Muscle strength imbalances and injuries

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Overload injury vicious cycle

- Musculotendinous tensile overload
- Tissue injury
- Decreased performance
- Functional biomechanical deficits
  - Muscular weakness
  - Inflexibility
  - Scar tissue
  - Muscle strength imbalance
- Micro and/or macrotears
- Clinical symptoms
  - Pain
  - Instability
  - Disfunction
- Healing
- Subclinical adaptations
- Return to participation

Muscle imbalance

- Failure of the agonist-antagonist relation when agonistic/antagonistic muscle groups function cooperatively to control the joints that they cross.

Sahrmann, 1987
Caillet, 1977
Muscle strength imbalance and injuries

- Throwers or tennis players: rotator cuff injuries
  - ER/IR muscle imbalances

Greiwe RM et al Orthopedic Clin N Am 2010; 41 (3): 309.23
Knee injuries

- Hamstring injury
  - Muscle imbalance (low H:Q ratio).
  - Muscle fatigue
  - Tightness
  - Insufficient warm up
  - Previous injury


Reliable, valid, feasible and safe tool to evaluate dynamic muscle strength?

Isokinetic dynamometry
Muscle imbalance assessment parameters: Ratios

- Agonist / antagonist ratios
  - Agonist conc / antagonist conc
  - Agonist ecc / antagonist ecc
  - Agonist ecc / antagonist conc (functional ratio)

- agonist ecc / conc ratios
Knee dynamic ratios


  \[ \text{hamstring}_{\text{ecc}} / \text{quadriceps}_{\text{conc}} \]

  The only ratio affected in deficient ACL.


  the functional hamstring:quadriceps ratio detects better hamstring contribution to dynamic joint stability.
Shoulder dynamic ratios

  
  $\text{ER}_{\text{eccc}}/\text{IR}_{\text{conc}}$

  
  $\text{ER}_{\text{conc}}/\text{IR}_{\text{conc}}$ ratio is less relevant than $\text{ER}_{\text{eccc}}/\text{IR}_{\text{conc}}$

- 41 male soccer players
- Velocities: 60, 120 and 300°/s
- Positioning seated


- 53 women (hockey, soccer and basketball)
- Sitting position
- Velocities 60 and 300°/s concentric

**MAIN FINDING**

- Hamstring:quadriceps ratio overuse knee injury prediction value.
Strength Imbalances and Prevention of Hamstring Injury in Professional Soccer Players

A Prospective Study

Jean-Louis Croisier, Ph.D, PT, Sebastien Ganteaume, PT, Johnny Binet, PT, Marc Genty, MD, and Jean-Marcel Ferret, MD

From the Department of Motricity Sciences and Rehabilitation, University and CHU of Liege, Belgium, the Clinique Valmont Genolier, Gilion, Switzerland, and the Center of Sports Medicine, Lyon-Gerland, France

The American Journal of Sports Medicine, Vol. 36, No. 8

• 462 soccer players preseason evaluation
• Seated position
• Velocities
  • 60 and 240°/s conc
  • 30 and 120°/s ecc
MAIN FINDINGS

- Deficits and H:Q ratios (specially Hamstring_{ecc}/quadriiceps_{conc}) have hamstring injury predictive value.
- Individualized intervention and isokinetic test follow-up reduced injury incidence.

**TABLE 2**
Hamstring Injury Frequency in Professional Soccer Players

<table>
<thead>
<tr>
<th>Group</th>
<th>Players, n (n = 462)</th>
<th>Injuries, n (n = 35)</th>
<th>Injury Frequency, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>A^a</td>
<td>246</td>
<td>10</td>
<td>4.1</td>
</tr>
<tr>
<td>B^b</td>
<td>91</td>
<td>15</td>
<td>16.5</td>
</tr>
<tr>
<td>C^c</td>
<td>55</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>D^d</td>
<td>70</td>
<td>4</td>
<td>5.7</td>
</tr>
</tbody>
</table>

*Croisier et al, 2008*
# Knee muscle imbalances

<table>
<thead>
<tr>
<th>Author</th>
<th>N</th>
<th>Gender</th>
<th>Sport</th>
<th>Velocities</th>
<th>Mode</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yeung SS, 2009</td>
<td>44</td>
<td>35 m</td>
<td>Sprinters</td>
<td>60,120,240</td>
<td>Conc Ecc</td>
<td>H:Q conc ratio predictive value</td>
</tr>
<tr>
<td>Bojsen-Møller J, 2007</td>
<td>38</td>
<td>27 m</td>
<td>Sailing</td>
<td>30, 240</td>
<td>Conc Ecc</td>
<td>Lower H:Q ratio</td>
</tr>
<tr>
<td>Bennell K, 1998</td>
<td>102</td>
<td>m</td>
<td>Australian football</td>
<td>60,180</td>
<td>Conc Ecc</td>
<td>Not predict. Injury risk</td>
</tr>
<tr>
<td>Forbes H, 2009</td>
<td>157</td>
<td>m</td>
<td>Soccer</td>
<td>60</td>
<td>Conc Ecc</td>
<td>Differences H:Q among ages</td>
</tr>
</tbody>
</table>
Gulick DT 2001 Side dominance does not affect dynamic control strength ratios in the shoulder. Isokinetics Exercise Science 9: 79-84

