# Compression Garment Promotes Muscular Strength Recovery after Resistance Exercise

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## ABSTRACT

GOTO, K., and T. MORISHIMA. Compression Garment Promotes Muscular Strength Recovery after Resistance Exercise. *Med. Sci. Sports Exerc.*, Vol. 46, No. 12, pp. 2265–2270, 2014. **Purpose**: This study aimed to investigate the effects of wearing a compression garment (CG) for 24 h on changes in muscular strength and blood parameters over time after resistance exercise. **Methods**: Nine trained men conducted resistance exercises (10 repetitions of 3–5 sets at 70% of one-repetition maximum (1RM) for nine exercises) in two trials, wearing either a CG or a normal garment (CON) for 24 h after exercise. Recovery of muscular strength, blood parameters, muscle soreness, and upper arm and thigh circumference were compared between the trials. **Results**: Both trials showed decreases in maximal strength after the exercise ($P < 0.05$). However, the CG trial showed faster recovery of one-repetition maximum for the chest press from 3 to 8 h after exercise ($P < 0.05$). Recovery of maximal knee extension strength was also improved in the CG trial 24 h after exercise ($P < 0.05$). The CG trial was associated with lower muscle soreness and subjective fatigue scores the following morning ($P < 0.05$). The upper arm and thigh circumferences were significantly higher during the recovery period in the CON trial, whereas no change was observed in the CG trial. Blood lactate, insulin like growth factor-1, free testosterone, myoglobin, creatine kinase, interleukin 6, and interleukin 1 receptor antagonist concentrations for 24 h after exercise were similar in both trials. **Conclusions**: Wearing a CG after resistance exercise facilitates the recovery of muscular strength. Recovery for upper body muscles significantly improved within 3–8 h after exercise. However, facilitation of recovery of lower limb muscles by wearing the CG took a longer time. **Key Words:** RESISTANCE EXERCISE, RECOVERY, MUSCULAR STRENGTH, COMPRESSION, FATIGUE, GARMENT, WHOLE BODY COMPRESSION

Because athletes commonly perform intensive physical training or competitions on consecutive days, rapid recovery of performance is important to maximize competitive success and prevent excessive fatigue (1). Several strategies are used in sports to aid the recovery process, including massage, active recovery, water immersion, contrast bathing, and macronutrient supplementation (2,15,31,32). In addition, the use of compression garments (CG) after exercise has been shown to promote strength recovery and attenuate exercise-induced muscle damage (15,23). The scientific evidence for the use of a CG as a recovery medium has come from clinical settings in which they are used extensively for the treatment of chronic inflammatory disorders (9). Another common application of the CG (also termed elastic stocking) is to assist venous return and reduce peripheral swelling in patients with vascular disease (24,27).

In sports, the use of CG during competition is hypothesized to delay the onset of fatigue or increase power output. Although some experimental studies have demonstrated potential beneficial effects of wearing a CG during exercise (3,30), several previous investigations did not confirm the performance-enhancing effect of the use of a CG during exercise (4,13,25). A recent review article by MacRae et al. (25) focused on the efficacious use of CG and exercise and suggested that the use of CG helps with certain aspects of jump performance in some situations (3,20,21). However, only limited data (30) showing the beneficial effects of CG on the performance of other exercise types (e.g., pedaling exercise) are available. A positive effect on faster recovery by wearing a CG during the postexercise period is more apparent (10,16). Kraemer et al. (23) demonstrated that wearing a full-body CG for 24 h after strenuous resistance training caused rapid recovery of power output for the bench press throw and attenuated muscle soreness and creatine

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kinase (CK) levels. Jakeman et al. (18) compared the jump performance recovery after 100 plyometric drop jumps in female volunteers between those who used a CG for 12 h after exercise and those who did not. Subjects who wore the CG showed significantly faster recovery of jump performance. The use of a CG for 24 h after repeated 20-m sprints and 10 plyometric bounds resulted in significantly lower muscle soreness 24 h after the exercise than that in the control group (11). Although these findings suggest that the use of CG produces faster recovery of muscle function and reduces muscle damage after strenuous exercise, the detailed changes in the recovery process over time remain unknown. Considering that most trained athletes often conduct daily training or compete several times in the same day, we wondered how many hours are necessary to promote recovery by wearing a CG in the postexercise period. Therefore, we investigated the effects of wearing a CG for 24 h on the changes in muscular strength and blood parameters over time after resistance exercise.

