



## 표면 열치료와 심부 열치료가 뒤넙다리근 유연성에 미치는 영향

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### Effects of Superficial and Deep Thermotherapy with Hot-pack and Ultrasound on Flexibility on Hamstring Muscles

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#### Abstract

**Purpose** : Most of the moderns have been spent sedentary life style in front of desk or on the chairs, so that their hamstring muscles are shorted commonly and the shortness of hamstring muscles are caused to some problems in functional activities. The purpose of this study was to compare the effectiveness of thermotherapy with hot-pack and ultrasound on the tightness of hamstring muscles in individuals with hamstring tightness.

**Method** : Twenty-eight persons with hamstring tightness participated in this study. They were randomly assigned to three exercise groups: stretching group(n=10), hot-pack group(n=9), and ultrasound group(n=9). Before experiment, this study measured the angle of hip flexion using a inclinometer in all participants. Stretching group conducted actively stretching on their shorted leg for 30 seconds, 3 times, and rest for 10 seconds between each exercises. Hot-pack group have applied hot-pack(70~75°C) on shorted hamstring muscles for 20 minutes before stretching exercise. Ultrasound group have applied therapeutic ultrasound(1 MHz and 1.5W/cm<sup>2</sup>) on shorted hamstring muscles for 10 minutes before stretching exercise. All data was analysed using one-way repeated ANOVA.

**Result** : The results revealed that ultrasound therapy before stretching is more effective to the flexibility on hamstring muscles than hot-pack before stretching and stretching only.

**Conclusion** : The results of this study show that thermotherapy with therapeutic ultrasound will be effective on the shortness of hamstring muscles before stretching exercise.

**Key words** : Muscle, Thermotherapy, Ultrasound

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## I. Introduction

According to statistical data of Ministry of Health & Welfare and Korea Centers for Disease Control and Prevention, Koreans spent average 7.5 hours to sit. Persons in 19-29 years old are the longest average 8.7 hours per day, persons in 30-39 years old are 7.6 hours and persons in 40-49 years old spent 7.3 hours to sit(Statistics, 2014). Most of the moderns have been spent sedentary life style in front of desk or on the chairs, so that their hamstring muscles are shorted commonly and the shortness of hamstring muscles are caused to some problems in functional activities(Kisner and Colny, 2012). The tightness of hamstring muscles is caused on a posterior pelvic tilt and decreases lumbar lordosis, resulting on low back pain(Gopi et al, 2014). Hamstring muscles primarily control the forward swing of the leg during terminal swing and also provide posterior support to the knee capsule when the knee is extended during stance phase(Kisner and Colby, 2012). Therefore, the shortness of hamstring muscles is to be main problem in personal healthy habits and rehabilitation settings.

To improve the shortness of hamstring muscles, previous studies have been conducted the stretching exercise on the lower extremity. Stretching exercise is a process whereby the overall functioning of a person may be improved by applying stretching techniques selectively to some muscles and joints but allowing limitation of motion to develop in other muscles or joints(Kisner and Colny, 2012). Several author suggested that 30-s duration of stretching one of three times a day is effective for increasing muscle flexibility(Marques et al, 2009).

In rehabilitation settings, thermotherapy is used primarily to control pain, to increase soft tissue extensibility and circulation, and to accelerate healing(Cameron, 2013). Force and time of stretching should be decreased as the temperature of muscle increases(Kisner and Colby,

2012). When soft tissue is heated before stretching, the soft tissue retains its length after removing the stretching force(Cameron, 2013).

Another most common thermotherapy modality is hot-packs, which conduct superficial heating agent. Hot-packs are usually made of bentonite, a hydrophilic silicate gel, covered with canvas and these types of hot-packs are made in various sizes and shapes designed to fit different areas of the body(Cameron, 2013). Hot-pack is often used as the prior therapeutic modality of muscle stretching(Yoshida et al, 2015). Before stretching, heat application to the shortness of hamstring muscles could result in greater increase in hamstring extensibility(Lee, 2008; Funk et al, 2001).

Therapeutic ultrasound is used to treat a variety of condition and it is often used as a thermal modality when treating soft tissue injuries(David et al, 1998). Therapeutic ultrasound has two important physical effects, thermal effect which is a increase of temperature on transmitted and boundary tissues, and nonthermal effects which is acoustic streaming, cavitation, and altering cell membrane permeability(Cameron, 2013). Persons with knee pain have relieved their pain after applying the therapeutic ultrasound(Nuri, 2008). Static stretching exercise for 30 seconds followed by therapeutic ultrasound showed a significant increase in the flexibility of hamstring muscles(Emad, 2014).

Although previous studies have been demonstrated the effectiveness of hot-pack and therapeutic ultrasound on improving on flexibility of hamstrings tightness, two modalities of thermotherapy have the different physical effects in human tissues, but there is insufficient of the comparing the effect of the two modalities of thermotherapy on the flexibility of hamstrings tightness. The purpose of this study was to compare the effectiveness of thermotherapy with hot-pack and therapeutic ultrasound on the tightness of hamstring muscles before in individuals with hamstring tightness.

