

“Muscle Soreness: Causes & Prevention”

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Abstract

Eccentric exercise continues to receive attention as a productive means of exercise. Coupled with this has been the heightened study of the damage that occurs in early stages of exposure to eccentric exercise. This is commonly referred to as delayed onset muscle soreness (DOMS). To date, a sound and consistent treatment for DOMS has not been established. Although multiple practices exist for the treatment of DOMS, few have scientific support. Suggested treatments for DOMS are numerous and include pharmaceuticals, herbal remedies, stretching, massage, nutritional supplements, and many more. DOMS is particularly prevalent in resistance training; hence, this article may be of particular interest to the coach, trainer, or physical therapist to aid in selection of efficient treatments. First, we briefly review eccentric exercise and its characteristics and then proceed to a scientific and systematic overview and evaluation of treatments for DOMS. We have classified treatments into 3 sections, namely, pharmacological, conventional rehabilitation approaches, and a third section that collectively evaluates multiple additional practiced treatments. Literature that addresses most directly the question regarding the effectiveness of a particular treatment has been selected. The reader will note that selected treatments such as anti-inflammatory drugs and antioxidants appear to have a potential in the treatment of DOMS. Other conventional approaches, such as massage, ultrasound, and stretching appear less promising.

INTRODUCTION

Muscle Soreness

At one time or another, all of us have experienced muscle soreness. From experiments specifically designed to induce such muscle soreness, it has been found that the degree of soreness is related to the type of muscle contraction performed. It is a common experience for novice weight trainers and sometimes even veteran strength athletes to notice delayed onset muscle soreness (DOMS) that appears twenty –four to fourth-eight hours after strenuous exercise.

Background

Hough gave the first detailed description of delayed on set muscle soreness (DOMS) in 1902. DOMS is a widely recognized entity and is experienced by nearly everyone during his/her lifetime. DOMS is defining as the sensation of discomfort or pain in the skeletal muscles following physical activity, usually eccentric to which an individual is not accustomed. Although DOMS is experienced widely, there are still controversies regarding its origin, etiology and treatment.

PATHOPHYSIOLOGY

Muscle pain mechanism

Tension of pain in skeletal muscle is transmitted by myelinated group III (A-delta fiber) and unmyelinated group IV (C-fiber) afferent fibers. Both group III and IV sensory neurons terminate in free nerve ending. The free nerve ending are distributed primarily in the muscle connective tissue between fibers (especially in the regions of arterioles and capillaries) and at the musculotendinous junction. The larger myelinated group III fibers are believed to transmit sharp localized pain.

The sensation of DOMS is carried primarily by group IV afferent fibers. The free nerves ending of group IV afferent fibers in muscles are polygonal and respond to a variety of stimuli including chemical, mechanical and thermal. Chemical substances that elicit action potentials in muscle group IV fibers in order of effectiveness are bradykinin, 5-hydroxytryptamine (serotonin), histamine and potassium.



Injury

- **Cramps**
- **Tendonitis**
- **Fascia injuries**
- **Ligament injuries**
- **Sprains or muscle tears**

Any time you do have inflammation or swelling, use the R.I.C.E. method of reducing damage and speeding healing. For injuries, R.I.C.E. is nice.

REST: When you are hurt, stop your workout immediately and take weight off the affected area.

Ice: Wrap ice in a towel and hold it against the injury for 10 to 20 minutes, three or four time a day until the acute injury diminishes.

Compress: Wrap the injured area in a snug, but not tight, elastic bandage.

Elevate: Raise the injured limb and rest it on a pillow to reduce swelling.

Etiology and path physiology

DOMS results from overuse of the muscle. Any activity in which the muscle produce higher forces than usual or produces forces over a longer time period than usual can cause DOMS. According to **Tiidus** and **Ianuzzo**, the degree of muscle soreness is related to both the intensity of the muscular contraction and

the duration of the exercise. The intensity seems to be more important in the determination than the duration.

Five hypotheses are used to explain the path physiology of DOMS.

- Structural damage from high tension
- Metabolic waste product accumulation
- Increased temperature
- Spastic contracture
- Myofibrillar remodeling

Frequency

Incidence of DOMS is difficult to calculate because most people with DOMS do not seek medical attention, and they accept DOMS AS temporary discomfort. Every healthy adult most likely has experienced DOMS on countless occasions. DOMS occurs regardless of the person's general fitness level.

Age: DOMS generally is not reported in children. Adults of all ages can experience DOMS.

