The Effectiveness of Heat Modalities and Vibration Plate Therapy on Hamstring Flexibility: A Randomized Control Study

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ABSTRACT

An important aspect of sports medicine is flexibility and its role in injury prevention and performance enhancement. The purpose of this research study is to compare the differences in flexibility associated with vibration platforms, moist heat packs, low emitting diode (LED) therapy, and diathermy. Testing was done at the hamstring complex and flexibility was measured through a sit and reach test. Volunteer test subjects (n=75) were between the ages of 18-25. The subjects were placed in the control group or one of the four experimental groups. The sit-and-reach test was used to measure lower extremity flexibility. The results showed p-values of 0.22, 0.34, 0.45 and 0.71 for diathermy, vibration plate, moist heat and LED respectively. Although there was no statistical significance between any of the different testing groups, the results suggested the possibility of clinical relevance or the need for further research on the use of certain modalities that are generally not used due to cost, such as diathermy and vibration plates.

INTRODUCTION

Therapeutic modalities and joint flexibility are both much-studied aspects of sports medicine. However, there is a shortage of comparison studies with regards to how modalities impact flexibility. Flexibility has been defined as the mobility of a body segment, dependent on soft tissue tolerance to movement and the ability of soft tissue to move with forces applied to it (Houglum, 2010). Research on flexibility has evolved based on a more modern understanding of the role of stretching and flexibility in injury prevention (Sands, McNeal, Stone, Russell, & Jemni, 2006; Shrier, 2004). Researchers have analyzed the effects of modalities such as ice and heat when paired with exercise or stretching. There are also studies evaluating the efficacy of stretching regimen alone. Many of these studies seem to be inconsistent which demonstrates the need for more research on the topic (Brodowicz, Welsh, & Wallis, 1996; Cetin, Aytar, Atalay, & Akman, 2008; Draper, Castro, Freeland, Schulthies, & Eggett, 2004).

The use of short-wave diathermy, vibration and low emitting diode (LED) as modalities for increasing range of motion are prevalent in rehabilitation settings. Heat is commonly used to increase range of motion, decrease joint stiffness, relieve muscle spasm and pain (Cetin et al., 2008; Henricson et al., 1984). Since short-wave diathermy heats a large area and penetrates deep into the muscle, it is often selected if increase flexibility is among objectives (Cetin et al., 2008).
Moist heat packs provide thermotherapy to the muscles in order to lengthen the fibers and flexibility (Starkey, 2004). Vibration plate therapy uses neurophysiological mechanisms which are influenced by the high accelerations of the vibration plates. This results in reflex muscle contractions and neurogenetic adaptations which are associated with neurogenetic flexibility of the muscle (Bosco, Colli, & Introini, 1999; Tillaar, 2006). These vibrations also impact pain sensations and the vibration plates create the same mechanisms compared to PNF stretching (Tillaar, 2006). The purpose of this study was to compare changes in flexibility pre and post short-wave diathermy, LED and vibration plates, and moist heat pack application.

**METHODS**

All subjects were male and female volunteer undergraduate students between the ages of 18-25 (n = 75). There were 45 males and 28 females with the mean age for the male being 19.8 years old and the mean age for the females being 20.1 years old. They were randomized into one of the five groups. Each patient gave written informed consent before proceeding. The Physical Activity Readiness Questionnaire (Par-Q), a survey commonly used for physical activity, was used to determine whether or not an individual would be able to safely participate in the study. Any subject who answered “yes” to any of the possible disqualification questions on the PAR-Q, was further questioned by an investigator who was a certified athletic trainer. Exclusion criteria included presence of a lower extremity injury that occurred within 2 weeks, or a spinal disk injury, which would be a contraindication for the vibration platform. However, none of the participants met any exclusion criteria.

The research was approved as safe for human subjects by an Institutional Review Board. The participants received no monetary compensation for their participation and were allowed to withdraw participation at any time. However, no dropouts occurred. Data collection for control, shortwave diathermy, LED, and moist heat packs occurred in a human performance laboratory. Vibration plate data collection occurred in an adjacent building, where the vibration apparatuses are housed. All measurements of the sit and reach box took place in the human performance lab. All sit and reach testing protocols yield moderate validity for measuring hamstring flexibility based on the specific . We chose to use the sit and reach test over other tests that measure hamstring flexibility because they are still the only field-tests that are practical and easy to administer (Bandy & Irion, 1994). The research conducted for this study took place within a specific time frame, between 12:00 and 2:00 PM and that was consistent throughout.

