

Accelerated Recovery of Muscle Function in Baseball Pitchers Using Post-Game Phase Change Material Cooling

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ABSTRACT

PURPOSE: No studies have documented recovery of strength in baseball pitchers nor interventions to accelerate strength recovery on the days after a pitching performance. The objectives of this study were to (1) document indices of recovery following a pitching performance, and (2) determine if recovery can be accelerated by providing prolonged post-game phase change material (PCM) cooling to the shoulder.

METHODS: Shoulder strength, pain and plasma creatine kinase (CK) levels were measured in 11 college baseball pitchers 48 h prior to a game, and 12 h and 36 h afterwards. Players were randomized to wearing PCM cooling packs (15° C) within a compression shirt for 3 h post game (PCM treatment), versus no treatment (control) and received the opposite post-game treatment one week later (randomized crossover design). Strength in internal rotation (IR), external rotation (ER) and empty can test (EC) was assessed using a hand-held dynamometer. Pitchers threw 45 pitches on each occasion. Effect of PCM cooling on strength, pain and CK was assessed with repeated measures analysis of variance.

RESULTS: There was IR strength loss in the control condition (18% at 12 h, 11% at 36 h, P<.01) but no strength loss in the PCM condition (<1% at 12 h and 36 h; Treatment effect P=.06, Treatment by Time P=.03). Similarly, there was ER strength loss in the control condition (14% at 12 h, 11% at 36 h, P<.01) but less strength loss in the PCM condition (8% at 12 h, 7% at 36 h; Treatment effect P<.01, Treatment by Time P=.58). Pitching had no effect on EC strength (Time effect P=.97). CK and pain were elevated on the days after the game (Time effects P<.01) with no difference between treatments (Treatment effect: CK P=.79, pain P=.73; Time by Treatment: CK P=.92; pain P=.70).

CONCLUSIONS: Strength loss, pain and elevated CK were evident 12-36 h post game. PCM cooling protected against strength loss but not pain or CK. Pain (peak 3 out of 10) may have been too low to have been affected by the intervention. This is the first study to document impairments in muscle function on the days after a baseball pitching performance. PCM cooling packs provides a practical means of delivering prolonged post-game cooling after pitchers have departed the training room.

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INTRODUCTION

THE PROBLEM

Considering the significance of pitching to success in baseball, and the importance placed on the number of days between starts, it is surprising that there is a dearth of research on recovery in pitchers. The research on recovery on the days after a pitching performance is limited to a few studies with small samples (6-10 subjects) (Potteiger et al 1992; Yanagisawa et al 2003a, 2003b; Yang et al 2016).

Despite the fact that post-game icing of the shoulder and elbow has been in common practice for years there is no good supporting science specific to recovery in baseball pitchers. The goal of post-exercise cryotherapy interventions is to reduce the proliferation of tissue disruption. Two limitations of post-exercise icing are (1) the thermal discomfort and (2) the limited treatment duration due to risk of cold-induced injury. Repeated ice treatments may be more beneficial than a single treatment but in practice are inconvenient as the athlete must remain in the training room.

Recently post-exercise cooling using phase change material (PCM) cooling packs worn inside compression shorts has been shown to accelerate recovery after eccentric exercise in recreational athletes (Kwiecien et al 2018) and after games in professional soccer players (Clifford et al 2018). The PCM packs in these studies froze at 15°C and maintained this temperature for at least three hours. These interventions provide marked reductions in intramuscular temperature (Kwiecien et al 2019) and allow the athlete to leave the training room while the treatment continues. Thus, the combination of safety and practicality make PCM cooling an attractive recovery intervention for athletes.

PURPOSE AND HYPOTHESIS

The purposes of this study were twofold. The first purpose was to examine the indices of recovery following baseball pitching, specifically examining strength recovery since only one prior small sample study has documented strength recovery in pitchers (Yanagisawa et al 2003b). The second purpose was to examine the effectiveness of post-game PCM cooling on indices of recovery in pitchers. Based on prior work (Kwiecien et al 2018; Clifford et al 2018) it was hypothesized that PCM cooling would accelerate recovery.

METHODS

PARTICIPANTS

16 college pitchers (age: 21±2 yr, 5 freshman, 5 sophomores, 2 juniors, 4 seniors).

MEASUREMENTS OF MUSCLE DAMAGE/RECOVERY



Strength: internal rotation (IR), external rotation (ER), empty can (EC) and grip strength were measured using a hand-held dynamometer (Lafayette Manual Muscle Tester).

Creatine Kinase (CK): CK finger prick blood (Reflotron CK, Roche Diagnostics, Mannheim, Germany).

