THE EFFECTS OF COMPRESSION GARMENTS ON RECOVERY PROCESS AFTER A MODERATE-INTENSITY RESISTANCE EXERCISE

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The purpose of this study was to determine whether compression garments (CG) are effective in facilitating recovery after moderate-intensity resistance exercise. Fifteen male subjects performed experimental trials in CG and control conditions during recovery after a deep squat exercise. Jump height, muscle soreness, and creatine kinase (CK) were measured before, immediately after, 24, 48 and 72 h after exercise. The CK was higher at 24h after exercise than before exercise in both conditions ($p = .009$, ES = 1.58). The jump height decreased immediately ($p = .003$, ES = -1.22) and 24H ($p = .012$, ES = -.98) after exercise in both conditions. However, there were no significant differences in CK, jump height and muscle soreness between the two conditions at any time. The application of CG cannot aid in the recovery after a moderate-intensity resistance training.

KEYWORDS: Recovery, compression garment, muscle soreness, resisitance training

INTRODUCTION: Recovery from exercise is essential to maintain performance. In recent years, compression garments (CG) has now been viewed as a potential tool for quicker recovery. The mechanisms behind the recovery benefits of CG are still unclear. The main hypotheses of benefits of CG are improvements in venous return for removal of waste products, the decrease in vibrations, the decrease in muscular micro traumatisms and reduced peripheral swelling(Beliard et al. 2015). A meta-analysis study suggested that the application of compression clothing may aid in the recovery of exercise induced muscle damage (Marques-Jimenez et al. 2016). However, it is not clear whether wearing a CG only during recover time can accelerate recovery after strength exercise. Thus, the aim of this study was to determine whether compression garments worn in recovery time are effective in facilitating recovery after a moderate-intensity resistance exercise.

METHODS: 15 healthy male college student with strength training experience (age 20.9 ± 1.8 y, body height 1.75 ± 0.04 m, and body mass 70.8 ± 5.8 kg) participated in this study. The subjects were asked to avoid vigorous activity 24 h before testing. The research protocol was approved by the Beijing Sport University Human Ethics Committee. Subjects were fully informed of the purposes and risks of participating in this study and signed an informed consent document prior to testing.
The moderate-intensity resistance training protocol consisted of 5-6 sets of 8-12 reps deep squat at 70 to 80% of 1RM.
The subjects performed experimental trials with wearing a compression garment (CG condition) or without a CG (CON condition) during the recovery period after performing the deep squat exercise. The CG and CON conditions were conducted in a random order and were separated 1 week apart. The subjects in the CG condition changed into compression garment after the deep squat exercise. The subjects were asked to wear CG as long as possible for the next 3 days. These compression garments exerted an average pressure of 17.4 mmHg at the thigh and 23.4 mmHg at the calf.
Counter movement jump (CMJ) measurements, subjective feelings of muscle soreness, and blood samplings were repeated before, immediately after, 24, 48 and 72 h after exercise to determine the changes in each parameter over time. Counter movement jump height was assessed with the impulse method using a force plate (9290 Q01, Kistler, Swiss). Participants were instructed to stand with their hands on their hips and perform a maximal jump. Participants performed 5 jumps in each trial and the highest of jumps in each trial was taken for analysis. Blood CK activity was measured by taking fingertip capillary blood samples. The fingertip was cleaned with alcohol and a 30 µL blood sample was taken into a capillary tube.

The sample was taken rapidly from the capillary tube onto the probe and the CK measurement was conducted using the colorimetric measurement procedure (Reflotron Plus, Roche Diagnostic, Germany). Global lower limb muscle soreness was analysed using a 10 points pain scale with no pain at 0 point and unbearable pain at 10 points. Participants were asked to perform a squat to 90° and mark their subjective feelings of pain on the scale.
Means and standard deviations (M ± SD) were calculated for all descriptive measures. A 2-way repeated-measure analysis of variance followed by Bonferroni pairwise comparisons were used to analyze the differences in each variable. When a significant interaction was observed, a 1-way repeated-measure ANOVA were performed. Paired sample t-tests were used to analyze the mean differences between the conditions (CG vs. CON) at the same time points for each variable. All tests were two-tailed and statistical significance was set at $P < .05$. All statistical analyses were performed using Statistical Package for Social Sciences software (SPSS Inc., Chicago, Illinois, USA).

