Effects of Cryotherapy on Quadriceps Concentric Peak Torque

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1. Introduction

Cryotherapy, meaning "cold therapy", is the application of cold for the treatment of acute trauma, subacute injury, and for the decrease of discomfort after reconditioning or rehabilitation. If applied immediately following injury, cryotherapy has been shown to decrease pain, muscle spasms, tissue damage, and/or swelling.[1]

Ice is commonly applied in the athletic setting to injured athletes or to patients in the clinical environment for treatment of injuries. If strength is immediately affected after application of ice, the athlete could be at an increased risk for injury. In addition, if the athlete's performance is affected, then it is important to know at what point strength will return to normal. The results of this study indicate icing may affect peak torque production or time required to return to peak torque of the quadriceps muscle group. In the realm of physical therapy, high speed activities involving the lower extremities immediately following icing of the quadriceps may be ill advised. In general, caution should be exercised any time strenuous activities are demanded of individuals receiving cryotherapy when adequate time is not given for muscular recovery.

2. Experiment, Results, Discussion, and Significance

A convenience sample of 27 adult male volunteers was studied. Each subject gave written informed consent and completed a medical history questionnaire prior to participation in the study. Participants filled out a health questionnaire in order to fulfill inclusion criterion (no lower extremity injuries or allergies/adverse reactions to cold). A subject was also excluded if their body mass index (BMI) exceeded 29.90. Each subject was tested at the same facility, using the same equipment. A subject was assigned a participant number to protect confidentiality. All subject rights were protected.

Concentric quadriceps strength was measured by angular peak torque generated on an open-chain isokinetic machine: The Lido Active (Loredan Biomedical Inc., Davis, CA). This equipment is a reliable method of assessing torque and velocity[2]. Exercise was conducted on a Schwinn® Airdyne® dual action exercise bike (exercise bike), configured to allow concurrent upper and lower extremity exercise. As a safety measure, Polar® heart rate monitors were used during the exercise phase to monitor heart rate. For the treatment phase, a moist white cotton towel was placed in a single layer over the thigh. A plastic bag filled with ice was placed over the towel. One tablespoon of salt was added to the bag to facilitate melting and create a colder mixture.[1] The ice bag was secured to the subject's thigh with a 4" x 5 yard ACE (Becton Dickinson and Company) bandage to provide optimum contact. The subject was positioned in a normal sitting position (short-sitting) on the isokinetic machine and given an explanation of the testing procedure. Right quadriceps concentric peak torque was tested in all subjects. All isokinetic testing was performed at 60 and 240°/s. The order of testing velocities (60 and 240°/s) was randomized using a coin flip. The machine was set at 5 to 90 degrees knee flexion for participant comfort. Each subject performed several contractions at each speed to become familiar with the machine. The subject executed 3 maximal contractions at the first testing velocity, rested for 30 seconds, and then executed maximal contractions at the second velocity. The maximal peak torque was recorded as "initial pre-exercise peak torque" for both test velocities. The subject was transferred to the exercise bike and exercised for 15 minutes at the target heart rate. After the exercise phase, the subject was returned to the isokinetic machine and performed 3 maximal contractions at both test speeds. The maximum peak torque was recorded as "post-exercise peak torque." Immediately following the post-exercise peak torque measurement, the subject underwent the treatment phase. The treatment group received ice to the quadriceps muscle, or right thigh, sitting comfortably for 20 minutes following exercise. The control group sat for 20

minutes without ice following exercise. At the end of the treatment phase, the ice modality (if present) was removed and the subject performed 3 maximal contractions, at the initial test velocity recorded as "post-ice peak torque (post test 1)." Measurements at the second test velocity were taken following a 30 second rest period. If either measured peak torque did not reach baseline levels, concentric peak torque measurements were re-assessed at 2-minute intervals until baseline was reached or a period of 8 minutes elapsed. Baseline peak torque is defined as the highest recorded peak torque value, based on "initial pre-exercise peak" and "post-exercise peak torque" measurements. However, if the "post-ice peak torque" measurements were within 1% or equal to baseline values or higher, at either velocity, further testing at that velocity was not conducted. At the conclusion of testing, each participant was instructed on proper cool down and stretching to diminish the possibility of post-test muscle soreness.

Descriptive statistics including means and standard deviations were calculated for each of the following variables for each group: height, weight, BMI, time until pre-torque levels were achieved and all pre-post peak torque measurements. A mixed design ANOVA was used to determine if cryotherapy affected pre and post-exercise peak torque. An independent t-test was used to determine if time to normalize peak torque was affected by cryotherapy. Statistical significance was defined as a p value less than .05 ($\propto$ = .05). The analyses were done using SPSS v13.5.

TABLE 1. Characteristics of subjects by groups: Mean (+/- SD) Height, Weight, and Body Mass Index (BMI).

	Treatment group (n = 14)	**Control group (n = 13)**
Height (cm)	180.5 (7.5)	179.2 (5.0)
Weight (kg)	84.7 (10.6)	81.4 (9.4)
BMI*	26.0 (2.9)	25.3 (2.9)

*BMI = (kg/m^2)

TABLE 2. Changes in peak torque (N•m) over time in treatment group (n=14) and control group (n = 13).

Speed (degree/second)	**Pretest**		**Post Exercise**		**Post test 1**	
	Treatment group	Control group	Treatment group	Control group	Treatment group	Control group
240	176.9*	165.5	179.5	176.0	169.6*	180.4
60	268.8	261.9	268.0	272.9	266.0	282.0

(* = Significant Difference at <= 0.05)

TABLE 3. Mean (+/- SD) time to recover at 240 and 60 (degree/second) for treatment group and control group.

Speed (degree/second)	**Group**	**Mean** (+/- SD)	**95% Confidence Interval about the Mean Difference**
240	Control group (n=13)	1.38 (1.70)	1.44 +/- 2.101 (.74)
	Treatment group (n=12)	2.83 (1.99)	
60	Control group (n=12)	.33* (1.15)	1.12 +/- 2.101 (.51)
	Treatment group (n=11)	1.45* (1.29)	

(*= Significant Difference at <= 0.05)

3. Conclusions

The results showed a significant decrease in peak torque at the higher velocity after the application of ice. Results at the slower velocity showed an increased duration of time required to return to baseline peak torque values following ice. Due to the limitations and errors experienced, further investigation would be of great clinical value.

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