Muscle injuries in the ER. A summary adapted from the Spanish Consensus Statement: The Treatment of Muscle Tears in Sport [1]

1. Inflammatory phase, duration 1-2 days
2. Degenerative and vascularization phase, until day 14 after injury onset
3. Cell-stimulating, proliferative, and fibrotic phase, until day 28 after injury onset
4. Remodeling phase, up to 3 to 6 months after injury onset

**Inflammatory Phase**

Cryotherapy to the affected area

Analgesic drugs such as acetaminophen based on pain intensity

Elevation of the affected limb

Rest

Non-use of complete immobilization

Vascular-type bandage or taping over the affected area

Non-use of nonsteroidal anti-inflammatory drugs (NSAIDs)

Empty the hematoma only in the presence of intense pain or when neurovascular compression phenomena occur

Mobilization of the affected area based on level of pain

Echography of the affected area after 48 to 72 hours is recommended by 80% of experts

Administration of inflammation bioregulators (Table 1).

Controversial- MRI in this early inflammatory stage

<table>
<thead>
<tr>
<th>Unanimous (100%)</th>
<th>Strongly recommended (75-99%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryotherapy</td>
<td>Compressive bandage</td>
</tr>
<tr>
<td>Elevation</td>
<td>Non-use of NSAIDs</td>
</tr>
<tr>
<td>Sport Rest</td>
<td>No weight bearing of affected limb</td>
</tr>
<tr>
<td>No complete immobilization</td>
<td>Drain haematoma with symptoms</td>
</tr>
<tr>
<td>Analgesia</td>
<td>Inflammation bioregulators</td>
</tr>
<tr>
<td></td>
<td>Echography after 48/72 hours</td>
</tr>
<tr>
<td></td>
<td>Mobilize affected area as tolerated</td>
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</tbody>
</table>
**Degenerative and Vascularization Phase**

Performing contractions based on tolerance, painless stretching, isometric exercises, maintaining aerobic conditioning (eg, water exercises), and a progressive increase of specific technical drills for each sports activity, not including the affected area.

Additionally, non-use of painful stretching and use of semi-invasive techniques (dry puncture, intra-tissue percutaneous electrolysis [IPE], etc) inside the injury site (Table 2).

Controversial- transforming growth factor beta (TGF-beta), massaging the affected area, drugs or techniques that increase oxygen supply, and satellite stem cell-stimulating drugs.

**Table 2. Therapeutic Indications in Degenerative/Vascularization Phase**

<table>
<thead>
<tr>
<th>Unanimity</th>
<th>Strongly Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractions based on tolerance</td>
<td>Echography</td>
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<tr>
<td>Pain-free stretching</td>
<td>Vascular physiotherapy</td>
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<tr>
<td>Isometric drills</td>
<td></td>
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<tr>
<td>Maintain aerobic capacities avoiding affected area</td>
<td></td>
</tr>
<tr>
<td>Non-use of semi-invasive techniques on affected area (dry punctures, IPE, etc)</td>
<td></td>
</tr>
<tr>
<td>Gradual increase of specific technique avoiding affected area</td>
<td></td>
</tr>
</tbody>
</table>

**Cell-Stimulating, Proliferative, and Fibrotic Phase**

In this third phase of muscle tears, stretching based on pain, increasing mechanical demands on the muscle based on pain (isometric, concentric, eccentric), as well as initializing basic movements with specific techniques for each sports activity.

**Remodeling Phase**

The most important event at this phase is when to decide on the patient’s return to sports training regimen. The only accepted factor in this phase that would indicate return to sport is performing basic sports techniques with no pain at all.

**Discussion**

Conservative treatment is most commonly applied in muscle tears, with surgery not being necessary in most cases. Surgery is exclusively indicated in the presence of massive tears showing functional impairment or massive hematoma accompanied by large blood loss.

