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A comparative study on the effect of hot pack and ultrasound therapy prior to passive stretching on the extensibility of plantar flexors among Asia Metropolitan University students

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Abstract

Title: A comparative study on the effect of hot pack and ultrasound therapy prior to passive stretching on the extensibility of plantar flexors among Asia Metropolitan University students.

Background: Reduced ankle dorsiflexion is a common problem which will cause calf pain. Limited dorsiflexion is so often caused by tight calf muscles and is itself linked to injuries such as Achilles tendonitis and plantar fasciitis. When the motion at the ankle is restricted, the ankle tries to compensate by increasing pronation at the foot, which as we have already seen can overwork the tibialis posterior muscle, lie deep inside the calf. Common causes of tight calf muscles appear in those who wear high heels because their feet are automatically pointed downward in a plantar-flexed position because of their high heels. A muscle needs to be at its ideal resting length to produce optimal performance. A tight, shortened muscle doesn't have the same range when it comes to contracting that a muscle of a healthy length has.

Objective: To compare the effect of hot pack and ultrasound therapy prior to passive static stretching on the extensibility of plantar flexors.

Design: A Quasi Experimental Design

Subjects: About 30 subjects were recruited for this study from the university. The baseline measurements of ankle dorsiflexion range of motion were assessed by appropriate tools. Based on the measurement obtained, the samples were allocated into two different groups, which received moist pack and ultrasound before passive stretching. After each day of therapy and stretching intervention, the new range of motion was measured again as it is done in the baseline.

Results: The results obtained in the pretest values of ultrasound group and hot pack mean are 11.33 and 9.33 respectively. It shows that the ultrasound group has a higher mean value compared to the hot pack group. However after the intervention, the posttest results showed significance where their p values was 0.00 where 'p' value were < 0.05 for both the groups that there was no significance difference between both the groups after 4 weeks of intervention, thus the null hypothesis is accepted.

Conclusion: Among the modalities tested, the use of ultrasound for 7 minutes prior passive stretching may be the most effective way for increasing ankle dorsiflexion ROM compared to hot pack prior to stretching within a shorter period of time than 4 weeks.

Keywords: Ultrasound, hot packs, goniometry, stretching etc.

1. Introduction

Plantar flexors muscles play a very crucial role in the human postural control and the gait cycle. Lack of extensibility in this muscle group may cause or be related to decrease in ankle dorsiflexion. This tightness will contribute to Achilles Tendinitis and also plantar fasciitis. Lack of stretching to these muscles causes the inextensibility^[1]. Maintaining normal muscle length requires regular stretching to prevent muscle stiffness and benefit from the risk of decreased risk of musculoskeletal injuries and enhanced physical performance^[2]. Dorsiflexion limitations, even in otherwise healthy individuals, can result in compensatory foot pronation, which alters patella femoral joint tracking^[3] and is a major contributing factor of lower leg running injuries, including plantar fasciitis and shin splints^[4]. Excessive pronation also exaggerates the transverse plane motion in the lower limb, thereby increasing potential for greater stress onto the medial aspect of the knee, hip, and low back^[5]. The risk of plantar

