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Effect of Localized Heating on Vascular Dysfunction

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ABSTRACT

Introduction: One way to quantify vascular dysfunction of an individual is to examine Flow Mediated Dilation (FMD). Aerobic exercise is characterized by increased blood flow and has been shown to either prevent or mitigate vascular dysfunction. However, exercise may not always be possible, especially in occupational settings that require long bouts of sitting or standing. Localized heating of the lower limb may be an alternative, especially since it also increases blood flow. However it is unknown how localized heating affects vascular function during prolonged sitting and standing. **Purpose:** The purpose of this study was to look at the effect that localized heating of the lower leg had on the FMD of the superficial femoral artery. We hypothesized that compared to the unheated leg; FMD will increase in the heated leg, indicating improved vascular function. **Methodology:** 26 healthy adults (13 male and 13 female) 18-30 years old completed this study. Participants completed 2 experimental trials. In one trial, subjects stood for 120 minutes while in the other trial the participants were required to sit for the 120 minutes. In both trials the treated leg was randomly selected, and a water perfusion suit was applied to the lower portion on the subjects leg (knee to ankle) and heated by circulating 49 °C water through the suit. Before, during (measurements where taken at the 10, 25, 50, 85, and 120 minutes) and after the experimental trial heart rate (HR) and mean arterial pressure (MAP) were recorded. FMD was measured before and after the 120 minutes of sitting/standing while the participant was in the supine position. **Results:** While controlling for FMD in the heated leg compared to the unheated leg did not significantly increase (1.49% 95% CI [-.01, 3.1]). In other words, there was a non-significant main effect of heating on FMD. Both MAP and HR increased during the standing and sitting periods, but returned to the baseline once the participant was supine. MAP increased by 9 mmHg (SD= 8.1, p<.001) and HR increased by 20 beats per minute (SD= 13.4; p<.001). **Conclusion:** The results of this study shows that localized heating of one lower limb during long duration sitting and standing did not increase FMD. However, in the control, unheated leg FMD did not decrease, thus it may not be too surprising that heat stress had no effect. That is, FMD could have been at a "ceiling" with no more room for improvement. However, larger, future studies should investigate if the statistically non-significant increase is clinically significant. Likewise, future studies should investigate if the setup could be applied to an occupational setting.

INTRODUCTION

- A major contributor to vascular dysfunction is the increase in sedentary lifestyles.
- A gold standard method of measuring vascular dysfunction is by measuring the flow mediated dilation (FMD) of an artery.
- Localized heating and exercise have a very similar vascular response in the body, because they both increase blood flow, which is beneficial to vascular health. However, exercise is not always feasible.
- Localized heating may be an effective counter-measure to the development of vascular dysfunction during long duration standing and sitting.
- We hypothesized that compared to the unheated leg, FMD in the heated leg would increase, indicating improved vascular function.

METHODS

Subjects

- 26 healthy adults (13 male and 13 female) 18-30 years old.

Protocol

- Two experimental trials where the subjects stood or sat for 120 minutes.
- In each trial the treated leg was randomly selected and a water perfusion suit was applied to the lower leg (knee to ankle) of the subject and heated to 49°C.
- Each trial consisted of a 20 minute baseline period, 120 experimental period, and a 20 minute post trial period (Figure 1).

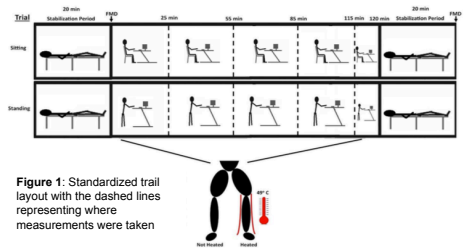

Figure 1: Standardized trail layout with the dashed lines representing where measurements were taken

Measurements

- During each trial the subjects had heart rate (HR), mean arterial pressure (MAP), and flow mediated dilation (FMD) measured.
- Flow Mediated Dilation was measured during the 20 minute baseline and 20 minute post trial period using a Doppler Ultrasound Machine.
- Mean arterial pressure and heart rate were both measured during each trial at minutes 10, 25, 50, 85, and 120.
- Mean arterial pressure was calculated using the formula:

  MAP= [(1/3)*Systolic Blood Pressure] + [(2/3)*Diastolic Blood Pressure]
- Heart rate was measured using the Sun Tech Tango+ and recorded in beats per minute.
- As part of a larger research question pulse wave velocity, endothelian-1, and circumference of the ankle and calf on both legs was measured (data not shown).

RESULTS

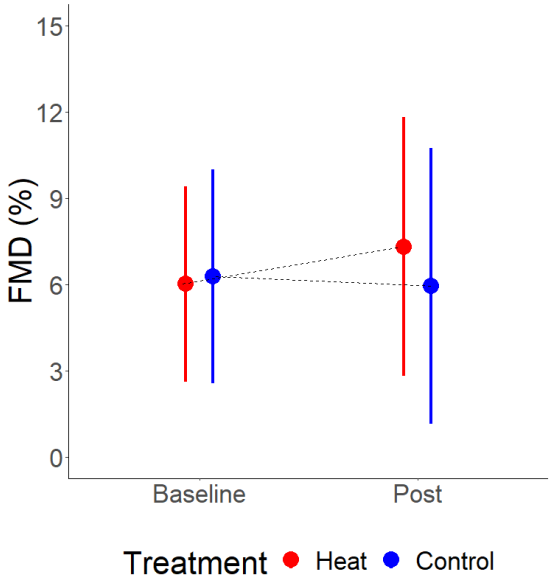

Figure 2. Flow-mediated dilation (FMD%) from baseline to post trial when the limb is passively heated or kept normothermic

- Compared to the FMD of the unheated leg the heated leg had no significant increase in FMD (1.49% 95% CI [-.01,3.1].
- During the 120 minute experimental period, heart rate increased 20 beats per minute (P<.001) showed an increase during the trial but returned to baseline during post trial.
- Mean arterial pressure increased 9mmHg (P<.001) showed an increase during the trial but returned to baseline during the post trial measures.

CONCLUSIONS

- Localized heating of one lower limb during long duration sitting and standing did not increase flow-mediated dilation (FMD).
- However in the control, unheated leg, the FMD showed no decrease. Since the control showed no decrease in FMD it may not be surprising that heating had no effect on FMD due to a low threshold, creating a "ceiling effect" in the body.
- Therefore, it can be concluded localized heating of the lower limb during prolonged sitting and standing has no significant impact on FMD.

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