

## Non-pharmacological interventions to combat exercise-induced muscle damage, a little natural tax on work out

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### Abstract

Debilitating pain, stiffness, tenderness, fatigue, impaired muscle function, lack of strength subsequent to exercise are not welcomed by those not accustomed to it. It may discourage an individual from participating in regular exercise. Numerous pharmacological and non-pharmacological strategies have been used to alleviate symptoms of muscle soreness, muscle pain, improving muscle function, the range of motion and recovery time. Non-steroidal anti-inflammatory drugs are suggested to have a beneficial impact on muscle soreness, but fail to rejuvenate muscle weakness and range of motion coupled with muscle soreness. Furthermore, oral anti-inflammatory drugs are widely used to mitigate muscle soreness symptoms, but chronic use can lead to different side effects in terms of peptic ulcer and liver toxicity. Non-pharmacological remedies and interventions can be a better choice. This narrative review is intended to provide insight into the non-pharmacological strategies to combat exercise-induced muscle damage.

**Keywords:** Eccentric exercises, Muscle soreness, Non-pharmacological strategies, Unaccustomed activity.

### Introduction

The initial statement on the irritability and inflammation of the muscle after vigorous physical activity was first coined by Hough in 1902,<sup>1</sup> who came up with an idea of the rupture of the myofibre as a source of exercise-induced muscle damage (EIMD) leading to the delayed onset of muscle soreness (DOMS). DOMS was detected after rapid and intense exercise, especially eccentric or lengthening contraction, as suggested by Asmussen<sup>2</sup> and subsequently established by a number of scientists.<sup>3,4</sup> The myofibre damage was seen exclusively after lengthening exercise.<sup>5</sup> In rat type 1, myofibre was revealed less vulnerable to strain than type II fibres.<sup>6</sup> Similarly, in humans, type II myofibre was revealed more

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vulnerable to muscle damage following eccentric exercises.<sup>5</sup> There are diverse theories proposed about persuading EIMD: microtrauma, inflammation, lactic acid accretion, electrolyte and enzyme influx and muscle spasm.<sup>2</sup> Although these theories have been described separately from each other, the scientists have consensus that any individual theory is not sufficient to describe the mechanism; rather these function together. Inflammatory cells aggregation is situated inside or out of the damaged myofibre following eccentric exercise,<sup>7</sup> concentric exercises and following stretching.<sup>8</sup>

### DOMS Induction

Unaccustomed vigorous physical training leads to type I muscle strain injury, evidenced by muscle soreness,<sup>9</sup> reduced muscle strength,<sup>3</sup> limited range of motion (ROM), increased muscle thickness,<sup>10</sup> aching,<sup>4</sup> stiffness, tenderness<sup>1</sup> and decreased functional movements.<sup>11</sup> These symptoms produced by eccentric exercises are called DOMS. Normally, it begins within 12 hours of the novel or strenuous activity.<sup>12</sup> The peak symptoms appear in 2-3 days and it takes 5-7 days to disappear.<sup>2</sup> The intensity and duration of training are the key factors to determine the severity of DOMS.

Particular training strategies have been adopted to produce DOMS, including electrical stimulation,<sup>13</sup> trail running,<sup>14</sup> voluntarily maximum contraction<sup>13</sup> and, eccentric,<sup>3</sup> concentric and stretching exercises.<sup>8</sup> Interestingly, it is demonstrated that there is less muscle damage in performing voluntary eccentric exercises compared to what is produced by stimulation even in isometrics.<sup>13</sup> Increased ROM and angular velocity are directly related to muscle damage while stimulating the nerve by surface electrodes induces no harm.<sup>2</sup>

### Biochemical Findings

Biochemical investigations of the trained muscle have disclosed the movement of lactic dehydrogenase and creatine kinase.<sup>15</sup> This reveals that myofibre injury is the

source of muscle soreness.<sup>16</sup> Previously, post-exercise, lactic acid accumulation was assumed one of the sources of DOMS. But recent studies on concentric exercises discredit this theory as concentric exercises do not induce soreness.<sup>5</sup> Normally, it takes one hour to return to baseline level following exercise. Consequently, it may be a source of acute pain and stiffness but not a potent molecule during peak DOMS. Increased resting muscular activity and connective tissue injury have been reported as the source of DOMS.<sup>7</sup>

Following the unaccustomed activity, there is a disruption of the sarcomere. Subsequently, there is an accretion of calcium, which causes more deterioration of the sarcomere. These intracellular destruction events lead to inflammatory responses and boost the cytokines and lymphocytes that eventually enhance the pain perception and soreness. Moreover, the nerve ending of the mechanoreceptor responds to the movement or manipulation of potentiate soreness perception.<sup>17</sup> Non-pharmacological interventions to combat EIMD Prevention strategies are not much handy as muscle soreness is a normal physiological response to vigorous physical activity. There is a lack of significant scientific data that affirm or negate the usefulness of available modalities. Nutraceuticals and other dietary sources,<sup>11,18,19</sup> stretching,<sup>8</sup> myofascial release,<sup>20</sup> manual massage therapy,<sup>21</sup> mechanical compression garments,<sup>22</sup> physical agents,<sup>23</sup> refraining from unaccustomed strenuous physical activities, physical and mental preparation, progressive eccentric exercises can reduce foretold muscle soreness.<sup>17</sup>