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fasciitis increases as the range of ankle dorsiflexion decreases. Individuals who spend the majority of their workday on their feet and that body mass index are $>30 \text{ kg/m}^2$ are also at increased risk for the development of plantar fasciitis. Reduced ankle dorsiflexion, obesity and work related weight bearing appear to be independent risk factors for plantar fasciitis [6]. The anatomy of the ankle joint as we can see in the diagram below, (Figure 1) is a complicated joint whereby many types of injuries can happen to the particular joint. The ankle joint is a synovial hinge joint with one degree of freedom movement that is it allows only plantar flexion and dorsiflexion. The forward and backward fluctuation of the line of gravity, which in normal standing falls in front of the joint, is regulated at the ankle so that it is kept within the limits of the supporting surface [7]. The gastrocnemius and the soleus are two muscles that make up the calf. The gastrocnemius is the larger of the two muscles. The gastroc tendon combines with the soleus tendon to form the Achilles tendon. To make sure that the ankle dorsiflexion is proper, the measuring instruments which are used are goniometer, visual observation, as well as inclinometer. In this study only goniometer is used. This is because it is widely used and proven to be valid. The normal range of motion of ankle is to be ranging from 15° to 20° . To ensure that the ankle dorsiflexion has a good range, stretching is emphasized to enable that the ankle to have more range of motion. Theoretically, the stretching protocols produce deformational changes that lengthen the connective tissue and increase joint ROM. The static stretching protocol requires that the stretch be performed in a slow, gradual manner and held at end range just before the point causes discomfort to the patient. Thermal agents also play a role in determining the amount of elongation obtained from a static stretch. Studies have shown that an elevated tissue temperature increases the amount of elongation obtained from a stretch. The clinician may use superficial heat or deep heat, or the patient may perform active exercises to warm up the muscles. Superficial heat may be applied in the form of hot pack paraffin, fluidotherapy and infrared radiation. Some physical therapist may commonly use hot packs because they are easy to apply and economical. Studies shows that applying superficial heat simultaneously with a low-load static stretch improves the flexibility of shoulder and hip muscles compared with stretching alone [1].

Methods and Materials

Study Design: A Quasi Experimental Design

Sampling Method: Simple Random Sampling

Sample Size: 30 subjects

Study Location: Asia Metropolitan University

Study Duration: 11 months

Intervention Duration: 4 weeks

Inclusion Criteria

- Male and female.
- Age between 18-30 years old.
- Sedentary lifestyles.
- Asia metropolitan university.
- Asymptomatic participants with $\leq 20^{\circ}$ of restriction in ankle dorsiflexion.

Exclusion Criteria

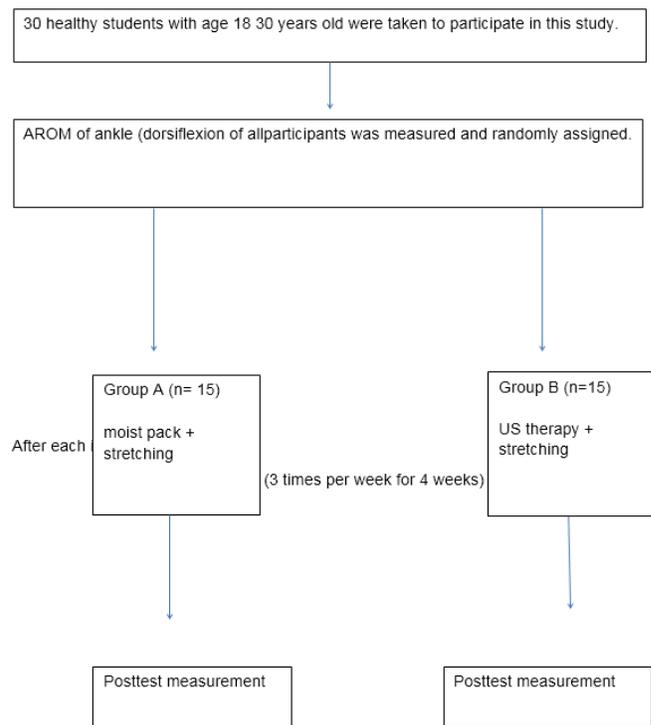
- Athlete
- Active in sports
- Fracture
- Hematoma
- Previous neuromuscular disorder of hip, knee, or ankle

pathologies (within past 2 years)

- Any subjects missing 2 sessions without stretching
- Bleeding disorder
- Impaired sensation

Procedures: The study is a quasi-experimental pretest posttest study design. The sampling method was purposive sampling. The sample size was about 30 subjects. Based on inclusion criteria, subjects were assigned into two different experimental group (Group A) hot pack therapy and (Group B) ultrasound therapy prior stretching. The duration of the study was 11 months. The intervention duration was 4 weeks and the stretching duration was given four times daily for 3 days in a week and hold time for 30 seconds. The study location was based in Asia metropolitan university. First an informed consent was given to a particular student to enter into the study. The baseline ankle dorsiflexion measurement was taken for one leg. Then the subjects were given the either hot pack or ultrasound prior passive stretching for 4 weeks. Measurements were taken before and after each session of heat therapy prior stretching and analyzed statistically to find out any significant improvement from the intervention within the group.

