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Editorial

What do we know about recovery interventions used in the management of delayed-onset muscle soreness?

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Editorial

Since the pioneering work of Hough in 1902[1], the term 'delayed-onset muscle soreness (DOMS)' has dominated the field of athletic recovery. DOMS typically occurs after exercise-induced muscle damage (EIMD), particularly if the exercise is unaccustomed or involves a large amount of eccentric (muscle lengthening) contractions. The symptoms of EIMD manifest as a temporary reduction in muscle force, disturbed proprioceptive acuity, increases in inflammatory markers both within the injured muscle and in the blood as well as increased muscle soreness, stiffness and swelling. The intensity of discomfort and soreness associated with DOMS increases within the first 24 h, peaks between 24 and 72 h, before subsiding, and eventually disappearing 5–7 days after the exercise. Consequently, DOMS may interfere with athletic training or competition, and several recovery interventions have been utilised by athletes and coaches in an attempt to offset the negative effects.

Although there has been a proliferation of research into the aetiology of DOMS following EIMD, little is known regarding the effective management of the condition. Recent systematic reviews and meta-analyses have examined the benefits of using cold water immersion (CWI)[2,3], contrast water therapy (CWT)[4], stretching[5], hyperbaric oxygen therapy[6] and compression garments[7] to reduce DOMS and augment recovery. Two other interventions, namely antioxidant supplementation[8] and whole-body cryotherapy[9], are currently being reviewed by the Cochrane Collaboration but have yet to be published.

Although the physiological and biochemical rationale for using many of these interventions remain elusive, elite athletes and coaches have incorporated them as part of their training and performance schedules. Previous research has suggested the hydrostatic pressure experienced during both CWI and CWT may reduce inflammation by creating a displacement of fluids from the periphery to the central cavity[2–4]. Moreover, it has also been purposed that CWT and CWI could enhance recovery by altering tissue temperature and blood flow and aid in the removal of waste products and muscle metabolites[4]. Compression garments are purported to alter blood flow and create a pressure gradient that reduces the space for inflammation following EIMD[7]. Herbert[5] eloquently describes how the theory of the pain-spasm-pain cycle was incorrectly used in early investigations examining the justification for using stretching before and after exercise. This theory, which has since been discredited, suggested that stretching the exercised muscle created a restoration of blood flow to the muscle to interrupt this pain spasm-pain cycle[5]. It is worth highlighting that one of the most commonly used outcome measures of athletic recovery is the subjective assessment of muscle soreness. Therefore, all of these interventions have the potential to improve an individual's psychological recovery following exercise, and the importance of this placebo effect should not be discounted[2,9].

Three of these reviews compared CWI[3], compression garments[7], hyperbaric oxygen therapy[6] and stretching[5] to a passive or control (no) treatment. Two of the remaining reviews compared CWI[2] and CWT[4] to active recovery, warm water immersion and compression garments in addition to a placebo/control and the other treatment (i.e. CWT vs. CWI). To study the efficacy of the treatments, these reviews have examined multiple outcome measures that are associated with recovery including objective (strength, power recovery, functional performance, haematological markers of muscle damage and inflammation) and subjective (assessment of muscle soreness using a visual analogue scale or similar) measurements. It has previously been suggested that exercise-induced hemoconcentration and/or hemodilution and alterations of tissue clearance can affect creatine kinase (CK) and myoglobin (Mb) concentration in the blood[2], and the relevance of using blood biomarkers to quantify the severity of EIMD has been questioned[4]. Therefore, the current editorial focuses predominantly on the recovery of soreness, strength and power after the use of the different interventions.

There was a high degree of heterogeneity within the reviews[2–7] in terms of the study design, including the treatment intervention, dosage, outcome measures, type of exercise and participants. Although Bleakley et al.[4] have previously noted that gender differences have been observed in serum CK activity, inflammatory cell infiltration and activation of protein degradation pathways following exercise,

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both male and female participants were included in these meta-analyses. In addition, the classification of participants from sedentary to elite (untrained individuals experience greater levels of DOMS following exercise compared to their trained peers) made meta-analysis and interpretation of collated evidence difficult.

The following is a summary of the current evidence.

- Muscle Soreness. Compared to a passive/control treatment, CWI[2,3], CWT[4] and compression garments[7] were effective in alleviating DOMS post exercise. Both Bleakley et al.[2] and Bieuzen et al.[4] reported that muscle soreness was not significantly different after either CWI or CWT; however, CWT tended to be better than warm water immersion[4]. Conversely, stretching (before or after exercise)[5] and hyperbaric oxygen therapy[6] were ineffective in reducing muscle soreness. In fact, some evidence suggests that hyperbaric oxygen therapy might actually hinder recovery from muscle soreness after laboratory-based eccentric exercise protocols[6].
- Muscle Strength. CWI was not effective in improving the rate of recovery of muscle strength post exercise[2,3]. Pooled results tended to favour the passive condition in the immediate period following the treatment[2]. The use of compression garments[7] and CWT[4] appeared to have a positive effect on the recovery of muscle strength post exercise when compared to a passive treatment. Moreover, Bieuzen et al.[4] reported that two small studies found CWT more beneficial than CWI in strength recovery. Bennett et al.[6] reported no significant difference in strength between hyperbaric oxygen therapy and a control treatment while Herbert et al.[5] did not include strength as an outcome measure in the stretching review.
- Power. Rate of recovery of muscle power post exercise appears unaffected after either CWI[2,3] or CWT[4] compared to a control treatment. Conversely, Hill et al.[7] reported that the use of compression garments has a moderate effect on the recovery of muscle power following exercise. Unfortunately, there were no data provided on power related outcome measures in the stretching[5] or the hyperbaric oxygen treatment[6] reviews.

Limitations and future research

These reviews have undoubtedly enhanced the evidence base and informed the sports medicine community regarding the management of DOMS. However, we must recognise that the quality and strength of recommendations in a review are only as strong as the quality of studies that it analyses. All of the reviews[2–7] discussed in this editorial have unanimously highlighted the brevity of high-quality randomised controlled studies that incorporated an adequate sample size. These reviews have also indicated a risk of bias with respect to the blinding of the participants, personnel and outcome assessors and allocation concealment in the existing studies[2–7]. While it is worth acknowledging that blinding participants to the treatment provided in these studies is difficult, particularly those employing water immersion and stretching, future studies should endeavour to blind the assessors recording the post-treatment outcome measures.

Future research should also consider the use of an effective sham therapy, give careful consideration (and report) any adverse effects and examine the cost utility of the therapies being examined. The current evidence regarding the effect on DOMS, and subsequent recovery strategies, is predominantly derived from young healthy active males, and more research incorporating female and master athletes is warranted. Finally, few authors have considered the impact of the chronic use of these recovery interventions, and research addressing the implications for overtraining and training maladaptation is required.

Abbreviations list

CWI, cold water immersion; CWT, contrast water therapy; DOMS, delayed-onset muscle soreness; EIMD, exercise-induced muscle damage.

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