Before each modality, subjects were asked to perform a sit and reach test with no shoes on using a Figure Finder Flex-Tester. Each patient placed the soles of their feet flat against the box with their legs fully extended. They then placed both hands, one on top of the other, on the measuring portion of the box, making sure that neither reached out further than the other. Next, each patient was asked to reach forward as far as possible while exhaling and dropping the head without flexing the knees. They were also instructed to maintain a slow and controlled motion rather than a quick and jerky movement. The tester then recorded the resulting score. Each patient performed three trials, from which the best of three was recorded. The sit-and-reach test was repeated a second time immediately after the application of the corresponding modality. In addition, before each modality was applied, the tester ensured no contraindications were present. Also, the tests were performed at mid-day for each subject so as to keep the conditions as similar as possible for each test.

The control group did not have any modality applied. They performed the sit and reach
test. They were then asked to sit in a comfortable position with their legs in an extended position so as not to tighten the hamstrings for 15 minutes. After, they performed the sit and reach test again and the data were recorded.

For short-wave diathermy, we used the ReBound ReGenerator Pro Diathermy Generator® using garment bags that were sized for the patient. Both legs were tested during the sit and reach test, but the dominant leg had short-wave diathermy applied to it. Short-wave diathermy was applied while the patient was either supine or seated with their knee extended in a comfortable position, whichever the patient felt to be more comfortable. The machine and garment bag were tuned to the patient so that it could provide the best treatment and the timer was set for 15 minutes at 100% continuous as has been performed in a previous study (Draper, Miner, Knight, & Richard, 2002). The sit-and-reach test was then performed again on both legs.

During LED therapy, the Solaris Series Dynatron 709® with a 3cm diameter head was used. Both legs were tested during the sit and reach test and the dominant leg had the laser therapy applied to it. LED therapy was applied while the patient was prone and in a comfortable position with knees extended. The tester and patient were wearing protective eyewear and the power/intensity was set at 2(J/cm²) with a wavelength of 600-1000 nanometers for a total of 5 minutes. The probe was placed directly on the skin over the hamstrings and moved after each 10 second interval throughout the hamstring musculature. The sit-and-reach test was then performed again.

In the application of the Chattanooga Hydrocollator® moist heat packs, both legs were tested during the sit-and-reach test and the modality was applied to both of them. In addition to the cover, two towels were placed around the moist heat pack. Patients were placed in a comfortable prone position and a moist heat pack was placed on both hamstrings. Patients were asked to maintain contact with the moist heat packs for 15 minutes while the tester continuously checked the patient and added towels if necessary. The moist heat packs were removed at the end of the 15 minutes. The sit-and-reach test was then performed again on both legs.

During vibration plate therapy, the Vibraflex Control 550® was used. Both legs were tested during the sit-and-reach test and had the modality applied to the patient. The patient was asked to stand with feet shoulder width apart and the knees slightly bent standing on the platform. The vibration plate was set at 25 hertz and ran for 5 minutes as has been suggested by previous studies (Gerodimos et al., 2010; J Rittweger, 2010). The sit and reach test was then performed again on both legs.

RESULTS

Seventy-five patients completed the trial. There were 18 participants in the control group (11 males, 6 females); 13 participants in the diathermy group (9 males, 5 females, 1 did not give gender); 14 participants in the laser group (10 males, 4 females); 16 participants in the moist heat group (6 males, 7 females); and 13 participants in the vibration group (7 males, 6 females).

The main question asked if there was a difference between pre and posttest scores between five different groups. a three way mixed ANOVA was used to analyze the data because the design of the research was a repeated measure. The alpha was set at .016 since three statistical tests were conducted on the data. There was no statistical significance between the pre and posttest values for each modality since the p-value was .306. There was also no statistical significance between pre and posttest broken down by gender, since p was .552. Furthermore, there was not a statistical significant difference in pre and posttest broken down by modality and
gender, since the p value was .447. Since all three p values were greater than the alpha of .016, we failed to reject the null hypothesis.