Study Methodology



Technique of Data Collection: The subjects were selected for this study based on inclusion criteria. Before the data was collected, the subjects were given a consent form to fill and treatment was given. The baseline ankle dorsiflexion measurement of the leg was taken using a goniometer. Then the subjects were given the heat treatment (hot pack or ultrasound) and passive stretching exercises for 4 weeks, 3 times per week with 4 repetitions per day with 30 seconds hold. After each session of treatment, the measurement was taken and recorded, after four weeks the final measurement of the ankle dorsiflexion of the chosen leg, were taken and analyzed statistically to find out any significant difference.



Subject filling the consent form



Taking measurement of ankle at neutral position.



Application of ultrasound



Taking measurement when the ankle was dorsiflexed.



Application of hot pack

Statistical Tools

The pretest and posttest values of the ankle dorsiflexion range of motion were subjected to statistical analysis. Repeated measures of ANOVA were done in order to compare the values of the pretest and posttest measurement of the two groups every week for four continuous weeks. It was also used to compare the posttest values of both the groups after the intervention.

Data Analysis

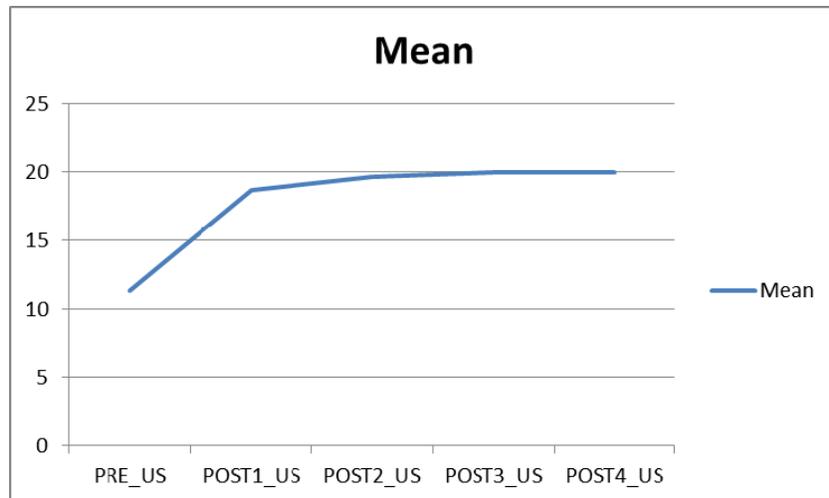
Data analysis is a method by which the validity of a research study is evaluated. It requires a number of closely related operations beginning from the establishment of a category of raw data through coding, drawing statistical inferences and also finally tabulation of the data that have been collected. A data collection was done in Asia Metropolitan University (AMU) from July 2015 to August 2015. 30 samples of data was collected according to the inclusion criteria and divided into 2 groups, 15 samples each group. The data analysis was done by using statistical package for social sciences (SPSS), version 2.0 software. The significance level will be set at $p \leq 0.05$. Descriptive statistic in this study calculated by using mean \pm standard deviation (SD). Repeated measure ANOVA used to identify the significant difference of ankle ROM between hot pack and ultrasound group. The analysis method after using repeated measure ANOVA followed by the Wilks' Lambda and Greenhouse-Geisser test to determine which group shows a significant difference.

Descriptive Statistical Representation

Pretest Value and Posttest Value of Ankle Dorsiflexion Range within 4 Weeks for Ultrasound Group.

