

## **Spanish Consensus Statement: The Treatment of Muscle Tears in Sport**

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On the 21st of March, 2015, experts met at Clínica CEMTRO in Madrid, Spain, under the patronage of The Spanish Society for Sports Traumatology (SETRADE), The Spanish Federation of Sports Medicine (FEMEDE), The Spanish Association of Medical Services for Football Clubs (AEMEF), and The Spanish Association of Medical Services for Basketball Clubs (AEMB) with the aim of establishing a round table that would allow specialists to consider the most appropriate current general actions to be taken when treating muscle tears in sport, based on proven scientific data described in the medical literature. Each expert received a questionnaire prior to the aforementioned meeting comprising a set of questions concerning therapeutic indications generally applied in the different stages present during muscle repair.

The present Consensus Document is the result of the answers to the questionnaire and resulting discussion and consensus over which are the best current indications in the treatment of muscle tears in sport. Avoiding immobilization, not taking nonsteroidal anti-inflammatory drugs (NSAIDs) randomly, fostering early mobilization, increasing vascularization of injured, site and regulating inflammatory mechanisms—without inhibiting these from the early stages of the recovery period—all stood out as main points of the Consensus Document. Additionally, there is controversy concerning cell stimulation techniques and the use of growth factors or cell inhibitors. The decision concerning discharge was unanimous, as was the

criteria considered when it came to performing sport techniques without pain.

**Keywords:** consensus document; injuries; muscle; treatment; therapeutic guide

Numerous scientific advances have been published concerning the knowledge of muscle repair, and yet there are no unified criteria when establishing therapeutic indications. There is a great variety of treatment patterns, many of which are based on individual clinical experience, and multiple Internet entries have been registered discussing partial indications and muscle repair models. Such a situation renders comparing results useless and provides an enormous array of research studies, which show that results remain uncertain on the subject of muscle repair.

We have thus considered it necessary to establish, using translational medicine, a knowledge link between basic science and clinical practice in order to point out the most appropriate therapeutic measures.

We know that muscle repair processes are continuous processes consisting of overlapping stages. Based on the works of Huard et al<sup>20</sup> and Järvinen et al<sup>23</sup> and with the aim of establishing a systematic approach instructively and unarbitrarily, the repair process has been broken down into several stages based on the predominant biological event taking place in each of these. Timespans mentioned have been approximately agreed based on published mean durations for muscle tears. The present consensus does not differentiate whether the origin of the injury is at the musculotendinous junction, the main muscle body, or at the myofascial area, nor does it specify the degree of muscle injury or each muscle's specific features. Vascularization and metabolic and oxygenation levels together with genomic response levels were not mentioned. Muscular tear is considered as a general concept.

It is therefore our aim, and the aim of all institutions included in the current document, to issue a consensus-based guide for muscle tears based on current biological and physiological knowledge.

## **Methods**

Thirty experts in sports traumatology, all medical doctors with more than 15 years experience in this specialty and nationwide-substantiated acknowledgement, have participated (university professors, orthopaedic surgeons, and/or sport medicine specialists).

With the aim of properly presenting the questions, the issued questionnaire differentiated 4 phases during muscle repair in a systematic and instructive way:

1. Inflammatory phase, duration 1-2 days: 15 questions
2. Degenerative and vascularization phase, until day 14 after injury onset: 17 questions
3. Cell-stimulating, proliferative, and fibrotic phase, until day 28 after injury onset: 8 questions
4. Remodeling phase, up to 3 to 6 months after injury onset: 2 questions

The questionnaire was prepared, revised, and completed by the experts themselves. Additionally, a conflict of interest declaration was signed with no expert receiving economical compensation of any kind from any of the companies for taking part in this event.

On the March 21, 2015, a clinical meeting was arranged at Clínica CEMTRO, Madrid, Spain, so that experts could clearly define and reach a consensus for each of the included questions. The following table describes the level of consensus reached.

