SOCIETÀ ITALIANA
G.U.I.D.A.
PER LA GESTIONE UNIFICATA E INTERDISCIPLINARE
DEL DOLORE MUSCOLO-SCHELETRICO E DELL'ALGODISTROFIA

V CONGRESSO NAZIONALE

EVERYTHING
YOU NEED TO KNOW

BOLOGNA
ROYAL HOTEL CARLTON
27 Febbraio - 1 Marzo 2025

Il dolore muscolare nello sportivo

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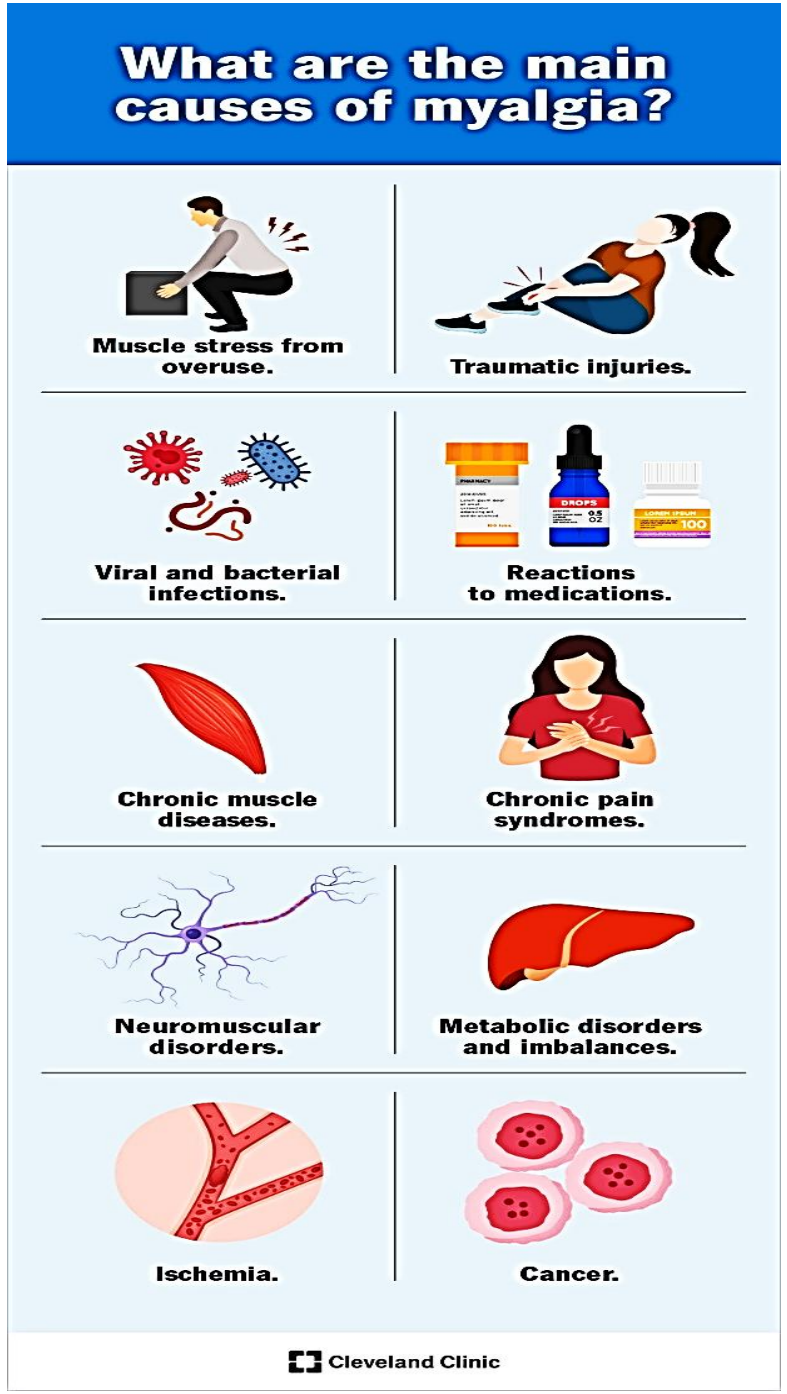
Il dolore muscolare negli sportivi è un problema comune che può essere causato da vari fattori, come sforzi eccessivi, infortuni o tecniche di allenamento errate. È importante valutare e trattare correttamente il dolore per evitare complicazioni e garantire un recupero ottimale.

Le basi fisiopatologiche del dolore muscolare sono complesse e coinvolgono una serie di reazioni cellulari e molecolari che si verificano in risposta a stress meccanici, metabolici e infiammatori.



- **Dolore acuto**: Comparso improvvisamente durante o subito dopo l'attività fisica. Può indicare un infortunio (come uno stiramento muscolare o uno strappo).

- **Dolore sordo o tardivo (DOMS - Delayed Onset Muscle Soreness)**: Tipico dopo allenamenti intensi o attività a cui il corpo non è abituato.
- Si manifesta tipicamente 24-48 ore dopo l'allenamento.

Il DOMS (Delayed Onset Muscle Soreness) è il dolore muscolare che si manifesta generalmente tra le 24 e le 48 ore dopo un'attività fisica intensa o non abituale, e di solito raggiunge il picco di intensità tra il secondo e il terzo giorno.

È considerato un fenomeno fisiologico, spesso associato a danni muscolari microscopici, e si verifica principalmente in seguito ad attività fisiche che comportano un carico muscolare eccentrico, come la discesa in corsa o il sollevamento pesi in cui il muscolo si allunga durante la contrazione.

AMERICAN
PHYSICAL EDUCATION REVIEW.

Vol. VII. MARCH, 1902. No. 1

ERGOGRAPHIC STUDIES IN MUSCULAR SORENESS.*

THEODORE HOUGH.

(From the Physiological Laboratory of the Massachusetts Institute of Technology and the Boston Normal School of Gymnastics.)

In my paper on neuro-muscular fatigue published in this journal for May, 1901, I made but slight reference to the subject of muscular soreness beyond the statement that "when an untrained muscle makes a series of contractions against a strong spring, a soreness frequently results which cannot be regarded as a phenomenon of pure fatigue." Further discussion of the matter was postponed to await the completion of the experiments which form the basis of the present paper.

The use of the word "trained" at that time was somewhat indefinite, and it may be well at the outset to define my use of it then and now, in order to prevent possible misconception. By a trained muscle or a muscle in training is meant one which has been making regular ergographic experiments for some time previously without resulting soreness or lameness. The muscle may have been accustomed to ergographic work and may be very strong; but if a considerable period of time have elapsed since the last experiment, such a muscle would be classified as untrained or out of training. I am unable to state what length of time must elapse to put a muscle out of training; but I have never classified a muscle as trained unless it had made an experiment within the preceding three weeks.

My attention was first attracted to the subject of muscular soreness in the latter part of November, 1899. Six months before a series of almost daily ergographic tracings from the flexors of the middle finger had been brought to a conclusion.† The muscle was in a high degree of training, the curve of work always

* Reprinted by permission from the American Journal of Physiology, Vol. VII, No. 1., April 1, 1902.

† Hough: American Journal of Physiology, 1901, v, pp. 258-259. The ergographic methods used in the present series of experiments are the same as those given in the above paper. The formula $\frac{C}{R} = \frac{\text{M Sec.}}{\text{N Sec.}}$ refers to the rhythm and means that it consisted of alternate periods of M seconds of contraction and of N seconds of rest.

Theodore Hough (1865–1924)

Meccanismi fisiopatologici coinvolti

Microlesioni muscolari
Infiammazione locale
Accumulo di metaboliti
Attivazione dei nocicettori
Spasmi muscolari e rigidità

BRIEF REVIEW

MEDICINE AND SCIENCE IN SPORTS AND EXERCISE
Vol. 16, No. 6, pp. 529–538, 1984

Mechanisms of exercise-induced delayed onset muscular soreness: a brief review

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CLINICAL SCIENCES

CLINICAL SYMPOSIUM

Interdisciplinary Symposium on Muscle Injuries

* * * * *

CHAIRPERSON: W. BEN KIBLER

Initial events in exercise-induced muscular injury

R. B. ARMSTRONG

Exercise Biochemistry Laboratory, Department of Physical Education, University of Georgia, Athens, GA 30602

- **Microlesioni delle fibre muscolari**: Durante l'attività fisica, soprattutto quando vengono effettuati esercizi eccentrici (come nel caso della discesa o del rallentamento), si verificano piccole rotture a livello delle fibre muscolari. Queste rotture non sono gravi, ma innescano una serie di reazioni infiammatorie che portano al dolore.
- **Rilascio di proteine muscolari**: La rottura delle fibre muscolari provoca il rilascio di proteine intracellulari (come la creatina chinasi e la lattato deidrogenasi) nel flusso sanguigno, che sono indicatori di danno muscolare.
- **Infiammazione locale**: Il danno alle fibre muscolari attiva il sistema immunitario, con il rilascio di mediatori infiammatori come prostaglandine, citokine (ad esempio, IL-6, TNF-α) e interleuchine, che aumentano la sensibilità al dolore e la percezione del dolore stesso.
- L'infiammazione provoca anche un **aumento della permeabilità capillare**, causando edemi e gonfiore.

Accumulo di Sostanze Metaboliche

- **Acido lattico**: Durante attività anaerobiche ad alta intensità, l'accumulo di acido lattico (o lattato) nei muscoli può provocare una sensazione di bruciore. Tuttavia, l'acido lattico non è direttamente responsabile del DOMS, che si sviluppa con un ritardo temporale.

- **Ioni di idrogeno (H^+)**: L'accumulo di ioni idrogeno a causa della glicolisi anaerobica può abbassare il pH muscolare, provocando un ambiente acido che irrita le terminazioni nervose e contribuisce al dolore acuto durante l'esercizio.

- **Disturbi nell'equilibrio ionico**: L'intensa attività fisica può alterare l'equilibrio degli ioni come sodio (Na^+), potassio (K^+) e calcio (Ca^{2+}), influenzando la funzione muscolare e la contrazione, con possibili danni cellulari e dolore.

Spasmi Muscolari e Tensione

Il dolore muscolare può essere amplificato da spasmi muscolari, in cui il muscolo si contrae involontariamente a causa di un'eccessiva sollecitazione o affaticamento. Questo causa ulteriore irritazione ai nocicettori e aumenta la percezione del dolore.