Symptoms of DOMS:

- Heavy unaccustomed exercise, particularly involving eccentric muscle contractions (e.g., downhill exercise) is reported.
- The patient complains of pain, soreness, swelling and a stiff or tender muscle spasm.
- The muscles are sensitive, especially upon palpation or movement.
- Decreased range of motion and reduce strength is noted (especially 24-48 hours post exercise).
- The patient has a sense of reduced mobility or flexibility.
- DOMS begins 8-24 hours after exercise and peaks 24-72 hours post exercise.
- Acute onset muscle soreness begins during exercise and continues for approximately 4-6 hours after exercise.
- The soreness normally increases in intensity during the first 24 hours after exercise and peaks in 24-27 hours, and then subsides over the next 5-7 days.

Physical:

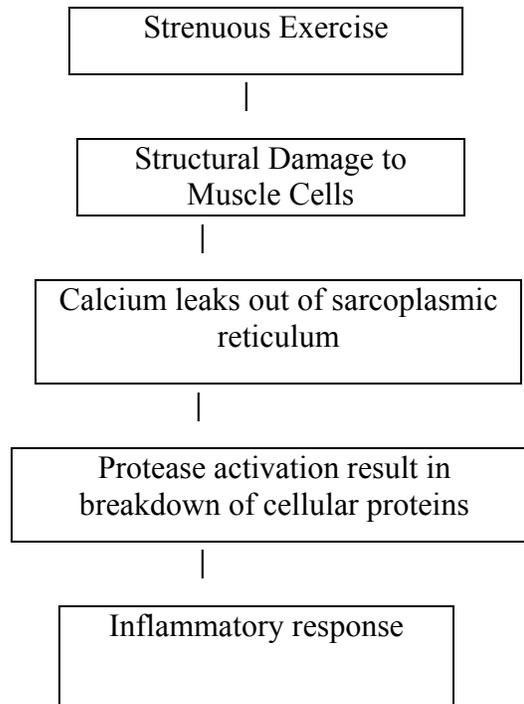
- The tenderness often is described as localized in the distal portion of the muscle in the region of the musculotendinous junction.
- In server DOMS, the pain is generalized throughout most of the muscle belly.
- Swelling of the muscle belly can occur.
- Muscle tenderness is present.
- Decreased muscle strength strength and flexibility also are noted.

Causes of Muscle Soreness:

- Heavy unaccustomed exercise contributes to development of DOMS.

- The exercise involving eccentric muscle contractions results in greater disruption or injury to the muscle tissues than concentric exercise.

Proposed Model to Explain Delayed Muscular Soreness by Armstrong

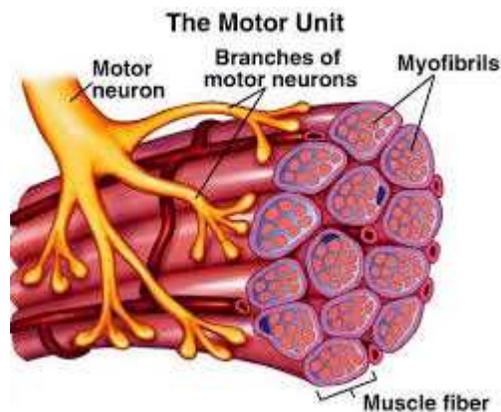


Muscle Soreness Theories

Tissue Damage, such as the microscopic tearing of muscle fibers, could explain muscle soreness.

Possibly, muscle soreness is caused by local muscular spasms (these reduce muscle blood flow, resulting in pain). This explanation of muscle soreness is called the “spasm theory”.

Overstretching could damage the connective tissues that surround the muscle fibers and the tendons, producing muscle soreness.



Other Problems to be considered:

- a) Muscle strain or tear.
- b) Muscle cramps.
- c) Phosphorylase deficiency (muscle soreness after exercise).
- d) Phosphofructokinase deficiency.
- e) Carnitine palmityl transferase deficiency.
- f) Other type of myopathies.

Comparative feature of pain during or immediately following exercise, delayed onset muscle soreness, and muscle cramps associated with exercise

	Pain During or Immediately Following Exercise	Delayed Onset Muscle Soreness(DOMS)	Muscle Cramps with Exercise
Etiology	Probable build up of metabolic by-products (include lactic acid, pyruvic acid)	Unaccustomed eccentric exercise	Hyper-excitability of lower motor neuron, possibly related to loss of fluid and electrolytes, and low magnesium level
Onset	During Exercise	12-48 hours post exercise	During or after the exercise
Duration/Recovery	Diminish upon termination of exercise and return of normal blood flow	Recovery within 7-10 days	Last usually from a few seconds to several minutes
Type of nerve ending	Type IV free nerve ending	Primarily type IV free nerve ending Type III is also involved	Most likely type III free nerve ending
Type of muscle contraction associated	Sustained or rhythmic concentric and isometric contractions	Unaccustomed eccentric muscle exercise	Severe, involuntary, electrically active contraction
Treatment	Terminate exercise	Exercise the "sore muscle". No other proven effective treatment	Gentle stretch of the affected muscle contraction of antagonistic muscle
Prevention	No proven effective preventive measure	No proven effective preventive measure	Quinine (medication) Stretch the muscles typically affected

Lab Studies:

Serum creatinine kinase level usually is elevated, but it is nonspecific.