RESULTS: The changes in the CK concentrations are presented in Figure 1. The CK concentrations were significantly higher at 24 h after exercise than those before exercise in both conditions ($P = .009$, ES = 1.58). However, there were no significant differences between the two conditions at any time (condition–time interaction, $P = .914$).
The jump height markedly decreased immediately after the resistance exercise in both conditions ($P = .003$, ES = -1.22). These values remained lower after 24H ($P = .012$, ES = -.975) and then slowly recovered to the pre-exercise values. However, there is no significant difference between CG conditions and CON conditions at any time (condition–time interaction, $P = .242$). Figure 2 represents the changes in jump height over time.
Figure 3 represents the changes in the subjective feelings of muscle soreness over time. The subjective feelings of muscle soreness were significantly higher immediately after ($P = .000$, ES = 1.92), 24H ($P = .000$, ES = 3.03), 48H ($P = 0.000$, ES = 2.32) and 72H ($P = .004$, ES = 1.15) after exercise than those before exercise in both conditions. However, there were no significant differences between the two conditions at any time (condition–time interaction, $P = .689$).

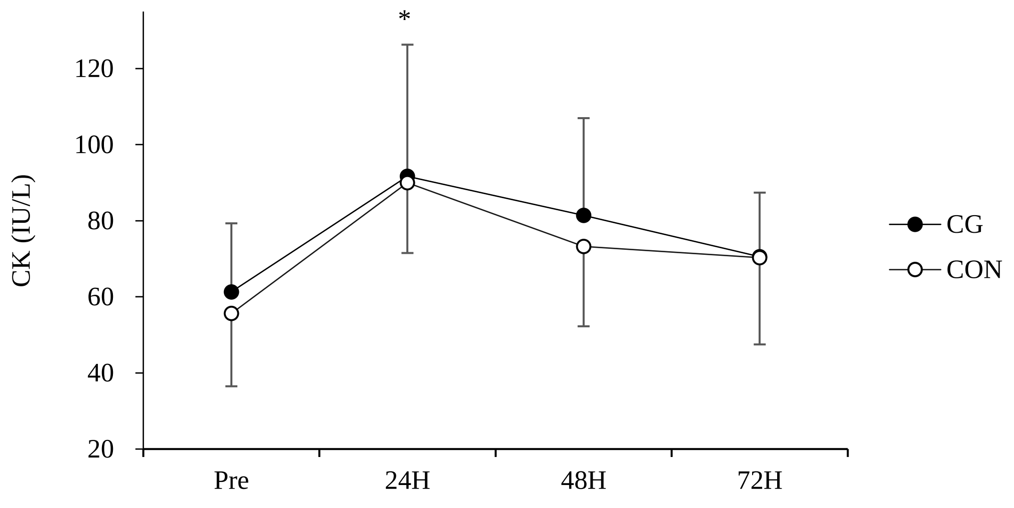

Figure 1: CK (mean ± SD) at before, 24, 48 and 72 hours after the fatiguing protocol. * denotes significant difference compared to baseline (P < 0.05).