Variazioni Vascolari

L'attività fisica intensa può causare un cambiamento nel flusso sanguigno, con una vasodilatazione iniziale per aumentare l'afflusso di ossigeno ai muscoli. Tuttavia, se l'esercizio è eccessivo, i vasi sanguigni possono essere danneggiati o la loro funzione può essere compromessa, contribuendo al gonfiore muscolare e al dolore.

Schroeter S[1], Bloch W[2,3], Hirschmüller A[3,4,5], Engelhardt M[1], Grim C[1], Heiss R[3,6], Hotfiel T[1,3,7]

Update: Delayed Onset Muscle Soreness (DOMS) – Muscle Biomechanics, Pathophysiology and Therapeutic Approaches

Update: Verspätet einsetzender Muskelkater – Muskelbiomechanik, Pathophysiologie und therapeutische Ansätze

CLINICAL REVIEW

ACCEPTED: July 2024

PUBLISHED ONLINE: August 2024

Schroeter S, Bloch W, Hirschmüller A, Engelhardt M, Grim C, Heiss R, Hotfiel T. Update: Delayed Onset Muscle Soreness (DOMS) – muscle biomechanics, pathophysiology and therapeutic approaches. Dtsch Z Sportmed. 2024; 75: 189-194. doi:10.5960/dzsm.2024.608

Summary Box

This review outlines the muscle biomechanics, the pathophysiology as well as prevention and treatment of Delayed Onset Muscle Soreness (DOMS). The pathophysiology of DOMS underlines the decisive influence of mechanical stress as the primary elicitor of this injury entity. The central target of prevention of DOMS is to prevent or alleviate the onset of the initial damage, known as "Exercise Induced Muscle Damage" (EIMD). In case of manifest DOMS, the intention is both to relieve the attendant symptoms and to promote rapid restoration of muscle function and performance.

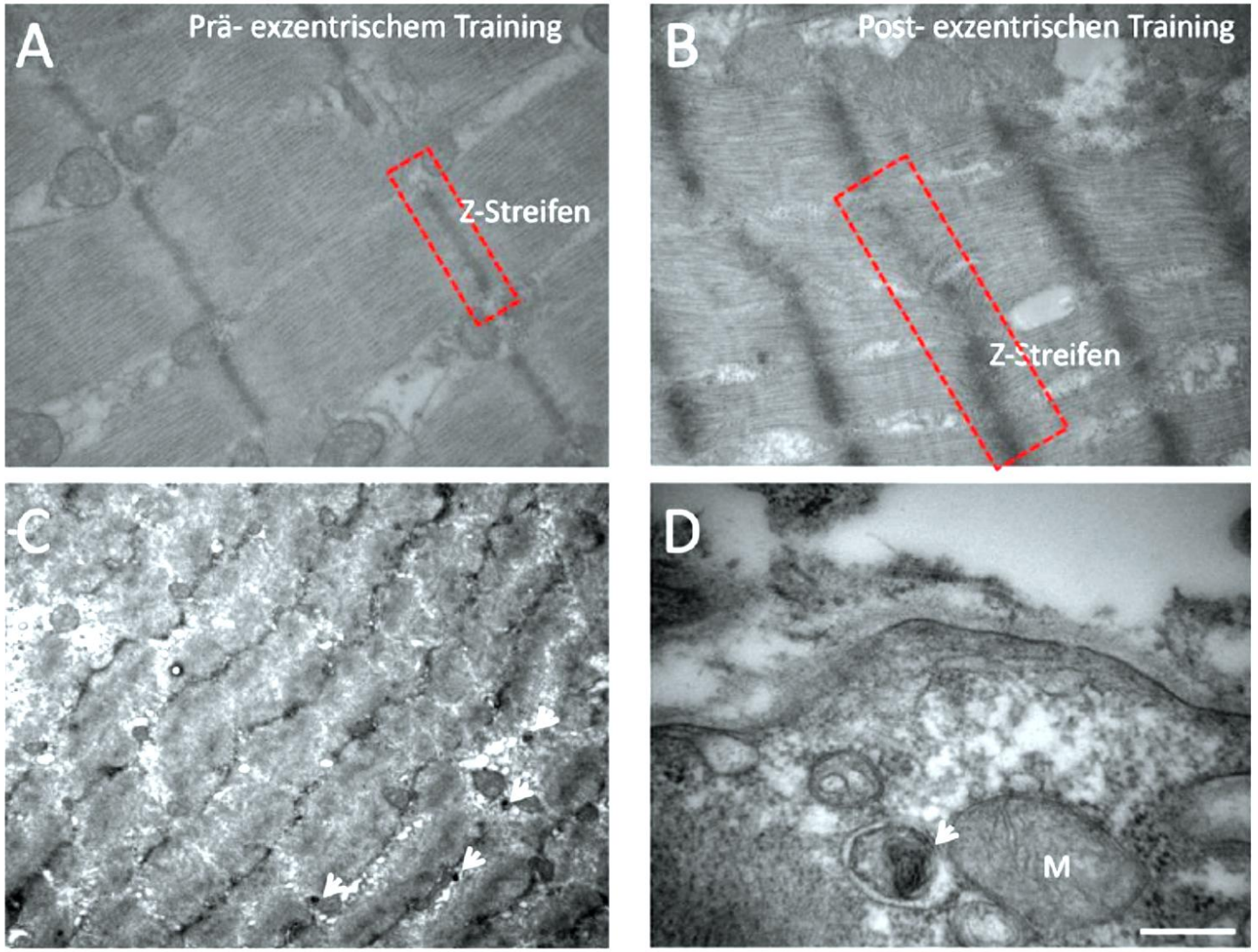

Figure 2

Electronic microscopic images of muscle fibers and the surrounding endomysium 24 h after eccentric muscle exertion (from: Esch W, Hottiger T, Debrecker B, Tischer T, Billy W, Engelhardt M. Anatomie-Physiologie der Muskelheilung. In: Engelhardt M, Mauch F, eds. Muskel- und Sehnenverletzungen. Pulle-Verlag, 2017:1-1. www.gots.org.) A) Biopsy before strength training with regularly formed sarcomeres and clearly demarcated thin Z-striae. B) After strength training, there is a partial destruction of the Z-striae and a partial dissolution of the classic sarcomere structure. C) Damaged sarcomeres with intervening autophagosomes (arrows). D) Autophagosome in formation next to a mitochondrion (M). Autophagosomes were formed during autophagy. They take up cellular material such as misfolded proteins or entire organelles for degradation.

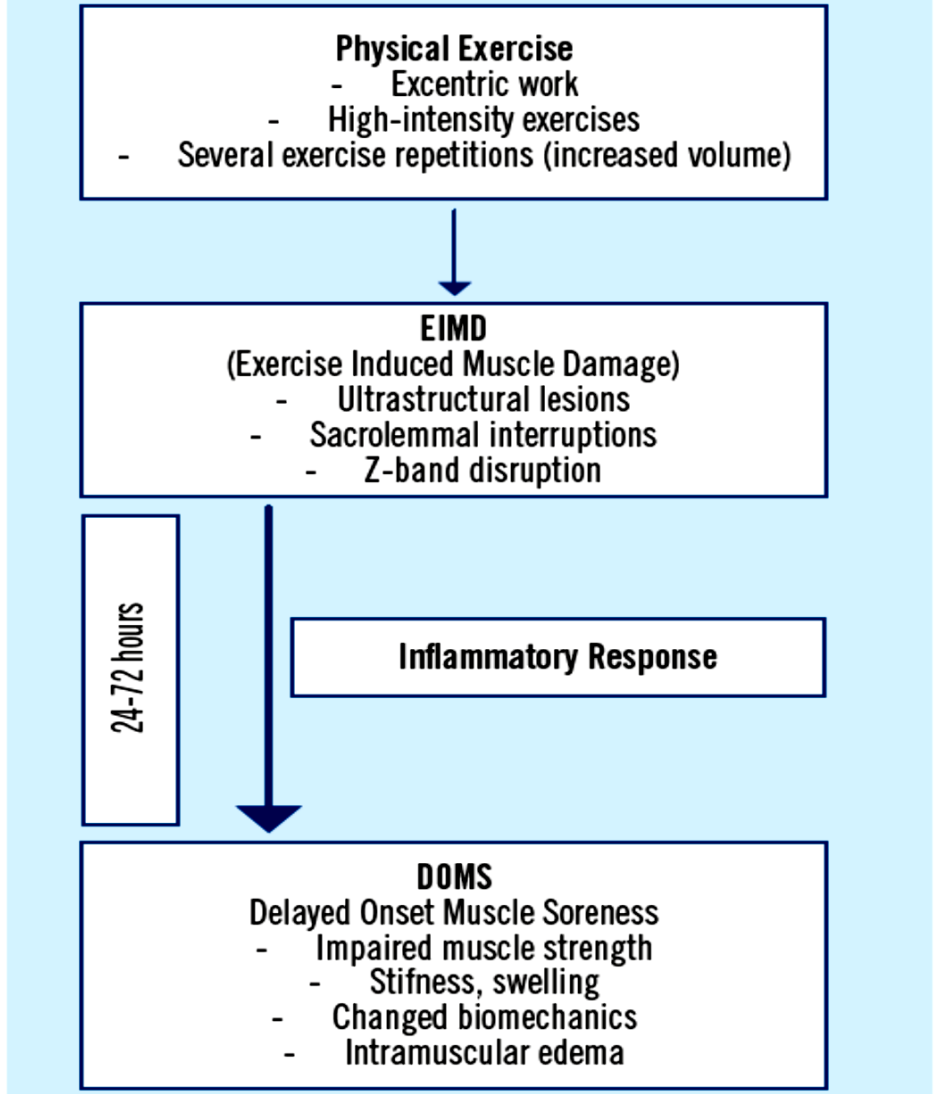

Figure 3

Depiction of the process of DOMS development. Due to excessive physical strain, microstructural lesions in the sense of exercise-induced muscle damage (EIMD) are elicited, which result in DOMS within 24-72 hours via an inflammatory response.