Additionally, the mean/medians between the groups were analyzed to see any changes that were made. This information can be found in Table 1. Since the mean and the median were greater than a quarter of a standard deviation apart in a few cases, it is appropriate to report the medians and the standard deviation although both are shown.

**TABLE 1.**

<table>
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<tr>
<th>Modality</th>
<th>Pre-Test Males</th>
<th>Post-Test Males</th>
<th>Pre-Test Females</th>
<th>Post-Test Females</th>
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<td>Control</td>
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DISCUSSION

The purpose of the study was to compare short-wave diathermy, LED, and vibration plates with moist heat packs to a control group. Short-wave diathermy and vibration plates have a possibility of more promising results than LED and moist heat packs. With a larger sample size, it is possible that the P-value may have changed to a statistically significant value. Deep tissue heating can facilitate muscle elongation and can cause muscle to retain the increase in length for a longer amount of time following the treatment. In a recent study, it was shown that the use of ultrasound, which penetrates deep into the tissues, increased tissue temperature and created greater tissue extensibility (Knight, Rutledge, Cox, Acosta, & Hall, 2001). The principle of deep heat versus superficial, when applied to our study, can be used to explain why short-wave diathermy possibly produced a greater difference compared to LED and moist heat, which are types of superficial heat modalities.

There have been several studies that investigate the effects of vibration on the development of strength and power, but very rarely do they include data on flexibility and range of motion. From our extensive review of literature, we were able to find a few comparable studies indicating that vibration plates increase muscle extensibility and enhance range of motion. Previous studies have observed that vibration training is associated with an increase in heart rate and blood flow, which, in turn, increases tissue temperature and consequently affects muscle flexibility (Kerscjan-Schindi, Grampp, & Henck, 2001; J. Rittweger, Beller, & Felsenberg, 2000). Vibration plate therapy also increases the sensitivity of the stretch reflex by inhibiting the activity of the agonist muscles therefore, inducing muscle relaxation (Kerscjan-Schindi et al., 2001). We found that the randomly selected patients who participated in vibration
plate therapy for five minutes produced the second largest average increase between pretest and posttest values, second only to diathermy, but again, without any statistically significant difference. When compared with the control group, which had about a 1cm increase, the vibration therapy group almost doubled the increase. The control groups’ values, as well as the increases for all of the groups could have been due to the learning effect, since the patients had more experience performing the sit-and-reach the second time.

Most of the literature on moist heat packs, looks at it in conjunction with stretching, making it difficult to decipher how much of the increase in flexibility is attributed to the heat and how much is attributed to the actual stretching. us to determine whether the superficial heat itself increased flexibility. Our results indicated a very low percentage of efficiency assurance and coincided with other studies that also determined the ineffectiveness of this modality.

The use of LED therapy to increase muscle flexibility, according to our study, was ineffective and the results were substantially lower than the rest. Its ineffectiveness could be due to the relatively large surface area of the hamstring in relation to the surface area of the LED head. Although there were set parameters for the use of the laser therapy, inter-tester reliability may have also contributed to the results since several testers performed the LED application.

**CONCLUSION**

This research study found that shortwave diathermy had the greatest difference between pretest and posttest scores, followed by vibration plate therapy. However, the differences between pretest and posttest were not statistically significant. This information is important for clinicians given the prevalence of moist heat pack use compared to other modalities. Since shortwave diathermy and vibration plate therapy produced greater differences in hamstring flexibility compared to moist heat packs and laser therapy, current and future clinicians may now consider using these modalities more often. At the least, it shows the importance of further testing on these modalities in order to determine their effectiveness.

There are a few reasons why the data may not have shown a statistically significant difference in the pre and posttest scores and possible threats to validity. The first reason could be due to sample size in each of the groups. It would be helpful to have more participants in each group. Also, there could have been a validity issue in the testing measures. There is the chance that the scores were influenced because the subjects may have known what our goals were. If we could have found a way to ethically deceive the participants so that they did not know what the goals were, we may have seen better results.

Future studies may consider incorporating a stretching intervention in addition to the use of the modalities in order to increase hamstring flexibility if that is an objective. Future research should expand the trial length to allow multiple trials involving the same individual. This would allow more consistent and accurate measurements than those produced from a single trial. Additionally, researchers could consider applying modalities to both legs, or only testing the dominant leg during the sit-and-reach test, which would eliminate possible differences between the participant’s hamstring flexibility.
REFERENCES


