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Compression garments for recovery from muscle damage: evidence and implications of dose responses

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Abstract

The use of compression garments (CG) has been associated with improved recovery following exercise-induced muscle damage (EIMD). The mechanisms responsible are not well established, and no consensus exists regarding the effects of compression pressure (i.e. the "dose"), which until recently was seldom reported. With the increasing prevalence of studies reporting directly measured pressures, the present review aims to consolidate current evidence on optimal pressures for recovery from EIMD. Additionally, recent findings suggesting that custom-fitted garments provide greater precision and experimental control are discussed. Finally, biochemical data from human trials are presented to support a theoretical mechanism by which CG enhance recovery, with recommendations for future research. The effects of compression on adaptation remain unexplored. More studies are required to investigate the relationship between compression pressure and the recovery of performance and physiological outcomes. Furthermore, improved mechanistic understanding may help elucidate the optimal conditions by which CG enhance recovery.

Introduction

In recent years the search for effective recovery strategies has become one of the most studied fields in sports science (1, 2). The term “recovery” describes the reestablishment of exercise performance following fatigue (2, 3), with far reaching implications for athletes at every level. For example, inadequate post-exercise recovery may reduce adherence in recreational exercisers (4), while consistent under-recovery may also lead to over-reaching and/or overtraining syndrome in competitive athletes, compromising health and performance (3). In addition to appropriate nutrition and rest/sleep, a multitude of physical recovery interventions have gained the attention of researchers and athletes (1, 2, 5). Whilst evidence on many such interventions is equivocal (2, 6), the volume and quality of evidence to support the use of compression garments (CG) has increased in recent years (7-10). Compression appears to be particularly beneficial for recovery from exercise-induced muscle damage (EIMD) (7, 8). The term EIMD describes the cellular disruption of myocytes, and is functionally defined by severe and persistent declines in isometric strength (11). Strength deficits following EIMD may exceed 50 % baseline values and persist for up to 10 days (11). Muscle damage also impairs muscular power and sprinting performance (12-14), endurance (15), and is associated with muscular soreness, impaired mobility and swelling (13, 14, 16). Accordingly, the use of CG may represent a particularly valuable recovery strategy, with the potential to increase the opportunity for athletes to train at high intensity.

Establishing a cause and effect relationship between compression and recovery

Conclusive evidence on the efficacy of any physiological intervention depends upon establishing a cause and effect relationship between an intervention and a beneficial outcome (17). Mechanistic evidence and observations of a dose-response relationship therefore provide valuable support for making conclusive recommendations (17). At the time of writing however, neither the mechanisms responsible nor the optimal compression pressures for recovery from EIMD have been definitively established. The effects of compression pressure on exercise recovery are further obscured by the scarcity of studies reporting directly measured pressure data, with many studies failing to report garment pressures (18), citing those estimated from manufacturer specifications (19), or derived from indirect modelling techniques (13). Even where researchers have reported garment pressures from prior pilot testing (20), such values may be inaccurate, as anthropometric differences lead to considerable between-individual variation in the pressures applied (21). This uncertainty over the pressures used in compression trials has provided a major obstacle to the systematic, scientific evaluation of CG. For example, a meta-analysis from 2015 failed to identify any effect of pressure on recovery (22), however, the analysis was limited by the small number of trials included (n = 6), and only three of these studies reported directly measured pressure data. Furthermore, only one of the studies reviewed focused specifically on damaging exercise, which seems to be the modality for which CG are most effective (7, 8). In contrast, studies comparing the effects of different, directly measured compression pressures for recovery have begun to emerge over the past three years (9, 23-25), providing evidence to support a dose-response relationship between compression and recovery variables following EIMD.

