Temperature Changes in Distal Quadriceps Muscle after 20- Minutes of Active and Passive Warm-up Treatments

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Background: Heating deep tissue for muscle pain/spasm relief or improvement in tissue compliance is often a goal of both active and passive heating techniques. However, the most optimal method of obtaining increases in both superficial and deep tissue temperature is unknown.
Purpose: To examine the effect of 20-minutes of stationary cycling (Bike), moist hot pack (MHP), and continuous shortwave diathermy (CSWD) on deep and superficial quadriceps intramuscular temperature.
Design: A 3 x 4 within-within repeated measure designs (treatment x time). Treatments included MHP, Bike, and CSWD and time included 5, 10, 15, and 20 minutes. Dependent variable was temperature change from baseline (°C). Alpha was set a priori at 0.05
Setting: Exercise Science/Athletic training research laboratory
Subjects: 11 subjects: males (n= 4) and females (n=7) volunteered for study. Average age: 21 yrs (18-39 yrs). Average mass: 69.7 kgs (59.4-83.9 kgs).
Methods: The deep thermocouple was inserted approximately 4 cm deep into the muscle tissue. The superficial thermocouple was inserted approximately 2.5 cm into the muscle tissue. The thermocouples were interfaced to a desktop computer through an Isothermex®. Twenty-minute treatments were counterbalanced and were applied to the distal thigh. The stationary cycling was completed at warm-up paces (heart rates progressing from 40-50% [10 minutes] and 60-70% [10 minutes]). MHP was applied using typically terry cloth cover and three layers of cotton towel and CSWD delivered at 13.1 MHz, 100% using a standard thigh sleeve.

