ACL Injury Prevention: What can we do to mitigate risk?

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• Soccer is the most widely played sport
  – 300 million registered players globally
    *Dvorak 2005, FIFA 2006*
  – 2\textsuperscript{nd} most popular sport in the USA: 24.4 million participants
    *US Census 2012, Jeffrey 2014*
  – USA: 1.6 million female players (13.36 globally)
    *Barreira, 2016*
  – 1\textsuperscript{st} US female collegiate game played in 1977, > 1200% growth in 40 years
    *Wimmer-Schwarb, 2019*
However, injuries continue to occur, and in some cases increase...

Can we mitigate ACL injury risk?
High School ACL Injury Rate: Girl’s soccer #1, Boy’s soccer #3

- 186,544 injuries in soccer annually < 18 years of age
- 43,125 ACL injuries occur annually in HS sports in the US

Yard, Comstock R, Collins C, 2009
LaBella, 2014
http://pediatrics.aappublications.org/content/133/5/e1437
Joseph, 2013
• ACL Injury rates in the NCAA
  
  
  Arendt and Dick, 1995

  – Data collected over a 5-year period (1989-1993)
  
  • 0.31 Women
  • 0.13 Male

  – NCAA ACL injury rates in females are nearly 3-6 times greater than males
    Arendt, 1999

• Within 7 years of an ACL injury, 65% no longer play soccer
  Brophy, 2012

• 1 in 19 female college soccer players will tear her ACL
  Yang, 2012
• 35 athletes had pre-collegiate reconstruction:
  – 17.1% reinjury to ipsilateral ACL & 20% injury to contralateral ACL

• 54 with intra-collegiate reconstruction
  – 1.9% reinjury rates to ipsilateral ACL & 11.1% injury to contralateral ACL

*Can we do better?*

*Would an injury mitigation intervention be feasible and effective?*

HISTORICALLY: 4 ACL CATEGORICAL RISK FACTORS

- Anatomy
- Biomechanics
- Environment
- Hormones

EXPANDED ACL CATEGORICAL RISK FACTORS

Anatomy

Q angle

Genetics

Environment

Hormones

Medical Training Resources

Biomechanics

Three video analysis studies for mechanism of ACL injury

- 73% defending, 51% Tackling & 15% cutting
- Hip & knee extension, knee valgus, foot planted, & unanticipated event

Defending Puts the Anterior Cruciate Ligament at Risk During Soccer: A Gender-Based Analysis

Robert H. Brophy, MD,‡1 Jeffrey Stepan, MD,‖ Holly J. Silvers, MPT,‡ and Bert R. Mandelbaum, MD†

Three distinct mechanisms predominate in non-contact anterior cruciate ligament injuries in male professional football players: a systematic video analysis of 39 cases

Markus Waldén,1,2 Tron Krosshaug,3 John Bjørneboe,3 Thor Einar Andersen,3 Oliver Faul,3 Martin Hägglund2,4

- 44% while defending (n=11)
- 20% landing after heading (n=5)
- 24% direct contact with leg or knee (n=6)

Indirect contact = to non-contact injury
- Pressing/tackling, tackled, regaining balance after kicking & landing from jump
- ACL’s more prevalent in 1st half

Systematic video analysis of ACL injuries in professional male football (soccer): injury mechanisms, situational patterns and biomechanics study on 134 consecutive cases

Francesco Della Villa,1 Matthew Buckthurpe,1 Alberto Grassi,2 Alberto Nabiuzzi,1 Filippo Tosarelli,1 Stefano Zaffagnini,2 Stefano Della Villa1

Analysis of mechanism
Analysis of mechanism

Preparing
- Hip Ext/ABD, Knee Flex

Shot Taken
- ↑ Trunk Flexion, Hip Flex, Knee Ex

Defender Encroaching
- ↑ Trunk Flex, Lat Trunk & Sig Hip ADD

Defender Acquiescing
- ↑ Trunk Flex, Sig Hip ADD & avoid contact

Reaction
- Hip Ext, Hip ADD, Knee Valgus
Evolvotion of injury prevention

Caraffa: 70%
Ettlinger: 62%
Heidt: 73%
Henning: 89%
Hewett: 88%
Mandelbaum: 88%
Gilchrist: 74%

% Decrease in ACL Tears
Effectiveness of a Neuromuscular and Proprioceptive Training Program in Preventing Anterior Cruciate Ligament Injuries in Female Athletes

2-Year Follow-up

Bert R. Mandelbaum,* MD, Holly J. Silvers,* T MPT, Diane S. Watanabe,* MA, ATC, John F. Knarr,* PT, ATC, Stephen D. Thomas,* MPT, Letha Y. Griffin,‡ MD, Donald T. Kirkendall,§ PhD, and William Garrett, Jr.*, MD, PhD

