INTRAMUSCULAR TENDON INJURIES

Gil Rodas MD, PhD

FCBarcelona Medical Department
This report contains results from the full 2015/16 season (July 2015 to May 2016) and includes data from 32 clubs that delivered full details during the season of all their injuries.

AC Milan, AFC Ajax, Arsenal FC, Athletic Club, Bayer 04 Leverkusen, Borussia Dortmund, CA Boca Juniors, Chelsea FC, Club Atlético de Madrid, Club Brugge KV, FC Barcelona, FC Basel 1893, FC Bayern München, FC Porto, FC Shakhtar Donetsk, FC Zenit, Galatasaray AŞ, Juventus, Liverpool FC, Manchester City FC, Manchester United FC, NK Maribor, Olympique de Marseille, Paris Saint-Germain, PSV Eindhoven, Real Madrid CF, RSC Anderlecht, SL Benfica, Southampton FC, Sporting Clube de Portugal, Tottenham Hotspur FC, West Bromwich Albion FC.
Injury incidence: the number of injuries of this type relative to exposure time, allowing the individual injury rate to be evaluated. Injury incidence is expressed as the number of injuries/1,000 hours of exposure.
Muscle injury incidence (15 seasons)

**Injury incidence:** the number of injuries of this type relative to exposure time, allowing the individual injury rate to be evaluated. Injury incidence is expressed as the number of injuries/1,000 hours of exposure.
Hamstrings injuries /1000 h

45 y.o patient, Clínica Creu Blanca.
The myotendinous junction is an interdigitated interface that lets the tendon nearest to the bone to be loaded in shear, increasing the strength of the interface.
Electronic microscope analysis of the human hamstring musculotendinous junction demonstrates a classic interdigitated MTJ and a previously undescribed flat MTJ. Implications for understanding muscle and muscle-tendon injuries (Geoff Verrall, 2014)
The skeletal muscle extracellular matrix (ECM) plays an important role in muscle fiber force transmission, maintenance, and repair.

KEY CONCEPT: THE ECM IMPORTANT ROLE
Muscle fibers are embedded in a complex connective tissue matrix and are intimately associated with ECM.

Two muscle fibers surrounded by perimysium “cables”

Fascia
Profunda
Epimisio
Tendón o Aponeurosis
Fascia Superficial

The ECM is the responsible of having much more “modulus” or “Stiffness” resistance in comparison with muscle fibres or muscle fibre groups.

HYPOTHESIS:

IN MUSCLE INJURIES, AS MUCH EXTRACELLULAR MATRIX (ECM) IS AFFECTED...

- INCREASES THE RECUPERATION TIME?
- MORE REINJURY RISK?

YES!
19 y.o profesional basketball player. 3 re-injuries
CmT: Comon Tendon; CT :Central Tendon; ST: Semitendinosus; BF : Biceps femoris; yellow arrow: gap.

Puigdellivol J, Guia M. FCB, 2015
HOW CAN WE UNDERSTAND THE INTRAMUSCULAR TENDON INJURY?

Xavier Alomar, 2016
Length of the free tendon is not associated with time to return to play in Biceps femoris muscle injury. 

no statistically significant correlation

Gil Rodas, Ricard Pruna, Anne D van der Made, Xavier Yanguas, Lluís Capdevila, Ramon Ballus, Xavier Alomar, Javier Arnaiz, Johannes L Tol
WHAT ABOUT BIBLIOGRAPHY CONCERNING THE RTP TIME AND THE INTRAMUSCULAR TENDON INJURIES??
## Acute Quadriceps Muscle Strains

Magnetic Resonance Imaging Features and Prognosis

<table>
<thead>
<tr>
<th>MRI Category × Site</th>
<th>Rehabilitation Interval (days): MRI Categories × Site</th>
<th>Interaction Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>N</td>
<td>Mean</td>
</tr>
<tr>
<td>Rectus femoris–central tendon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proximal</td>
<td>2</td>
<td>19.50</td>
</tr>
<tr>
<td>Middle</td>
<td>5</td>
<td>34.20</td>
</tr>
<tr>
<td>Rectus femoris–peripheral</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proximal</td>
<td>6</td>
<td>8.33</td>
</tr>
<tr>
<td>Middle</td>
<td>2</td>
<td>10.00</td>
</tr>
<tr>
<td>Vasti</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proximal</td>
<td>4</td>
<td>4.50</td>
</tr>
<tr>
<td>Middle</td>
<td>3</td>
<td>4.33</td>
</tr>
</tbody>
</table>
Acute First-Time Hamstring Strains During High-Speed Running