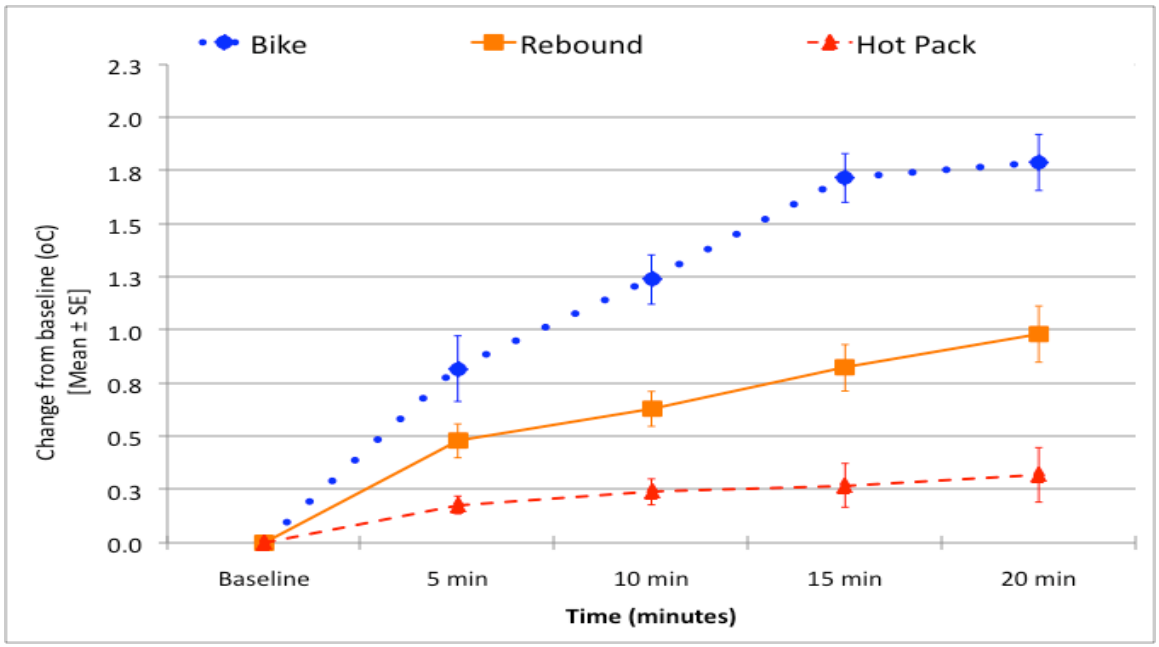

Figure 1: Deep intramuscular changes after 20 minute treatment

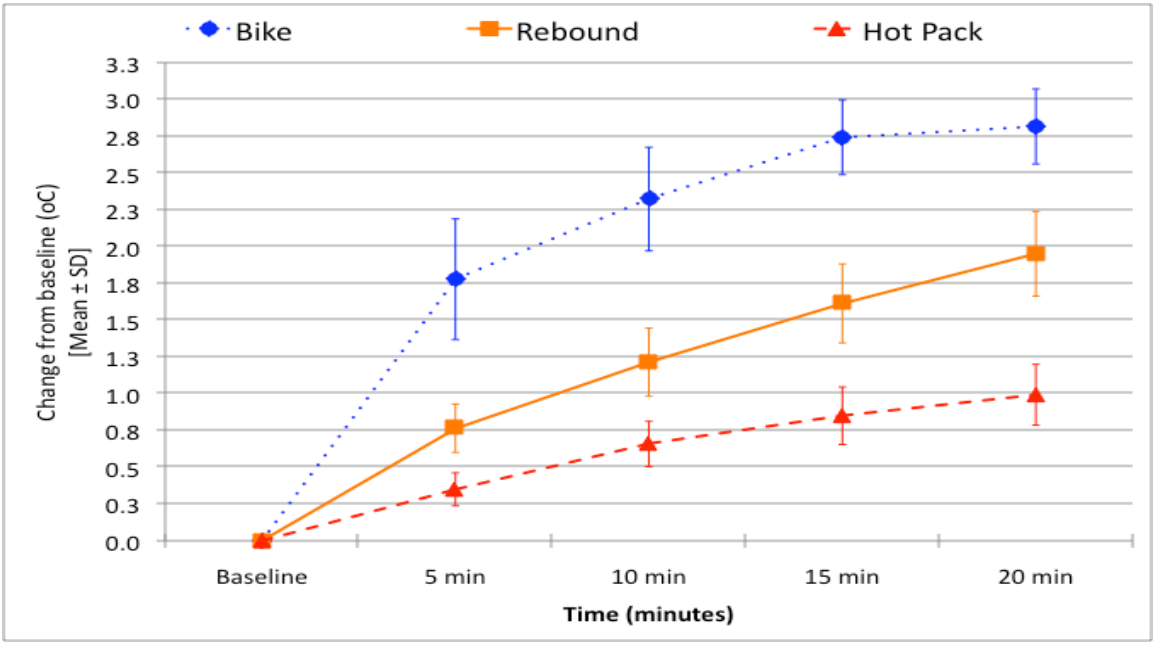

Figure 2: Superficial intramuscular changes after 20 minute treatment

Results: For superficial temperature change there were condition ($F(2, 14) = 17.2$; $p < 0.001$) and time ($F(3, 21) = 29.1$; $p < 0.001$) main effects. Mean±SE were 2.4±0.2°C (Bike), 1.4±0.2°C (CSWD), and 0.7±0.1°C (MHP). Bike was significantly warmer than both MHP and CSWD ($p < 0.05$). For deep temperature change there was a treatment x time interaction ($F(6,60) = 8.98$; $p < 0.001$). By 10 minutes, both CSWD and Bike had heated the deep quadriceps to significantly greater change from baseline than the MHP ($p< 0.05$). Mean±SE at 10 minutes were 1.2±0.2°C (Bike), 0.63 ±0.2°C (CSWD), and 0.23 ±0.1°C (MHP). By 20 minutes the changes were even more pronounced for each treatment (1.8 ±0.2°C (Bike), 0.98 ±0.2°C (CSWD), and 0.32 ±0.1°C (MHP)). CSWD continued to be warmer than MHP; however, active cycling heated the quadriceps the most ($p < 0.05$).

Conclusions: Active and passive heating modalities are often used in the clinical setting because patients who are recovering from injury and/or surgery typically need pain reduction and/or healing stimulation. Both stationary cycling (active) and MHPs (passive) are the most popular methods to produce intramuscular heating, while shortwave diathermy (passive) has traditionally not been as popular. In order to increase tissue metabolism, which would help promote recovery and reduce pain, it has been reported that a 1-2°C tissue temperature rise is the necessary thermal change. Based on our results, active cycling seems the best way to produce 2°C temperature changes in both the deep and superficial quadriceps of healthy subjects. However, not all patients are able to actively cycle for 20 minutes. If the 1°C tissue temperature benchmark is used, then both the Bike and CSWD are effective treatments to raise temperature close to or above 1°C in both the deep and superficial quadriceps whereas MHPs are unable to raise temperature to this level. Therefore when comparing the two passive modalities effect on deep muscle tissue, the CSWD produces greater tissue heating than the MHP after only 10 minutes. Another benefit of using CSWD is that the circumferential sleeve provides heat to both the agonist and antagonist muscles. While further research is being conducted to gain additional information between treatments and the heating effects of CSWD, clinicians are encouraged to use CSWD, as it seems to be a more effective alternative to MHPs especially if the target tissue is deeper.