Descriptive Statistics			
	Mean	Std. Deviation	N
PRE_US	11.3333	4.02965	15
POST1_US	18.6667	2.28869	15
POST2_US	19.6667	1.29099	15
POST3_US	20.0000	.00000	15
POST4_US	20.0000	.00000	15

Pretest and Posttest Mean Of Ankle Dorsiflexion Range within 4 Weeks Ultrasound Group



The above table 1 shows the mean value for the ultrasound therapy. In the descriptive data analysis shows that the mean \pm SD is calculated. So here, for PRE_US is (11.33 \pm 4.02), POST_US_1 (18.66 \pm 2.28), POST_US_2 (19.66 \pm 1.29), POST_US_3 (20.00 \pm 0.00), POST_US_4 (20.00 \pm 0.00) respectively. Graph 1 shows the mean value of ankle dorsiflexion for ultrasound group before intervention and after

each week of intervention which was measured using repeated measures of ANOVA. The pretest mean of ankle dorsiflexion was 11.33 which increased in the first week after intervention to 18.66. The mean of second week increased to 19.66 and became 20.00 on the third week and remained constant throughout the study period.

Multivariate Tests ^a									
Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power ^c
ROM_TIME_US	Pillai's Trace	.859	24.311 ^b	3.000	12.000	.000	.859	72.932	1.000
	Wilks' Lambda	.141	24.311 ^b	3.000	12.000	.000	.859	72.932	1.000
	Hotelling's Trace	6.078	24.311 ^b	3.000	12.000	.000	.859	72.932	1.000
	Roy's Largest Root	6.078	24.311 ^b	3.000	12.000	.000	.859	72.932	1.000

Tests of Within-Subjects Effects									
Measure: MEASURE_1									
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power ^a
ROM_TIME_US	Sphericity Assumed	834.667	4	208.667	53.472	.000	.793	213.887	1.000
	Greenhouse-Geisser	834.667	1.573	530.757	53.472	.000	.793	84.089	1.000
	Huynh-Feldt	834.667	1.737	480.466	53.472	.000	.793	92.891	1.000
	Lower-bound	834.667	1.000	834.667	53.472	.000	.793	53.472	1.000
Error(ROM_TIME_US)	Sphericity Assumed	218.533	56	3.902					
	Greenhouse-Geisser	218.533	22.016	9.926					
	Huynh-Feldt	218.533	24.321	8.985					
	Lower-bound	218.533	14.000	15.610					

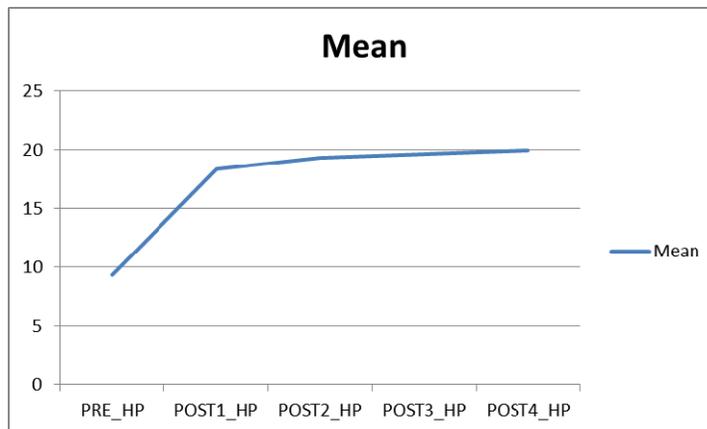
Table 2 explains about the inferential statistics. In inferential statistic, the multivariate test is done and Wilks' Lambda is rounded of for significance. For test within the subject effect Greenhouse-Geisser is taken into account. For pairwise comparison, paired t test is used .In Wilks' Lambda F=

24.311 at $P \leq 0.05$ is 0.00 whereas for Greenhouse-GeisserF (4 = 53.472) at $P \leq 0.05$ is 0.00.

Pretest Value and Posttest Value of Ankle Dorsiflexion Range within 4 Weeks for Hot Pack Group.