Improvements in the accuracy of quantifying garment pressures and evidence of a dose-response relationship between pressure and exercise recovery

Over the last decade portable pressure monitors have become available which provide valid and reliable readings (26), allowing researchers to systematically evaluate the effects of compression. Furthermore, recent developments in 3-D scanning technology (24) have enabled the design and manufacture of custom-fitted garments, providing greater accuracy and precision when controlling garment pressures (9, 24). To the authors' knowledge, only four studies to date (Table 1) have directly compared the effects of CG providing different, directly measured (in-vivo) pressures for recovery following damaging exercise (9, 23-25). These studies were identified as comparing the effects of CG (providing at least two different verified pressures) on neuromuscular performance following exercise with an eccentric component. Indirect physiological markers of EIMD were also quantified, such as intramuscular enzyme concentration/activity, soreness, or limb circumference (16). These studies provide varying degrees of evidence that the effects of CG for recovery are mediated by garment pressures.

Evidence from Hill et al. (23) reported that recovery was superior when class-II clinical stockings were worn (applying 14.8 ± 2.2 mmHg at the thigh and 24.3 ± 3.7 mmHg at the calf) in comparison to sports compression leggings providing lower pressures (8.1 ± 1.3 mmHg and 14.8 ± 2.1 mmHg, respectively). The authors reported improved recovery of jump performance with greater levels of compression when garments were worn throughout 72 h recovery following 100 drop-jumps (Table 1). Clinical grade stockings effected a 9 % improvement for recovery of countermovement-jump performance compared to sports leggings at 24 h. Conversely, standard sized CG provided no benefits compared to a sham treatment, with the authors suggesting that the lower pressures applied were suboptimal for recovery. However, no condition x time interaction was observed for the recovery of isometric strength - the defining functional measure of EIMD (16). Further evidence that CG enhance recovery in a dose-dependent manner is provided by the work of Mizuno and colleagues (9), who recently reported superior post-exercise jump performance from CG providing moderate levels of compression (16.1 ± 2.0 and 17.9 ± 3.5 mmHg at the thigh and calf, respectively) compared to high pressure CG (26.9 ± 3.3 and 29.2 ± 3.8 mmHg) and controls (< 5 mmHg). Immediately after 120 min uphill running, a significant 8.5 % benefit in jump performance was reported alongside a significantly lower area under the curve for IL-6 when moderate-pressure CG were worn throughout exercise (Table 1). However, the use of uphill running, assessing performance only immediately post-exercise, and the lack of isometric strength assessment makes it difficult to ascertain if the benefits of CG were related to an ameliorative effect on EIMD. Interestingly however, these findings suggest the existence of an optimal pressure for recovery, beyond which compression may exert negative effects. Indeed, increasing compression pressures have been associated with perceived discomfort (27), which could theoretically undermine functional benefits (28).

In contrast with the studies above, Zinner et al. (25), failed to identify a significant effect of garment pressure on recovery from a repeated sprint protocol in well-trained handball players. Garments providing 23 ± 2 mmHg, 11 ± 1 mmHg and 3 ± 1 mmHg (controls) at the thigh were worn for 48 h post-exercise and compared for recovery of countermovement-jump and sprint performance using a crossover design. No time x condition interaction was apparent for either outcome when performance measures were taken at baseline and 48 h post-exercise. However, it is unclear if exercise caused significant muscle damage in these participants, as no time-effect was reported and only trivial performance decrements were apparent. Furthermore, neither performance variable was measured immediately post-exercise and isometric strength was not recorded. As post-exercise decrements in isometric strength are considered the primary indicator of the severity of EIMD (16), the presence of muscle damage cannot be confirmed. Despite the lack of performance benefits, the authors reported a 'likely' to 'very, very likely' ameliorative effect of moderate compression on CK at 24 h, supporting the existence of optimal compression pressures. However, beneficial reductions in CK were calculated using magnitude based-inference only, while no significant time x condition interaction was reported. Accordingly, the authors' interpretation that these data represented a limited dose-response from compression for recovery cannot be considered conclusive.