100%	Unanimity
99%-75%	Strongly recommended
74%-55%	Recommended
<55%	Controversy

### *Statistical Analysis*

A descriptive analysis was carried out since we are dealing with categorical variables, and each has been expressed as an absolute number or percentage.

## **Results**

### *Inflammatory Phase*

#### Unanimity

Cryotherapy to the affected area was considered by 100% of experts; analgesic drugs such as paracetamol or metamizol were also accepted based on pain intensity together with elevation of the affected limb. With regard to physical activity, sports rest must be followed. Consensus was also reached on the non-use of complete immobilization.

#### Strongly Recommended

Highly recommended indications are considered when no unanimity has been reached yet at least 75% of experts agree on their use. The most agreed upon indication, showing a 93% level of agreement, is the use of vascular-type bandage or taping over the affected area, closely followed by the non-use of nonsteroid anti-inflammatory drugs (NSAIDs), with 90% level of agreement; 90% level of agreement was also shown for the need to empty the hematoma only in the presence of intense pain or when neurovascular compression phenomena occur, thus relieving the area from

any unnecessary pressure. Eighty-three percent of experts begin 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, as well as the administration of inflammation bioregulators (Table 1).

**Table 1.** Therapeutic Indications in the Inflammatory Phase

Unanimity	Strongly Recommend
Cryotherapy	Compressive bandage
Elevation	Non-use of NSAIDs
Sport Rest	No weightbearing of affected limb
No complete immobilization	Drain haematoma with symptoms
Analgesia	Inflammation bioregulators
	Ecography after 48/72 hours
	Mobilize affected area as tolerated

#### Recommended

Seventy percent of experts have agreed on extracting the hematoma whenever possible.

#### Controversies

Requesting magnetic resonance imaging (MRI) study in this early inflammatory stage is considered useful by only 40% of participants.

#### *Degenerative and Vascularization Phase*

##### Unanimity

Unanimity was reached concerning the indication for performing contractions based on tolerance, painless stretching, isometric exercises, maintaining aerobic condition (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, intratissue percutaneous electrolysis [IPE], etc) inside the injury site have also reached a consensus (Table 2).

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

Unanimity	Strongly Recommend
Contractions based on tolerance	Echography
Pain-free stretching	Vascular physiotherapy
Isometric drills	Degradation-enhancing enzymotherapy
Maintain aerobic capacities avoiding affected area	
Non-use of semi-invasive techniques on affected area (dry punctures, IPE, etc)	
Gradual increase of specific technique avoiding affected area	

### Strongly Recommended

With a 93.3% level of agreement reached, the list of highly recommended indications is headed by physiotherapy techniques, which increase vascularization in affected area. MRI is also highly recommended, with a 90% value, and an 80% level of agreement follows the application of enzyme therapy, with the aim of increasing the degradation of damaged extracellular fibers and matrix.

### Recommended

Vascularization-enhancing techniques and drugs show a 73.3% level of agreement, and thermotherapy techniques and drugs 70%.

### Controversies

Actions that did not reach a 55% level of agreement were the use of transforming growth factor beta (TGF-beta), massaging the affected area, drugs or techniques that increase oxygen supply, and satellite stem cell-stimulating drugs.

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

#### Unanimity

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, all reached consensus (Table 3).

**Table 3.** Therapeutic Indications in Cell-Stimulating, Proliferative, and Fibrotic Phase

Unanimity	Strongly Recommended
Stretching as tolerated	Reinforce use of antithrombotic therapies
Increase mechanical demand on muscle as tolerated	Echography
Basic sport technique movements	Increase metabolic supply
Gradual increase of sport-specific technique	

Strongly Recommended

The majority (86.7%) of experts agreed on performing echography studies and considered promoting the use of antifibrotic substances and techniques, and 76.7% acknowledged the need to ensure an increase in protein administration.

