest between sets.

Each subject in PNF group received hot pack for 10 mins. For modified hold-relax stretching, each subject in PNF group will be comfortably positioned in a supine lying position on a plinth with the hip fixed at 90 degrees of flexion. Therapist stretched the hamstrings passively until the subject felt and reported a mild stretch sensation; that position will be held for 7 seconds. The subjects were asked to perform maximal isometric contractions of the hamstrings for 7 seconds by attempting to push their leg back toward the table against the resistance of the therapist. After the contraction, the subjects will be instructed to relax for 5 seconds. This sequence was repeated 3 times in each session for 5 consecutive days in this control group. Post session readings were taken on day 1 and day 5.

RESULTS

Data analysis was performed. Pre-test and Post-test values of the Control group and Experimental group were statistically analysed by means of paired t-test. Post-test values of the Control and Experimental groups were statistically compared by means of unpaired t-test.

Table 1 representing mean and standard deviation of control and experimental group of stretching.

Table 1: Demographic Data			
	No. of Subjects	No. of males	No. of females
Control	21	1	20
Experimental	22	5	17

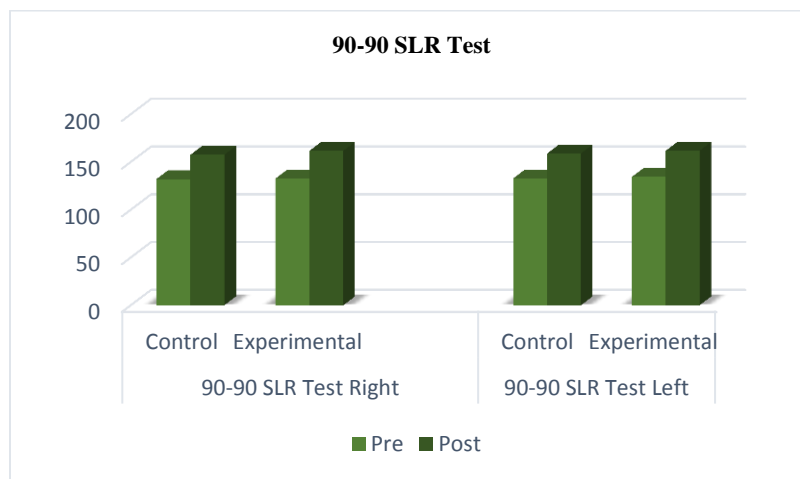
Table 2

	GROUPS	Mean		t value	p value	Unpaired t- test
		Pre	Post			
90-90 SLR Test Rt	Control	131.95±7.822	157.41±5.909	19.497	<0.0001*	0.0706
	Experimental	132.55±8.484	161.59±6.261	20.331	<0.0001*	
90-90 SLR Test Lt	Control	132.68±7.060	158.77±8.837	11.823	<0.0001*	0.6251
	Experimental	134.32±7.319	161.73±6.489	18.067	<0.0001*	

Unpaired t-test for control and experimental is not significant.

*<0.0001- extremely significant.

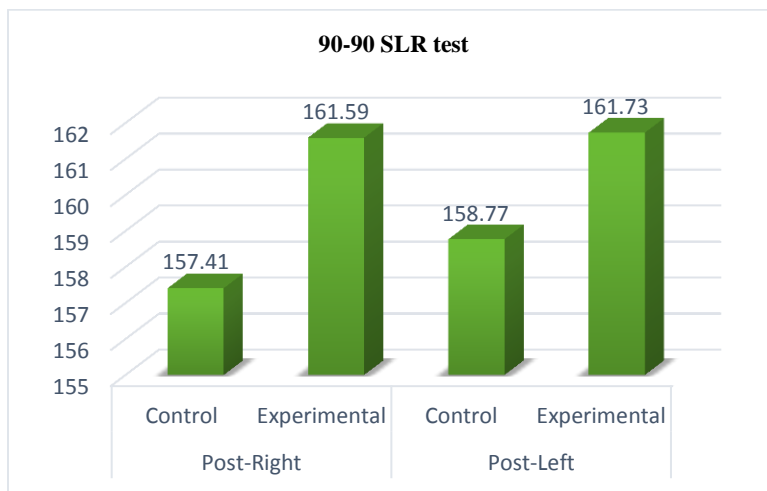
Graph 1 represents the Pre and Post treatment change in PNF group of Right and Left Hamstrings.



GRAPH 1

*<0.0001- extremely significant.

Graph 2 represents the comparison between the post-treatment changes of control and experimental groups of right and left respectively.



GRAPH 2

DISCUSSION

The current study was undertaken to assess if there is a significant difference in ballistic stretching and PNF hold-relax stretching on hamstrings flexibility in healthy young adults.