Table 1. Effect of compression garment pressure on performance recovery following damaging exercise

Study	Participants	Design	High pressure CG	Low/moderate pressure CG	During/ post exercise	Exercise challenge	Effect of CG pressure on recovery	Measures of EIMD
Hill et al., 2017	45 recreationally active participants (72.2 ± 11.9 kg; 30 ± 2 y, 26 m, 19 f)	Parallel, blinded (x 3; HP, LP, sham)	Full length stockings (thigh = 14.8 ± 2.2; calf = 24.3 ± 3.7 mmHg)	Sports compression leggings (thigh = 8.1 ± 1.3; calf = 14.8 ± 2.1 mmHg)	Post	100 drop jumps	HP: MVIC$\uparrow^{G}$ HP: CMJ$\uparrow^{TxG\ (24\ h)}$	MVIC*, CK*, Mb, GSOR*, LBSOR*, CRP
Mizuno et al., 2017	8 physically active males (62.3 ± 3.3 kg, 23 ± 2 years)	Crossover (x 3; HP, MP, CON)	Custom made leggings (thigh = 26.9 ± 3.3; calf = 29.2 ± 3.8 mmHg)	Custom made leggings (thigh = 16.1 ± 2.0; calf = 17.9 ± 3.5 mmHg)	During	120 min uphill run (7 % at 60% of VO2max)	MP: CMJ$\uparrow^{TxG\ (post)}$ MP: IL-6_{EX} AUC$\downarrow$	CK*, [Mb]*, [IL-6]*
Zinner et al., 2017	12 well-trained male handball players (89.7 ± 12. kg, 22 ± 4 years)	Crossover RCT (x 3; HP, LP, CON)	Compression tights (thigh = 23 ± 2 mmHg)	Compression tights (thigh = 11 ± 1 mmHg)	Post	30 × 30 m sprints	CMJ$\leftrightarrow$, 30 m Sprint$\leftrightarrow$	CK^{NG}, [CRP]^{NG}, [Urea]^{NG}, perceived recovery*
Brown et al., 2020	45 male university rugby players (91.9 ± 14.1 kg, 23 ± 4 y)	Parallel, blinded (x 3; HP, LP, sham)	Custom made stockings (thigh = 19 ± 3; calf = 24 ± 4, ankle = 32 ± 3 mmHg)	Sports compression leggings (thigh = 7 ± 3; calf = 10 ± 3, ankle = 11 ± 5 mmHg)	Post	20 x 20 m sprints (5 m deceleration) + 100 drop jumps	HP: MVIC$\uparrow^{TxG\ (24\ h,\ 48\ h)}$ CMJ $\leftrightarrow$, 30m sprint$\leftrightarrow$ HP: CK$\downarrow^{TxG\ (24\ h,\ 48\ h)}$ HP: MTG$\downarrow^{TxG\ (24\ h,\ 48\ h)}$	MVIC*, CMJ*, 30m sprint*, LBSOR*, CK*, MTG*

CG = compression garments, MVIC = maximal voluntary isometric contraction, CK = circulating creatine kinase activity, [Mb] = circulating myoglobin concentration, GSOR = global soreness, LBSOR = lower body soreness, [CRP] = circulating C-reactive protein concentration, [IL-6] = circulating interleukin-6 concentration, [Urea] = circulating urea concentration, MTG = mid-thigh girth, IL-6_{EX} AUC = IL-6 area under the curve during exercise, HP = high pressure (defined by authors), MP = moderate pressure (defined by authors), LP = low pressure (defined by authors), CON = control garment providing negligible pressure. Effects of compression pressure given with arrows, with the timing of significant post-hoc comparisons provided in superscript. $\leftrightarrow$ = No effect of compression pressure, $\uparrow$ = significant increase, $\downarrow$ = significant decrease, ^{TxG} = Significant beneficial time x group effect for compression garments, ^{G} = Significant benefit of compression for group only (no time x group effect); * = Significant deterioration in markers of muscle damage (denoting an increase in raw values, except for MVIC and CMJ, where it denotes an absolute decrease), ^{NG} = time effect not given

