

## A COMPARATIVE STUDY ON THE EFFECTS OF SUPERFICIAL HEATING AND COOLING APPLICATION OVER THE HAMSTRING PRIOR TO STRETCHING IN NORMAL INDIVIDUALS

Ravindra kumar Boddeti<sup>1</sup>, V.Thirupathi Rao<sup>2</sup>, V. Srikanth Babu<sup>3</sup>, A. J. Oliver Raj<sup>4</sup>

Kugler Memorial Physiotherapy Degree College, Guntur, Andhra Pradesh, India.

### ABSTRACT

**Background:** Prior to stretching the muscle need to warm up or relaxation to obtain greater extent of the joint range of motion. **Materials and Methods:** The study was carried out with Sixteen healthy male subjects, in outpatient department of Kugler physio & pain care clinic, Guntur. Measured knee joint range of motion in pre-treatment, After applying superficial heat, superficial heating plus static stretch and superficial cooling and superficial cooling plus static stretch and compared the obtained range of motions. **Results:** While applying the superficial heating and superficial cooling plus stretching, there is a greater extent of range of motion obtained compare to the other modalities. **Conclusion:** Superficial heating modality is effective in conjunction with static stretch to improve the muscle flexibility as well as joint range of motion.

**KEY WORDS:** STATIC STRETCHING, GONIOMETER, HOT PACK, ICE PACK, LABORATORY THERMOMETER

**Address for correspondence:** Dr.Ravindra Kumar Boddeti, Assistant Professor Anatomy, H.No. 20-21-18, Vinayak Nagar, Vizianagaram, India. E-Mail: dr.ravindrakumar@gmail.com

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### INTRODUCTION

Unrestricted pain free range of motion is often required to perform many functional daily living tasks as well as occupational or recreational activities. Mobility and flexibility of the soft tissues that surrounds a joint, that is muscles, connective tissue and skin in conjunction with adequate joint mobility are necessary for normal range of motion. Muscle injuries are common among the peoples performing high speed and high load activities. Inadequate warm-up, inflexibility and poor stretching programs can predispose the person to injury. Among all the muscles of lower limb, hamstring is more prone to injury according to Garrett(1984).

Zachezeweski (1989) defined flexibility as "the ability of a muscle to lengthen. Allowing one or more than one joint to move through a range of motion".

Stretch programs are aimed at decreasing the likelihood of injury (Liemohn.W, 1978). Physical therapists often advocate the use of stretching techniques as a means of increasing and maintaining hamstring length (Stannish And Hubble-Kozly, 1984), thus decreasing risk of injury. Superficial heating and cooling modalities is often used in conjunction with static stretch in attempt to increase the efficacy.

The principle methods by which both superficial heat and cold may improve the efficiency of stretching are by reducing muscle pain and decreasing muscle guarding. (Lehmann, 1990; Fischer And Solomon, 1965; Melzack R And Wall, 1971).

Warming up soft tissue prior to stretching will increase the extensibility of the shortened tissues. The application of cold prior to stretching (Cryostretching) has been advocated to decrease the muscle tone and make the muscle less sensitive to stretch in healthy subjects.

## MATERIAL AND METHODS

A pre-treatment, post-heat, post-heat with stretch, post cold and post cold with stretch is chosen for the study to determine the effectiveness of thermal modalities on static stretch.

**Study Setting** This study was conducted in the outpatient physiotherapy department of Kugler physio & pain care clinic, Guntur.

**Study Sample** Active healthy individuals, a total of sixteen students were taken; the individuals age group of 18 – 24 years were selected randomly. All subjects were signed on consent.

**Design of the Study** It is study with the same sixteen subjects, treated with two different superficial modalities i.e., Heat and cold prior to stretching and compared the for their effects with pre-treatment range of motion.

Eight subjects underwent superficial heating first and after one week followed by superficial cooling modality to eliminate carry over effects; if any, the other subjects underwent superficial cooling first and then superficial heating modality. This was done to counter – balance the order effect (Carolyn Hicks, 1995).

**Main Study** The subjects wore shorts and were positioned according to the phase of treatment and while the subjects positioned, and take a care to insure the proper relaxation to the muscles and proper comfort to the subject.

**Treatment Procedure** Study was conducted with each treatment modalities spaced from each other by one week to eliminate the carry over effects.

On arrival each subjects was asked to lie supine on the couch with neutral hip and knee for 2 minutes to eliminate any temporary length gains. Anatomical land marks like mid-axillary line, greater trochanter, and lateral femoral epicondyle used in Goniometry were felt-tip penned and Goniometer placed accordingly. In all the measurement procedures ankle was maintained in plantar flexion to eliminate calf tightness.