## II. Methods

### 1. Subjects

Twenty-eight persons with the tightness of hamstring muscle participated in this study. They were in attendance at B university at Chungcheongnam-do and those who understanding the purposes and procedures of the experiment and were going to participate voluntarily. The selection and exclusion criteria of the participants were as followings:

#### A. Selection Criteria

1) Participants who appealed the tightness of posterior femur when bent forward at the waist in standing position and showed a positive reaction in the hamstring contracture test(Magee, 2008)

2) Participants who did not have any problem to affect the results of this study such as discondition in hip joint and knee joint

3) Participants who did not have any neurological disorders

However, this study excluded the participants who had a open wounds of hamstring muscles and participants who currently underwent periodic treatment on their lower extremities.

### 2. Experiment Equipment

#### A. Hamstring extensibility

Before and after the experiment, participants were measured their dominant leg's hip joint flexion angle to know the hamstring extensibility using Inclinometer (Figure 1).

#### B. Measurement of active range of motion

When measuring the active range of motion of hip

joint, subjects were asked to lie down in a supine posture and laid a towel from the inferior waist and the non-dominant leg was fixed with strap to remove the compensation and assistant was fixed the pelvis to make no movement. Participants were performed straight leg raise(SLR) test which is to be hip joint flexion with knee joint full extension, when the participants felt the pain on their posterior femoral, they express their pain in words and at that point examiner measured the angle on end point of flexion(Oh, 2013). Inclinometer placed on upper part of the femoral measured participants' flexion angle after adjusting the zero.

### 3. Experiment Procedure and Methods

#### A. Group Allocation

Twenty-eight subjects were randomly assigned to group 1(stretching group), group 2(hot-pack group), group 3(ultrasound group) and specific details of each group are as follows(Table 1).

#### B. Stretching Exercise

Hamstring stretching exercise was a self-stretching exercise. Participants were asked to lie down in a supine position and laid a towel from the inferior waist and the non-dominant leg was fixed with strap to remove the compensation. Participants held their dominant leg's back of the femoral with hip joint 90° flexion by themselves and they extended knee to the point where the pain was starting to feel and maintained. Each stretching exercise was repeated for 30 second, three times with a 10 second rest between each trials(Kim, 2014).

#### C. Hot pack Therapy

The electrical plug-in hot pack was used and participants were asked to lie down in a supine posture and the hot pack which set to a temperature of 70~75°C with 5 layers of towel was applied to dominant leg's ham-

string for 20 minutes(Dararat, 2015).

#### D. Therapeutic ultrasound

Ultrasound device (Pulson 200, Gymna, Bilzen, Belgium) was used for thermotherapy with therapeutic ultrasound. Participants were asked to lie down in a supine posture and a 1-MHz US head was used, set to an intensity 1.5W/cm<sup>2</sup>. Therapeutic ultrasound was applied on medium 1/3 of dominant leg's hamstring muscles for 10 minutes(Nuri, 2008).

#### 4. Statistical Analyses

Statistical analyses were performed with Windows PASW ver.18.0(SPSS Inc. Chicago, USA) in this study. One-way repeated ANOVA was used to test the homogeneity of the collected data. Paired t-test was used to compare the angle before and after the experiment in each group and one-way repeated ANOVA was used to examine the difference between the value of the change amount before and after the experiment in each group. Scheffe were used for post-hoc. The alpha level was set 0.05 for statistical significance.

### III. Results

#### 1. General Characteristics of the Study

##### Subjects

This study investigated the age, height and weight among the general characteristics of the study subjects. Each mean and standard deviation of the general characteristics are as follows: stretching group was age 21.40±1.90, height 170±7.20cm, weight 62.40±8.57 kg, hot-pack group was age 21.78±1.20 years, height 173.33±6.91 cm, weight 68±11.23 kg, ultrasound group was age 20.22±1.64, height 168.11±11.35 cm, weight 58.78±13.51 kg(Table 1).

#### 2. Homogeneity between the groups

A value analyzed for homogeneity between the groups are described in Table 2. After a homogeneity test, there was no significant difference among three groups.

#### 3. Comparison pre- and post-test in each group

Table 3 shows the results of angle on hip joint flexion in three groups. Before and after the experiment, results of the measurement of the angle is as follows: stretching group increased from 39.90±9.88° to 51.50±2.83°, hot-pack group increased from 41.44±10.85° to 63.33±10.77°, ultrasound group increased from 41.89±9.25° to 73.44±2.24°. The angle on hip joint flexion shows significantly increase after intervention (p<.05).

#### 4. Changeable values after intervention in Each Group

Table 4 shows the comparison among three group, stretching, hot-pack, and therapeutic ultrasound groups. Results of the measurement of changeable values in each group is as follows: stretching group was 12.20±4.24°, hot-pack group was 21.89±4.60°, ultrasound group was 31.56±7.27°. Ultrasound group showed the greatest change amount and stretching group showed the smallest change amount. Before and after the experiment the value of the change amount showed a significant difference(p<.05).

