ACL PREVENTION: BEFORE AND AFTER

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• I have no disclosures
Is it possible to prevent ACL injury in the athletic population by utilizing targeted prevention programs?

• Literature Review:
  – Search criteria:
    • ACL + Prevention
    • ACL + Neuromuscular
    • ACL + Strength
    • ACL + Screening
  
  • Resulted in multiple journal articles with varying levels of recommendations.
Did a review for ACL literature (2004-2008)
- ACL articles – 8,038
- ACL + Reconstruction- 3,736
- ACL + Prevention – 455
  - 151/455 dealt with prevention of ACL injury vs preventing surgical complications
  - 92/151 (61%) written in 2004-2008

- ACL Articles - 5,650
- ACL Reconstruction – 3,190
- ACL Prevention – 488
Several studies show a decreased incidence of knee injury after participating in a specific training program.

- Hewett TE, AJSM 2013: 41(1) 216-224
- Quest to validate ACL Prevention programs within the literature.
Teenage Girls

• Greatest impact of an ACL prevention program was seen in teenage girls
  – Aged 14-18 vs 18-20 or adults
  – 72% reduction in risk for 14-18 y.o.
  – 16% reduction for > 18
  – Early puberty just before NM risk factors become evident

• Post ACLR
  – Greatest risk of re-rupture is ACLR
Creating Programs to Prevent ACL Injury

• ACL Risk Assessment
  – Why? Rate of Injury in sport/activity
  – Who? Pre/Post Injury Risk Factors

• Screening for Injury Risk
  – What are we looking for?
    • Hierarchy of modifiable changes
  – How can we quantify these risk?
    • Properly utilizing Screenings as Tools of assessment

• Transitioning from Therapy to Sport
  – Protocols for successful RTP
  – Preventative Training Strategies
  – Our Strategies
Identifying NM Imbalances:

- Ligament Dominance
- Quad Dominance
- Leg Dominance
- Trunk Dominance

From Video Study: Females

- 4 components of ACL injury
  - Buckles inward
  - Knee Relatively straight
  - Most weight on single LE
  - Trunk tilted laterally

**Hewett’s work forms the basis of many ACL preventative programs**
### Table 1. Relationship between Mechanism, Neuromuscular Imbalance, and Neuromuscular Intervention for ACL Injury Prevention in Female Athletes.

<table>
<thead>
<tr>
<th>Injury Mechanism Component</th>
<th>Underlying Neuromuscular Imbalance</th>
<th>Targeted Neuromuscular Intervention Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee adduction during landing</td>
<td>Ligament dominance</td>
<td>Train for proper technique</td>
</tr>
<tr>
<td>Low flexion angle in landing</td>
<td>Quadriceps dominance</td>
<td>Strengthen posterior chain</td>
</tr>
<tr>
<td>Asymmetrical landings</td>
<td>Leg dominance</td>
<td>Train side/side symmetry</td>
</tr>
<tr>
<td>Inability to control center of mass</td>
<td>Trunk dominance (&quot;Core Dysfunction&quot;)</td>
<td>Core stability &amp; perturb training</td>
</tr>
</tbody>
</table>
• High risk for re-rupture within first 7 months post ACLR
• 1-4 - 1-5 young athletes will undergo a second ACL injury following ACLR.
• Neuromuscular asymmetry
Screening for Injury: Risk Factors

Raschner, C., H.-P. Platzer, C. Patterson, I. Werner, R. Huber, and C. Hildebrandt
Screening for Injury: What are we looking for?

- ACL injury occurs at a higher rate in games compared with practice settings.\(^{(3)}\)
- Single Leg (SL) maneuvers, including cutting, exhibit more risk on ACL vs Double Leg (DBL) movements.\(^{(3)}\)
- Correct foot positioning in dynamic movements, playing surface, fatigue.\(^{(3)}\)

Conclusion:
We need a screening process to find neuromuscular and biomechanical risks in static, dynamic, controlled, and uncontrolled environments.
Screening for Injury: What are we looking for?

- **Neuromuscular Factors**
  - Quad & Hamstring Strength
  - Quad & Hamstring Co-Contraction
  - Timing of Muscle Recruitment and Activation

- **Biomechanical Factors**
  - Knee Flexion
  - Knee Valgus & Varus Alignment
  - Hip Motion

*Herrington & Comfort*
Screening for Injury: What can we change?