## METHODS

**Subjects.** Nine men (mean ± SE: age, 21.0 ± 0.4 yr; height, 172.7 ± 2.0 cm; body mass, 69.1 ± 2.4 kg; body mass index, 23.2 ± 0.9 $\text{kg}\cdot\text{m}^{-2}$) participated in this study. All subjects were physically active and had several years of experience performing strenuous resistance training. The inclusion criteria for subject selection were experience with strenuous resistance training for >2 yr and no smoking history. The subjects were informed about the purpose of the study and the experimental procedures, and all provided a written informed consent. The study was approved by the Ethics Committee for Human Experiments at Ritsumeikan University, Japan.

**Experimental design.** The subjects visited the laboratory three times throughout the experimental period. On the first visit, each subject's one-repetition maximum (1RM) for eight exercises was measured to determine the weights to be used for each exercise on the experimental days (amount of time required, 60 min). On the second and third visits, the subjects performed experimental trials with the use of a CG or without the use of a CG (CON) during the recovery period after performing the resistance exercise (amount of time required for resistance exercise, 60 min). The CG and CON trials were conducted in a random order 1 month apart. Immediately after completing the resistance exercise in each trial, the subjects in the CG trial changed into a whole body CG (Recharge; Under Armour, Baltimore, MD). The subjects in the CON trial wore a non-CG. The appropriate size of the CG for each subject was chosen on the basis of the garment's instruction manual and involved measurement of the chest, waist, and ankle circumferences. The subjects wore the prescribed garments throughout the 24-h recovery period, except during performance measurements and when showering at night. The changes in the upper and lower body muscle strength, blood hormone and cytokine levels, enzyme activities, subjective feelings of muscle soreness, and upper arm and thigh circumferences were monitored for 24 h after resistance training. Strength measurements and blood samplings were repeated before exercise and at 1, 3, 5, 8, and 24 h after exercise to determine the changes in each parameter over time. Measurement of muscle soreness was only performed 24 h after exercise. The upper arm and thigh circumferences were evaluated before exercise and at 8 and 24 h after exercise.

For 24 h after resistance exercise, the subjects rested in our laboratory and read books, listened to music, or watched DVD. They were allowed to consume water *ad libitum*. The subjects were given identical lunch (1.5 h after exercise) and dinner (9.5 h after exercise) in both trials. The sleep duration on exercise days was controlled from 2300 to 0700 h.

**Strenuous resistance exercise.** On each experimental trial day (CG or CON trial), the subjects performed warm-up sets comprising 10 repetitions at 50% of the 1RM and stretching of the major muscle groups targeted by the exercises. After these warm-up exercises, muscular strength measurements of the upper limbs (1RM for chest press) and lower limbs (maximal voluntary contraction (MVC)), determination of subjective muscle soreness and circumferences, and collection of resting blood samples were performed to determine baseline values. After completing these baseline measurements, the subjects began the resistance exercises, which comprised six exercises for the upper body muscles (chest press, lat pulldown, seated rowing, shoulder press, arm curl, and triceps press-down) and three for the lower body muscles (bilateral leg press, bilateral knee extension, and calf raise). Each exercise set comprised 10 repetitions involving five sets for bilateral leg press and bilateral knee extension and three sets for the remaining seven exercises. The intensity of all exercises aside from the calf raise was set at 70% of the 1RM. The subjects performed three sets of 20 repetitions of the calf raise. They rested for 90 s between sets and exercises.