Most recently, work from our own laboratory (24) reported improved recovery of isometric strength (knee extension) following 20 x 20 m sprints and 100 drop jumps in male university level rugby players when high pressure CG were worn following exercise. Custom-fitted stockings providing (19 ± 3, 24 ± 4 and 32 ± 3 mmHg) pressure at the thigh, calf and ankle respectively, significantly improved the recovery of isometric knee extension strength over 48 h compared to both a sham treatment and sports compression leggings (7 ± 3, 10 ± 3 and 11 ± 5 mmHg). In players wearing custom fitted garments, recovery at 24 h was 9.4 % and 5.9 % greater than sham and sports CG respectively, with 9.1 % and 9.7 % improvements at 48 h. Custom-fitted CG were also associated with attenuated creatine kinase (CK) activity throughout recovery. Furthermore, in addition to the greater pressures applied with custom-fitted garments ($p < 0.001$), subsequent analysis (unpublished data) demonstrated that significantly greater precision was also achieved when compared with the standard sized leggings (29). The pressures applied by custom-fitted CG demonstrated a smaller between-individual variation in pressure (expressed as a percentage of mean pressure), compared to sports compression leggings (Figure 1.d.). This between-group comparison revealed significantly lower coefficients of variation (CVs) at both the thigh ($\chi 2 = 3.92$, $p = 0.048$) and the ankle ($\chi 2 = 16.0$, $p < 0.001$). Subsequently, the athletes in the CF group were also fitted for standard-sized garments (Figure 1.b.) to allow a within-group statistical comparison of the consistency of pressures applied (30), although lower CVs were apparent at the ankle only ($t = 3.53$, $p = 0.004$).