<table>
<thead>
<tr>
<th>Velocities:</th>
<th>Positioning:</th>
<th>Subjects</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 and 120º/s</td>
<td>Non-athletic</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15M;16F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Results:</th>
<th>Vel / side</th>
<th>ER_{ecc}/IR_{conc}</th>
</tr>
</thead>
<tbody>
<tr>
<td>90º/s / Dom</td>
<td>1.23</td>
<td></td>
</tr>
<tr>
<td>120º/s / Dom</td>
<td>1.22</td>
<td></td>
</tr>
<tr>
<td>90º/s / non Dom</td>
<td>1.08</td>
<td></td>
</tr>
<tr>
<td>120º/s / non Dom</td>
<td>1.13</td>
<td></td>
</tr>
</tbody>
</table>

Velocities: Positioning: Subjects n
300º/s

Positioning:

Subjects

Baseball players (BP) 16
Non athletic (NA) 43

Results:

<table>
<thead>
<tr>
<th>Subject / side</th>
<th>( ER_{ecc} / IR_{conc} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP / Dom</td>
<td>1.17*</td>
</tr>
<tr>
<td>BP / no Dom</td>
<td>1.48</td>
</tr>
<tr>
<td>NA / Dom</td>
<td>1.37</td>
</tr>
<tr>
<td>NA / no Dom</td>
<td>1.60</td>
</tr>
</tbody>
</table>

Velocities: Positioning: Subjects n
30°/s

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Injured</th>
<th>Uninjured</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{RE}<em>{\text{conc}}/\text{RI}</em>{\text{conc}}$</td>
<td>0.83*</td>
<td>0.78</td>
<td>0.66*</td>
</tr>
<tr>
<td>$\text{RE}<em>{\text{ecc}}/\text{RI}</em>{\text{ecc}}$</td>
<td>0.71</td>
<td>0.78</td>
<td>0.67</td>
</tr>
<tr>
<td>$\text{RE}<em>{\text{ecc}}/\text{RI}</em>{\text{conc}}$</td>
<td>1.08*</td>
<td>0.89*</td>
<td>0.86*</td>
</tr>
</tbody>
</table>
### Shoulder ER/IR muscle imbalances

<table>
<thead>
<tr>
<th>Author</th>
<th>N</th>
<th>Gender</th>
<th>Sport</th>
<th>Velocities</th>
<th>Mode</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newsham KR, 1998</td>
<td>16</td>
<td>m</td>
<td>Baseball</td>
<td>180,300,450</td>
<td>Conc</td>
<td>No dominance effect</td>
</tr>
<tr>
<td>Michael JW, 2005</td>
<td>30</td>
<td>15m, 15f</td>
<td>Handball</td>
<td>60,180</td>
<td>Conc</td>
<td>No dominance effect</td>
</tr>
<tr>
<td>Andrade S, 2010</td>
<td>27</td>
<td>f</td>
<td>Handball</td>
<td>30,90,300</td>
<td>Conc Ecc</td>
<td>Differences regarding dominance</td>
</tr>
<tr>
<td>Wong E, 2009</td>
<td>31C, 27NC</td>
<td>37m, 21f</td>
<td>Climbing</td>
<td>60</td>
<td>Conc Ecc</td>
<td>Climbers lower ER:IR</td>
</tr>
<tr>
<td>Saccol MF, 2010</td>
<td>40</td>
<td>26m, 14f</td>
<td>Tennis</td>
<td>60,180</td>
<td>Conc Ecc</td>
<td>Dominance effect</td>
</tr>
<tr>
<td>Edouard P, 2009</td>
<td>33</td>
<td>m</td>
<td>Rugby (R) / non-athletic (NA)</td>
<td>60,240</td>
<td>Conc Ecc</td>
<td>No Differences H:Q (R a NA)</td>
</tr>
</tbody>
</table>
Dynamometer Biodex system 3 ©
DFM and PFM
60° of Total ROM (20° of DF and 40° of PF)
Positioning *

* Forthomme B et al. Isokin Exerc Sci 2002

** ISOKINETIC TEST:**

Con test at 30 and 90°/sec (5 reps)
Ecc test at 60°/sec (5 reps)
Fatigue test Con at 60°/sec (until exhaustion)
## Dorsal flexor/palmar flexor (DF/PF) ratios

<table>
<thead>
<tr>
<th></th>
<th>Patients</th>
<th>Controls</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DF/PF ratio</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Con 90°/sec</strong></td>
<td>0.39±0.17</td>
<td>0.40±0.19</td>
<td>0.731</td>
</tr>
<tr>
<td><strong>Con 30°/sec</strong></td>
<td>0.41±0.10</td>
<td>0.46±0.14</td>
<td>0.042</td>
</tr>
<tr>
<td><strong>Ecc 60°/sec</strong></td>
<td>0.42±0.15</td>
<td>0.61±0.20</td>
<td>0.013</td>
</tr>
</tbody>
</table>
Muscle imbalances are probably one of the main biomechanical deficit related to musculoskeletal injury. Isokinetic assessment of imbalances has provided valid data to predict injury and assess hamstring injury treatment and prevention programs in soccer players. However, isokinetic dynamometry use in muscle imbalances assessment is not generalized in sports/musculoskeletal settings. Beyond isokinetic devices availability, protocol and results variability may be a cause. Further research is needed pertaining female sports participants, joints and sportive activities not yet tested. Practice guidelines for clinicians would be highly welcome.
Research Project

- Muscle imbalances and tightness assessment around the knee joint
- Male and female elite hockey players
- Relationship with previous injuries and prospective analysis of new injuries.
Thank you