**Strength measurements.** To monitor the recovery of upper body muscle strength, the 1RM for the chest press was determined using a weight stack machine (Life Fitness, Ltd., Tokyo, Japan) before performing the resistance exercise and during the recovery period. To measure the 1RM, the load was progressively increased until the subjects were unable to complete a successful lift. The subjects rested for 2 min between repetitions. To monitor the recovery of lower limb muscle strength, the MVC during the unilateral knee extension exercise was measured. The subjects were familiarized with the test procedures before the measurements were performed. The MVC of the right leg was determined using an isokinetic dynamometer (Biodex System 4; Biodex, Osaka, Japan). The subjects sat on a chair with the right ankle firmly attached to the lever of the dynamometer by a strap. The pivot of the lever was aligned with the rotation axis of the knee joint. Alignment of the joint angles and dynamometer axes was maintained during the movement. The MVC was measured at a knee angle of 80° (full extension of the lower leg was expressed as 0°). The subjects were instructed to exert a maximal force for 3 s. The highest value of two trials was adopted.

**Blood sampling and analyses.** Venous blood samples were obtained from an antecubital vein at the same time points as the muscular strength measurements to measure the concentrations of blood lactate, serum free testosterone, insulin-like growth factor-1 (IGF-1), CK, myoglobin (Mb), plasma interleukin-6 (IL-6), and IL-1 receptor antagonist (IL-1ra).

Serum and plasma samples were obtained by centrifuging the blood specimens for 10 min and were stored at −85°C until analysis. The serum free testosterone concentration was measured by radioimmunoassay using commercially available kits (Mitsubishi Chemical Medience Corporation, Tokyo, Japan; Immunotech, California). The plasma IGF-1 concentration was measured with an enzyme-linked immunosorbent assay kit (R&D Systems, Minneapolis, MN). The serum CK and Mb concentrations were measured at the SRL Clinical Laboratory in Tokyo, Japan. The plasma IL-6 and IL-1ra concentrations were assayed with an enzyme-linked immunosorbent assay kit (R&D Systems, Minneapolis, MN). The intraassay coefficient of variation for each measurement were as follows: 6.3% for free testosterone, 5.0% for IGF-1, 0.04% for CK, 7.4% for Mb, 4.5% for IL-6, and 3.4% for IL-1ra. Blood lactate concentration was measured immediately after blood collection using an automatic lactate analyzer (Lactate Pro; Arkray Inc., Kyoto, Japan).

**Measurements of circumference and muscle soreness.** The upper arm and thigh midpoint circumferences were measured using a tape measure before the resistance exercises and at 8 and 24 h after the resistance exercises. Each measurement was performed twice by the same investigator, and the average value of two measurements was adopted.

Twenty-four hours after the resistance exercise in each trial, muscle soreness was assessed using a 100-mm visual analog scale in which 0 mm represented "no pain at all" and 100 mm represented "unbearable pain" (5). The subjects used the visual analog scale to rate the soreness experienced during each measurement.

**Statistical analysis.** Data are expressed as mean ± SE. Changes in muscular strength and blood parameters over time were initially compared using two-way ANOVA with repeated measures. When the ANOVA revealed significant interaction or main effect, the Tukey–Kramer test was performed for *post hoc* analyses. The subjective feeling of muscle soreness was compared using a paired *t*-test. For all tests, $P < 0.05$ was considered to be statistically significant.

## RESULTS

**Recovery of muscular strength.** The 1RM for the chest press and the MVC for the knee extension exercise markedly decreased after the resistance exercise in both trials ($P < 0.05$). These values remained lower throughout the postexercise period but then slowly recovered to the preexercise values. Figure 1 represents the changes in muscular strength over time relative to the values before exercise. Although both trials showed significant decreases in the 1RM for the chest press after exercise ($P < 0.05$), recovery was significantly faster in the CG trial than that in the CON trial (trial–time interaction, $P < 0.05$ and $P < 0.05$ between the trials at 3, 5, and 8 h after exercise). With respect to the lower limb muscle strength, both groups showed marked decreases in the MVC after exercise ($P < 0.05$). Recovery of the MVC was significantly faster in the CG trial than that in the CON trial (trial–time interaction, $P < 0.05$ and $P < 0.05$ between the trials at 24 h after exercise).