The study was performed on 43 healthy subjects with mean age 22 years. Then the subjects were randomly allocated into experimental (n=22) and control group (n=21) respectively, in which the experimental group received ballistic stretching along with moist heat application. The experimental group performed 3 sets of each exercise for 30 seconds. The control group received PNF hold-relax stretching for bilateral hamstrings along with moist heat. 3 repetitions were given in each session. Each patient received 5 consecutive days of treatment. The outcome measure was 90-90 Straight Leg Raise Test using a universal goniometer.

In this study, the changes observed in 90-90 SLR test for experimental group showed statistically significant improvement in the pre-post analysis ($p < 0.0001$). Bandy et al concluded that applying a stretching technique for 30 seconds was the most effective duration, because the extensibility was not increased further in applications lasting more than 30 seconds⁷. One of the studies by Andreas Konrad et al showed an increase in RoM, using Ballistic stretching but no significant adaptation in measured structural parameters which could explain the RoM gains [8].

Guissard et al. found that larger stretching amplitude led to a decreased H-reflex, which is related to neuromuscular sensitivity [9]. This reduction may be related to the tension of stretching, when the mechanism to protect the muscle is less than the resistance applied. This phenomenon has not been documented with small amplitude stretching. Hence, a probable explanation for the results of the ballistic component of the current study could be that the increased RoM following stretching is due to an altered perception of stretch and pain, or stretch tolerance rather than altered muscular or tendon structures⁸. However, the study by Camila Lima et al. demonstrates that static and ballistic stretching should not be performed immediately before maximal strength performance, as it decreases hamstrings strength [12]. The study also revealed that ballistic stretching may be beneficial to

decrease muscular fatigue and both stretching types can be used to increase acute ROM.

The changes observed in 90-90 SLR test for control group showed statistically significant improvement in pre-post analysis ($p < 0.0001$). Wallin et al found an increase of 6.2° of hip flexion range after 14 sessions of a contract - relax method. Sady et al found an increase of 9.4° in hip flexion range after 18 sessions of a contract - relax - antagonistic - contract method. In the study, modified PNF-technique was used. The stretching regimes in this study were only performed once for 2 minutes yet appeared to result in greater changes than the published studies described previously [10]. A study comparing the long term effects of the static stretching, active self-stretching, and PNF stretching techniques among adults who had hamstring muscle tightness reported that only the group receiving the static stretching technique showed a significant difference from the control group, and that application of the active self-stretching and PNF stretching techniques 3 times a week, the same schedule as the static stretching technique, was not sufficient for stretching a contracted hamstring muscle [11]. In contrast, several researchers have stated that the PNF stretching technique is more effective at increasing mobility than the static stretching technique [12].

Modified hold-relax stretching improves flexibility through relaxation of the contractile component of the muscles [13]. A study by Hashim Ahmed et al. showed that their study demonstrated that both of these mechanisms play equal roles in improving the flexibility of the muscles. Feland et al. reported that contract-relax and static stretching had similar benefits in improving flexibility [14]. Similarly, Gribble et al. found that static and hold-relax stretching were equally effective in improving hamstring range of motion [13]. Recently Lim et al. reported similar effects of static and PNF stretching on hamstring muscle extensibility [15].

A possible mechanism for the improvement of hamstring range of motion relies on the effects of autogenic inhibition. Autogenic inhibition is contingent on the function of the Golgi tendon organs, which not only detect changes in length but also changes in tension. Tension is produced in the antagonists with PNF hamstring stretching techniques [13]. Another possible mechanism for the increase in range of motion is augmentation of stretch tolerance. This is supported by Halbertsma

et al., who reported an increase in hamstring flexibility in their study [16]. Sharma et al. reported stretching along with warming up is an effective way to improve hamstring flexibility [18]. Moreover, their participants reported an increase in pain tolerance at the end of study. They attributed the gains in flexibility to an increase in stretch tolerance.

The post-intervention between group analysis showed statistically insignificant difference between control and experimental groups ($p=0.0706$ for right and $p= 0.6251$ for left). This intergroup comparison of the study revealed that hamstrings flexibility shows significant improvement with both control and also experimental group, but that one technique is not necessarily better than the other. The possible reason for this maybe that altered perception of stretch or improved stretch tolerance is believed to play a part in improving RoM in both Ballistic and PNF hold-relax techniques. Another possible reason for this could be that both Ballistic and PNF hold-relax techniques which have their own mechanisms of improving RoM eventually bring out similar results. The post- treatment measurements were taken immediately after the

study concluded. Long term effects or carryover of stretching maneuvers were not assessed. The scope of this study can be that it can be performed with a larger sample size. Study can be done to compare the effects of stretching in males and females. Ballistic stretching is seldom used in non-athletic population as it is known to have soreness. This study did not detect any soreness when given along with moist heat. As this protocol has shown no side effects, it can be taught to healthy young adults as home program.

CONCLUSION

The study concluded that though there is no significant difference between PNF Hold-Relax stretching and Ballistic stretching on hamstrings flexibility in healthy young adults, both are effective treatment methods.

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