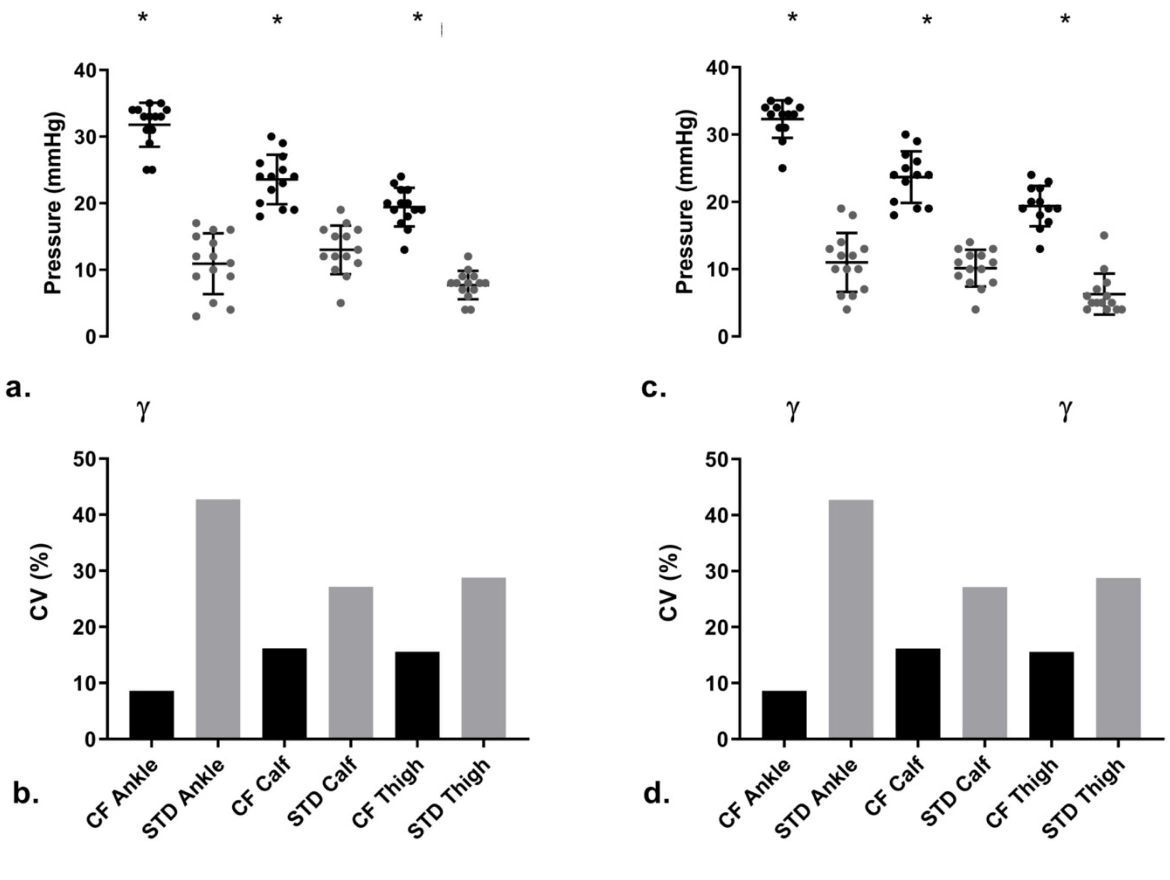

Figure 1. Recorded garment pressures and coefficients of variation (CV) for custom-fit, compared to sports compression leggings. CF = Custom-fitted garments; STD = Sports compression leggings, sold in standard sizes; Black circles/columns = CF; Grey circles/columns = STD. Garment pressures are plotted in the upper panels (a and c) as means ± standard deviations (black vertical lines) alongside individual data points; a = repeated-measures comparison, c = parallel-group comparison. Coefficient of variation (CV) values are plotted in the lower panels (b and d) as solid columns; b = repeated-measures comparison, d = parallel-group comparison. * = significant difference in mean pressures between garments ($p < 0.001$); γ = significant difference in CV between garments ($p < 0.05$)

Recent findings provide support for the existence of optimal compression pressures for recovery from EIMD (9, 23, 24), and the capacity of custom-fitted garments to apply target pressures with improved precision (24). Although a clear dose-response relationship has yet to be established for recovery, unpublished data from the study on rugby players (24) demonstrated a significant correlation between changes in isometric strength and the pressures applied by CG (Figure 2.a.). A moderate correlation was observed. The study was limited by the small range of pressures and variety of garments assessed, however, such a finding is promising considering the large inter-individual variation in muscle damage responses typically observed following EIMD (16). While this cohort included both highly trained sub-elite rugby players and recreational players leading to variation in recovery profiles, greater pressures were associated with improved recovery in this group (Figure 2.a.).

Although the purpose of this article is to discuss CG for recovery from EIMD, a dose response has also been observed for other exercise modalities, with a recent study reporting improved recovery of next-day cycling performance from high (15 ± 3 and 10 ± 3 mmHg at the calf and thigh, respectively) compared to low (7 ± 3 and 5 ± 2 mmHg) levels of compression (31). Performance in an 8 km time trial was significantly improved when high pressure CG were worn for 24 h following high-intensity exercise. A dose response may also explain apparent discrepancies between two recent studies assessing the effects of CG for short-term recovery following running (32, 33). In both studies, the authors examined the effects of CG for recovery between two 5 km time-trials separated by 1 h. Whilst the first of two crossover trials reported insignificant results from compression socks providing 23 ± 8 mmHg at the calf compared to a control condition (32), a subsequent study using more compressive garments in the same group of runners (37 ± 4 mmHg) reported a significant time x condition interaction in favour of compression (33). Although there were other key differences between trials, including whether CG were worn during the first exercise bout (33) or throughout recovery only (32), the variation in applied pressures represents an important difference between these studies.