**Blood parameters.** The changes in the plasma IGF-1 and serum free testosterone concentrations are presented in Figure 2. The plasma IGF-1 concentrations did not change significantly for 24 h after exercise, and there were no significant differences between the two trials at any time (trial–time interaction, $P > 0.05$). The serum free testosterone concentrations were significantly lower after exercise (at 1–8 h after exercise) than those before exercise in both trials ($P < 0.05$). However, there were no significant differences between the two trials at any time (trial–time interaction, $P > 0.05$). The blood lactate concentration rapidly

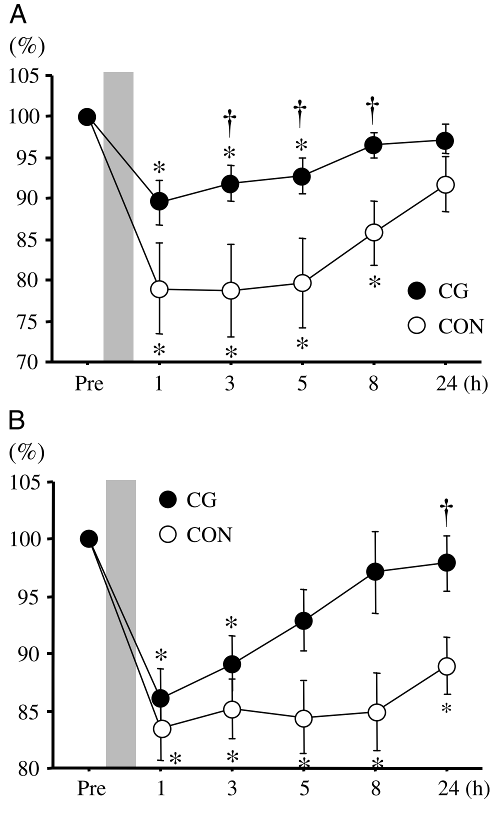

FIGURE 1—Percentage change in the 1RM for the chest press (A) and MVC for knee extension (B) for 24 h after exercise in each trial. The values are expressed as the percentage change relative to the preexercise value. The *gray bar* indicates the duration of resistance exercise. Values are means ± SE (*n* = 9). *$P < 0.05$ vs pre. †$P < 0.05$ between CG and CON trials.

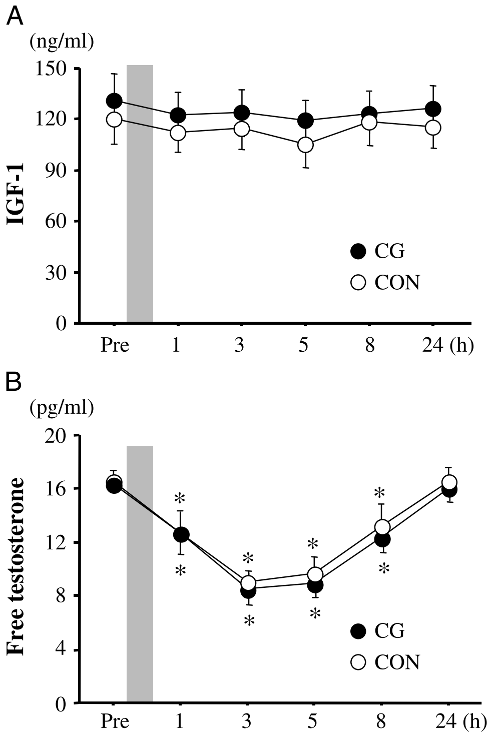

**FIGURE 2—Changes in plasma IGF-1 (A) and serum free testosterone (B) concentrations over time for 24 h after exercise in each trial. The *gray bar* indicates the duration of resistance exercise. Values are means ± SE ($n = 9$). *$P < 0.05$ vs pre.**

increased immediately after exercise in both trials ($P < 0.05$), but the concentration was similar between the two trials for 24 h after exercise.