J Physiol Sci (2016) 66:43–52
DOI 10.1007/s12576-015-0397-0

MINI-REVIEW

Delayed onset muscle soreness: Involvement of neurotrophic factors

Kazue Mizumura[1] · Toru Taguchi[2]

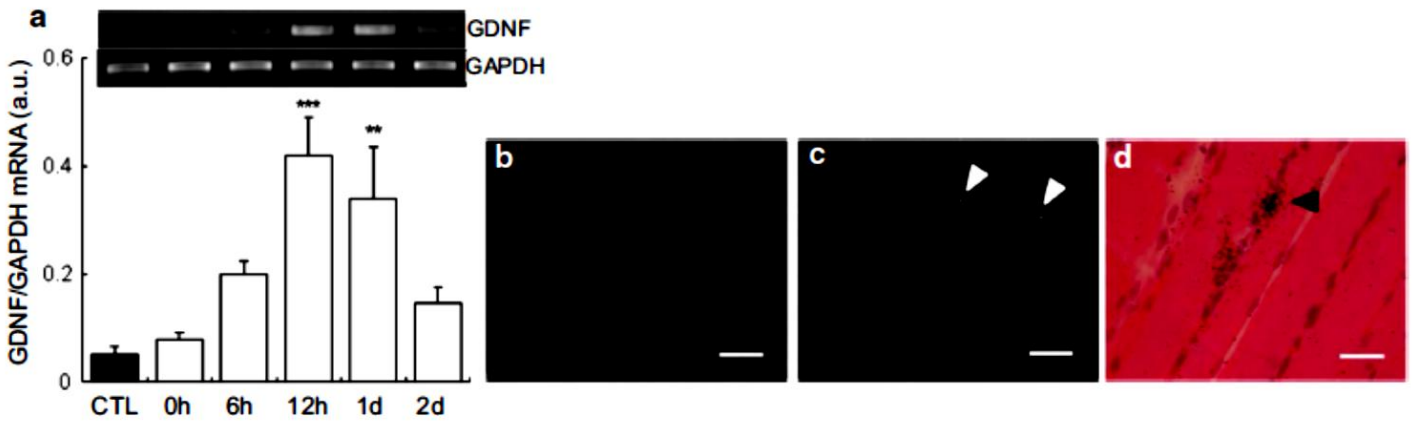

Fig. 3 GDNF upregulation in the muscle after LC. **a** GDNF mRNA of the EDL was upregulated 12 h–1 day after LC. **b**, **c** Expression of GDNF mRNA (*white arrowheads*) in EDL muscle 12 h after LC, shown by use of dark-field photomicrographs of in-situ hybridization histochemistry (oblique sections), was increased on the ipsilateral side (**c**) compared with the contralateral side (**b**). *Scale bar* 100 μm. **d** Bright-field photomicrograph (longitudinal section) at greater magnification shows in-situ hybridization signals for GDNF mRNA (*black arrowhead*) in the ipsilateral muscle. *Scale bar* 10 μm. Note that GDNF mRNA signals are observed around the nuclei of muscle cells and/or satellite cells. Modified from Murase et al. [47]

Diversamente dalle precedenti osservazioni, abbiamo osservato iperalgesia meccanica nei ratti 1–3 giorni dopo LC senza alcun danno microscopico apparente del muscolo o segni di infiammazione.

Con il nostro modello abbiamo scoperto che due percorsi sono coinvolti nell'indurre iperalgesia meccanica dopo LC: attivazione del percorso recettore bradichinina B2-fattore di crescita nervosa (NGF) e attivazione del percorso fattore neurotrofico derivato dalla linea cellulare gliale COX-2 (GDNF).

Questi fattori neurotrofici sono stati prodotti da fibre muscolari e/o cellule satellite.
Ciò significa che il danno alle fibre muscolari non è essenziale, sebbene sia sufficiente, per l'induzione di DOMS.

Invece, NGF e GDNF prodotti da fibre muscolari/cellule satellite svolgono ruoli cruciali nei DOMS.

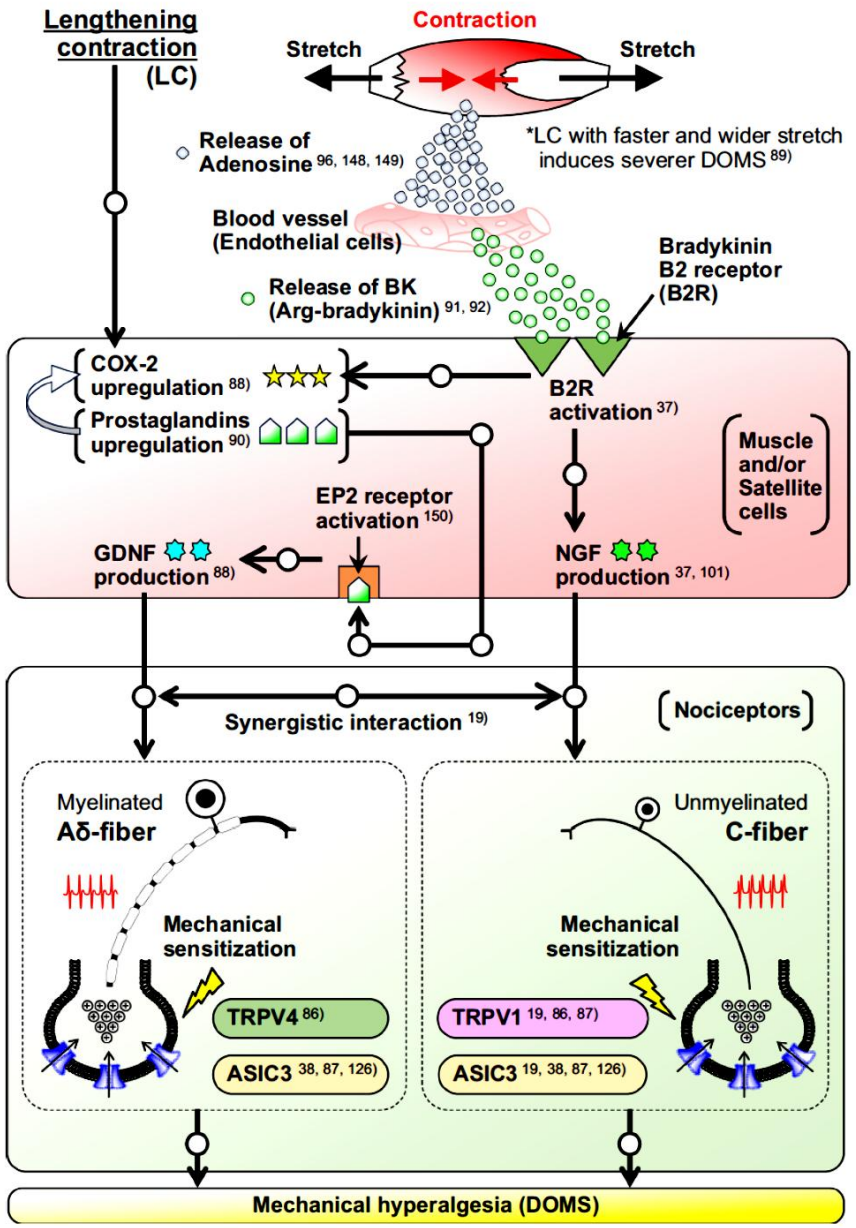

Diagramma schematico del meccanismo proposto per DOMS.

BK, sostanza simile alla bradichinina (Arg-bradichinina nei ratti);
COX2, cicloossigenasi-2;
PG, prostaglandine;
EP2, recettore prostaglandina EP2; GDNF, fattore neurotrofico derivato dalla linea cellulare gliale;
NGF, fattore di crescita nervoso;
ASIC, canale ionico di rilevamento acido; TRPV1 e TRPV4 potenziale recettore transitorio vanilloidi 1 e 4.

frontiers in Physiology

ORIGINAL RESEARCH
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Investigation of the Sympathetic Regulation in Delayed Onset Muscle Soreness: Results of an RCT

Johannes Fleckenstein[1†], Elmo W. I. Neuberger[2†], Philipp Bormuth[1,3], Fabio Comes[1,4], Angelika Schneider[1,5], Winfried Banzer[1,5], Lorenz Fischer[6‡] and Perikles Simon[2‡]*