*Remodeling Phase*

Unanimity

The most important event at this phase, apart from continuing with previously mentioned indications, is when to decide on the patient’s return to sports training regimen. The only accepted factor in this phase that would indicate such a return is performing basic sports techniques under no pain at all.

Recommended

Painless stretching and contractions as an indicator of return to sports training did not reach consensus (Table 4).

**Table 4.** Therapeutic Indications in Remodeling Phase

Unanimity	Strongly Recommended
OK to join work-out sessions if sport technique is pain-free	OK to join work-out sessions if stretching and contractions are pain-free

Decision on when to return to sports activity:

- 100% IF basic sports technique movements in absence of pain.
- 92.3% IF stretching in absence of pain.

84.6% IF contractions in absence of pain.

## **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 great blood loss.<sup>22,30</sup>

Once surgical procedures have been discarded, any applied therapeutic process should consider time from onset of injury and the predominant biological phase when treatment is applied.<sup>16,28,29</sup>

### *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.<sup>1,25,32,50</sup>

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.<sup>19,47</sup>

Paracetamol or metamizol-like drugs do not interfere with other biochemical processes during the inflammatory phase. Limb elevation and sport rest are classic synergistic measures.<sup>2,33,35,44,51</sup>

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.<sup>52</sup>

Administration of inflammatory bioregulators regulates any response, promoting an anti-inflammatory process activation.<sup>14</sup> The literature has an ever-increasing number of articles showing that anti-inflammatory administration must be avoided since it greatly affects biochemical reactions present in inflammation, thus causing muscle recovery to slow down.<sup>24,33</sup>

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.<sup>32,54</sup> 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 periosteum, which may cause myositis ossificans. Intermuscular hematomas must always be evacuated. 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 fibers.<sup>20,23</sup>

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, in cases of “invisible” muscles, 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.<sup>4,8,9,12,13,26,27,38,43</sup>

### *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 water exercises or the like. 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.<sup>3,46,57</sup>

Physiotherapy techniques that increase vascularization at the injury site and thermotherapy techniques are highly recommended together with orally administered enzyme therapy to intensify and shorten the fiber and extracellular matrix injury degradation process as well as other substances

that increase vascularization of injury site, despite showing some limitations, according to certain authors.<sup>31</sup>

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.<sup>7,14,18,34,57,59</sup> Certain inhibitors such as curcumine, decorine, and suramine have proven their efficiency in clinical practice.<sup>5,7,15,40,45,49,59</sup>

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.<sup>36,48</sup>

An additional measure that has proven to be efficient is active mobilization of muscular structures that allow satellite cells to be stimulated. Extra oxygen supply has not proven to be efficient despite certain authors trying to use hyperbaric chamber, aerobic exercises, or tecartherapy techniques.<sup>14,37,51,53,56</sup>

### *Cell stimulating, Proliferative, and Fibrotic Phase*

For practical purposes, we have considered the length of this phase to include 4 weeks after the onset of muscle fiber tear. The continuation of stretching exercises and increasing muscular mechanical demands as tolerated has unanimously been agreed upon: isometric, concentric, and excentric contractions are indicated, carefully considering their load, frequency, and load angle since inadequate excentric contractions may provoke onset of reinjured muscle tears.<sup>6,10,11,21,55</sup>

Fundamental sport technique movements may be initialized, leading to specific techniques for each sport, always bearing in mind clinical symptoms and muscle pain while working out.