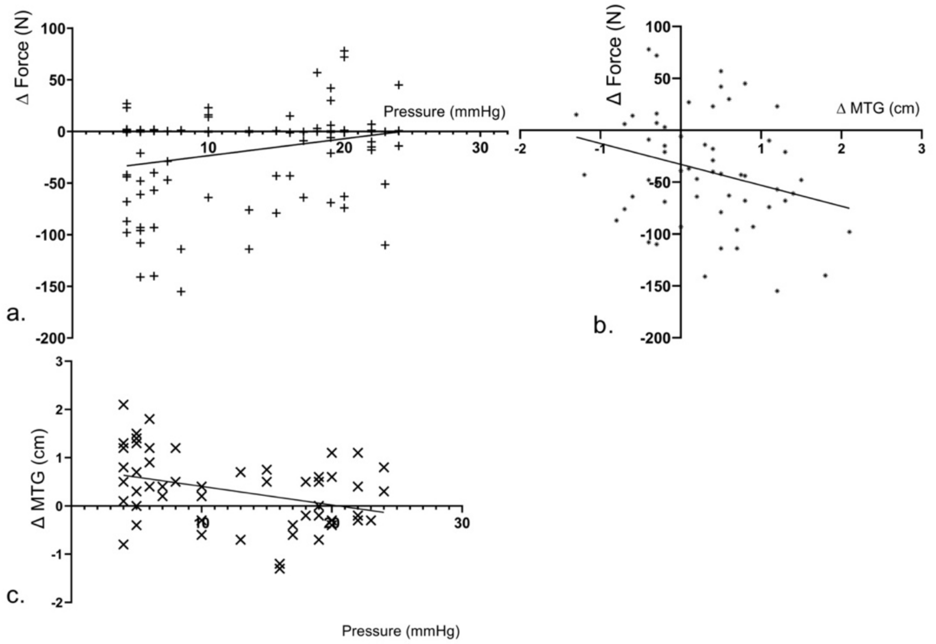

Figure 2. Observed relationships between compression pressures and changes in isometric knee extension strength and mid-thigh girth throughout recovery from muscle damage in rugby players

a. Changes in isometric knee extension force from baseline (ΔF) vs. applied pressures ($r = 0.432$, $p = 0.001$); b. ΔF vs. changes in mid-thigh girth (ΔMTG; $r = -.0275$, $p = 0.037$); c = ΔMTG vs. applied pressures ($r = 0.368$, $p = 0.005$)

Dose responses and the physiological effects of compression – implications for potential mechanisms

Findings from our laboratory (24) demonstrated that certain physiological indices of recovery (namely CK activity and oedema) were also dependent upon garment pressures, adding weight to the notion that the benefits of CG are mediated by biological rather than perceptual factors (24, 32). This conclusion is strengthened by the use of an effective sham treatment in this study. These findings draw parallels with existing clinical literature. The benefits of CG for improving venous return and ameliorating oedema in clinical patients for example, have been reported to exhibit a clear dose response, which may translate into improved functional outcomes (34, 35). Furthermore, the magnitudes of optimal pressures observed in a clinical setting (34, 35) appear similar to those reported for recovery (9, 23-25). The greater control of the pressures applied by CG that is now possible may allow a more systematic approach to investigate dose-responses, as well as informing researchers on the potential mechanisms involved.

Despite evidence that improved haemodynamic function is related to garment pressures in both an exercise (36) and a clinical setting (34, 35), the relevance of these effects to athletic recovery is unclear. However, the benefits of CG for recovery do consistently occur alongside reduced swelling (Figure 2 - (13, 14, 18, 20, 24)). Conversely null-effects have been reported where pressures were insufficient to attenuate oedema (37), or where the exercise challenge employed did not cause muscular swelling (5, 19). Indeed, it has been proposed that the oedema-reducing effects of CG may mediate improvements in pain and mobility to enhance recovery (13, 14, 20). It is therefore likely that effective compression pressures for recovery should be sufficient to influence local haemodynamics, as the attenuation of oedema is compromised below or above optimal pressures (34, 35). Accordingly, a haemodynamic mechanism would explain recent reports that either insufficient (9, 23) or excessive (9) pressures are suboptimal for recovery following strenuous exercise. Such findings have important implications for the pressures selected for recovery and require further investigation.