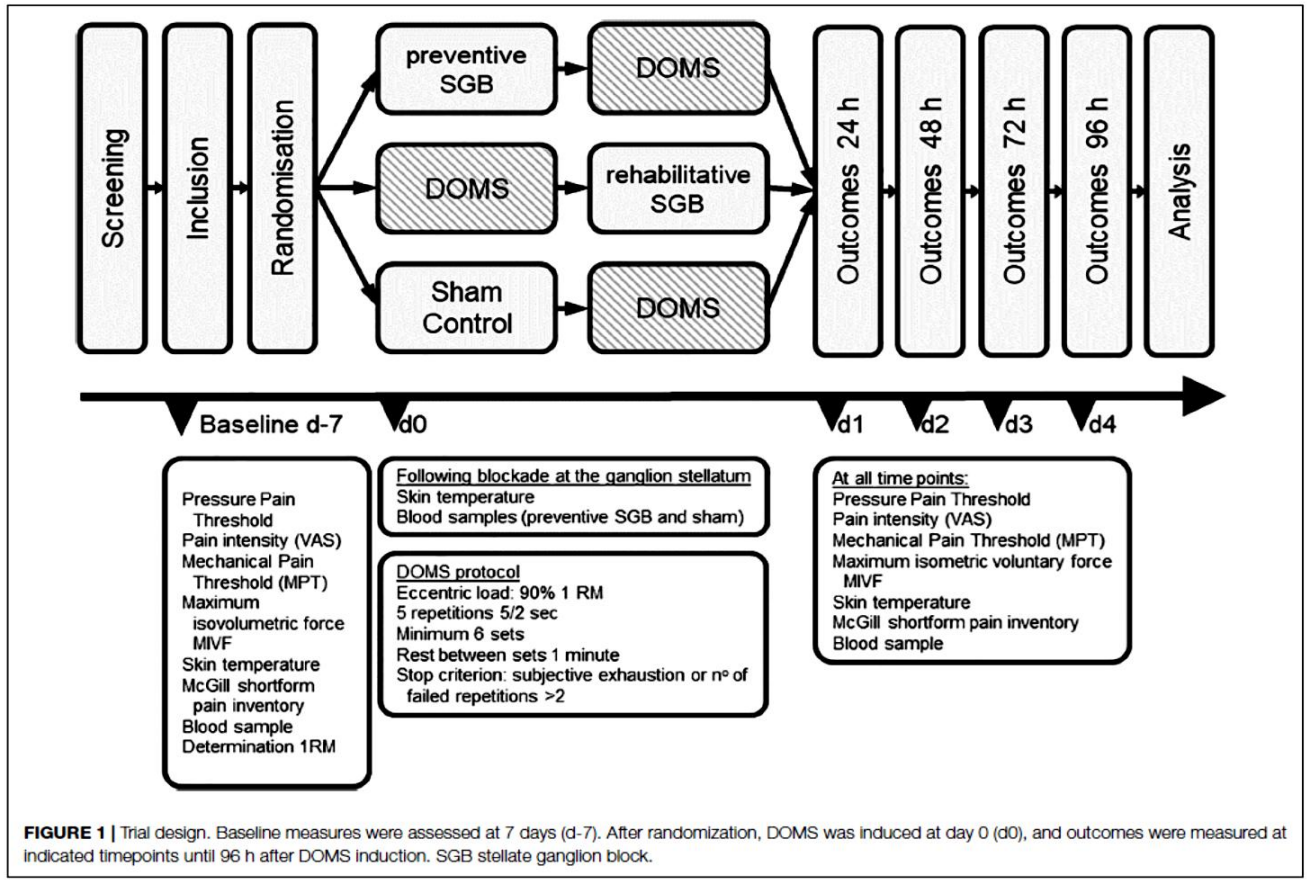
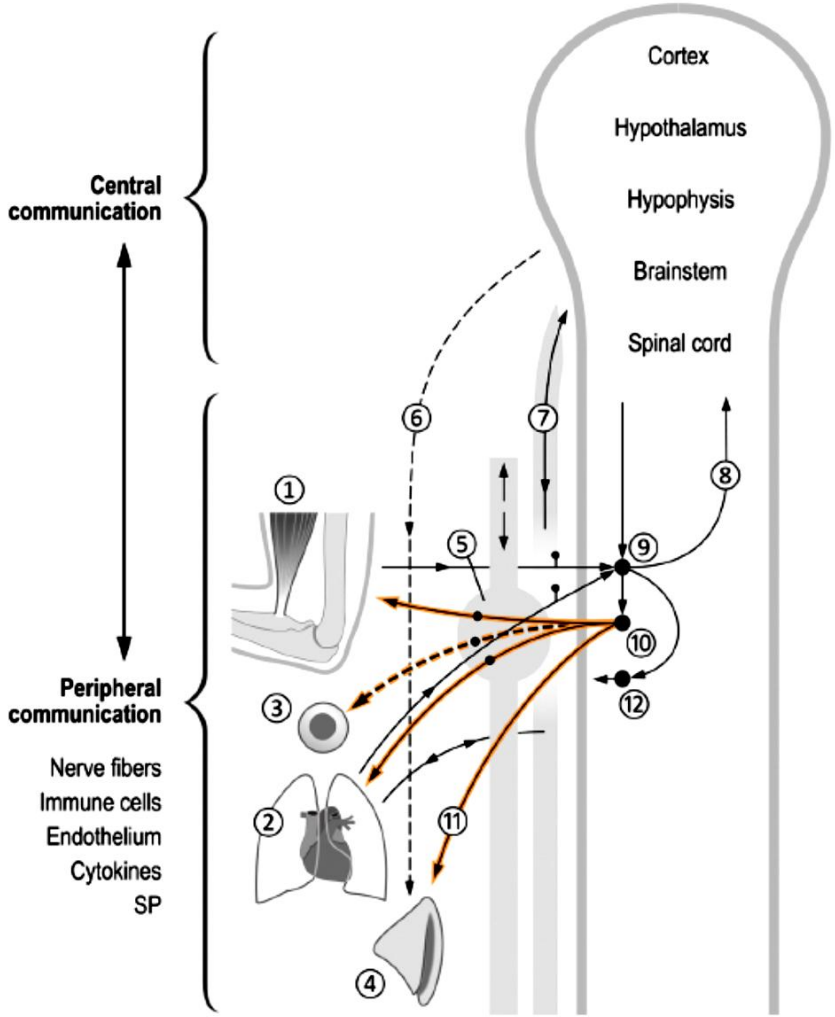


FIGURE 1 | Trial design. Baseline measures were assessed at 7 days (d-7). After randomization, DOMS was induced at day 0 (d0), and outcomes were measured at indicated timepoints until 96 h after DOMS induction. SGB stellate ganglion block.



① Muscle – fascia – skin
② Plexus cardiacus / Plexus pulmonalis
③ Immune cells (cfDNA / cytokine release)
④ Adrenal gland
⑤ Stellate ganglion
⑥ HPA axis
⑦ Vagus nerve
⑧ Tractus spino-thalamicus
⑨ Dorsal horn / WDR-neuron
⑩ Nucleus intermediolateralis
⑪ Sympatho-adrenal system
⑫ α-Motoneuron

USASP
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Negative Psychological Factors' Influence on Delayed Onset Muscle Soreness Intensity, Reduced Cervical Function and Daily Activities in Healthy Participants

Raúl Fabero-Garrido,* Gustavo Plaza-Manzano,*,† Patricia Martín-Casas,*,† Tamara del Corral,† Marcos Navarro-Santana,‡ and Ibai López-de-Uralde-Villanueva†

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Gli autori hanno esaminato l'influenza di fattori psicologici negativi (catastrofizzazione, angoscia e kinesiofobia) sull'intensità del dolore muscolare a insorgenza ritardata (DOMS), sulla funzionalità cervicale (forza e ampiezza del movimento) e sulle attività quotidiane (ADL).

I fattori psicologici e la funzionalità cervicale sono stati valutati in 86 partecipanti sani all'inizio prima di applicare un protocollo di provocazione DOMS nei muscoli flessori cervicali. Dopo 24 ore, la funzionalità cervicale è stata rivalutata. Inoltre, a 24 e 48 ore, l'intensità del DOMS e il suo impatto sull'ADL sono stati valutati utilizzando la scala analogica visiva (VAS).

Il disagio psicologico (ansia e depressione), ma non la kinesiofobia e il catastrofismo, hanno previsto una perdita di forza cervicale (spiegata il 43% della varianza) e di ampiezza di movimento (spiegata il 22% della varianza) dopo l'induzione di DOMS.

Inoltre, il livello di ansia dei partecipanti ha previsto l'intensità di DOMS a 24 ore (spiegata il 19% della varianza).

Gli autori concludono che i risultati evidenziano la rilevanza della valutazione del disagio psicologico come misura preventiva/terapeutica, dato che livelli elevati di disagio potrebbero portare a un dolore più intenso e invalidante nelle lesioni acute e che tutti questi aspetti sono considerati fattori di rischio per la cronicizzazione dei sintomi.

International Journal of *Molecular Sciences*

Review

Is "Delayed Onset Muscle Soreness" a False Friend? The Potential Implication of the Fascial Connective Tissue in Post-Exercise Discomfort

Jan Wilke [1,2,*] and Michael Behringer [1]

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https://doi.org/10.1007/s00424-023-02896-8

SENSORY PHYSIOLOGY

Pain quality patterns in delayed onset muscle soreness of the lower back suggest sensitization of fascia rather than muscle afferents: a secondary analysis study

Andreas Brandl[1,2,3] · Jan Wilke[4] · Christoph Egner[5] · Tobias Schmidt[6,7] · Andreas Schilder[8] · Robert Schleip[2,4]

Fu *et al. Insights into Imaging* (2024) 15:67
https://doi.org/10.1186/s13244-024-01619-6

Insights into Imaging

ORIGINAL ARTICLE Open Access

MRI T2 mapping and shear wave elastography for identifying main pain generator in delayed-onset muscle soreness: muscle or fascia?

Congcong Fu[1†], Yu Xia[2†], Bingshan Wang[1], Qiang Zeng[1*] and Shinong Pan[3*]

Best Practice & Research Clinical Rheumatology 38 (2024) 101944

Contents lists available at ScienceDirect

Best Practice & Research Clinical Rheumatology

journal homepage: www.elsevierhealth.com/berh

Myofascial pain – A major player in musculoskeletal pain

Christopher Lam [a], Vinicius Tieppo Francio [a], Kelsey Gustafson [a], Michael Carroll [b], Abigail York [a], Andrea L. Chadwick [a,*]

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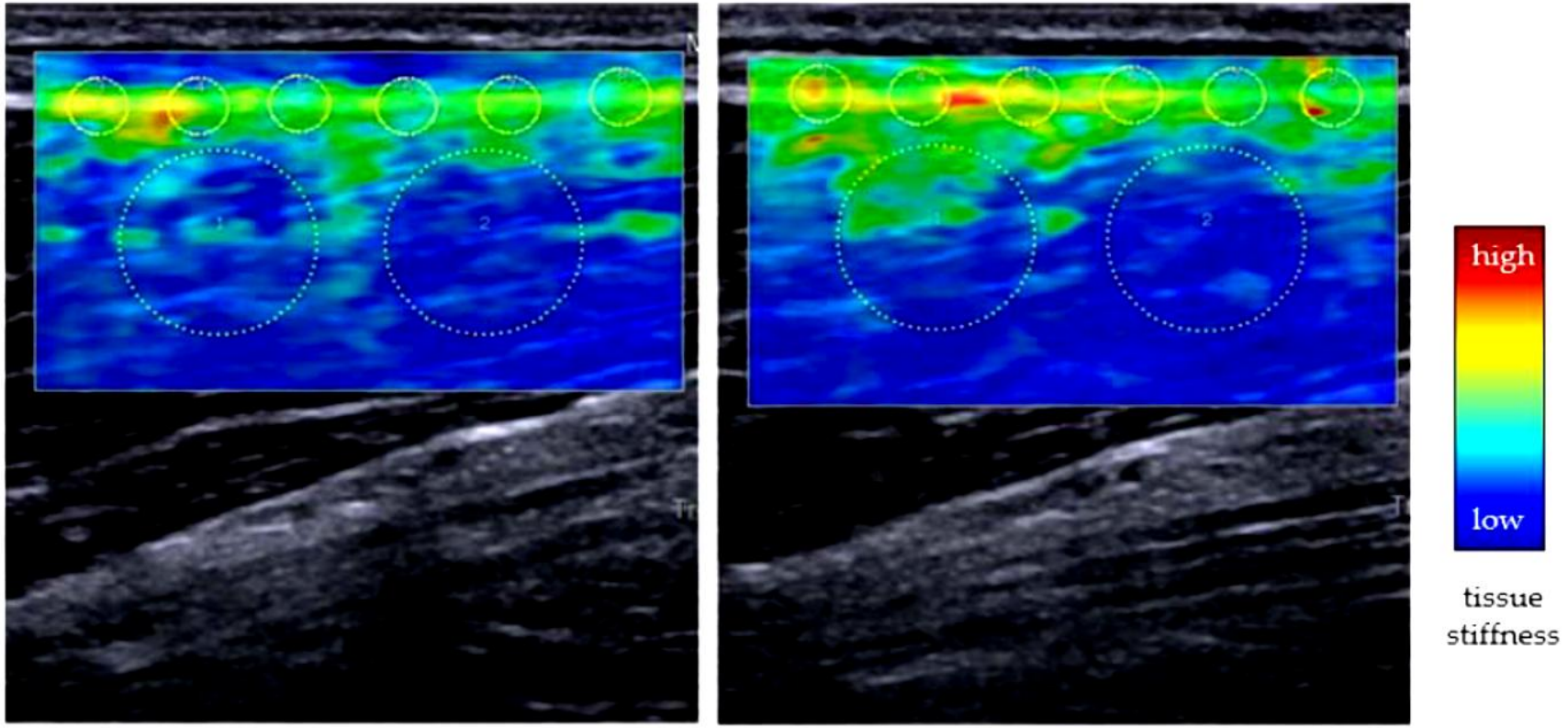