**Phase I** Measured the Pre-treatment range of motion for the knee joint extension, was taken using the active knee extension method (Gajdosik and Lusin, 1983) where the experimental hip as in 90 degree of flexion and individual was asked to extend the knee until slight discomfort was felt in the posterior knee, hamstrings or hip. In all measurement procedures ankle was maintained in plantar flexion to eliminate calf tightness.

**Phase II** The heat treatment then followed which consisted of hot pack at 60<sup>o</sup>C wrapped in 4 layers of towel applied to posterior thigh and applied heat for 10 minutes (Lehmann, JF, de lateur, J.B 1990), and measured the knee extension by using active knee extension method.

**Phase III** The heat treatment combined with the static stretching and measured the knee extension by using active knee extension method.

**Phase IV** The cold treatment then followed after a week which consisted of 1°C Ice pack in one layer of cloth towel to posterior thigh and applied ice pack for 10 minutes (Pegg, SMH, Littler, 1969), and measured the knee extension by using active knee extension method.

**Phase V** The cold treatment combined with the static stretch and measured the knee extension by using active knee extension method.

All subjects were prone position for the duration of their heat and cold treatments. The superficial modalities were given for 10 minutes, after which the hot and cold modalities were weaned.

**RESULTS**

In this study Pre-treatment Range of Motion and range of motion after application of superficial heating and cooling and these modalities combined with static stretch are interpreted.

**Table: 1.1** In this table compare the ROM in pre-treatment and after the application of superficial heating and heating combined with static stretch. After the heating combined with static stretching there is a 11.58 % ROM gained when compared with the pre-treatment ROM.

After the application of heating modality there is only 9.19 % ROM gained compared with the pre-treatment ROM. (Table 1.1)

Phases	No. of subjects	Mean ROM	SD	% of Increase in ROM
Pre-treatment	16	130.78	2.1	---
After the (Phase II)	16	142.81	3.44	9.19
Heat combined with the static stretch(Phase III)	16	145.93	3.06	11.58

**Table: 1.2** In this table compare the ROM in pre-treatment and after the application of superficial cooling and cooling combined with static stretch. After the cooling combined with the static stretch there is a 9.67 % ROM gained when compared with the pre-treatment ROM. After the application of cooling modality there is only 7.47% ROM gained compared with the pre-treatment ROM. (Table 1.2)

Phases	No. of subjects	Mean ROM	SD	% of Increase in ROM
Pre-treatment (Phase I)	16	130.78	2.1	---
After the application of cooling (Phase IV)	16	140.56	3.3	7.47
Cooling combined with the static stretch (Phase V)	16	143.43	3.44	9.67

**Table: 2** In this table compare the ROM in pre-treatment and after the application of superficial heating and cooling and these modalities combined with static stretch. This values indicates that when the superficial heating combined with static stretch

Phases	No. of subjects	Mean ROM	SD	% of Increase in ROM
(Phase I) Pre-treatment	16	130.78	2.1	---
After the application of heat (Phase II)	16	142.81	3.44	9.19
Heat combined with the static stretch (Phase III)	16	145.93	3.06	11.58
After the application of cooling Range of motion (Phase IV)	16	140.56	3.3	7.47
Cooling combined with static stretching (Phase V)	16	143.43	3.44	9.67



will obtain greater range of motion (11.58%) compared with all other modalities and the second best modality to obtain the greater extent of range of motion (9.67%) is superficial cooling combined with static stretch. (Table 2)

**Table: 3.1** In this table compare the ROM in pre-treatment and after application of superficial heating and cooling modalities. While applying the superficial heating there is 9.19%, for cooling there is 7.47% of ROM are obtained. (Table 3.1)

Phases	No. of subjects	Mean ROM	SD	% of Increase in ROM
Pre-treatment (Phase I)	16	130.78	2.1	---
After the application of heat (Phase II)	16	142.81	3.44	9.19
After the application of cooling (Phase IV)	16	140.56	3.3	7.47

**Table: 3.2** In this table compare the ROM in pre-treatment and after application of heating & cooling modalities combined with static stretch. After applying the heating combined with static stretch there is 11.58% and for cooling combined with static stretch there is a 9.67% ROM obtained compare to the pre-treatment range of motion. (Table 3.2)

Phases	No. of subjects	Mean ROM	SD	% of Increase in ROM
Pre-treatment (Phase I)	16	130.78	2.1	---
Heat combined with the static stretch (Phase III)	16	145.93	3.06	11.58
Cooling combined with the static stretch (Phase V)	16	143.43	3.44	9.67

## DISCUSSION

The results of the study, supports the hypothesis that there is significant difference in knee range of motion (Hamstring Length), in heat with stretch group compared to cold with stretch. It may be due to increase in the collagen tissue extensibility following heating modalities thus increases efficacy of stretch. Wessling et al, in his study of triceps surae muscle group, showed a significant increase in ankle dorsiflexion with use if ultrasound combined with static stretch.