Year 1: 88% ↓
RR = 0.11, p = 0.0001
(95% CI, 0.03-0.48)

Year 2: 74% ↓
RR = 0.26, p = 0.005 (95% CI, 0.09-0.73)

A Randomized Controlled Trial to Prevent Noncontact Anterior Cruciate Ligament Injury in Female Collegiate Soccer Players

Julie Gilchrist,*† MD, Bert R. Mandelbaum,‡ MD, Heidi Melancon,§ MPH, George W. Ryan,‖ PhD, Holly J. Silvers,‡ MPT, Letha Y. Griffin,§ MD, PhD, Diane S. Watanabe,‡ MA, ATC, Randall W. Dick,‖ MS, and Jiri Dvorak,** MD

- NCAA Div. I women’s soccer - PEP
  61 Teams (833 Control / 561 Intervention)
- Injury Rate:
  0.04 Intervention vs. 0.15 Control
- Non-Contact ACL Injuries occurred over three times more frequently in control vs. intervention
NCAA ACL Injury Rates per 1000 AE

<table>
<thead>
<tr>
<th>Category</th>
<th>Intervention</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of ACL</td>
<td>0.02</td>
<td>0.1</td>
</tr>
<tr>
<td>Late in Season</td>
<td>0.02</td>
<td>0.11</td>
</tr>
<tr>
<td>Practice</td>
<td>0.05</td>
<td>0.1</td>
</tr>
<tr>
<td>Practice &amp; Game</td>
<td>0.04</td>
<td>0.14</td>
</tr>
</tbody>
</table>

**% decrease in IR**
- History of ACL: 100%
- Late in Season: 100%
- Practice: 100%
- Practice & Game: 72%

DEVELOPMENT OF FIFA 11+

• International group: Oslo, Switzerland and USA in 2005
• The FIFA 11+: dynamic warm-up designed to ↓ ALL injury
• On-field warm-up: 15 – 20 minutes with no additional equipment necessary
• Imparts physiological & neuromuscular preparedness
• Addresses musculature not directly associated w/ sport
• Initially tested in large RCT in Norwegian female soccer players: N = 1892, aged 13-17
  – 32% ↓ in all injuries
  – 53% ↓ in overuse injury and a 45% ↓ in severe injury

Soligard, 2008
Does the 11+ Program decrease the rate of ACL injury in soccer players?
### Analysis of ACL Injury Rate

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Intervention</th>
<th>RR (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Injuries</strong></td>
<td></td>
<td></td>
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<tr>
<td>N / % IR</td>
<td>665/100%</td>
<td>285/100%</td>
<td>0.54 (0.49-0.59)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Total Game</td>
<td>392/58.9%</td>
<td>185/64.9%</td>
<td>0.59 (0.52-0.68)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Practice</td>
<td>273/41.1%</td>
<td>100/35.1%</td>
<td>0.46 (0.38-0.57)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td><strong>Knee Injuries</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N / % IR</td>
<td>102/15.3%</td>
<td>34/11.9%</td>
<td>0.42 (0.29-0.61)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Total Contact</td>
<td>6/0.90%</td>
<td>1/0.35%</td>
<td>0.21 (0.03-1.74)</td>
<td>0.148</td>
</tr>
<tr>
<td>Non-contact</td>
<td>10/1.50%</td>
<td>2/0.70%</td>
<td>0.25 (0.06-1.15)</td>
<td>0.049*</td>
</tr>
</tbody>
</table>

- **Significant decrease in Total ACL IR (76%, p=0.021)**
  - Significant decrease in Non-contact ACL IR (75%, p=0.049)
  - No statistical difference in contact ACL IR (p=0.148)
11+ Compliance and Time Loss

Does compliance impact time loss due to injury?

- Statistical difference between High compliance and Low/Moderate groups ($p = .004$, $R^2 = .29$)
High adherence to a neuromuscular injury prevention programme (FIFA 11+) improves functional balance and reduces injury risk in Canadian youth female football players: a cluster randomised trial

- Pre and Post season Performance assessment
- Explored different delivery methods: supervised/unsupervised
- N = 266 players
- High adherence to the 11+ = significant improvements in functional balance & ↓ IR (IRR = 0.28)

Another for Adherence!
Why is Compliance so Challenging?

- Injuries in sport are an important public health problem
- IPEP’s (Injury Prevention Exercise Programs) have been scientifically vetted to ↓ injury rates
- Translating IPEP into practice has been difficult

• Determine if ACL risk can be detected in pretesting
• Determine if the screening tool has the *intended specificity* to identify high risk or ability to RTP
• Refine existing injury IPEP’s and therapy to reflect new knowledge
• Be mindful of the neural components to ACL (EMG, Cortico-Motor Control)
• Provide equal resources to female athletics to mitigate risk
  – Quality & availability of medical staff
  – May improve compliance to IPP
Thank You!

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