Figure 2. Shear-wave elastography (SWE) of the ventral thigh before (**left**) and 48 h (**right**) after lower leg eccentric exercise. In SWE, an acoustic radiation force impulse is used to produce shear waves traveling perpendicularly. Measuring the speed of this horizontal shear wave propagation allows the calculation of mechanical properties. The colored regions of interest indicate the tissue's mechanical stiffness: while blue represents low values, red represents high values. Note the marked stiffness increase in and near the deep fascia over the muscle (small circles). The scans used for this figure were acquired in the authors' laboratory.

Wilke, J.; Behringer, M. Is "Delayed Onset Muscle Soreness" a False Friend? The Potential Implication of the Fascial Connective Tissue in Post-Exercise Discomfort.
***Int. J. Mol. Sci*. 2021, 22, 9482.https://doi.o rg/10.3390/ijms22179482**

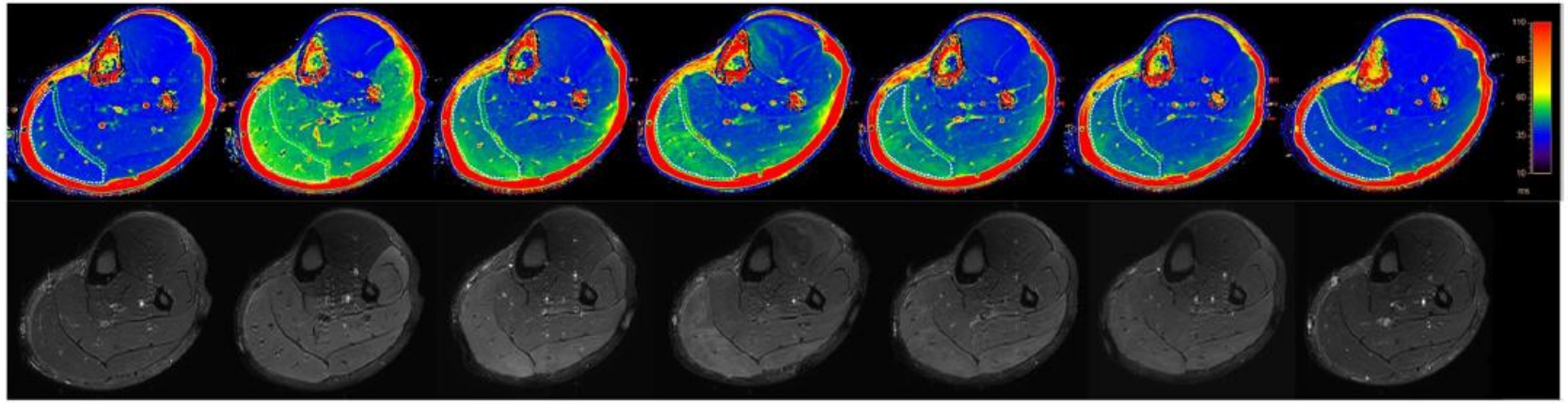


Fig. 1 **a** T2 maps. **b** Fat-suppressed T2W images. **a** and **b** show the calf muscle before and after eccentric exercise; the data are measured on T2 maps. The color bar of the T2 maps ranges from 10 to 110

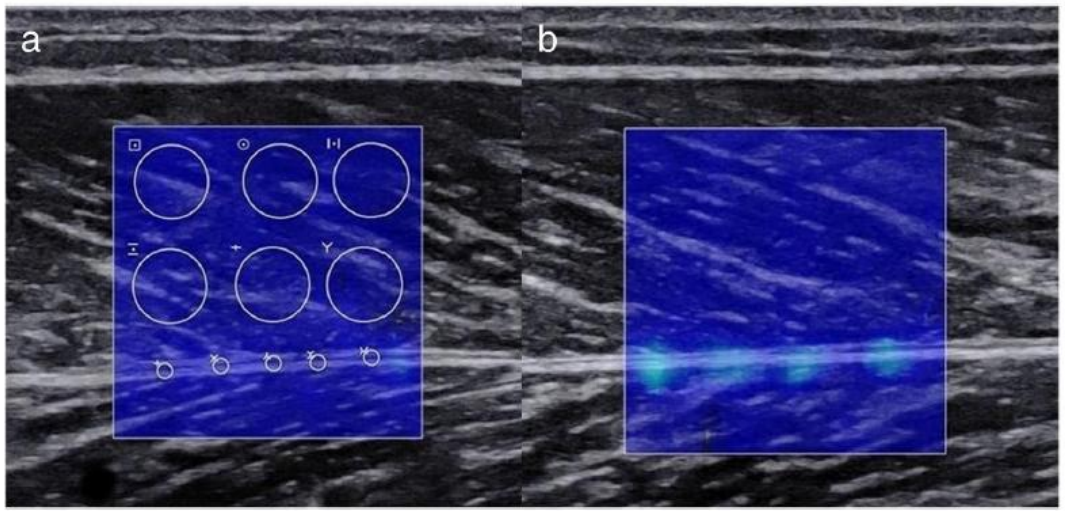


Fig. 2 **a** and **b** separately show the shear wave elastography qualitative color maps of the lower leg soft tissue before and 48 h after exercise. Six regions of interest (diameter = 5 mm) were manually located at the medial head of the gastrocnemius muscle, while five regions of interest (diameter = 1 mm) were manually located equidistantly along the deep fascia

Fu et al. Insights into Imaging (2024) 15:67 https://doi.org/10.1186/s13244-024-01619-6

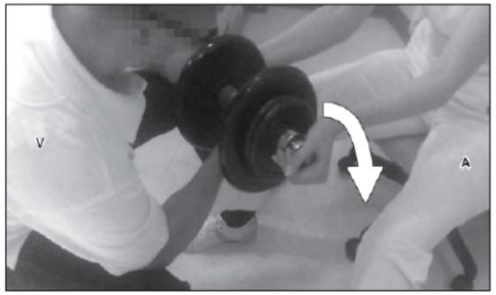


Fig. 2—Photograph shows eccentric resistance exercise performed by volunteers. In sitting position, volunteer (V) placed elbow of nondominant arm on ipsilateral knee and brought weight down (*arrow*) slowly in approximately 3–5 seconds until elbow was fully extended (eccentric resistance exercise). Assisting person (A) took weight from volunteer while volunteer brought his or her arm back to starting position with flexed elbow without weight.

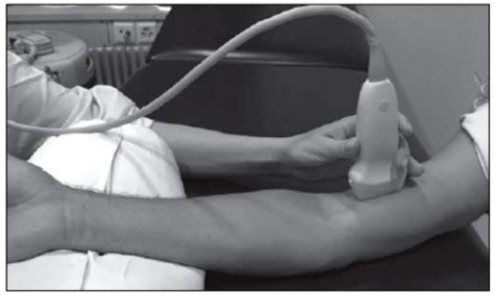
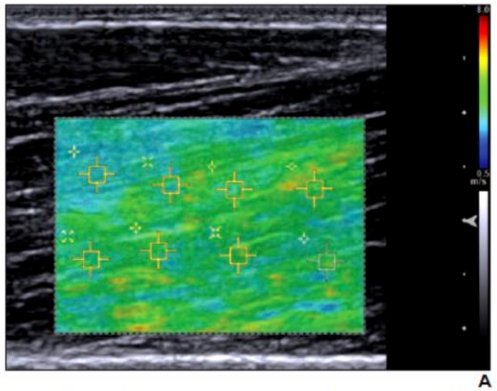


Fig. 3—Shear-wave ultrasound elastography. Photograph shows position of arm for scanning: Volunteer rests wrist on pillow and relaxes brachialis muscle, and transducer is parallel to long axis of brachialis muscle belly.



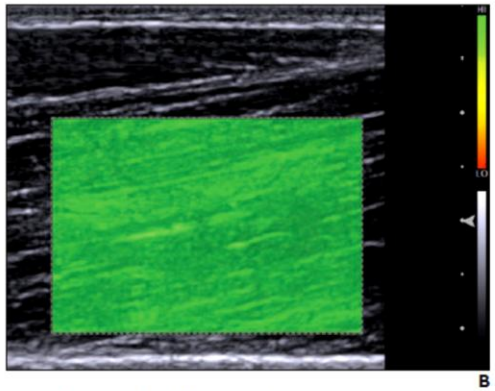


Fig. 4—Color-coded shear-wave ultrasound elastography maps of 40-year-old male volunteer (male volunteer 5 in Tables 1 and 2). Maps were obtained using Virtual Touch Tissue Imaging Quantification (VTIQ, Siemens Healthcare) software.
A, Color-coded map obtained before exercise shows shear-wave velocities (SWVs) and positioning of ROIs in superficial and deep portions of brachialis muscle belly.
B, Quality map for **A**. Quality maps are provided by software to indicate quality and reliability of SWV measurements (HI = high quality [green], LO = low quality [red]). Measurements were repeated until map showing optimal quality, like map shown here, was obtained.