Figure 3 represents the changes in the serum Mb, plasma IL-6, and IL-1ra concentrations. Both trials showed significant increases in the serum Mb concentration after exercise ($P < 0.05$), but there were no significant differences between the two trials at any time (trial–time interaction, $P > 0.05$). The plasma IL-6 and IL-1ra concentrations significantly increased during the recovery period in both trials ($P < 0.05$ for IL-6 and IL-1ra). However, these responses were not significantly different between the CG and CON trials (trial–time interaction, $P > 0.05$ for IL-6 and IL-1ra). The serum CK concentrations showed relatively high interindividual variation and did not change significantly over time in either trial.

**Circumference and muscle soreness.** The upper arm circumference increased significantly at 8 and 24 h after exercise in the CON trial ($P < 0.05$), whereas no significant changes were observed in the CG trial ($P < 0.05$ between the trials at 24 h after exercise). Similarly, thigh circumference increased significantly after exercise in the CON trial ($P < 0.05$), whereas no significant changes were observed over time in the CG trial ($P < 0.05$ between the trials at 24 h after exercise).

At 24 h after exercise, the subjective feelings of muscle soreness (49 ± 6 mm for CG, 73 ± 5 mm for CON; $P < 0.05$) and fatigue (35 ± 7 mm for CG, 63 ± 8 mm for CON; $P < 0.05$) were significantly higher in the CON trial than those in the CG trial.

## DISCUSSION

The main finding of the present study is that wearing a CG after strenuous resistance exercise promotes muscular strength recovery of the upper body and lower limb muscles. Furthermore, upper body strength improved within 3–8 h after exercise, whereas significantly greater lower limb muscle strength recovery occurred at 24 h after exercise. Muscle soreness and fatigue were also reduced by wearing the CG during the postexercise period. These findings indicate that the use of a CG is recommendable for promoting muscular strength recovery of the upper body and lower limbs.

The CG and CON trials showed significant reductions in maximal strength for the 1RM for the chest press and MVC

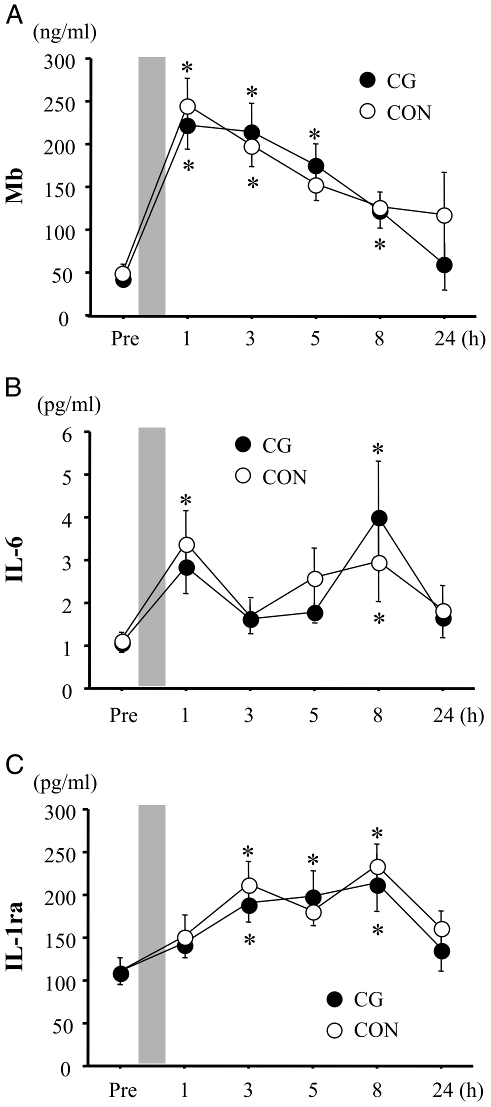

**FIGURE 3—Changes in serum Mb (A), plasma IL-6 (B), and IL-1 receptor antagonist (IL-1ra) (C) concentrations over time for 24 h after exercise in each trial. The *gray bar* indicates the duration of resistance exercise. Values are means ± SE ($n = 9$). *$P < 0.05$ vs pre.**

