

MUSCLE INJURIES

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The spectrum of muscle injuries is wide (musculoskeletal overuse injuries, contusions, lacerations, delayed-onset muscle soreness, muscle strains) and frequent in athletes (10 to 55% of all acute injuries).

EPIDEMIOLOGY

Muscles and muscle groups more frequently involved are those whose origin and insertion cross two joints, as well as those whose percentage of type II fibers is relatively high, such as:

- The hamstrings
- The rectus femoris
- The medial head of gastrocnemius.

Muscle strain commonly occurs in athletes whose sport requires high speeds or rapid acceleration, such as football, track and field, basketball and soccer.

In particular, muscle injuries are usually caused by a direct trauma or during the eccentric contraction in case of an indirect insult.

In professional soccer, muscle lesions account for 31% of all injuries, and are caused by an indirect trauma.

- In rugby, account for 11%
- In running sports, 16%
- In basketball, 18%

AETIOPATHOGENESIS

➤ TRAUMATIC LESIONS DEPEND ON:

- The impact intensity
- The state of contraction of the muscle
- The traumatic moment
- The specific muscle injured

➤ INDIRECT TRAUMA does not depend on external traumatic forces, rather on an excessive eccentric force along the muscle-tendon-bone axis.

CONSIDERING OVERUSE MUSCLE LESIONS, THE STARTING POINT IS A DISTURBANCE OF THE HOMEOSTASIS BETWEEN WORKLOAD AND REST: overloading is deliberately programmed as part of the endurance in the athlete's training process, stimulating physiological and psychological adaptations and improving physical performance, this way the body is forced to adaptation.

However, excessive and repetitive overloading followed by inadequate recovery may lead to overreaching and overtraining syndrome.

CLASSIFICATIONS

The development of a universally applicable terminology and classification is challenging.

ACUTE MUSCLE INJURIES ARE COMMONLY CLASSIFIED AS:

- STRAINS (GRADE I)
- PARTIAL TEARS (GRADE II)
- COMPLETE TEARS (GRADE III)

This classification does not take into account the location of lesions → with the advent of mri and us imaging, new grading systems have been recently proposed.

ITALIAN CONSENSUS' MUSCLE INJURIES CLASSIFICATION (2018):

STAGING INDIRECT MUSCLE INJURIES BY <u>US EXAMINATION</u>: Delayed-onset muscle soreness (DOMS) Fatigue-induced muscular disorder (FIMS) Grade 0 to III lesions
STAGING INDIRECT MUSCLE INJURIES BY <u>MRI</u>: Delayed-onset muscle soreness (DOMS) Fatigue-induced muscular disorder (FIMS) Grade 0 to III lesions
STAGING DIRECT MUSCLE INJURIES BY <u>CLINICAL, MRI AND US EVALUATION</u>: Minor direct muscle injury Moderate direct muscle injury Severe direct muscle injury

OVERLOAD MUSCLE INJURIES (aka cumulative trauma disorders)

They are defined as gradually developing injuries, resulting from repetitive demand over time. Musculoskeletal overuse injuries are of important concern in athletics, especially in endurance sports where the balance between workload and rest is often ignored to reach maximal performance results.

The spectrum of underperformance conditions include:

- FUNCTIONAL OVERREACHING (FOR): a short-term reduction of performance (days to few weeks) followed by a supercompensation after recovery, with a consequent improvement of performance.
- NON-FUNCTIONAL RECOVERY (NFOR): a short-term decrease in performance (weeks to months) followed by a full recovery, but the previous performance abilities may not always be restored.
- OVERTRAINING SYNDROME (OTS): after a long-term recovery (usually several months), it combines decrease of performance abilities and psychological symptoms.

OVERREACHING and OVERTRAINING negatively affect muscle strength, power and velocity. Unlike overreaching subjects, the reduction in maximal force production persists in **overtrained** athletes. The

spectrum of overtraining effects on muscles include underperformance, muscle weakness, chronic fatigue and muscles soreness, higher stress perceived during activity

- AN INITIAL CLINICAL SIGN MAY BE THE DELAYED ONSET MUSCLE SORENESS (DOMS). IT USUALLY STARTS 12-24 HOURS AFTER AN EXCESSIVE WORKLOAD. TENDERNESS AND STIFFNESS DEVELOP, SORENESS REACHES THE CLIMAX 48 HOURS LATER, THEN SYMPTOMS RESOLVE WITHIN 10 DAYS.
- PERSISTING IN HARD WORKLOAD DURING THE DOMS SYMPTOMATIC PERIOD MAY COMPROMISE SHOCK ABSORPTION ABILITY, STRENGTH OUTPUT, FORCE STEADINESS AND COORDINATION, FINALLY RESULTING IN OVERTRAINING MUSCLE LESIONS.