Cinque volontari maschi (età media ± DS, 39,6 ± 4,6 anni) e cinque femmine (30,6 ± 13,5 anni) sono stati sottoposti a risonanza magnetica da 1,5 T prima e dopo (15 minuti, 1 giorno, 3 giorni, 7 giorni) l'esecuzione di esercizi di resistenza eccentrica unilaterale dei muscoli flessori del gomito. Gli esami di risonanza magnetica includevano sequenze di imaging fluido-sensibile, DWI e tensore di diffusione della parte superiore distale del braccio. Sono stati valutati edema muscolare, coefficiente di diffusione apparente (ADC) e anisotropia frazionaria (FA).
È stata eseguita un'ecografia del muscolo brachiale prima e dopo (15 minuti, 12 ore, 1 giorno, 2 giorni, 3 giorni, 7 giorni) l'esercizio per misurare la velocità media delle onde di taglio (SWV). Sono stati valutati dolore e tensione muscolare.
CONCLUSIONE. FA è inversamente correlato al dolore e può essere un utile parametro di imaging per la valutazione del DOMS. L'elastografia ecografica a onde di taglio mostra un aumento temporaneo della rigidità muscolare dopo un esercizio che induce DOMS, ma non è correlata ai parametri quantitativi della risonanza magnetica o ai sintomi clinici.

AJR 2017; 208:402–412

Delayed-Onset Muscle Soreness: Temporal Assessment With Quantitative MRI and Shear-Wave Ultrasound Elastography

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Florian M. Buck[1,2]
Linda Dyer[3]
Martin Flück[2,4]
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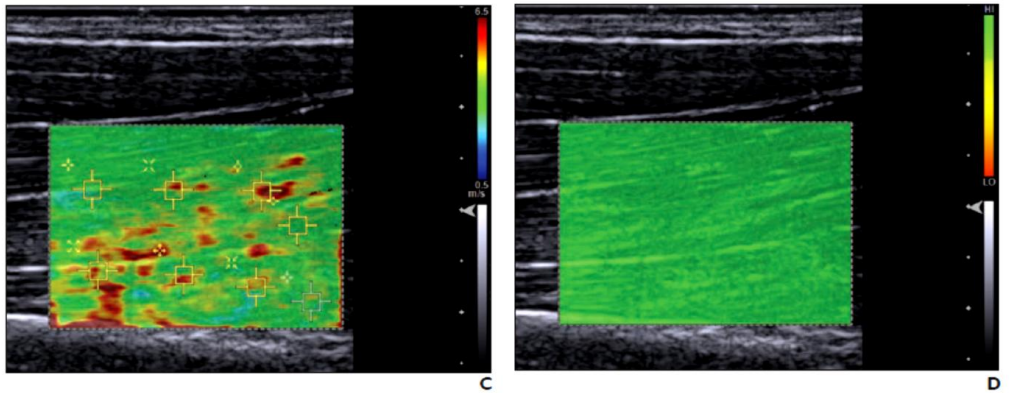

Fig. 4 (continued)—Color-coded shear-wave ultrasound elastography maps of 40-year-old male volunteer (male volunteer 5 in Tables 1 and 2). Maps were obtained using Virtual Touch Tissue Imaging Quantification (VTIQ, Siemens Healthcare) software.
C, Color-coded map obtained 15 minutes after exercise shows shear-wave velocities (SWVs) and positioning of ROIs in superficial and in deep portion of brachialis muscle belly.
D, Quality map (HI = high quality [green], LO = low quality [red]) for **C** shows SWV measurements are optimal quality and reliability.

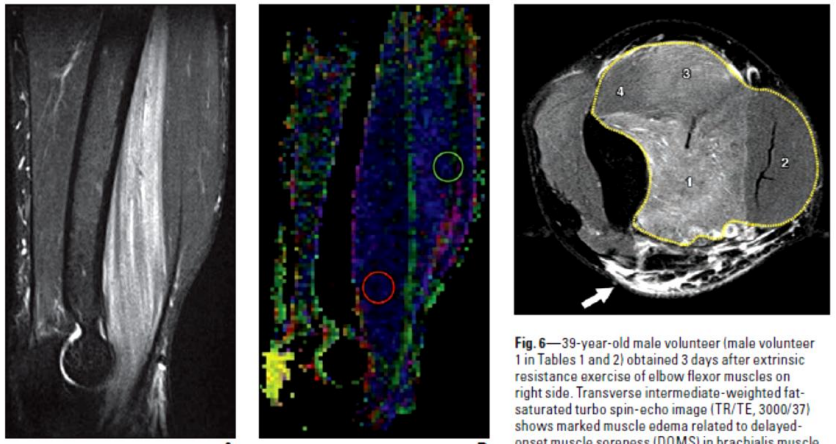

Fig. 5—Images of 40-year-old male volunteer (male volunteer 5 in Tables 1 and 2 [also shown in Fig. 4]) obtained 3 days after eccentric resistance exercise of elbow flexor muscles on right side.
A, Sagittal STIR MR image (TR/TE, 4000/456) shows severe edema in brachialis muscle.
B, Fractional anisotropy map shows ROI in brachialis muscle (*red circle*) and biceps brachii muscle (*green circle*).

Fig. 6—39-year-old male volunteer (male volunteer 1 in Tables 1 and 2) obtained 3 days after extrinsic resistance exercise of elbow flexor muscles on right side. Transverse intermediate-weighted fat-saturated turbo spin-echo image (TR/TE, 3000/37) shows marked muscle edema related to delayed-onset muscle soreness (DOMS) in brachialis muscle (1), no edema in biceps brachii muscle (2), marked muscle edema related to DOMS in brachioradialis muscle (3), and no edema in extensor carpi radialis longus muscle (4). Cross-sectional area (*dotted line*) of flexor compartment was measured just proximal to level of pronator teres muscle to include all mentioned muscles because separation of muscles was often not possible. Arrow shows adjacent soft-tissue edema in subcutaneous fat.

La valutazione del DOMS si basa principalmente sulla storia clinica e sulla valutazione dei sintomi.

Anamnesi e storia dell'esercizio:

- **Indagare sulla tipologia e l'intensità dell'attività fisica che ha preceduto il dolore.**
- **Chiedere se l'attività fisica era più intensa o diversa dal normale allenamento dell'atleta.**
- **Indagare sul tipo di muscolo coinvolto e su eventuali movimenti eccentrici (es. discesa in corsa, ecc.).**

Sintomi:

- **Dolore muscolare generalmente sordo e diffuso, localizzato in zone specifiche dei muscoli più sollecitati.**
- **L'intensità del dolore aumenta nei primi giorni post-allenamento e può essere accompagnata da rigidità muscolare, gonfiore e tensione.**

Esame fisico:

- **Palpazione muscolare: può essere dolorosa nelle aree muscolari interessate, con un grado di sensibilità variabile a seconda della gravità.**
- **Test di forza: può essere presente una temporanea riduzione della forza muscolare, dovuta al dolore e alla rigidità.**
- **Ampiezza di movimento: la limitazione della mobilità dovuta al dolore può essere valutata durante l'esame fisico.**

Valutazione strumentale:

- **Ecografia muscolare per identificare eventuali lesioni più gravi.**
- **RMN (risonanza magnetica) nei casi di incertezze diagnostiche.**

REVIEW ARTICLE

Sports Med 2003; 33 (2): 145-164
0112-1642/03/0002-0145/$30.00/0

Delayed Onset Muscle Soreness

Treatment Strategies and Performance Factors

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Sports Medicine - Open

SYSTEMATIC REVIEW Open Access

Effectiveness of Recovery Strategies After Training and Competition in Endurance Athletes: An Umbrella Review

Shuting Li[1*], Matthias Kempe[1], Michel Brink[1] and Koen Lemmink[1]

Journal of *Clinical Medicine*

MDPI

Protocol

Physical Therapies for Delayed Onset Muscle Soreness: A Protocol for an Umbrella and Mapping Systematic Review with Meta-Meta-Analysis

Szczepan Wiecha [1,*], Paweł Posadzki [2,3], Robert Prill [4,5] and Maciej Płaszewski [1]

Trattamento del DOMS

Riposo attivo: È importante permettere al muscolo di riprendersi senza interrompere completamente l'attività fisica. Il riposo totale potrebbe rallentare il recupero. L'attività fisica leggera, come camminare o eseguire esercizi di stretching a bassa intensità, può essere utile per stimolare la circolazione sanguigna e accelerare il recupero.

Terapia del ghiaccio: L'applicazione di ghiaccio nelle prime 24-48 ore può ridurre l'infiammazione e alleviare il dolore. Ghiaccio o impacchi freddi possono essere applicati per 15-20 minuti ogni 1-2 ore, in caso di dolore acuto.

Calore (dopo le prime 48 ore): Il calore può essere utile per rilassare la muscolatura e migliorare il flusso sanguigno. Può essere applicato sotto forma di **impacchi caldi** o **bagni caldi**.

Farmaci antidolorifici e antinfiammatori: Farmaci come il **paracetamolo** o i **FANS** (farmaci anti-infiammatori non steroidei, es. ibuprofene) possono essere utilizzati per alleviare il dolore e ridurre l'infiammazione.

Massaggio muscolare e foam rolling: L'auto-massaggio o il massaggio professionale possono favorire il rilassamento muscolare e il miglioramento della circolazione. Il **foam rolling** può essere utile per ridurre la tensione muscolare.

Stretching e mobilizzazione: Stretching delicato e **mobilizzazione articolare** possono contribuire a ridurre la rigidità muscolare. Tuttavia, lo stretching dovrebbe essere fatto con cautela per evitare di aggravare la condizione.

Fisioterapia: Nei casi in cui il dolore è particolarmente debilitante, il trattamento con un fisioterapista potrebbe includere tecniche come **terapia manuale**, **ultrasuoni**, e **elettrostimolazione**.

frontiers in Physiology

SYSTEMATIC REVIEW
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An Evidence-Based Approach for Choosing Post-exercise Recovery Techniques to Reduce Markers of Muscle Damage, Soreness, Fatigue, and Inflammation: A Systematic Review With Meta-Analysis

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OPEN ACCESS

L'obiettivo del presente lavoro era di eseguire una meta-analisi che valutasse l'impatto delle tecniche di recupero su indolenzimento muscolare a insorgenza ritardata (DOMS), affaticamento percepito, danno muscolare e marcatori infiammatori dopo l'esercizio fisico.