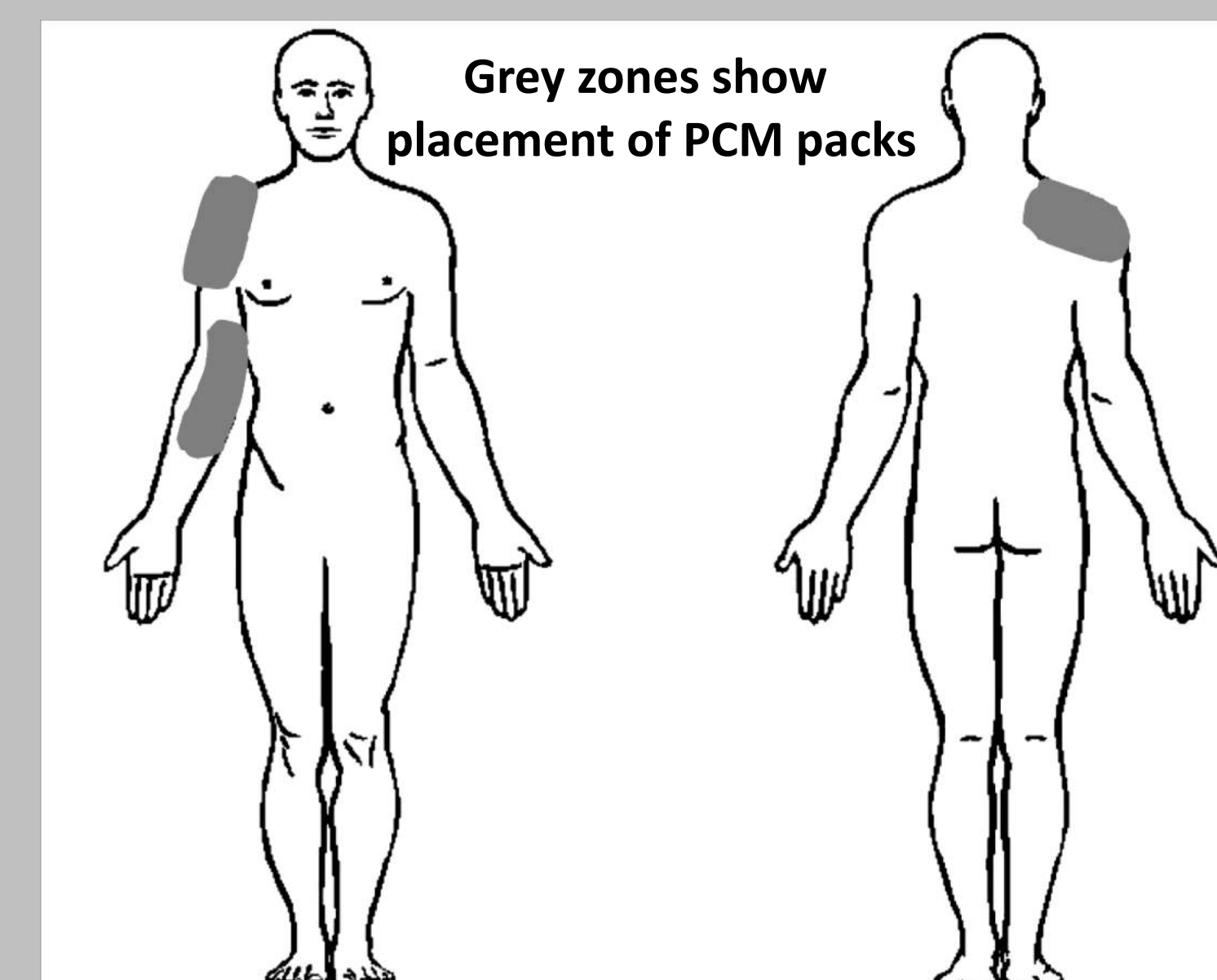
Soreness: VAS 0=no pain or soreness, 10=extreme pain or soreness.



EXPERIMENTAL DESIGN

Testing Pre Game (day before pitching), 1 Day Post Pitching, 2 Days Post pitching. Pitchers randomly assigned to receive PCM cooling packs versus no treatment post game.

PCM COOLING INTERVENTION



Immediately following pitching, 2 PCM packs "frozen" at 15°C (Glacier Tek LLC, Minneapolis, MN) were placed inside a compression shirt. One PCM pack was orientated on the anterior shoulder with the other on the posterior shoulder. A third pack, made of a nylon and filled with flexible PCM microspheres (PureTemp LLC, Minneapolis, MN), was placed over the medial elbow, covering the flexor mass of the forearm held with a compression sleeve (Musetech, TN). The shoulder packs weighed 1 lb each; the elbow pack weighed 1.5 lb.

STATISTICS

Effect of postgame PCM cooling on strength, soreness and CK levels was assessed using treatment (PCM vs. control) by time (Pre, Day 1 post, Day 2 post) analysis of variance with repeated measures for time and treatment as a between subjects factor since not all pitchers had both treatments with matching numbers of pitches.