• Biomechanical and Neuromuscular factors among the most important modifiable risk factors for designing prevention programs.
  – Neuromuscular aspects need to be focused in the prevention programs including:
    • proprioception,
    • muscle activation,
    • and inter-joint coordination

• Protecting knee joint by bracing or taping may bring prophylactic benefit.

• The best prevention programs are designed based on sufficient evidence with regards to risk factors of ACL Injury.

Psychological Screening

• Many athletes are physically ready, but they aren’t mentally ready to RTS.
• Kinesiophobia
  – Fear of reinjury
• Multiple screening tools to assess mental readiness to RTS
  – Need to screen for the mental as well as the physical
Screening for Injury Risks: How to Quantify Risks

• Creating Athletic Profile
  – *Body Composition, Hypermobility
  – Sport: Position Demands, Experience, Skill

• Training Age
  – Exercise Experience, Technique

• Equipment (*Shoes*)
  – Proper Equipment for tasks

• Screening
  – FMS, SL Squat, Tuck Jump, Hop Tests, Psychological Screening

• Warm-Up Program
Screening for Injury Risk: Functional Movement Screening

Purpose:

FMS is the screening tool used to identify limitations or asymmetries in seven fundamental movement patterns that are key to functional movement quality in individuals with no current pain complaint or known musculoskeletal injury.

These movement patterns are designed to provide observable performance of basic loco motor, manipulative and stabilizing movements by placing an individual in extreme positions where weaknesses and imbalances become noticeable if appropriate mobility and motor control is not utilized.

Screening is a tool for discovering weaknesses and imbalances. It is not a diagnostic tool, merely informs the screener of flaws in the movement.
Screening for Injury Risks: Utilizing Screening as Tool for Assessment

- **Ligament Dominance**
  - Lower extremity valgus at landing
  - Foot placement not shoulder width apart

- **Quadriiceps Dominance**
  - Excessive Landing contact noise

- **Leg Dominance or Residual Injury Deficits**
  - Thighs not equal side to side during flight
  - Foot placement not parallel (front-to-back)
  - Foot contact timing not equal

- **Trunk Dominance ("Core" Dysfunction)**
  - Thighs do not reach parallel (peak of jump)
  - Pause between jumps
  - Does not land in the same footprint

- **Technique Perfection**
  - Perfect Technique declines prior to 10 seconds

Figure 5. Tuck jump criteria grouped by modifiable risk factor categorizations.

Graziano, Jessica, PT, DPT, CSCS, Daniel W. Green, MD, MS, and Frank A. Cordasco, MD, MS.
Transitioning from Therapy to Sport: Protocol for Successful RTP

• Movement Screening:
  – FMS/Tuck Jump, SL Squat
  – What did we learn?

• Installing Neuromuscular Principles & Mechanics

• Installing Sports Skills – Basic
  – Strength & Conditioning: Support Focused
  – Break down skill/slow down the speed/build up the confidence

• Installing Sports Skills – Intermediate
  – Strength & Conditioning: Sport Focused

• Installing Sports Skills Advanced
  – Strength & Conditioning: Season Focused
Transitioning from Therapy to Sport

- **Skill**
  - Acceleration, Max V., Multi-D
  - Sport Specific:
    - Throws, Tosses, Tackle, Swinging

- **Conditioning**
  - Endurance, Intermittent Sprint, etc.
  - Muscle End, STR End, POW End, etc.
  - Single Event, Multiple Event

- **Competition**
  - Offseason:
    - Introduction to sport mvmt, warm-up routine
  - Preseason:
    - Warm-up, sport mvmt Simulate tempo w/Closed Skills
  - In-Season:
    - Warm-up, sport mvmt, simulate tempo w/Closed & Open Skills
  - Post Season:
    - Warm-up, sport mvmt, simulate tempo w/Randomized Open Skill