Il massaggio sembra essere il metodo più efficace per ridurre DOMS e affaticamento percepito.

L'affaticamento percepito può essere gestito efficacemente utilizzando tecniche di compressione, come indumenti compressivi, massaggi o immersione in acqua.

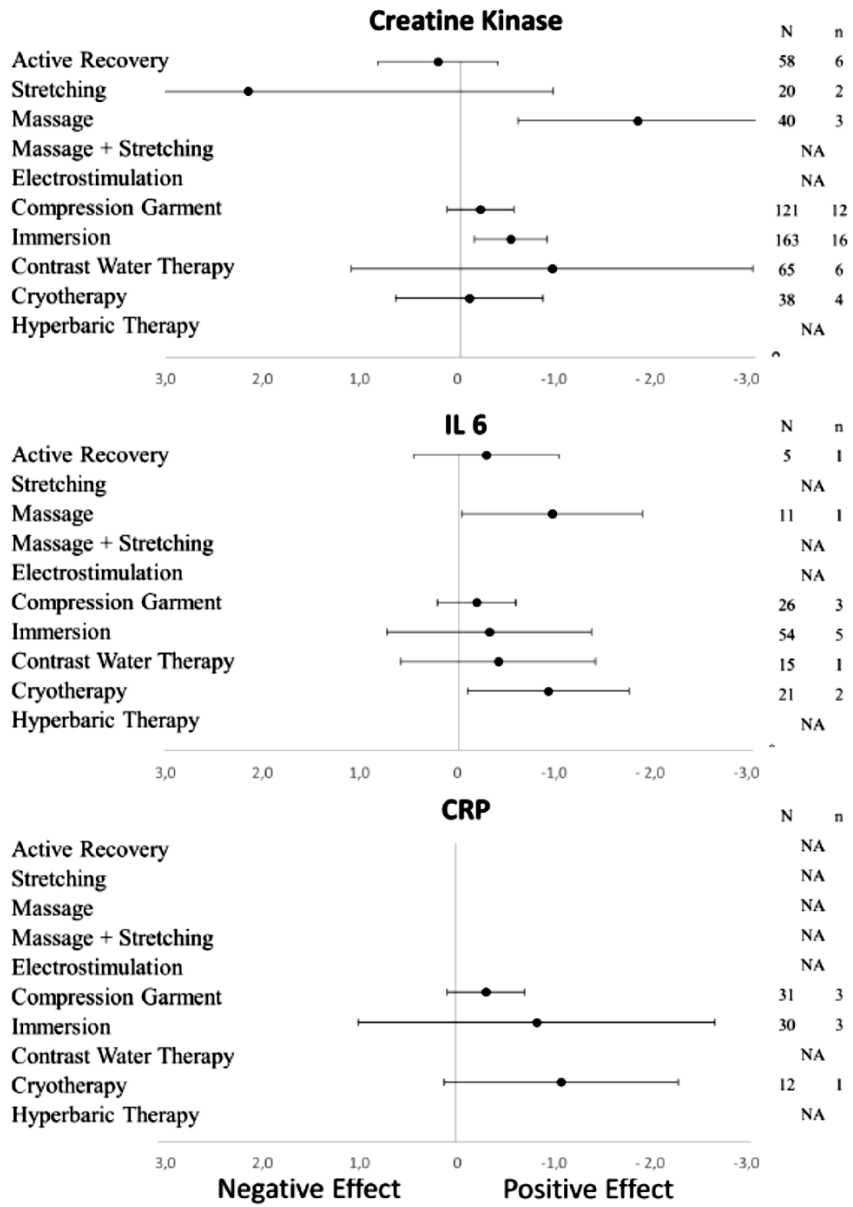

FIGURE 2 | Effects of recovery techniques on the kinetics of muscle damage (CK) and inflammatory markers (CRP and IL-6) (NA, not available; N, number of subjects; n, number of experimental groups).

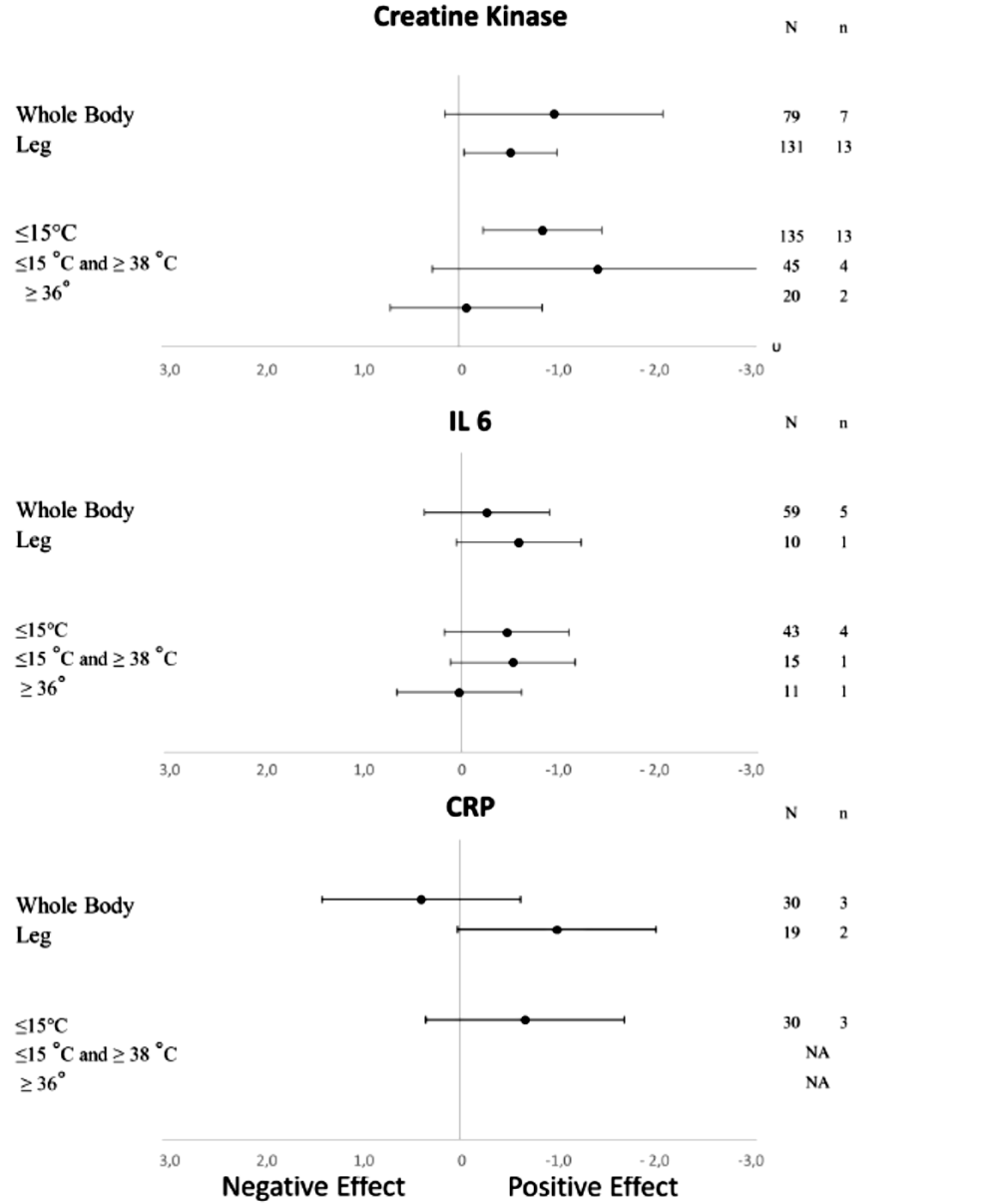

FIGURE 3 | Effects of the characteristics of immersion on the kinetics of muscle damage (CK) and inflammatory markers (CRP and IL-6) (NA, not available; N, number of subjects; n, number of experimental groups).

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Sports Medicine - Open

SYSTEMATIC REVIEW Open Access

Attenuating Muscle Damage Biomarkers and Muscle Soreness After an Exercise-Induced Muscle Damage with Branched-Chain Amino Acid (BCAA) Supplementation: A Systematic Review and Meta-analysis with Meta-regression

Atef Salem[1,2,11*], Khouloud Ben Maaoui[1], Haithem Jahrami[3,4], Mezna A. AlMarzooqi[5], Omar Boukhris[6], Balsam Messai[1,2], Cain C. T. Clark[7], Jordan M. Glenn[8], Hadeel A. Ghazzaoui[9], Nicola Luigi Bragazzi[10], Achraf Ammar[1,11], Khaled Trabelsi[1,12] and Hamdi Chtourou[1,2]

Tarsitano et al.
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Journal of Translational Medicine

REVIEW Open Access

Effects of magnesium supplementation on muscle soreness in different type of physical activities: a systematic review

Maria Grazia Tarsitano[1*], Federico Quinzi[2], Katia Folino[2], Francesca Greco[3], Francesco Pio Oranges[1], Claudia Cerulli[3] and Gian Pietro Emerenziani[2]

The Journal of Pain, Vol 8, No 3 (March), 2007: pp 237
Available online at www.sciencedirect.

ELSEVIER

Caffeine Attenuates Delayed-Onset Muscle Pain and Force Loss Following Eccentric Exercise

Victor Maridakis, Patrick J. O'Connor, Gary A. Dudley, and Kevin K. McCully
Department of Kinesiology, University of Georgia, Athens, Georgia.

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http://www.jssm.org DOI: https://doi.org/10.52082/jssm.2024.317

Research article

Effects of Omega-3 Supplementation on the Delayed Onset Muscle Soreness after Cycling High Intensity Interval Training in Overweight or Obese Males

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Review Article

Effects of Resveratrol Supplementation on Delayed Onset Muscle Soreness and Muscle Recovery: A Systematic Review

Nurdiana Zainol ABIDIN[1], Ooi Cheong Hwa[1], Kazunori NOSAKA[2], Vishanth RATHAKRISHNAN[1], CHAN Siok Yee[3], Noor Khairiah A KARIM[4]

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Evaluation of curcumin intake in reducing exercise-induced muscle damage in athletes: a systematic review

Popescu-Radu Daniel Vasile[a], Martinez-López Patricia[b], Massip-Salcedo Marta[c] and Esquius Laura[d]

Prevenzione del DOMS

Allenamento progressivo: Iniziare gli allenamenti in modo graduale, aumentando l'intensità e la durata in maniera progressiva. Evitare allenamenti troppo intensi all'inizio di una nuova stagione sportiva o dopo un lungo periodo di inattività.