The association between improved recovery and reductions in limb swelling

Evidence that improved recovery following the use of CG is consistently associated with an ameliorative effect on oedema may also explain observations that compression has resulted in positive effects for recovery following markedly different exercise challenges. For example, our recent meta-analysis revealed that while CG may be particularly effective for recovery from EIMD (7), compression was also associated with large improvements following cycling, an exercise modality with minimal eccentric load (38). Closer inspection revealed that studies on both cycling (20) and eccentric exercise (13, 14, 18) in which CG were effective, commonly reported that compression served to moderate post-exercise swelling. However, although we report moderate correlations between compression pressures and both the magnitude of post-exercise recovery (Figure 2.a.) and changes in limb circumference (Figure 2.c.), the relationship between compression, swelling and recovery is still uncertain. Relationships between indices of EIMD are known to be highly variable between individuals, with only weak relationships apparent between changes in limb-circumference and strength recovery following damaging exercise (16). Our data on rugby players demonstrate a significant inverse relationship between strength recovery and post-exercise changes in limb circumference (Figure 2.b.), however, this correlation was only weak. Further research in large and homogenous populations is required to evaluate the effects of CG in relation to any attenuative effects on swelling, while more research is required to establish the mechanism by which CG aid recovery.

Proposed mechanisms for compression-mediated recovery from EIMD

Although reported associations between recovery and improvements in swelling do not confirm a causative relationship, these findings coupled with recent evidence that CG may ameliorate muscular inflammation (9, 10) may highlight a novel mechanism by which CG enhance recovery from damaging exercise. Current opinions on proposed mechanisms appear to be divided, with several theories incompatible with experimental observations. For example, the haemodynamic effects of CG have been proposed to accelerate metabolite clearance and nutrient delivery to enhance recovery (27, 32). However, whilst CG have been associated with improved lactate clearance (20), the relevance to functional recovery is unproven (39). Furthermore, the notion that CG enhance recovery by augmenting nutrient delivery is undermined by observations that compression is ineffective for influencing blood glucose uptake (40), while the short term benefits of CG cannot be explained by an acceleration of structural syntheses, which are known to take weeks (41). In contrast, observations that CG may influence inflammation in clinical patients (42), and more recently in an exercise setting (10) may better explain reported outcomes. Such a mechanism may also explain the greater benefits of CG for EIMD in comparison to other exercise modalities (7) as the propagation of EIMD is largely attributable to post-exercise inflammation (43). Furthermore, the theory that CG may attenuate local inflammation is compatible with observations that CG are effective when worn for recovery only (13, 14), rather than simply providing protection to muscle throughout the preceding exercise bout. Finally, this hypothesis would also explain the observed short-term effects of compression for recovery (18), with CG serving to ameliorate secondary damage, rather than enhancing synthetic processes.

Evidence for an anti-inflammatory effect of compression in recovery from EIMD

To our knowledge, only one study has demonstrated that CG improve *intramuscular* inflammation following damaging exercise (10). Such evidence is important because it is well established that circulating inflammatory markers may not reflect the inflammatory status of exercised muscle (43-45). Valle and colleagues (10) reported attenuated neutrophil and macrophage infiltration with reduced muscular trauma, as indicated by albumin influx, 48 h after CG were worn during 40 min of downhill running. Although no measures of limb circumference were taken to assess swelling, these findings may be explained by considering the role of inflammation and vascular stasis in propagating EIMD. Vascular stasis and oedema caused by inflammatory stimuli lead to reduced flow rates of blood and lymph to further facilitate leukocyte adhesion and transmigration (46). In short, oedema plays a role in propagating the inflammatory response rather than representing a symptom alone. Accordingly, the effects of CG for maintaining haemodynamic flow (34, 36) may help regulate local inflammation. However, since CG were worn throughout exercise and removed soon after, and no measures of muscular performance were taken, the relevance of Valle and colleagues' findings for informing post-exercise recovery strategies is uncertain.