DIAGNOSIS

Imaging of sports-related injury is pivotal for aiding with prognosis and management.

- Cross-sectional imaging of muscle and muscle injury in sport is usually undertaken by magnetic resonance imaging (MRI) and/or ultrasound (US). Myositis ossificans aside, radiography, computed tomography (CT) and nuclear medicine are often useless in imaging of muscle injury.

→ INNOVATIVE TECHNIQUES SUCH AS DIFFUSION TENSOR IMAGING AND MR SPECTROSCOPY PROVIDE QUANTITATIVE INFORMATION IN MUSCLE INJURY:

However, diagnosis based merely on imaging is not appropriate, since no information on muscle tone, pain, functional loss or previous injuries are provided.

MANAGEMENT

According to the Italian Consensus Conference on conservative management of muscle injuries in athletes, the optimal TREATMENT OF DOMS, FIMS AND GRADE 0 muscle lesions consists in:

- Suspension or reduction of the functional load
 - Contrast therapy (hot/cold)
 - Hydrokinesitherapy
 - Endogenous thermotherapy
 - Massage
- For GRADE I MUSCLE INJURIES onwards, the rehabilitation must respect the three biological phases of recovery (destruction phase, repair/regeneration phase and remodelling phase). The duration of each phase depends on the severity of the lesion.

➤ **DURING THE FIRST DESTRUCTION PHASE (2-7 POSTLESION DAYS):**

- Isometric contraction is recommended
- Protection, rest, ice, compression, elevation (PRICE)
- A short period of rest/immobilization is possible, immediately after the injury for 3-5 days.
- During the first 72h, therapies inducing endothermia should be avoided, as well as massages of the affected area.
- An echo-guided aspiration of the haematoma is recommended if necessary.

➤ **DURING THE SECOND REPAIR/REGENERATION PHASE (8-14 POSTLESION DAYS):**

- Intense exercises based on concentric contractions may be started, limiting the eccentric phase.
- A «core stability program» should be introduced, also adding stationary bike and deloaded run.

➤ **DURING THE THIRD REMODELLING PHASE (14-21 POSTLESION DAYS, BUT MAY LAST EVEN 60 DAYS AFTER INJURY):**

- Isokinetic exercises should be included, followed by elastic resistance exercises when the eccentric phase intensity increases, followed by eccentric contractions whose intensity progressively grows.
- Stretching may be introduced, as well as running, only if the dynamometric values of the injured muscle have been restored to at least 70% of the preinjury level.
- Sport-specific exercises should be gradually reintroduced at the end of this phase.

INSTRUMENTAL THERAPIES such as neuromuscular electrostimulation (NMES), ultrasound therapy, laser therapy, hyperthermia therapy, extracorporeal shock wave therapy (ESWT) are widely used to reduce the inflammatory process and stimulate tissue regeneration, increasing the levels of growth factors.

PHARMACOLOGICAL TREATMENT should be carefully considered: NSAIDS and analgesic drugs such as paracetamol are suggested in case of grade II-III muscle injuries and in the early post-injured period. Others like corticosteroids or mesenchymal stem cells have been discouraged as they seem to limit muscle tissue regeneration, as well as increase necrosis. The use of calcium chelants as EDTA and platelet-rich plasma is still debated.

• **MAIN INDICATIONS TO SURGERY ARE:**

- A complete lesion of the muscle belly or of the musculotendinous junction.
- A subtotal lesion associated with persistent pain and loss of strength after conservative treatment.
- Muscle laceration, though high clinical failure rate
- An acute compartment syndrome, which may be a complication of soft tissue injury.

The main purpose of surgical approach to the acute compartment syndrome is to decrease the intracompartmental pressure, increased after the formation of a slow but constant post-traumatic hemorrhage.

POSSIBLE COMPLICATIONS:

THE REGENERATIVE CAPACITY OF THE INJURED MUSCLE IS LIMITED. FIBROTIC TISSUE FORMS AT THE INJURY SITE → IT DELAYS THE FUNCTIONAL RECOVERY AND PREDISPOSES TO RECURRENCE.
IN RARE CASES OF MAJOR MUSCLE INJURIES, SOME COMPLICATIONS AS MYOSITIS OSSIFICANS, CYSTIC DEGENERATION, HETEROTOPIC OSSIFICATION AND LIQUID FLAPPER MAY OCCUR.

TO CONCLUDE...

- **PREVENTION:** preseason evaluation, training.
- **DIAGNOSIS:** clinical evaluation and imaging.
- **MANAGEMENT:** enhance biological repair processes.
- **NON-SURGICAL TREATMENT OF MOST MUSCLE INJURIES MAY BE EFFECTIVE: SEVERE RUPTURES MAY NEED SURGICAL TREATMENT.**
- **RETURN TO SPORT** after full functional restoration.