A Longitudinal Study Including Clinical and Magnetic Resonance Imaging Findings

Carl M. Askling, Magnus Tengvar, Tönö Saartok, Alf Thorstensson

From the Swedish School of Sport and Health Sciences, Stockholm, Sweden, the Department of Radiology, Södersjukhuset Hospital, Stockholm, Sweden, and the Section of Orthopaedics and Sports Medicine, Department of Molecular Medicine and Surgery, Karolinska Institutet, Stockholm, Sweden

Figure 1. Schematic drawing in the frontal plane of the muscle-tendon complex of the long head of biceps femoris showing the 6 different regions used when analyzing the injury location and tissues involved: 1. proximal tendon (PT), ie, free tendon proximal to muscle fiber attachment; 2. proximal muscle-tendon junction (PMTJ), defined as the proximal intramuscular tendon and attached muscle fibers; 3. proximal muscle-belly (PMB), ie, muscle proximal to the midpoint of the whole muscle-belly; 4. distal muscle-tendon junction (DMTJ), defined as the distal intramuscular tendon and attached muscle fibers; 5. distal muscle-belly (DMB), ie, muscle distal to the midpoint of the whole muscle-belly; and 6. distal tendon (DT), ie, free tendon distal to muscle fiber attachment.

Figure 2. Time to return to pre-injury level for the sprinters with injuries either involving the proximal free tendon (PT) of the biceps femoris long head (n = 6) or not involving the PT (n = 12). Values are means ±1 SD. * denotes a significant difference between the 2 groups (P = .009, Mann-Whitney U test).

INJURIES AFFECTING THE RF CENTRAL TENDON AT ITS PROXIMAL LEVEL HAVE A LONGER SPA “SPORTS PARTICIPATION ABSENCE” TIME
Return to Competitive Play After Hamstring Injuries Involving Disruption of the Central Tendon

Jules Comin, MBBS, Peter Malliaras, PhD, Peter Baquie, MBBS, Tim Barbour, MBBS, and David Connell, MBBS

Investigation performed at Imaging @ Olympic Park, Melbourne, Australia

TABLE 1
Number and Median Recovery Time of Hamstring Injuries

<table>
<thead>
<tr>
<th>Tendon Type</th>
<th>No.</th>
<th>Median Recovery Time (interquartile range), d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biceps femoris, total</td>
<td>45</td>
<td>21 (12-56)</td>
</tr>
<tr>
<td>Central tendon, intact</td>
<td>33</td>
<td>21 (9-28)</td>
</tr>
<tr>
<td>Central tendon, disrupted</td>
<td>9</td>
<td>72 (42-109)</td>
</tr>
<tr>
<td>Semimembranosus</td>
<td>11</td>
<td>32 (21-35)</td>
</tr>
<tr>
<td>Semitendinosus</td>
<td>6</td>
<td>14 (12-22)</td>
</tr>
<tr>
<td>Total hamstring injuries</td>
<td>62</td>
<td>21 (14-42)</td>
</tr>
</tbody>
</table>

*There were 3 further central disruptions that went on to surgical repair and were excluded from further analysis. These 3 injuries had a median recovery time of 91 days.

Figure 6. Distribution of recovery times for biceps femoris injuries with and without central tendon disruption.