Riscaldamento adeguato: Un buon riscaldamento prima dell'esercizio fisico (attività aerobica leggera seguita da esercizi di stretching dinamico) aiuta a preparare i muscoli per l'attività fisica intensa.

Stretching e defaticamento: Il **defaticamento** dopo l'esercizio fisico, che include stretching statico e attività a bassa intensità, può favorire un recupero muscolare ottimale.

Nutrizione e idratazione: Una corretta alimentazione, che comprenda una quantità adeguata di proteine per il recupero muscolare, carboidrati per il reintegro energetico, e grassi sani, è essenziale. L'**idratazione** è altrettanto cruciale per prevenire i crampi muscolari e supportare il recupero.

Uso di tecniche di recupero avanzate: Tecniche come **compressione** (es. maniche compressive), **terapia con onde d'urto** o **idroterapia** (bagni di contrasto caldo-freddo) possono contribuire a prevenire o ridurre il DOMS, specialmente in atleti professionisti.

ACSM Information On...

Delayed Onset Muscle Soreness (DOMS)

Any type of activity that places unaccustomed loads on muscle may lead to delayed onset muscle soreness (DOMS). This type of soreness is different from acute soreness, which is pain that develops during the actual activity. Delayed soreness typically begins to develop 12-24 hours after the exercise has been performed and may produce the greatest pain between 24-72 hours after the exercise has been performed.

A COMPLETE PHYSICAL ACTIVITY PROGRAM

A well-rounded physical activity program includes aerobic exercise and strength training exercise, but not necessarily in the same session. This blend helps maintain or improve cardiorespiratory and muscular fitness and overall health and function. Regular physical activity will provide more health benefits than sporadic, high intensity workouts, so choose exercises you are likely to enjoy and that you can incorporate into your schedule.

ACSM's physical activity recommendations for healthy adults, updated in 2011, recommend at least 30 minutes of moderate-intensity physical activity (working hard enough to break a sweat, but still able to carry on a conversation) five days per week, or 20 minutes of more vigorous activity three days per week. Combinations of moderate- and vigorous-intensity activity can be performed to meet this recommendation.

Examples of typical aerobic exercises are:
- Walking
- Running
- Stair climbing
- Cycling
- Rowing
- Cross country skiing
- Swimming.

In addition, strength training should be performed a minimum of two days each week, with 8-12 repetitions of 8-10 different exercises that target all major muscle groups. This type of training can be accomplished using body weight, resistance bands, free weights, medicine balls or weight machines.

While origins of the soreness and accompanying symptoms are complex, it is well-established that many types of physical activity can cause delayed soreness. Most believe soreness develops as a result of microscopic damage to muscle fibers involved the exercise. This type of damage likely results from novel stresses that were experienced during the exercise. One common misconception about DOMS is that it is due to lactic acid accumulation, but lactic acid is not a component of this process. DOMS appears to be a side effect of the repair process that develops in response to microscopic muscle damage.

Examples of activities that are known to cause DOMS include:
- Strength training exercise
- Walking down hills
- Jogging
- Step aerobics
- Jumping

Activities which cause DOMS all cause muscles to lengthen while force is applied. This is eccentric muscle action. Examples of eccentric muscle actions include the lowering phase of a bicep curl exercise or the lengthening of the thigh muscles while the limb brakes against your body's momentum as it walks or jogs down a hill. Jogging or running on a flat surface can

also elicit DOMS symptoms for those who are unaccustomed to this type of activity.

The severity of soreness depends on the types of forces placed on the muscle. Running down a hill will place greater force on the muscle than walking down the same hill. The soreness that develops will likely be greater after running down a hill. A high number of repetitions will cause more damage and soreness than a low number of repetitions. As a result, work your way gradually into a new exercise program.

All people are susceptible to DOMS, even those who have been exercising for years. However, the severity of soreness normally becomes less as your body becomes adapted to work it regularly performs. Just one bout of soreness-producing exercise actually develops a partial protective effect that reduces the chance of developing soreness in that same activity for weeks or months into the future.

DOES DOMS ONLY CAUSE SORENESS?

There are numerous characteristics of DOMS beyond local muscle pain. Some of the most common symptoms include:
- Swelling of the affected limbs;
- Stiffness of the joint accompanied by temporary reduction in a joint's range of motion;
- Tenderness to the touch;
- Temporary reduction in strength of the affected muscles (lasting days);
- In rare and severe cases, muscle breakdown to the extent that the kidneys may be placed at risk; and
- Elevated creatine kinase (CK) enzyme in the blood, signaling muscle tissue damage.

SEEKING MEDICAL TREATMENT

DOMS symptoms do not typically necessitate the need for medical intervention. If the pain level becomes debilitating, if limbs experience heavy swelling or if urine becomes dark, then medical consultation is advisable.

DOMS PREVENTION

One of the best ways to reduce the severity of DOMS is to progress slowly in a new program. Allowing the muscle time to adapt to new stress should help to minimize the severity of symptoms, but it is unlikely that soreness can be avoided altogether. It is also important to allow the muscle time to recover from work that produces soreness, and participating in the same exercises on subsequent days should to be done judiciously.

Proper warmup is also important in preparing the muscle for the types of forces that may cause damage, but there is little evidence that warm-up will be effective in preventing DOMS symptoms. Stretching is sometimes done before exercise, but it is better to stretch after the body is warmed up and after exercise. Stretching has not been shown to reduce or prevent symptoms of DOMS, but DOMS should last only a few days (usually 3-5 days) and the involved muscles will be better prepared for future bouts of the same type of exercise.

DISCONTINUING EXERCISE

Often, symptoms diminish during activity, but they will return after recovery. Performing exercise while experiencing severe symptoms may make matters worse. On the other hand, light activity should not impair your recovery. However, there is also not much evidence that this will hasten your recovery. If you find that your symptoms make it difficult or too painful to perform the activity, then it is advisable to refrain from the activity for a few days and return to the activity as symptoms subside.

EASING DOMS SYMPTOMS

There is little evidence that such treatment strategies will hasten recovery and return to normal function. If the primary goal is to reduce symptoms, then treatments such as ice pack application, massage, tender-point acupressure, and oral pain relief agents may be useful in easing pain. It is important to be aware that pain reduction does not represent recovery. Rather, these treatments may only be effective in reducing symptoms of pain, but underlying muscle damage and reduced function may persist.

NO PAIN, NO GAIN?

It is unlikely that you will avoid soreness altogether when beginning a new exercise program. However, pain does not need to be present to achieve gains in fitness status, and pain may indicate a need to reduce or refrain from an activity. While eccentric loading of muscle to achieve gains in muscle size appears to be important, gains in strength will occur without overemphasizing the eccentric component of a weightlifting exercise. Pain that occurs during exercise (i.e., acute) signals a problem with the exercise (too intense, bad form, etc.) and should be halted before muscle or joint damage occurs.

STAYING ACTIVE PAYS OFF!

Those who are physically active tend to live longer, healthier lives. Research shows that moderate physical activity – such as 30 minutes a day of brisk walking – significantly contributes to longevity. Even a person with risk factors like high blood pressure, diabetes or even a smoking habit can gain real benefits from incorporating regular physical activity into their daily life.

As many dieters have found, exercise can help you stay on a diet and lose weight. What's more – regular exercise can help lower blood pressure, control blood sugar, improve cholesterol levels and build stronger, denser bones.

THE FIRST STEP

Before you begin an exercise program, take a fitness test, or substantially increase your level of activity, make sure to answer the following questions. This physical activity readiness questionnaire (PAR-Q) will help determine if you're ready to begin an exercise routine or program.
- Has your doctor ever said that you have a heart condition or that you should participate in physical activity only as recommended by a doctor?
- Do you feel pain in your chest during physical activity?
- In the past month, have you had chest pain when you were not doing physical activity?
- Do you lose your balance from dizziness? Do you ever lose consciousness?
- Do you have a bone or joint problem that could be made worse by a change in your physical activity?
- Is your doctor currently prescribing drugs for your blood pressure or a heart condition?
- Do you know of any reason you should not participate in physical activity?

If you answered yes to one or more questions, if you are over 40 years of age and have recently been inactive, or if you are concerned about your health, consult a physician before taking a fitness test or substantially increasing your physical activity. If you answered no to each question, then it's likely that you can safely begin exercising.

PRIOR TO EXERCISE

Prior to beginning any exercise program, including the activities depicted in this brochure, individuals should seek medical evaluation and clearance to engage in activity. Not all exercise programs are suitable for everyone, and some programs may result in injury. Activities should be carried out at a pace that is comfortable for the user. Users should discontinue participation in any exercise activity that causes pain or discomfort. In such event, medical consultation should be immediately obtained.

AMERICAN COLLEGE of SPORTS MEDICINE
LEADING THE WAY

 This brochure was created and updated by William Braun, Ph.D., and Gary Storzo, Ph.D. It is a product of ACSM's Consumer Information Committee. Visit ACSM online at www.acsm.org.

TAKE HOME MESSAGES

Il dolore muscolare negli sportivi, che si manifesta come una reazione fisiologica al danno muscolare, è il risultato di una serie di meccanismi biochimici, infiammatori, e meccanici che coinvolgono danni alle fibre muscolari, accumulo di metaboliti, risposta infiammatoria e attivazione dei nocicettori.

La comprensione di questi meccanismi è fondamentale per sviluppare strategie efficaci di prevenzione e trattamento del dolore muscolare, migliorando il recupero e riducendo il rischio di infortuni.

Il DOMS è una reazione fisiologica comune che segue esercizi fisici intensi o non abituali, soprattutto quelli che coinvolgono contrazioni eccentriche.

Comprendere la fisiopatologia, eseguire una corretta valutazione dei sintomi, adottare strategie di trattamento tempestive e seguire un piano di prevenzione possono ridurre significativamente l'intensità del dolore e favorire un recupero più rapido e sicuro.

SOCIETÀ ITALIANA

G.U.I.D.A.

PER LA GESTIONE UNIFICATA E INTERDISCIPLINARE
DEL DOLORE MUSCOLO-SCHELETRICO E DELL'ALGODISTROFIA