Davis & young (1983) warmed the triceps surae muscle group with hot water baths and showed increases in peak power output with cycling and jumping tasks. Sargeant (1987) also used hot water bath and showed increase in peak force and power of 11% after heating and reduction of up to 21% after cooling. Carlisle (1956) showed improvements in swimming times after hot shower ( 8 minutes in 40 °C ). Laban, 1962; Lehmann et al 1970 ; Warren et al, 1971 have demonstrated increase in extensibility of tendons in vitro when heat is combined with stretching. Our study thus supports the premise that superficial heating modalities alter extensibility of tissue being stretched by one prolonged (60 Sec) stretch of hamstrings. The results of current study supports the finding of other studies that static stretching is effective in increasing hamstring length (Gajdosik RL, (1991); Hennricson A.S, (1984). Though, there is significant difference in all the subjects i.e. static stretching alone, cold with static stretch and heat with static stretch among the phases of pre-stretching, post-stretching, after application of heat and heat combined with static stretch, after cold application and cold application combined with static stretching differences were found statistically insignificant. This suggests findings of Newton (1985), who found the use of vapocoolants, in a spray and stretch technique, did not increase passive hip flexion in healthy adults.

Hareett W (1984); Bassett (1984) stated cooling modalities are frequently used to minimize stretch-induced pain by acting as a counter-irritant.

Wassen et al (1976) ; Halvorson (1990) found cryostretch type of stretching is only of use where muscles spasms is the limiting factor in mobility when connective tissue contraction has occurred heat would be treatment of choice as it will aid in tissue elongation is less likely to cause tissue damage. Thus our study supports heat to be better choice than cold improving efficacy of static stretch.

The efficacy of our post stretch seems to be supported in the all phases of treatment. The greatest length changes of 6.5 degree of knee extension were obtained. In that, larger and significant gains were present in the muscle tendon unit's capacity to stretching. It supports the hypothesis and study of Cornelius (1988) who found more permanent gains in flexibility when stretching is performed after exercise.

Hareett W (1984); Bassett (1984) stated cooling modalities are frequently used to minimize stretch-induced pain by acting as a counter-irritant.

#### **The gains in temporary length following pre-treatment may be due to –**

- 1) Increase in intra muscular temperature following contraction.
- 2) Increase Reduction of intramuscular matter allowing the muscles to shorten more, thus antagonist gets stretched more and more.

#### **The difference gaining flexibility among individuals and groups may be due to –**

- i) Body changes (mostly marked in higher age groups, so flexibility is less in older individuals compared to younger counterparts).

- ii) Volume of surrounding tissue (lean individual have less restriction compared to obese, as they longer muscle length and less in breadth of bulk.).

Character of muscle tissue (endurance individuals have more

- i) flexibility compared to strength individuals.).
- ii) Tendons and Joint capsules.

The degree of improvement of flexibility on adaptation of muscle to sarcomere number which in turn relies on passive tension that the muscle is exposed to and/or degree of muscle activation.(Hink et al, 1985).

Girls had more flexibility compared to males a study by Golderg et al (1980) as they believed girls are flexible than boys, but is not clear whether it is due to body structure or social and environmental influences.

There is a significant difference in age groups, the age groups 18 –25 showed better response according to the study of Broms. J (1984) .

#### **This may be due to –**

1. As age progresses it is believed that rest, myosin cross bridges remain less extended as a result of decrease of electrostatic forces, thus decreasing the resting length of muscle i.e. because both changes are negative (the high energy ionized compound molecules called ATP which is present at end of cross bridges with negative at base of cross bridge) the two ends repel each other thus allowing bridges to stay extended.

On getting older there is a decline in muscle size in part due to reduced amount of muscle protein, decline in number of muscle fibers while it is not clear the exact cause behind decrease in resting length.

In general, flexibility decreases with age although between individuals this trend is very much depended on activity levels and other life style factors.

### Clinical Implications

Superficial heating and cooling modalities followed by stretching will increases greater extent of range of motion as well as increases the flexibility of the muscle. Relieves the muscle tightness which is clinically important for the physiotherapist when treating the patient with muscle contracture, the therapist can also apply the heating modality prior to stretching while performing the stretching maneuvers to obtain greater extent of the joint range of motion.

### CONCLUSION

This study provides the clinician with evidence that superficial heating modality is effective in conjunction with static stretch. However, the effects of static stretching in association with thermal modalities may be highly individualized on age and sex.

The study however cannot be generalized to the population as it was conducted on a younger age group of 18 to 25 years. As in the literature it was noticed that younger age groups of males and females have greater flexibility than older counterparts and females showed grater-resting length to males. Conclusion of this study on different age group is advised.

The duration and force of static stretch should be considered that as the subjects were stretched on basis of their discomfort i.e. unequal weight, so further examination should be considered with constant weight than can give accuracy in level of stretch.

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