### **The Stretching Hope**

Stretching is thought to be a useful remedy, which normally athletes perform to avoid or attenuate muscle soreness and to improve muscle function. There is still a lack of significant evidence whether stretching has some role in attenuating muscle soreness or boosting muscle performance. Ozmen et al in 2017 conducted a study to explore the effect of dynamic, static stretching and Kinesio taping on muscle soreness and flexibility following strenuous exercise. They included 65 young females and examined the effect of this regimen at 24 hours and 48 hours following the induction of muscle soreness in the hamstring. They concluded that these interventions prior to strenuous exercises may help in attenuating muscle soreness, but these have no role in

improving muscle flexibility.<sup>8</sup> Interestingly, in another study, the researchers included 26 young, healthy females and performed stretching for four weeks and showed remarkable improvement in hamstring flexibility.<sup>24</sup> Wang in 2017 performed a study to analyse the effectiveness of both static and dynamic stretching in 48 healthy participants in calf muscles, and concluded that there was a time difference in all variables. However, the impact of stretching was insignificant on muscle soreness. It may be concluded that short-term stretching exercises possibly may have some beneficial impact on muscle soreness, but have an insignificant impact on muscle performance and flexibility.<sup>25</sup> Mild to moderate-intensity stretching is prophylactically useful in DOMS. However, extensive stretching can be a source of muscle damage.

### **The Myofascial release Hope**

Rehabilitation experts frequently advise myofascial release technique by employing foam rolling as a preventive or therapeutic remedy to improve muscle recovery, performance and ROM before or after intensive exercises. Su Chang et al. conducted a study to observe the acute, preventive impact of foam rolling, static and dynamic stretching for flexibility, muscle strength, and muscle soreness. In a crossover study design, 15 male and 15 female young healthy college students were recruited. Isokinetic peak torque modified Thomson test and sit and reach test was introduced. They concluded that foam roller is a superior way to improve flexibility without lowering muscle strength.<sup>20</sup> Contrarily, a small dose of form roller did not produce any significant difference.<sup>26</sup> Moderate and long-term application of myofascial release (5 to 10 minutes/ session) prior to inducing DOMS may have positive outcomes in terms of improving fatigue and pain perception.

### **The Nutraceuticals Hope**

Preventive or therapeutic use of dietary sources in the form of antioxidants, vitamin D, protein and carbohydrate drinks are perceived useful. Data revealed that protein and antioxidants supplements can minimise the effect of soreness and fatigue consorted with strenuous activity.<sup>11,18,19</sup>

Fish oil and vitamin D supplementation is suggested to have a significant impact to alleviate muscle soreness. Tinsley et al. conducted a study to investigate the effect of fish oil on post-exercise muscle soreness. They

concluded that fish oil supplementation is very handy to alleviate post-exercise muscle soreness<sup>11</sup> Ives et al. conducted a study to examine the impact of protein and antioxidant supplementation on muscle soreness, muscle function, and inflammation. They had recruited 60 sedentary males and assessed isometric and isokinetic torque, muscle soreness and thigh circumference. They concluded that protein ameliorates muscle soreness and function. The addition of antioxidant improves more muscle function than using protein and carbohydrate alone.<sup>18</sup> Curcumin or turmeric has anti-inflammatory and anti-oxidant effects and capable of damping muscle damage and speedy recovery. In a recent study, researchers observed a significant improvement in pain and muscle soreness after ingestion of oral curcumin. They had conducted a study to examine the effect of curcumin in 17 men on muscle soreness and strength following intensive eccentric exercise. They had taken oral curcumin (2.5 grams, twice a day) 2 days before the induction of muscle soreness. At 24 hours and 48 hours after inducing muscle soreness, they found a significant reduction of pain. Besides these effect, curcumins also boost muscle performance and anti-inflammatory markers.<sup>19</sup> The metabolic changes in EIMD led the increased demand for protein, especially in sports involving strenuous physical activities. Nutraceuticals can be handy in alleviating the symptoms and boosting speedy recovery.