RESULTS

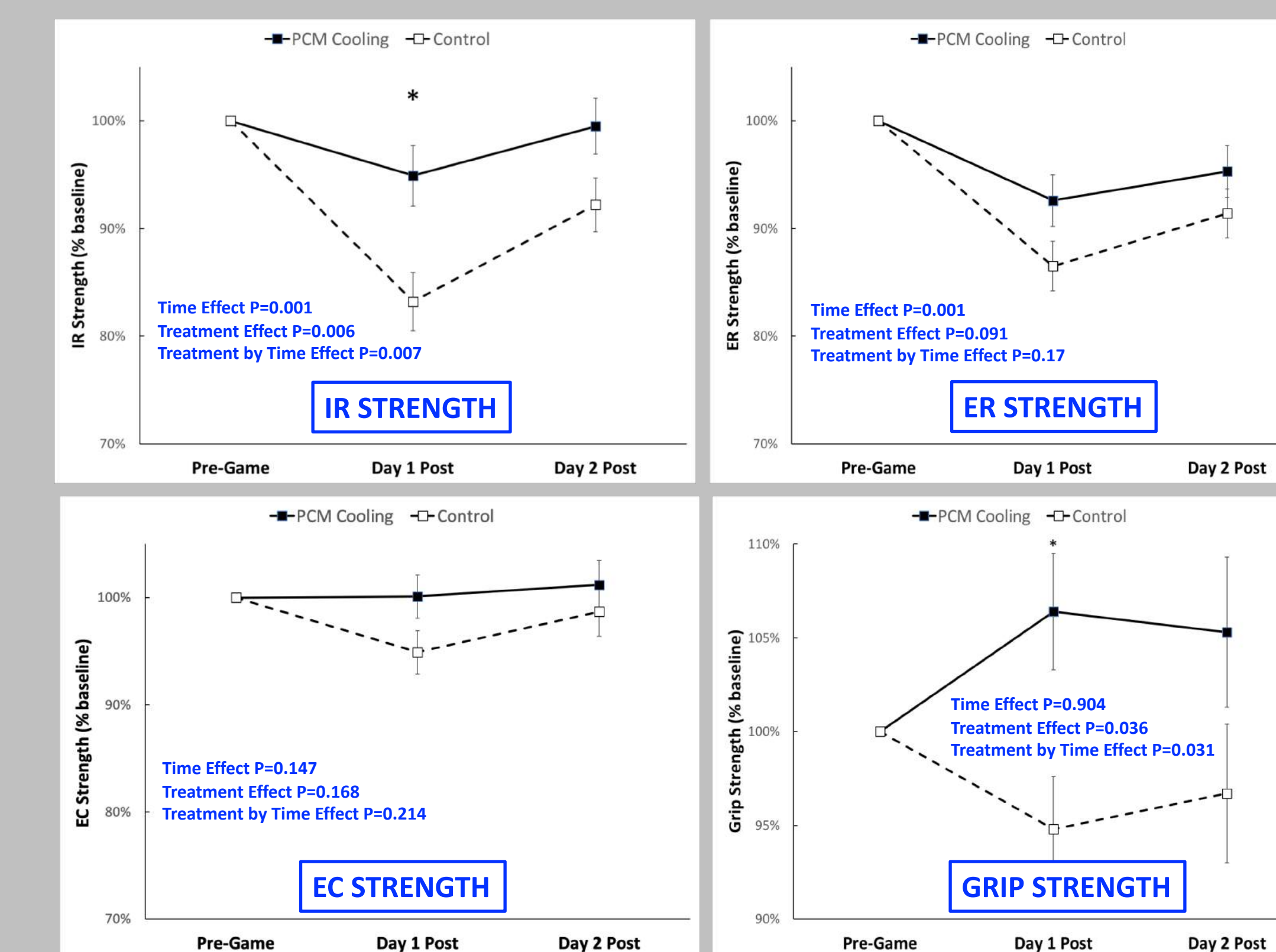
Data were collected in the NCAA sanctioned fall season (September) and the NCAA sanctioned preseason (January/February). All pitchers were on a prescribed number of innings for a given outing and threw a minimum of 45 pitches to a maximum of 90 pitches, depending on the stage of their progression established by the coaching staff.