**Inflammatory Phase**

This phase lasts approximately 2 to 3 days, depending on the size of the tears and the extension of the histological muscle break-down. Points upon which consensus by all experts was reached are: the non-use of immobilization with rigid systems such as posterior splints, considering that relevant literature indicates it leads to total muscle immobilization, which produces shortening and other secondary effects to immobilization. All authors agree on the use of cryotherapy, although there is still controversy concerning time and frequency of its application due to the fact that it has been proven that an
excessive application produces a decrease in cell metabolism and a subsequent slowing down of the entire muscle repair process.

Acetaminophen does not interfere with other biochemical processes during the inflammatory phase. Limb elevation and rest are classic synergistic measures. Vascular bandages or other types of elastic compression are highly recommended with the aim of improving venous drainage, blood flow, and interfiber hematoma compression and reabsorption.

The literature has an ever-increasing number of articles showing that anti-inflammatory administration should be avoided since it affects biochemical reactions present in inflammation, causing muscle recovery to slow down.

Load diminishing in torn muscles is positive, but not so through the use of raised insoles or other orthotics, which can lead to muscle shortening and subsequent muscle repair complications. Benefits of early mobilization have often been described and proven as long as they are pain-free, thanks to their activation of cell-regenerating processes and enhancement of extracellular matrix production. Most authors apply combined therapies: topical or oral administration of drugs and bioregulators while avoiding parenteral, intravenous, or intramuscular administration directly at the injury site.

Hematoma evacuation is unanimously recommended in the presence of a great amount of blood, causing intense pain with neurovascular symptoms by compression, in cases of muscle tears by direct impact, or when the hematoma is extremely close to the bone periostium, which may cause myositis ossificans. However, minimal interfiber or intramuscular hematomas that have not caused full rupture of the injured fiber ends do not require hematoma evacuation. These hematomas may very well favor muscle fiber tip penetration and regeneration within the muscle fiber.

Echography studies are highly recommended as image diagnosis procedures as long as they are performed between 48 and 72 hours of injury onset. Earlier use may lead to wrongly diagnosed cases. Ruled application of magnetic resonance is highly controversial, proving useful in those cases in which echography has not been conclusive, or when determination of the exact muscle tear boundaries (or any other associated injury) is necessary. Magnetic resonance would therefore be mainly recommended in those cases in which there is an obvious discrepancy between the patient’s symptoms, clinical findings, and/or the need to clearly define the echography image in areas such as the groin or musculotendinous junction and cases where NMR shows to have a higher definition and thus possible associated injuries may be assessed.

Degenerative and Vascularization Phase

This phase lasts from injury onset day until 14 days after. Continuation of therapeutic measures applied during the inflammatory phase will depend on clinical findings and the athlete’s pain. Authors unanimously recommend starting muscle contractions according to pain tolerance, painless stretching, and isometric exercises. The athlete’s aerobic condition is also a concern and must be maintained with alternate activity. There must be an increase in the specific sports technique for each sport, avoiding using the injured site to maintain physical condition and proprioception. Semi-invasive techniques such as dry punctures and intratissue percutaneous electrolysis (IPE) at the injury site are not indicated, although some authors perform these techniques in perilesional sites to treat complications and secondary muscle contractures.
Physiotherapy techniques that increase vascularization at the injury site and thermotherapy techniques are highly recommended to intensify and shorten the fiber and extracellular matrix injury degradation process as well as other substances that increase vascularization of injury site.

Echography studies are highly recommended in this phase since the 72-hour limit after injury onset has been overpassed.

Controversy exists regarding growth factor inhibitors such as the TGF-beta family since there are certain factors that promote fibrosis while others have the same effect concerning satellite cell stimulation and extracellular matrix repair. Certain inhibitors such as curcumine, decorine, and suramine have proven their efficiency in clinical practice.

Controversy is further present regarding the application of measures that may stimulate satellite cells, as it is yet to be fully proven, and further research studies are needed to confirm their efficacy, doses, indications, and duration of application. Platelet-rich plasma is included among this group—a measure that is used by only 15.38% of consulted experts.

An additional measure that has proven to be efficient is active structures that allow satellite mobilization of muscular cells to be stimulated. Extra oxygen supply has not proven to be efficient despite certain authors trying to use hyperbaric chamber or aerobic exercises.