for the knee extension exercise during the postexercise period. However, muscular strength recovery was significantly improved when the subjects wore the CG during the postexercise period. The rapid recovery of muscular strength in the CG trial is consistent with the results of previous studies in which subjects performed 100 plyometric drop jumps (18) or whole-body strenuous resistance exercises (23). A unique aspect of our study is that we determined the time course of recovery for 24 h after exercises in subjects who used and did not use a CG. Although recovery was significantly faster in the CG trial than that in the CON trial, the changes in muscular strength recovery over time differed between the upper body (1RM for the chest press) and lower limb muscles (MVC for the knee extension). Notably, a significantly faster recovery of upper body strength occurred within 3–8 h after exercise compared with up to 24 h for the recovery of lower limb strength. The majority of previous studies examining the use of a CG involved lower limb exercises (e.g., sprinting or repeated jumps). In contrast, Kraemer et al. (23) used resistance exercises for the whole body and demonstrated that the bench press throw power measured at 24 h after the resistance exercise was significantly higher in subjects wearing a CG than in those not wearing a CG. However, at an identical time point, there were no differences in squat jumps between the two conditions. The reason for the different effect of wearing a CG on muscular strength recovery between the upper body and lower limb muscles remains unclear.

The CG trial not only promoted muscular strength recovery but also showed significantly less muscle soreness and fatigue at 24 h after exercise. In addition, exercise-induced swelling of upper limb and lower limb muscles was diminished in the CG trial. The use of a CG is thought to attenuate exercise-induced muscle damage and swelling by applying pressure to the exercised muscles (9,18,22,23). A systematic review article (17) with meta-analysis also indicated the efficacy of CG during recovery from damaging exercise. Compression may enhance muscle blood volume (8) and facilitate the clearance of exercise-induced metabolites (3,6,19). Because the subjects in the present study began wearing the CG immediately after exercise, it seems that the CG protected them from secondary muscle damage, which causes delayed-onset muscle soreness (28). Some researches have suggested that localized swelling causes muscle soreness after damaging exercise (7,14). Moreover, Kraemer et al. (22) speculated that a "dynamic casting" effect caused by compression may promote stable alignment of muscle fibers and attenuate inflammatory response. However, in the present study, the changes in blood parameters over time did not correspond with the results of muscle soreness and swelling; we found no significant differences between the two trials in the Mb, CK, IL-6, or IL-1ra concentrations at any time points during the 24-h recovery period. We also measured the plasma IGF-1 and serum free testosterone concentrations as markers of anabolic response during the postexercise period, but these responses were not different between the CG and CON trials. Inconsistent results between blood parameters and performance re covery were also reported by Jakeman et al. (18). They found that wearing a CG during the postexercise period facilitated the recovery of jump performance but did not affect plasma CK concentrations. Considering the substantial interindividual variation in indirect blood biomarkers of exercise-induced muscle damage, direct measurement (e.g., T2 relaxation time evaluated by magnetic resonance imaging) may be more appropriate (19,26).