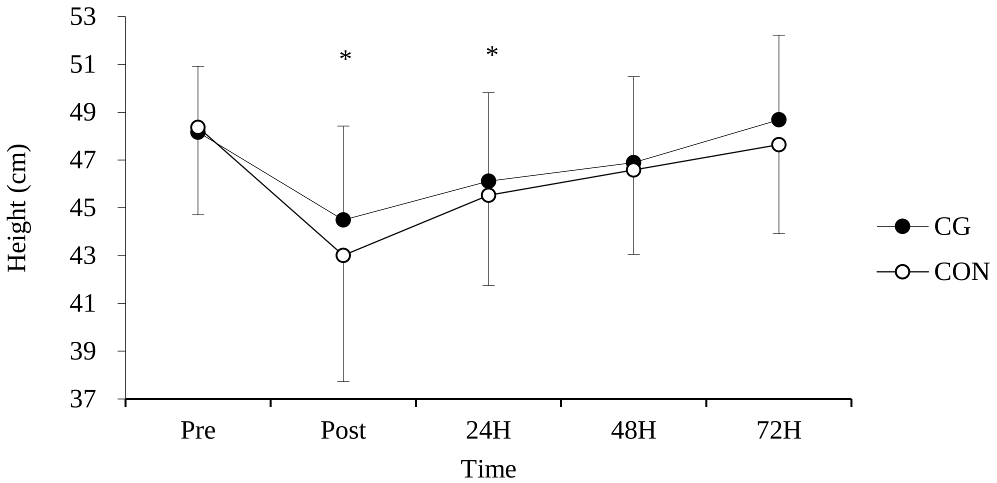

Figure 2: Counter movement jump height (mean ± SD) at before, immediately after, 24, 48 and 72 hours after the fatiguing protocol. * denotes significant difference compared to baseline (P < 0.05).

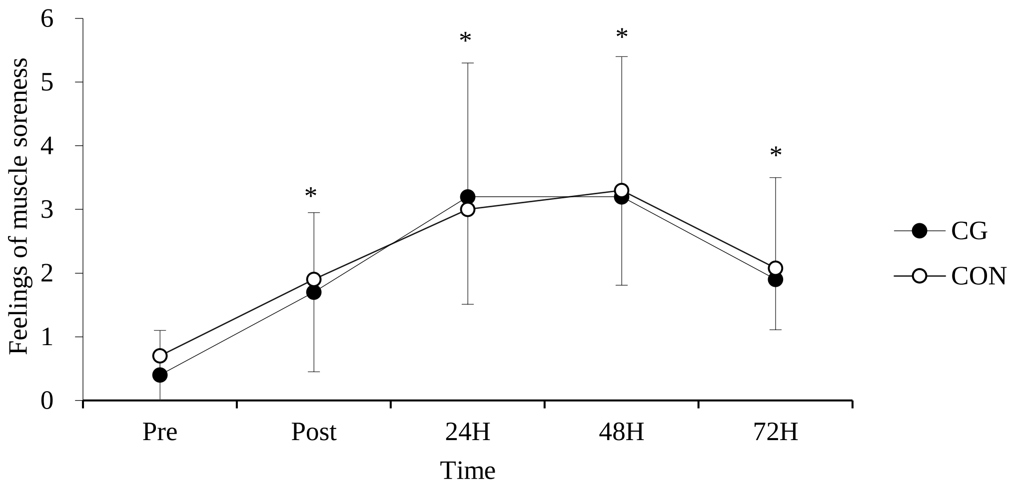

Figure 3: Subjective feelings of muscle soreness (mean ± SD) at before, 24, 48 and 72 hours after the fatiguing protocol. * denotes significant difference compared to baseline (P < 0.05).

DISCUSSION: The current study investigated the effects of compression garments on delayed onset muscle soreness after deep squat exercises in recreational athletes. Evidence for the use of a CG as a recovery tool showed that wearing compression garments for 24 h following intensive resistance exercise led to faster recovery of power output during bench press, and reduced perceived muscle soreness and CK concentrations (Kraemer et al. 2010). However, there was no difference in CK, jump height or muscle soreness between CG and CON conditions in the current study.