Descriptive Statistics			
	Mean	Std. Deviation	N
PRE_HP	9.3333	2.38048	15
POST1_HP	18.3333	2.43975	15
POST2_HP	19.3333	1.75933	15
POST3_HP	19.6667	1.29099	15
POST4_HP	20.0000	.00000	15

Pretest And Posttest Mean Of Ankle Dorsiflexion Range Within 4 Weeks Hot Pack Group.



The above table 3 shows the mean value for the hot pack therapy. In the descriptive data analysis shows that the mean \pm SD is calculated. So here, for PRE_HP is (9.33 \pm 2.38), POST_HP_1 (18.33 \pm 2.43), POST_HP_2 (19.33 \pm 1.75), POST_HP_3 (19.66 \pm 1.29), POST_HP_4 (20.00 \pm 0.00) respectively.

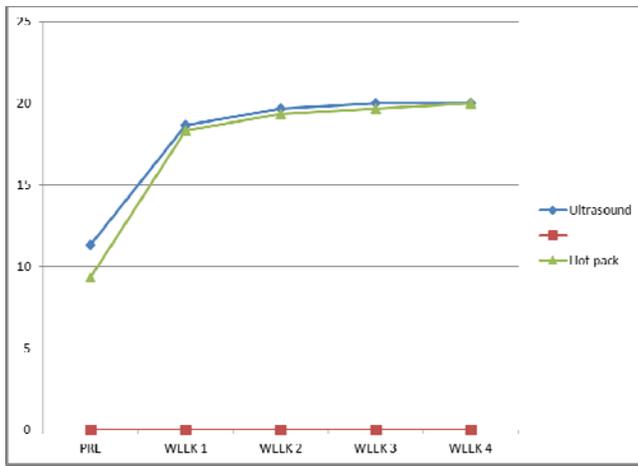
Graph 2 shows the mean value of ankle dorsiflexion for hot

pack group before intervention and after each week of intervention which was measured using repeated measures of ANOVA. The pretest mean of ankle dorsiflexion was 9.33 which increased in the first week after intervention to 18.33. The mean of second week increased to 19.33 and became 19.66 on the third week and achieved f 20.00 on the fourth week of the study period.

Multivariate Tests ^a									
Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power ^c
ROM_TIME_HP	Pillai's Trace	.979	126.771 ^b	4.000	11.000	.000	.979	507.085	1.000
	Wilks' Lambda	.021	126.771 ^b	4.000	11.000	.000	.979	507.085	1.000
	Hotelling's Trace	46.099	126.771 ^b	4.000	11.000	.000	.979	507.085	1.000
	Roy's Largest Root	46.099	126.771 ^b	4.000	11.000	.000	.979	507.085	1.000

Tests of Within-Subjects Effects									
Measure: MEASURE_1									
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power ^a
ROM_TIME_HP	Sphericity Assumed	1223.333	4	305.833	143.359	.000	.911	573.438	1.000
	Greenhouse-Geisser	1223.333	2.301	531.679	143.359	.000	.911	329.854	1.000
	Huynh-Feldt	1223.333	2.779	440.187	143.359	.000	.911	398.414	1.000
	Lower-bound	1223.333	1.000	1223.333	143.359	.000	.911	143.359	1.000
Error(ROM_TIME_HP)	Sphericity Assumed	119.467	56	2.133					
	Greenhouse-Geisser	119.467	32.212	3.709					
	Huynh-Feldt	119.467	38.908	3.071					
	Lower-bound	119.467	14.000	8.533					

Table 4 explains about the inferential statistics. In inferential statistic, the multivariate test is done and Wilks' Lambda is rounded off for significance. For test within the subject effect Greenhouse-Geisser is taken into account. For pairwise comparison, a paired t test is used. In Wilks' Lambda $F = 126.771$ at $P \leq 0.05$ is 0.00 whereas for Greenhouse-Geisser $F(4 = 143.35)$ at $P \leq 0.05$ is 0.00.