PCM 23 Games 60±16 Pitches

CONTROL 24 Games 62±17 Pitches

** Elbow PCM was only applied in Jan/Feb games (11 PCM games, 13 control games)

STRENGTH CHANGES



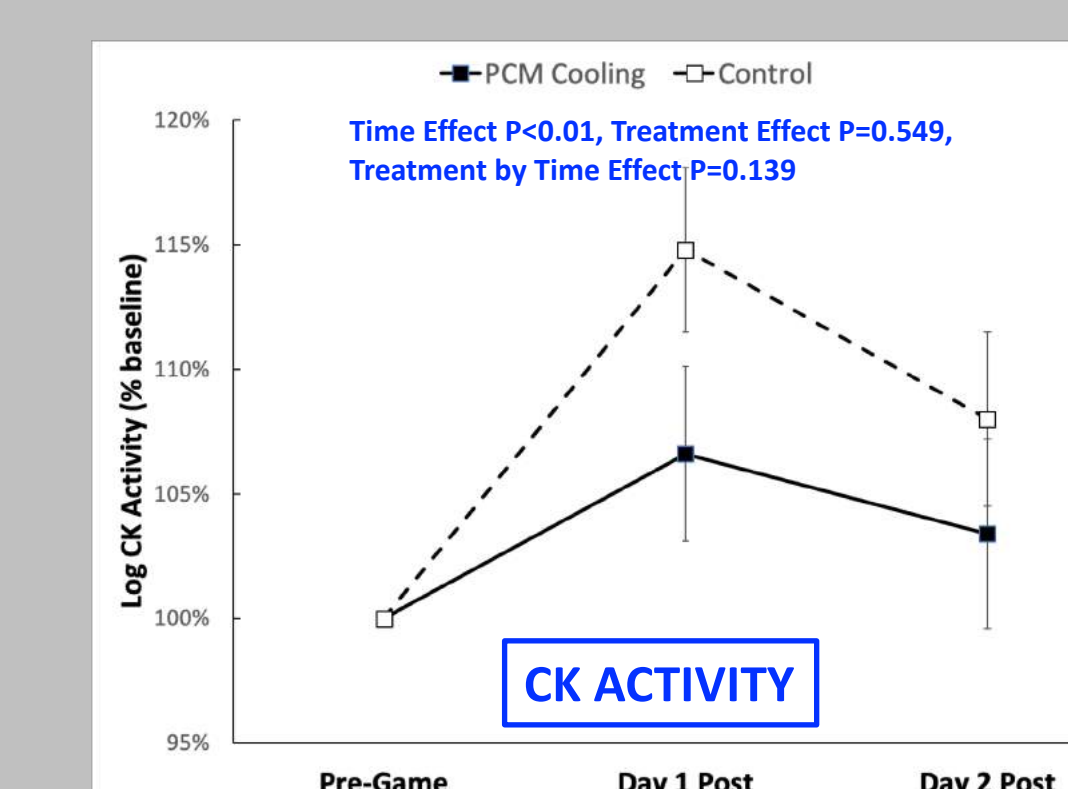
PCM Cooling protected against IR and Grip strength loss

- IR strength was 95±14% of baseline one day after pitching in the PCM cooling condition versus 83±13% of baseline for control (P=0.008)
- One day after pitching grip strength was 106±10% of baseline for the PCM condition versus 95±10% for the control condition (P=0.022)

There was a trend for protection of ER strength.

EC strength was unaffected by pitching and thus there was no treatment effect.

CK CHANGES



CK activity increased on the days after pitching (PCM P=.016; control P<.001), with no significant difference between treatments (P=.139)

SORENESS CHANGES

Shoulder soreness for PCM cooling and control conditions (0-10 scale)

	Pre Game	Day 1 Post	Day 2 Post	Effect of Time
PCM Cooling	0.5±0.9	3.3±1.8*	1.7±1.5*	P<0.001
Control	0.4±0.8	3.2±1.8*	1.8±1.6*	P<0.001

Time effect P<.001, Treatment effect P=0.947, Treatment by Time P=0.885; * significantly greater than Pre Game P<.01. Mean±SD.

Elbow soreness for PCM cooling and control conditions (0-10 scale)

	Pre Game	Day 1 Post	Day 2 Post	Effect of Time
PCM Cooling	0.5±1.2	3.2±2.2*	1.5±1.3	P=.001
Control	0.4±0.8	1.8±1.7*	0.9±1.2	P=.002

Time effect P<.001, Treatment effect P=.134, Treatment by Time P=.206; * significantly greater than Pre Game P<.05. Mean±SD.

CONCLUSION

This is the first study to document impairments in muscle function on the days following baseball pitching, and the first study showing a novel intervention that accelerates recovery of muscle function in baseball pitchers. The results indicate that significant muscle damage occurs in collegiate level pitchers after throwing and average of 60 pitches and recovery is incomplete two days after pitching. Prolonged PCM cooling accelerated recovery of strength but did not impact soreness or CK responses. The effect of PCM cooling of the medial elbow and forearm on grip strength recovery is very encouraging considering the role the wrist flexors play in dynamic stability of the elbow.

Clinical Relevance: PCM cooling packs placed in compression garments provide a practical means of delivering prolonged post-game cooling to baseball pitchers after they have departed the training room.