The possible effect of psychological factors (placebo effect) must also be considered when interpreting the results of the present study. In the CON trial, the subjects wore normal garments without extra compression during the postexercise period. The subjects wearing the CG sensed greater compression, which might have elicited a placebo effect. In fact, some previous studies showed significantly lower muscle soreness and perceived exertion by wearing a CG, with no differences in physiological performance or biochemical parameters, compared with the control condition (11–13). In the present study, the CG trial showed significantly lower muscle soreness and subjective fatigue scores than the CON trial did, with rapid performance recovery (1RM for the chest press and MVC for the knee extension). Therefore, we believe that the placebo effect is likely to be small and that the rapid recovery of muscle function in the CG trial was due to compression-induced physiological mechanisms. A plausible factor for the different effect of wearing a CG on recovery of exercise performance between present study and previous studies (11,29) may be due to the magnitude of reduction of exercise performance by exercise intervention. Previous researches with lack of facilitation of strength and power output recovery did not show marked reduction of exercise performance during recovery period, whereas the present study revealed sustained reductions of muscular strength until 8 h after exercise for upper body and 24 h after exercise for the lower limb muscle.

In summary, the use of a CG during the postresistance exercise period facilitated recovery of muscular strength. For the upper body muscles, faster recovery of muscular strength was observed within 3–8 h after exercise in the CG trial. For the lower limb muscle, a significantly faster recovery of muscular strength occurred at 24 h after exercise. Furthermore, the use of a CG reduced muscle soreness and fatigue. However, changes in blood parameters over time were not significantly different between the two trials. These findings indicate that the use of a CG after strenuous exercise helps facilitate the recovery of muscular strength. Wearing a CG during the postexercise period is a new strategy for facilitating recovery in athletes and may be particularly applicable to athletes who perform strenuous training several times a day or on consecutive days.

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There is no conflict of interest to be declared by any of the authors.

The results of the present study do not constitute endorsement by the American College of Sports Medicine.

