

## **The Effects of Dose and Application of Menthol on Local and Systemic Strength and Blood Flow**

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The purpose of this study is to compare the peak quadriceps strength and popliteal artery blood flow in both the treated and untreated legs under three treatment conditions (3.5 % menthol, wipe with 10% menthol, and a control condition with no application of menthol). 16 healthy young adults (mean age = 24±2.97, mean body fat percentage = 17.61±6.35, male = 50 %, female = 50%) were recruited to participate in a 3 week protocol. Prior to undergoing any data collection session all subjects completed written informed consent and a familiarization trial in order to acquaint them with the blood flow and leg strength data collection protocols. Following this familiarization trial subjects completed a data collection session once per week for the next three weeks. One of three randomly applied treatments (3 ml of menthol 3.5% ointment, 1 menthol wipe 10% and a non treatment control) were applied to individual subjects right thigh. Following obtaining the subject's informed consent subjects were assessed at baseline for popliteal blood flow (ml/min) and arterial diameter (mm) in both legs using a Doppler ultra sound. Following this initial assessment of blood flow each subject's maximum isokinetic leg extension (quadriceps) and flexion (hamstring) (max torque in kg) in both legs were assessed. Immediately following this baseline blood flow and strength assessment a treatment was applied to the subject's circumferential right thigh from the knee to the inguinal fold. At 5 minutes following the application of the treatment blood flow was again assessed in both legs. At 15, 25 and 35 minutes following the application of the treatment maximum leg extension (quadriceps) and flexion (hamstring) in the leg

where the treatment was applied was again assessed. Repeated measures analysis and Fisher's LSD post hoc analysis ( $p < 0.05$ ) addressing significant main and interaction effects was employed to address the study hypotheses. This analysis indicated a significant interaction of time by group on the arterial blood flow or arterial diameter of the right leg. When menthol 3.5% ointment was applied blood flow and arterial diameter in the right leg declined significantly. The menthol wipe had no significant effect on blood flow with a significant decrease in arterial diameter. Under the control condition the right leg blood flow and arterial diameter significantly increased. The left leg which did not receive direct treatment the menthol 3.5% ointment treatment resulted in significant declines in blood flow on the left while arterial diameter in the left leg did not change. The menthol wipe treatment did not change blood flow or arterial diameter in the left leg. Under the control condition the blood flow significantly increased in the left leg with no change in arterial diameter. No significant differences within or between treatment groups were observed over the four data collection points at which strength was assessed. These findings indicate that menthol 3.5% ointment significantly reduced blood flow and arterial diameter in the leg where the treatment was applied and appears to significantly reduce blood flow in the contralateral leg indicating a systemic effect of the treatment. The menthol wipe did not effect blood flow in the treatment leg but exhibited lower blood flow compared with the control condition. The menthol wipe did reduce arterial diameter in the treatment leg with no impact in the contralateral leg. No treatment had a significant effect on strength in either leg. The differences in the effects of menthol 3.5% ointment and the menthol wipe may be attributable to the medium in which the menthol is suspended.