Graph 3 explains the biweekly changes in active ROM (in degree) between groups. Ultrasound group was the group that received ultrasound for 7 minutes before performing passive stretch for 30 seconds. Hot Pack group was the group that received superficial moist heat from hot pack for 20 minutes before receiving the passive stretch.

Discussion: The study was designed to find out the effects of hot pack and ultrasound therapy prior to passive static stretching on the extensibility of plantar flexors among Asia metropolitan university students. In this study, the result shows that, there is no significant difference on the plantar flexor muscle extensibility among subject with different heating intervention prior stretching. The results also prove that there was no significant difference in the ankle range of motion between both the groups after 4 weeks of intervention, but there was an earlier result in the ultrasound group when compared to the hot pack group. The ultrasound sound group showed full AROM at the end of 2nd week of intervention whereas the moist pack group showed full AROM only at the end of 3rd week. According to the data analysis and results of this study, it proves to be relevant with other studies done by comparing hot pack and ultrasound prior runner's stretch on individuals. *Claudia A Knight et al* (2001) conducted a study and proved in a treatment lasting 4 weeks or less, hot pack prior to stretching or ultrasound prior to stretching achieved similar results in increasing ankle dorsiflexion AROM. In terms of cost effectiveness, hot pack prior stretching would increase AROM sufficiently over a 4 weeks' time frame. If increase in ankle dorsiflexion, AROM and a treatment duration of at least 2 weeks are desired, then ultrasound is the treatment of choice. When treating a patient for 4 weeks, however hot pack prior stretching will increase ankle dorsiflexion equally to the ultrasound. As the available Rom at the ankle joint is less compared to that of other joints, it may have changed differences in the effectiveness of the treatment. Furthermore the controlled force applied to every individual during stretching may explain the non-significant differences across the group after four weeks of intervention. *Lentell G et al* (1992) conducted a study which proved that application of

superficial heat and stretching showed a marked increase comparatively to only stretching or cold application prior stretching. The entire following intervention group showed marked short term gain in the ROM following single treatment sessions. The greatest gains were consistently produced when the intervention included the application of moist heat in the initial stages of stretch compared to the application of cold therapy. This was the only intervention group involving modalities that produced significantly greater gains in flexibility compared to the stretch alone. *Bandy WD et al* (1994) conducted a study whereby the results of this study suggests that a duration of 30 seconds is an effective time of stretching for enhancing the flexibility of the hamstring muscles. Given the information that no increase in flexibility of the hamstring muscles occurred by increasing the duration of stretching, it shows that stretching alone over duration of 6 weeks is enough to attain a full ROM. It clearly shows that, a good heating modality combined with a proper stretching technique will produce an adverse effect on the muscle lengthening.

Conclusion: In this study there was a no significant difference between the two groups of hot pack and ultrasound prior stretching intervention. The individuals who received ultrasound intervention showed a faster gain in the full AROM compared to the individuals who received hot pack, it took only 2 weeks for the ultrasound group to attain Full AROM and 3 weeks plus for the hot pack group to attain full AROM. This study shows that both has equal results in increasing the ankle full AROM after 4 weeks of intervention. This result will allow clinicians to choose the intervention which is more cost effective. Hence taken into consideration this study shows the importance of plantar flexor stretching in avoidance of any further musculoskeletal disorder that will affect the people in the sedentary lifestyle.

Limitation: The limitations of this present study are mainly the number of subjects that involved in the study. I was not able to find more than 30 students at the moment of my data collection due to time factor and the inclusion criteria. Secondly, it was done using universal goniometer with low calibrations instead of inclinometer due to financial factor. Finally, the environmental factor which may influence the effect the effectiveness of hot pack because the study was conducted in an air conditioned environment.

Recommendation: On the basis of the findings of the present study, the following recommendations are made: a). Similar study may be conducted with comparison of male and female participation with large population. b). Further study can be taken up by adding other musculoskeletal parameter as an outcome of the study. c) Similar study may be conducted with a difference in the male and female population.

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