Strength exercise that damages skeletal muscle cells results in an increase in blood CK. Therefore, CK is frequently used as a marker of delayed onset muscle soreness. In the current study, there was no difference between conditions, although CK increased significantly after exercise in both groups. Previous investigations have observed reductions in concentrations of CK with the application of compression, which may be attributed to an attenuation of CK into the blood, the improved venous return and the enhanced clearance of metabolites (Ali, Caine and Snow 2007). However, our results indicate that this benefit is not shown. The peak concentrations of CK observed of the current study (161 IU/L), is much smaller than the values

observed in other studies (> 1000 IU/L) (Gill, Beaven and Cook 2006). It is possible compression is not effective at modulating clearance of CK at lower concentrations.
It was believed that CG decreases oscillatory displacement of the leg muscles during vertical jumping, reducing the muscular activity (Nigg and Wakeling 2001). Some evidence from volleyball players wearing compression garments during CMJ task indicates that jump height and leg power may be maintained while wearing compression garments (Kraemer et al. 1996). However, the current study showed no significant differences between CG interventions and control conditions at any time after deep squat exercises.
The application of compression clothing was suggested to improve recovery after muscle-damaging exercise protocols by enhancing lymphatic outflow, thus reducing post-exercise muscle swelling and pain (Born, Sperlich and Holmberg 2013). However, there were no significant between group differences observed for global lower limb soreness, this is similar to previous findings (Hill et al. 2017). The reason may be that the subjects with strength training experience have had extensive exposure to heavy eccentric loading.
The main limitation of the current study is that the moderate-intensity resistance training protocol does not cause enough exercise-induced muscle damage and muscle soreness, which can be inferred from low concentrations of CK and perceived muscle soreness. This might be the primary reason why the compression clothing did not promote the recovery process in the current study. Further studies are warranted to determine the relationship between intensity of strength exercise and benefits of wearing compression garment CG for performance recovery.

CONCLUSION: The findings of the current study indicate that the application of compression clothing cannot aid in the recovery process after a moderate-intensity resistance training workout. Therefore, further studies are warranted to determine the relationship between intensity of strength exercise and beneficial effects of wearing compression garment for performance recovery.

REFERENCES

Ali, A., M. P. Caine & B. G. Snow (2007) Graduated compression stockings: physiological and perceptual responses during and after exercise. *J Sports Sci,* 25**,** 413-9.
Beliard, S., M. Chauveau, T. Moscatiello, F. Cros, F. Ecarnot & F. Becker (2015) Compression garments and exercise: no influence of pressure applied. *J Sports Sci Med,* 14**,** 75-83.
Born, D. P., B. Sperlich & H. C. Holmberg (2013) Bringing light into the dark: effects of compression clothing on performance and recovery. *Int J Sports Physiol Perform,* 8**,** 4-18.
Gill, N. D., C. M. Beaven & C. Cook (2006) Effectiveness of post-match recovery strategies in rugby players. *Br J Sports Med,* 40**,** 260-3.
Hill, J., G. Howatson, K. van Someren, D. Gaze, H. Legg, J. Lineham & C. Pedlar (2017) The Effects of Compression-Garment Pressure on Recovery After Strenuous Exercise. *Int J Sports Physiol Perform,* 12**,** 1078-1084.
Kraemer, W. J., J. A. Bush, J. A. Bauer, N. T. Tripleft-Mcbride, N. J. Paxton, A. Clemson, L. P. Koziris, L. C. Mangino, A. C. Fry & R. U. Newton (1996) Influence of compression garments on vertical jump performance in NCAA Division I volleyball players. *Journal of Strength & Conditioning Research,* 10**,** 180-183.
Kraemer, W. J., S. D. Flanagan, B. A. Comstock, M. S. Fragala, J. E. Earp, C. Dunn-Lewis, J. Y. Ho, G. A. Thomas, G. Solomon-Hill, Z. R. Penwell, M. D. Powell, M. R. Wolf, J. S. Volek, C. R. Denegar & C. M. Maresh (2010) Effects of a whole body compression garment on markers of recovery after a heavy resistance workout in men and women. *J Strength Cond Res,* 24**,** 804-14.
Marques-Jimenez, D., J. Calleja-Gonzalez, I. Arratibel, A. Delextrat & N. Terrados (2016) Are compression garments effective for the recovery of exercise-induced muscle damage? A systematic review with meta-analysis. *Physiol Behav,* 153**,** 133-48.
Nigg, B. M. & J. M. Wakeling (2001) Impact Forces and Muscle Tuning: A New Paradigm. *Exercise and Sport Sciences Reviews,* 29**,** 37-41.