42-109 days

Central tendon pathology
The hamstring muscle complex

A. D. van der Made · T. Wieldraaijer ·
G. M. Kerkhoffs · R. P. Kleipool · L. Engebretsen ·
C. N. van Dijk · P. Golanó

<table>
<thead>
<tr>
<th>Table 2 Mean lengths of free tendon, total tendon and MTJ per muscle including length as a proportion of muscle length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscle</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>Proximal</td>
</tr>
<tr>
<td>BFh</td>
</tr>
<tr>
<td>ST</td>
</tr>
<tr>
<td>SM</td>
</tr>
<tr>
<td>Distal</td>
</tr>
<tr>
<td>BF</td>
</tr>
<tr>
<td>ST</td>
</tr>
<tr>
<td>SM</td>
</tr>
</tbody>
</table>
The soleus muscle: MRI, anatomic and histologic findings in cadavers with clinical correlation of strain injury distribution

Ramon Balius · Xavier Alomar · Gil Rodas · Maribel Miguel-Pérez · Carles Pedret · Mari Carmen Dobado · Juan Blasi · George Koulouris
TABLE 5
Return to Play According to Lesion Location$^a$

<table>
<thead>
<tr>
<th>Injury Location</th>
<th>n</th>
<th>Mean ± SD</th>
<th>Range</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myotendinous</td>
<td>32</td>
<td>27.0 ± 17.7</td>
<td>6-79</td>
<td>20.6-33.9</td>
</tr>
<tr>
<td>MTM</td>
<td>13</td>
<td>25.0 ± 10.7</td>
<td>13-54</td>
<td>18.5-31.4</td>
</tr>
<tr>
<td>MTC</td>
<td>7</td>
<td>44.29 ± 23.0$^b$</td>
<td>21-79</td>
<td>22.3-66.2</td>
</tr>
<tr>
<td>Myofascial</td>
<td>12</td>
<td>34.6 ± 21.8</td>
<td>9-81</td>
<td>20.7-48.3</td>
</tr>
<tr>
<td>MTL</td>
<td>12</td>
<td>19.2 ± 13.5$^b$</td>
<td>6-54</td>
<td>10.5-27.7</td>
</tr>
<tr>
<td>MFA</td>
<td>8</td>
<td>33.1 ± 19.0</td>
<td>9-62</td>
<td>17.2-48.9</td>
</tr>
<tr>
<td>MFP</td>
<td>4</td>
<td>37.5 ± 29.4</td>
<td>17-81</td>
<td>3.4-67.7</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>29.1 ± 18.8</td>
<td>6-81</td>
<td>23.05-34.8</td>
</tr>
</tbody>
</table>

Time to return to full training is delayed and recurrence rate is higher in intratendinous ('c') acute hamstring injury in elite track and field athletes: clinical application of the British Athletics Muscle Injury Classification

Noel Pollock, Anish Patel, Julian Chakraverty, Anu Sukkas, Stephen L J James and Robin Chakraverty

Br J Sports Med published online July 17, 2015

Figure 1  Overview of British Muscle Injury Classification by anatomical site in biceps femoris muscle injury.
<table>
<thead>
<tr>
<th>British Athletics classification</th>
<th>n</th>
<th>Mean TRFT* in days: (SD; range)</th>
<th>Recurrence rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>21</td>
<td>10 (4.7; 4–21)</td>
<td>1 (5%)</td>
</tr>
<tr>
<td>1a</td>
<td>5</td>
<td>18 (3.8; 13–21)</td>
<td>0</td>
</tr>
<tr>
<td>1b</td>
<td>4</td>
<td>18 (11.0; 12–31)</td>
<td>2 (50%)</td>
</tr>
<tr>
<td>2a</td>
<td>2</td>
<td>25 (5.7; 21–29)</td>
<td>0</td>
</tr>
<tr>
<td>2b</td>
<td>17</td>
<td>21 (10.2; 12–49)</td>
<td>1 (6%)</td>
</tr>
<tr>
<td><strong>2c</strong></td>
<td>8</td>
<td><strong>27 (6.8; 18–35)</strong></td>
<td><strong>5 (63%)</strong></td>
</tr>
<tr>
<td>3a</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>3b</td>
<td>1</td>
<td>41 (NA)</td>
<td>0</td>
</tr>
<tr>
<td><strong>3c</strong></td>
<td>7</td>
<td><strong>84 (49.4; 40–128)</strong></td>
<td><strong>4 (57%)</strong></td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Six injuries that occurred prior to return to full training excluded from the mean TRFT (1b(1); 2b(1); 2c(1); 3c(3)).