TREATMENT

Rehabilitation Programme:

- **Physical Therapy:** Break –up of adhesions from the injured sore muscles take place during exercise.
 - Increased blood flow or temperature in the muscle helps to decrease the accumulation of noxious waste products.
 - Endorphin released by neurons in the central nervous system increases during exercise.
 - Increased afferent input is noted from large, low-threshold sensory units in muscles (muscle group IA, IB and II fibers [gate control theory]).
 - Subjects direct attention to the activity and away from the pain.
 - Training effect appears to be highly specific, not only for the particular muscles involved in the type of exercise, but also for the type of contractions performed. For example, Schwann and Armstrong found that in rats the muscle damage that occurs during downhill running is prevented by downhill or level training but not by uphill training.

Medical Issues/Complications: No evidence exists to support the premise that DOMS is associated with any long- term damage or reduced function in The muscles or any other complication.

Other Treatment (injection, manipulation, etc.):

- **Barlas** et al found that acupuncture generally is not effective in the treatment of DOMS; however, another unblended study by **Lin and Yang** suggests effectiveness of acupuncture in treating individuals with DOMS.
- **Mekjavic** et al concluded that **hyperbaric oxygen therapy** does not affect recovery from delayed onset muscle soreness.
- **Zhang** et al note that a double layer of Far bloc, an electromagnetic shield, wrapped around the thigh has been shown to reduce DOMS.
- Combined low intensity laser therapy was not shown to be effective in DOMS.
- **Pulsed ultrasound therapy (PUS)** in one small (6 subjects in each group) randomized double-blind placebo-controlled study by **Hassan** et al, showed significantly less soreness in individual treated with PUS. However, in a larger (12 patients in each group) randomized **double-blind placebo controlled study by Craig** et al, no significant benefit from PUS was demonstrated. In a study by **ciccone** et al, there was some suggestion that ultrasound may enhance DOMS, but phonophoresis with salicylate may have therapeutic benefits.

- **Transcutaneous electrical nerve stimulation (TENS), in an uncontrolled study by Deneger et al**, showed some benefit in relieving the soreness associated with DOMS; however, in a randomized placebo-controlled study by Craig et al, the use of TENS did not show any significant benefit.
- **Dexamethasone iontophoresis** immediately after exercise has shown to decrease DOMS.

Deterrence /Prevention:

- **Armstrong** states in his review there no preventive measures for DOMS, except for previous specific training of the involved muscle.
- No study has demonstrated that proper warm-up before exercise and cool-down after exercise could help prevent DOMS.
- **Johansson** et al discovered that pre-exercise static stretching has no preventive effect on the muscular soreness, tenderness and force loss that follows heavy eccentric exercise.
- Nonsteroidal anti-inflammatory medications are not effective in preventing DOMS.
- **Thompson** et al note that oral contraceptive use attenuates soreness following an exhaustive stepping activity in women, but no association can be drawn between estrogen ingestion and exercise-induced muscle damage.
- **Boyle** et al showed that yoga training and a single session of yoga appear to attenuate peak muscle soreness in women following about of eccentric exercise. These finding have significant implications for coaches, athletes and the exercising public who may want to implement yoga training as a preseason regimen or supplemental activity to lessen the symptoms associated with muscle soreness.

Prognosis:

- DOMS can reduce muscular performance temporarily. The diminished performance results both from reduced voluntary effort due to the sensation of soreness and lowered inherent capacity of muscle to produce force.
- No evidence exists to support that DOMS is associated with long –term damage or reduced function in the muscle.
- Animal studies indicate that injured muscle regenerate during the period following exercise and the process essentially is completed within 2 weeks.

Conclusion:

With a better understanding of the causes of DOMS, the health and fitness professional is better equipped to help clients avoid it's complications. It is hoped that the information in this article will add to the 'tool box' of knowledge from which personal trainers can draw from in an effort to optimize the health and fitness results obtained by their clients.

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