## REFERENCES

1. Bahnert A, Norton K, Lock P. Association between post-game recovery protocols, physical and perceived recovery, and performance in elite Australian Football League players. *J Sci Med Sport*. 2013;16:151–6.
2. Beaven CM, Maulder P, Pooley A, Kilduff L, Cook C. Effects of caffeine and carbohydrate mouth rinses on repeated sprint performance. *Appl Physiol Nutr Metab*. 2013;38:633–7.
3. Berry MJ, McMurray RG. Effects of graduated compression stockings on blood lactate following an exhaustive bout of exercise. *Am J Phys Med*. 1987;66:121–32.
4. Burden RJ, Glaister M. The effects of ionized and nonionized compression garments on sprint and endurance cycling. *J Strength Cond Res*. 2012;26(10):2837–43.
5. Chapman DW, Newton M, McGuigan MR, Nosaka K. Comparison between old and young men for responses to fast velocity maximal lengthening contractions of the elbow flexors. *Eur J Appl Physiol*. 2008;104:531–9.
6. Chatard JC, Atlaoui D, Farjanel J, et al. Elastic stockings, performance and leg pain recovery in 63-year-old sportsmen. *Eur J Appl Physiol*. 2004;93:347–52.
7. Cleak MJ, Eston RG. Delayed onset muscle soreness: mechanisms and management. *J Sports Sci*. 1992;10:325–41.
8. Dascombe BJ, Hoare TK, Sear JA, Reaburn PR, Scanlan AT. The effects of wearing undersized lower-body compression garments on endurance running performance. *Int J Sports Physiol Perform*. 2011;6:160–73.
9. Davies V, Thompson KG, Cooper SM. The effects of compression garments on recovery. *J Strength Cond Res*. 2009;23:1786–94.
10. de Glanville KM, Hamlin MJ. Positive effect of lower body compression garments on subsequent 40-kM cycling time trial performance. *J Strength Cond Res*. 2012;26:480–6.
11. Duffield R, Cannon J, King M. The effects of compression garments on recovery of muscle performance following high-intensity sprint and plyometric exercise. *J Sci Med Sport*. 2010;13:136–40.
12. Duffield R, Portus M. Comparison of three types of full-body compression garments on throwing and repeat-sprint performance in cricket players. *Br J Sports Med*. 2007;41:409–14.
13. Faulkner JA, Gleadon D, McLaren J, Jakeman JR. Effect of lower-limb compression clothing on 400-m sprint performance. *J Strength Cond Res*. 2013;27:669–76.
14. Friden J, Sfakianos PN, Hargens AR. Muscle soreness and intramuscular fluid pressure: comparison between eccentric and concentric load. *J Appl Physiol (1985)*. 1986;61:2175–9.
15. Gill ND, Beaven CM, Cook C. Effectiveness of post-match recovery strategies in rugby players. *Br J Sports Med*. 2006;40:260–3.
16. Hamlin MJ, Mitchell CJ, Ward FD, et al. Effect of compression garments on short-term recovery of repeated sprint and 3-km running performance in rugby union players. *J Strength Cond Res*. 2012;26:2975–82.
17. Hill J, Howatson G, van Someren K, Leeder J, Pedlar C. Compression garments and recovery from exercise-induced muscle damage: a meta-analysis. *Br J Sports Med*. 2014;48(18):1340–6.
18. Jakeman JR, Byrne C, Eston RG. Lower limb compression garment improves recovery from exercise-induced muscle damage in young, active females. *Eur J Appl Physiol*. 2010;109:1137–44.
19. Jayaraman RC, Reid RW, Foley JM, et al. MRI evaluation of topical heat and static stretching as therapeutic modalities for the treatment of eccentric exercise-induced muscle damage. *Eur J Appl Physiol*. 2004;93:30–8.
20. Kraemer WJ, Bush JA, Bauer NT, et al. Influence of compression garments on vertical jump performance in NCAA division I volleyball players. *J Strength Cond Res*. 1996;10:180–3.
21. Kraemer WJ, Bush JA, Newton RU, et al. Influence of a compression garment on repetitive power output production before and after different types of muscle fatigue. *Sports Med Training Rehabil*. 1998;8:163–84.
22. Kraemer WJ, Bush JA, Wickham RB, et al. Influence of compression therapy on symptoms following soft tissue injury from maximal eccentric exercise. *J Orthop Sports Phys Ther*. 2001;31:282–90.
23. Kraemer WJ, Flanagan SD, Comstock BA, et al. Effects of a whole body compression garment on markers of recovery after a heavy resistance workout in men and women. *J Strength Cond Res*. 2010;24:804–14.
24. Lawrence D, Kakkar VV. Graduated, static, external compression of the lower limb: a physiological assessment. *Br J Surg*. 1980;67:119–21.
25. MacRae BA, Cotter JD, Laing RM. Compression garments and exercise: garment considerations, physiology and performance. *Sports Med*. 2011;41:815–43.
26. Marqueste T, Giannesini B, Fur YL. Comparative MRI analysis of T2 changes associated with single and repeated bouts of downhill running leading to eccentric-induced muscle damage. *J Appl Physiol (1985)*. 2008;105:299–307.
27. Mayberry JC, Moneta GL, DeFrang RD. The influence of elastic compression stockings on deep venous hemodynamics. *J Vasc Surg*. 1991;13:91–9.
28. Nosaka K, Aldayel A, Jubeau M, Chen TC. Muscle damage induced by electrical stimulation. *Eur J Appl Physiol*. 2011;111:2427–37.
29. Pruscino CL, Halson S, Hargreaves M. Effects of compression garments on recovery following intermittent exercise. *Eur J Appl Physiol*. 2013;113:1585–96.
30. Scanlan AT, Dascombe BJ, Reaburn PR, Osborne M. The effects of wearing lower-body compression garments during endurance cycling. *Int J Sports Physiol Perform*. 2008;3:424–38.
31. Suzuki M, Umeda T, Nakaji S, Shimoyama T, Mashiko T, et al. Effect of incorporating low intensity exercise into the recovery period after a rugby match. *Br J Sports Med*. 2004;38:436–40.
32. Viitasalo JT, Niemela K, Kaappola R, et al. Warm underwater water-jet massage improves recovery from intense physical exercise. *Eur J Appl Physiol*. 1995;71:431–8.