### **The Massage Hope**

Massage is suggested to have a potent impact on alleviating DOMS symptoms. However, the results from scientific studies on massage are equivocal.<sup>21,27,29</sup> These variations in outcomes may be connected to the application methods, scheduling and duration of massage application. Furthermore, the mechanism of action is still ambiguous. Massage therapy is a useful remedy, and patients normally trust massage for DOMS pain and soreness relief, or to avert other symptoms. At present, little scientific data is available focussed on the effectiveness of massage on muscle soreness and pain following strenuous exercise. Furthermore, the effectiveness of massage in DOMS is dubious. Very little data is available which supports the effectiveness of massage as a remedy to attenuate muscle soreness and pain. Torres et al. reviewed the effectiveness of massage by analysing 9 studies on massage and found a slight

improvement in symptoms<sup>27</sup> Guo et al. conducted an analytical study on the effectiveness of massage following DOMS and suggested that it can be a promising remedy for improving muscle function and attenuating DOMS symptoms. They included 11 articles after fulfilling the inclusion criteria and found that massage significantly reduces the soreness rating and muscle function. Moreover, creatine phosphokinase (CPK) level was also lowered in subjects taking massage therapy. No doubt, it is a great news for dealing DOMS with massage.<sup>21</sup> On the other hand, Imtiyaz et al, in 2014 found that massage has a minimal role in restoring DOMS pain compared to vibration therapy. They found vibration therapy more useful in lowering lactate dehydrogenase (LDH) level and minimising muscle pain.<sup>29</sup> Similarly, a review identified massage therapy a less promising VS anti-inflammatory. Zainuddin et al. in 2005 proved that massage has a statistically significant impact on alleviating pain linked with DOMS, but failed to prove the impact of massage on muscle weakness and function.<sup>28</sup> Massage can reduce inflammation linked to muscle damage. How massage works, still remains a mystery. The application of massage cannot have standardised and it is subjective, so its effectiveness depends on circumstances and the skill level of the particular therapist.

### **The Mechanical Compression Hope**

Mechanical compression in the form of compression garments is being used frequently in venous haemodynamics. Recently, mechanical compression has been proposed for the relief of muscle soreness by lessening the inflammation, pain and facilitating quick recovery after unaccustomed exercise.<sup>30</sup> Evidence for attenuating DOMS and EIMD symptoms are conflicting, both affirming and refuting the efficacy of compression garments.<sup>14,22</sup> A study has demonstrated that continuous mechanical compression supported the preservation of muscle strength, muscle soreness, muscle performance and ROM.<sup>22</sup> Hill et al. in 2017 investigated the effect of compression garments in alleviating the symptoms associated with EIMS and DOMS. They had taken 45 recreational, active participants and concluded that pressure exerts a significant effect on muscle recovery after unaccustomed exercise.<sup>22</sup> Continues compression therapy can limit the severity of the symptoms associated with DOMS.

## The Physical Agents Hope

Physical agents like heat and cold therapy are used extensively to cope with post-exercise muscle pain, fatigue and muscle soreness for centuries.<sup>9,31</sup> Cold therapy is normally used to alleviate muscle soreness. However, recently researchers suggested that heat therapy has a good prophylactic effect on improving muscle flexibility, muscle soreness and muscle performance.<sup>9</sup> Most scientists have consensus that cold therapy is the superior therapeutic intervention to deal with acute tissue damage, muscle soreness and inflammation primarily related to sports injuries.<sup>31,32</sup> The cooling therapy in sports medicine has been acknowledged as a vital remedy. Recently, it was demonstrated that the cold-water immersion is an efficacious contrive to belittle pain, inflammation, and fatigue subsequent to exhaustive exercise.<sup>32</sup> Whole-body cooling is another safe and potential method to cope with overuse syndrome, muscle injuries and to cut the cure time between the training periods. This treatment fails to cause any alterations in haematological and biochemical parameters. It was figured that whole-body cooling is safe compared to the ice bag<sup>33</sup> and does not cause any damaging impact on athletes.<sup>34</sup> Pre-training warm-up or heat therapy and post-training cryotherapy in the form of whole-body cooling is suggestive to avoid muscle soreness.

## Eccentric Exercise Hope

Tailored exercises are one of the useful remedies to attenuate muscle pain, soreness, and performance after EIMD followed by unaccustomed exercises. Continuous exercise is one of the most useful tools to combat muscle soreness. The release of endorphins, which diminishes pain and improvement in local blood circulation following exercise may be the contributing factor in relieving muscle soreness symptoms.<sup>17</sup> Furthermore, eccentric exercise elicits a number of health-promoting benefits in the form of improved insulin sensitivity, oxidative stress and inflammatory status.<sup>7</sup> Initially, eccentric exercises have a pro-inflammatory response, but later on, they induce an anti-inflammatory response.<sup>35</sup> Sports person should be trained to bring down the exercise duration and intensity for 24 to 48 hours following EIMD or perform an exercise on the unaffected body parts.<sup>8</sup> Moderate load exercises should be encouraged to perform progressively over 1-2 weeks

in order to avoid training disruption or muscle damage.

## Conclusion

Nutriceutics, physical agents, myofascial release and moderate intensity regular exercises are recommended to combat DOMS and its symptoms. Pre-training stretching or heat and post-training myofascial release and cold therapy can be devised to limit the symptoms of DOMS. The review represents just one component of a decision-making process. Careful monitoring of the symptoms arising from a muscle injury need diagnosis and management by a clinician. Future studies are recommended to find the prophylactic effect of short-term myofascial release on DOMS.

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