NA, not applicable; TRFT, time to return to full training.
Figure 3: Re-injury Rates (%) in British Athletics Muscle injury groups myofascial (A), musculotendinous (B) and intratendinous (C).
• Very important to recognize the tendon component in muscle injuries.

• Enough scientific evidence to know that this type of injuries has a longer RTP and higher reinjury risk.
What are the findings?

- Injuries involving the quadriceps or hamstring intramuscular tendon have prolonged rehabilitation and return to play times—they must be treated differently to ‘muscle strains’.
- Differentiation of these intramuscular tendon injuries seems particularly important in injuries to the biceps femoris and rectus femoris muscles.
- If injury to these tendons is suspected, MRI is indicated for accurate diagnosis and athlete/player and coach/agent education.
- There may be a role for surgical repair of the tendon in injuries with significant damage of the intramuscular tendon.

When codifying an intra-tendon injury or an injury affecting the MTJ or intramuscular tendon showing disruption/retraction or loss of tension exist (gap), a superscript (r) should be added to the grade.
THE RUPTURE IS IN THE MTJ and/or THE TENDON??

AND THE STRUCTURE OF THIS TENDON, IS IT NORMAL??
CLINICAL EXAMPLES
Case 1

Distal MT injury of the BFlh proximal tendon
PREVIOUS HISTORY
March 2009, Distal MT injury of the BFlh proximal tendon. LEFT
After two days, he was walking without pain. After 5 days, he was running without pain, and he had a good response to isometric and concentric exercise. After 1 week, he returned to training with absolute normality. The RTP was after 14 days, and he played 16 min.

Coronal and axial T2-weighted image with fat saturation showing small region of muscle fibre disruption (arrows) reflecting grade 1-2 injury, involving aponeurosis of long head of biceps femoris.

1st Injury

24th October 2014
Zip between BF Lh and BF Sh

BF LH tip of intramuscular **proximal** tendon
BF Lh Injury
BF Sh injury
BF Lh+Sh = Zip Injury
Distal Tip Proximal Tendon BF Lh

4 kinds of injuries in the same axial view. Balius R. & Rodas G, 2017
4 semanas

1
24 - octubre - 2014

2
28 - noviembre - 2014

3
27 – diciembre - 2014

RTP = 14 días

RTP = 21 días
Acute muscle strain injuries: a proposed new classification system
Ottar Une, Angelo Del Bosco, Thomas M. Redfern, Nicaita Maitland

Terminology and classification of muscle injuries in sport: a consensus statement
Br J Sports Med published online October 18, 2012
doi: 10.1136/bjsports-2012-091448

British athletics muscle injury classification: a new grading system
Noel Pollock, Steven L. James, Justin C Lee, et al.
doi: 10.1136/bjsports-2013-093032

Muscle Injuries in Sports: A New Evidence-Informed and Expert Consensus-Based Classification with Clinical Application
1. 2012

2. C d distal (c) myotendinous (d)

3. B Moderate partial muscle tear Positive for significant fiber disruption, probably including some retraction. With fascial injury and intermuscular haematoma

2/3; B/C musculotendinous (b); 2 if high signal change will either measure between 10% and 50% of the cross-sectional area; C if tendon affected

3. 2014

Ip-Dp-G2-1 Indirect by sprinting (Ip); Distal but proximal tendon (Dp); Including fiber retraction with gap (G3); 1st re-injury (1)

4. 2016
Case 2

Mild discomfort during days, not a sharp pain.
Football player 20 y.o.
DO YOU LET HIM PLAY IN 5 DAYS ????
10 DAYS AFTER

LONGITUDINAL RUPTURE OF THE BFlh CENTRAL TENDON
4 WEEKS AFTER THE REINJURY
TAKE HOME MESSAGES

• It is necessary to have a better diagnosis of injuries affecting intramuscular tendons. That will improve our predictions of the RTP and decrease the re injury risk.

• Very important to adapt the rehabilitation programs to this kind of injuries. We have to investigate WHAT, HOW, WHEN AND WHERE.

• Surgery treatment has to be taken into account (although it is not clear yet).
MUCHAS GRACIAS POR VUESTRA ATENCIÓN