### IV. Discussion

Hamstring shortening can easily happen because modern people spend most of their daily livings to sit in a

chair. Due to that the hamstrings tightness generate a posterior pelvic tilt and decreases lumbar lordosis, which can result in low back pain. Lack of hamstring muscles extensibility decreases pelvic mobility, could also cause a various of functional disabilities such as abnormal gait, back pain (Gopi et al, 2014)

Various stretching exercises for the hamstring shortening was studied and also study about pre-treatment for stretching exercises was performed. Generally, hot-pack and therapeutic ultrasound were used to assist as warm-up period on stretching exercises and study is also conducted to prove it, but these study were done independently, study that comparing two pre-treatment is insufficient.

This study applied hot-pack and therapeutic ultrasound as the warm-up on hamstring stretching about hamstring shortening and was conducted to suggest better warm-up method by comparing hamstring extensibility through the hip joint flexion test. Hamstring shortening is a case that appeal the tightness of posterior femur when bent forward at the waist in standing position and shows a positive reaction in the hamstring contracture test(Magee, 2008). Therefore, this study measured hip joint flexion angel through the straight leg raise(SLR) test before and after experiment to observe the changeable amount of hamstring stretching.

The result of this study ultrasound group was the most effective among the three groups to increase the hamstring extensibility. The group that applied ultrasound as pre-treatment appeared the largest increase of hip joint flexion angle according to before and after experiment and the group that applied hot pack as pre-treatment showed the second largest variation. On the other hand, group that not performed any warm-up showed the lowest value variation. Thus, thermotherapy was certain effect to pre-treatment on hamstring stretching exercise, deep heat therapy can be considered that there is a larger effect than superficial heat therapy.

Limitations of this study rather difficult to generalize the results of the study because the participants consisted of three groups, each group consisting of 9-10 people so the small number of participants. Also, It may not be objective by the number of variables because this study compared hamstring extensibility before and after experiment using only inclinometer without other measure equipment. The site of application of hot-pack and therapeutic ultrasound may be some errors in the application site so it is considered to be able to affect the study results. As this study performed stretching exercise, it may be not objective that did not considered the individual's exercise capacity. Therefore future study should be conducted suggested that the study complements these limitations.

## V. Conclusion

This study was participated by twenty-eight persons with tightness of hamstring muscles and participants were randomly assigned to one of the following groups: stretching group, hot-pack group, ultrasound group. After examining flexibility of dominant side hamstring, each group were performed stretching, stretching applied after hot-pack, stretching applied after ultrasound and then observe the influence on the extensibility of the hamstring. Furthermore study was made to suggest to more effective warm-up of hamstring stretching exercise. The group that performed stretching exercise after apply the hot pack showed tendency to increase the extensibility than group that applied stretching exercise, the group that performed stretching exercise after apply the ultrasound showed tendency to increase the extensibility than group that performed stretching exercise after apply the hot pack. This results support the effectiveness of heat therapy as a pre-treatment on stretching exercise and it will be able to provide useful data for future study.

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Appendix 1. Table

Table 1. General Characteristics of the Study Subjects (N=28)

	Stretching group(n=10)	Hot-pack group(n=9)	Ultrasound group(n=9)
Age	21.40±1.90*	21.78±1.20	20.22±1.64
Height (cm)	170±7.20	173.33±6.91	168.11±11.35
Weight (kg)	62.40±8.57	68.0.±11.23	58.78±13.51

\*mean±SD

Table 2. Homogeneity of Subjects (N=28)

Variable	Stretching group(n=10)	Hot-pack group (n=9)	Ultrasound group (n=9)	F	p
Angle	39.30±9.90*	41.44±10.90	41.89±9.30	0.184	.833

\*Mean±SD

Table 3. Comparison before and after the experiment in each group (N=28)

Groups	Pre-test	Post-test	t	p
Stretching group(n=10)	39.90±9.88*	51.50±2.83	-9.105	<.001
Hot-pack group(n=9)	41.44±10.85	63.33±10.77	-14.292	<.001
Ultrasound group(n=9)	41.89±9.25	73.44±2.24	-13.031	<.001

\*mean±SD

Table 4. Changeable values between pre- and post-test (N=28)

Variable	Stretching group (n=10)	Hot-pack group (n=9)	Ultrasound group (n=9)	F	p
Angle	12.20±4.24*	21.89±4.60	31.56±7.27	29.498	<.001

\*Mean±SD

Appendix 2. Figure



Figure 1. Inclinometer

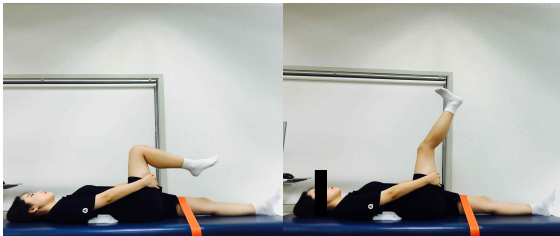


Figure 2. Stretching exercise of hamstring muscles (A: start position, B: end position).