Antifibrotic substances and techniques are highly recommended in this phase as well as metabolic provision (proteins, metabolic supplements, etc) in cases of deficient nutrition. Healthy, well-fed athletes would not need such measures, although a rich aminoacid environment appears to favor muscle injury repair.<sup>41</sup>

Scheduled echography studies may allow for the assessment of muscle tears and control their evolution.<sup>9,13,38</sup>

### *Remodeling Phase*

This is the final stage toward work-load and sports technique adaptation. All experts agree on progressively continuing with mechanical

demands on the affected muscle while taking care with the nature of contractions performed. From the clinical point of view, the patient is given the ok to begin sport-specific workouts when basic sports techniques are pain-free and show the same range of mobility as the unaffected limb. Nevertheless, pain-free stretching and contractions, which represent 80% to 85% of the contralateral muscle strength while also showing an adequate speed of contraction, may also be performed in this phase.<sup>10,11,17,39,42,58</sup>

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No participant in this event or any follow-up proceeding has received any type of retribution whatsoever, be it economic or of other nature. So as to avoid such conflict of interests, an independent Technical Assistance service provider (BSJ) was prompted to dispense participants any kind of need in this event.

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## **Supplementary file**

Based on current scientific findings, do you agree on the below outlined general treatment guidelines applied to muscular repair processes and their multiple phases regardless of the degree of injury sustained and its location?

### **A) Inflammatory phase, duration 1-2 days:**

- 1) Complete immobilization (eg, splint)
- 2) Vascular taping or similar elastic compression system
- 3) Cryotherapy
- 4) Administration of inflammation bioregulators
- 5) Administration of NSAIDs (ibuprofene, diclofenac, etc)
- 6) Always release hematoma
- 7) Release hematoma only under intense pain or in the presence of neurovascular compressive syndrome symptoms
- 8) Administration of analgesics based on pain intensity (paracetamol, metamizole, etc)
- 9) No weightbearing on affected limbs (ie, crutches, heel)
- 10) Mobilization based on pain tolerance
- 11) Drug administration: parental/oral/topical/combined
- 12) Elevation
- 13) Sport rest
- 14) Echography test
- 15) Magnetic resonance test

### **B) Degenerative and vascularization phase, until day 14 after injury onset:**

- 1) Maintain previously adopted measures:
  - Full immobilization
  - Elastaic bandage
  - Cryotherapy
  - Inflammatory bioregulators
  - NSAIDs
  - Always release hematoma:
  - Release hematoma only under intense pain or in the presence of neurovascular compressive syndrome symptoms
- 2) Vascularization enhancing physiotherapy techniques
- 3) Administration of enzyme therapy to increase degradation
- 4) Administration of TGF-beta growth factor inhibitors
- 5) Perform muscle contractions as tolerated
- 6) Use of techniques and substances to stimulate satellite cells; if so, please specify

- 7) Use of techniques and substances to increase oxygen supply; if so, please specify
- 8) Use of thermotherapy techniques
- 9) Massage
- 10) Semi-invasive techniques (dry puncture, IPE, etc)
- 11) Pain-free stretching
- 12) Stretching with pain
- 13) Administration of vascularization-enhancing substances
- 14) Start isometric drills
- 15) Maintain aerobic capacities (eg, water exercises)
- 16) Gradual increase of sport technique avoiding use of affected area
- 17) Echography test

**C) Cell-stimulating, proliferative and fibrotic phase, until day 28 after injury onset:**

- 1) Maintain previously adopted measures:
  - Complete immobilization
  - Elastic bandage
  - Cryotherapy
  - Inflammation bioregulators
  - NSAIDs
  - Drain all hematomas
  - Drain hematoma if intense pain or compression is present:
  - Analgesics
  - No weightbearing
- 2) Reinforce use of antifibrotic substances and techniques
- 3) Stretching as tolerated
- 4) Increase metabolic supply (proteins, food supplements, etc)
- 5) Increase mechanical demand on muscle as tolerated (isometric, concentric, excentric contractions, etc)
- 6) Begin basic sport technique movements as tolerated
- 7) Gradual increase of specific sport technique for each sport
- 8) Echography study

**D) Remodeling phase**

- 1) Maintain previously adopted measures
- 2) Decision on return to sports activity, when
  - Pain-free stretching
  - Pain-free contractions
  - Pain-free basic sport technique movements