Evidence that CG may moderate perturbations in redox chemistry (47) further supports the theory that CG attenuate inflammation. Oxidative stress arises following EIMD when the cytotoxic activity of leukocytes is enhanced in the acute phase of inflammatory response, resulting in the release of oxidative species or "neutrophil burst" (43). Conversely, leukocyte inactivation reduces oxidative stress following exercise (48). Therefore, evidence that the use of CG has been associated with both reduced leukocyte infiltration (10), and a reduction in reactive oxygen metabolite concentrations (47) suggests that the antioxidant effects of CG may describe an aspect of an anti-inflammatory mechanism.

Implications for muscular adaptation

Evidence of anti-inflammatory (10, 42) and anti-oxidant (47) effects from CG may have important consequences for the use of CG throughout training and competition. Emerging evidence suggests that many recovery strategies restore short-term performance at the expense of chronic adaptation by attenuating cellular signalling processes (44, 45, 49), with impaired adaptive responses reported following the use of high-dose antioxidants (49), cold-water immersion (45) and non-steroidal anti-inflammatory drugs (50). However, to date, no research has been carried out to assess the effects of CG on muscular adaptation. Further research on CG is required to ascertain the effects on adaptive responses.

Conclusions

Recent analyses have reported that the use of CG is associated with clear and significant improvements to recovery following EIMD (8, 24). Indeed, the evidence on CG appears to compare favourably with other recovery interventions (2, 6-8). The information presented in this review has consolidated recent evidence which suggest that that the effects of CG for recovery from EIMD are mediated by compression pressures and display a dose-response relationship (9, 23, 24). Evidence of CG ameliorating inflammation in both clinical and exercise settings (9, 10, 42) has been discussed, and a physiological rationale by which CG may ameliorate muscle damage has been proposed. While the mechanisms involved are still uncertain, evidence that CG attenuate muscular trauma and functional indices of EIMD alongside improvements in swelling may provide some explanation for the apparent influence of garment pressures, and is supported by clinical findings (34, 35). To the authors' knowledge, no studies have yet reported harmful effects from CG on recovery. However, the reported anti-inflammatory effects of compression may have important implications for muscular adaptation following the prolonged use of CG. Further evidence is required to explore the effects of CG on intramuscular inflammation and to verify the apparent dose-response relationship between compression and recovery, before a cause and effect relationship can be confirmed.

Implications for applied practice

- To date, evidence suggests that optimal pressures for recovery from EIMD lie in the region of 14 – 19 mmHg at the thigh and 19 – 24 mmHg at the calf
- Consistent evidence that the benefits of CG are associated with attenuated oedema and altered haemodynamics suggests that garments should be chosen that provide sufficient pressures to reduce swelling
- Considering the propensity of a particular exercise modality to elicit swelling may therefore help inform the decision on whether to use CG for recovery
- Since the effects of CG on muscular adaptations are still unknown, athletes, coaches and sports scientists should be wary of using CG for prolonged periods, throughout heavy blocks of training

Future directions

All future research on CG should take care to accurately characterise the garments, populations and exercise modalities studied. Research is required to more clearly elucidate the optimal compression pressures for recovery. Studies should investigate at least three levels of compression to evaluate the effects of pressures above and below hypothesized optima. Examining greater numbers of participants and compression pressures will provide improved resolution when assessing potential dose responses. Studies are required to evaluate the effects of CG on muscular adaptations, while more clearly establishing the mechanisms, biochemical and physiological effects of compression may help to better determine the optimal conditions of use. Such findings may help guide the effective use of CG throughout training and competition. Previous research demonstrating reduced leukocyte adherence from compression following damaging exercise should be expanded to assess the effects of CG worn throughout recovery only, as well as the effects of CG on isometric strength and limb circumference.

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