Injury Management – A Biomechanical Perspective
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Biomechanics of injury

▪ Injury
  ▪ Load/force on tissue > tissue strength
  ▪ Acute (single catastrophic event) vs Chronic/Overuse

▪ Prevention
  ▪ Understand risk areas
    ▪ High load relative to positional strength
  ▪ Adapt... position/load/strength
Forces applied in swimming


<table>
<thead>
<tr>
<th>Stroke</th>
<th>Fmax (N)</th>
<th>Fmax (N·kg⁻¹)</th>
<th>Fmean (N)</th>
<th>Fmean (N·kg⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front crawl (n = 32)</td>
<td>232.6 ± 63.2ᵃᵇ</td>
<td>3.43 ± 0.68ᵃᵇ</td>
<td>92.8 ± 33.7</td>
<td>1.34 ± 0.36</td>
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<tr>
<td>Backstroke (n = 8)</td>
<td>211.6 ± 47.5ᶜᵈ</td>
<td>3.13 ± 0.47ᶜᵈ</td>
<td>99.9 ± 29.1</td>
<td>1.47 ± 0.27</td>
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<tr>
<td>Breaststroke (n = 8)</td>
<td>513.0 ± 153.9ᵃᶜᵉ</td>
<td>7.35 ± 1.26ᵃᶜᵉ</td>
<td>115.6 ± 30.5</td>
<td>1.68 ± 0.26ᵃ</td>
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<tr>
<td>Butterfly (n = 16)</td>
<td>394.4 ± 134.4ᵇᵈᵉ</td>
<td>5.63 ± 1.45ᵇᵈᵉ</td>
<td>88.9 ± 34.9</td>
<td>1.25 ± 0.33ᵃ</td>
</tr>
</tbody>
</table>
Freestyle/Front Crawl and Shoulders

Figure 3: Torque about the shoulder, elbow and wrist joints for one cycle of freestyle stroke. The recovery phase for each arm is indicated by a shaded area.

- Harrison, Cohen, Clearly, Mason & Pease (2014) - Torque and power about the joints of the arm during the freestyle stroke. *XIlth International Symposium for Biomechanics and Medicine in Swimming.*
Freestyle/Front Crawl and Shoulders

- Harrison, Cohen, Clearly, Mason & Pease (2014) - Torque and power about the joints of the arm during the freestyle stroke. *XIIth International Symposium for Biomechanics and Medicine in Swimming*. 
Freestyle/Front Crawl and Shoulders

- Hand entry in line with shoulder
- Avoid excessive internal rotation of shoulder
  - Indicators: Hand pointing out/thumb first entry

Freestyle/Front Crawl and Shoulders
Freestyle/Front Crawl and Shoulders

- Not always as it seems...

- Weaker on the left
- Less propulsion on the left (strength and technical)
- Injured on the right
Breaststroke and knees

Graph showing velocity over time and duration of the stroke.
Breaststroke and knees

- Primarily medial and anterior knee pain
  - High force in internally rotated, flexed position
  - Linked to hip abduction
  - Highly associated with rapid increases and overall volume of breaststroke (kick)
  - Imbalanced kick and compensatory overload

Biomechanics of injury: Summary

- **Technique**
  - Understand risk areas and try to correct and/or limit
  - Be aware changes in training load – movement specific not just overall volume
    - Develop load on good technique (fatigue and technical failure)

- **Strength**
  - Actual forces are often not high in terms of overall lower and upper body strength (peak ~60kg). Issue is application in end-range positions
    - Strength through range, not passive flexibility/range of motion
    - Develop joint stability and resilience