<table>
<thead>
<tr>
<th>Bilateral jump landing</th>
<th>Session 1 &amp; 2</th>
<th>Sets</th>
<th>Repetitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bt</td>
<td>Board jump (stick landing)</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Ac</td>
<td>Squat jumps</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Cm</td>
<td>Forward jumps (over 15cm hurdle)</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Cm</td>
<td>180° jumps</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Bt</td>
<td>Walking Lunges</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Ac</td>
<td>Session 3 &amp; 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bt</td>
<td>Board jump (stick landing)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Ac</td>
<td>Squat jumps</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Cm</td>
<td>Forward jumps (over 30cm hurdle)</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Cm</td>
<td>180° jumps</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Un</td>
<td>Walking Lunges</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Ac</td>
<td>Session 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bt</td>
<td>Hop and hold</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Ac</td>
<td>Jump, jump, single land</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Cm</td>
<td>Lateral hops (over 15cm hurdle)</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Cm</td>
<td>90° hops</td>
<td>1</td>
<td>10 (5 each way)</td>
</tr>
<tr>
<td>Un</td>
<td>Split squat jumps</td>
<td>8</td>
<td>2 per leg</td>
</tr>
<tr>
<td>Ac</td>
<td>Session 11 &amp; 12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cm</td>
<td>Exercise</td>
<td>Sets</td>
<td>Repetitions</td>
</tr>
<tr>
<td>Un</td>
<td>Crossover hop (4 hops)</td>
<td>6</td>
<td>1 per leg</td>
</tr>
<tr>
<td>Ac</td>
<td>Jump, jump, single land</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Cm</td>
<td>Lateral hops (over 15cm hurdle)</td>
<td>7</td>
<td>3</td>
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<tr>
<td>Un</td>
<td>Split squat jumps</td>
<td>5</td>
<td>4 per leg</td>
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Comfort, Paul, MSc, Herrington, Lee C., PhD.
Transitioning from Therapy to Sport: Preventative Strategies Pre/Post Injury

- **Time:** 10-30 minutes (minimum)
- **Mode:** General to Sport Specific
- **Volume:** (*)
- **Frequency:** 2-3x/week
- **Intensity:** Moderate to Vigorous
- **Duration:** 8 – 24wks
ACL Prevention Key Components

Summary

- Prevention programs should include multiple-plane biomechanical components.
- Prevention training programs need to incorporate aspect of single-leg training.
  - DBL maneuvers < risk on ACL vs. SL movements (cutting)
- Prevention programs should focus on reaction and decision making to unanticipated conditions.
  - Because ACL injury occurs at a higher rate in games compared with practice settings
- Prevention Programs need to incorporate correct foot positioning in dynamic movements.
- Must consider Playing surfaces in order to reduce ACL injury.
- Prevention programs need to stress the quality of dynamic movements.
  - Fatigue likely attributes risk movements of ACL injury
- Prevention programs need to focus on neuromuscular aspects
  - including proprioception, muscle activation, and inter-joint coordination
- Prevention programs should address the mental as well as the physical
  - Break down the tasks/speed, re-enforce and encourage
- Protecting knee joint by bracing or taping may bring prophylactic benefit.

Communication!
Transitioning from Therapy to Sport: UOA Strength & Conditioning Protocol

- **Screening**
  - Functional Movement Screening
  - ACL Field Test: Hop Tests, Tuck Jump Test

- **Warm-Up**
  - Foam Rolling
  - Multi-Planar Hamstring, Gluteal, Calf Stretch
  - Gluteal Activation

- **Core Strength**
  - Front Functional Axis
  - Back Function Axis
  - Trunk/Rotary Stability

- **ACL Specific Programming**
  - Prevent injury Enhance Performance (PEP) Program
  - ACL Female Jump Landing Programming

- **Sports Performance Programming**
  - Sports Skills: Sprint & Agility Mechanics, Sports Specific Techniques
  - Sports Conditioning: ensuring physiological requirements for sports season
    - Strength
    - Energy System
    - Game Simulation

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**Tuck Jump Assessment**

<table>
<thead>
<tr>
<th>Knee and Thigh Motion</th>
<th>Pre</th>
<th>Mid</th>
<th>Post</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Knee extensor valgus at landing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Thighs do not reach parallel (peak of jump)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Thighs not equal side-to-side (during flight)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Foot Position During Landing**

| 4. Foot placement not shoulder width apart | | | |
| 5. Foot placement not parallel (front to back) | | | |
| 6. Foot contact timing not equal | | | |

**Plyometric Technique**

| 7. Excessive landing contact noise | | | |
| 8. Pause between jumps | | | |
| 9. Technique declines prior to 10 seconds | | | |
| 10. Does not land in same footprint (excessive in-flight motion) | | | |

Total __________ Total __________ Total __________

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Graziano, Jessica, PT, DPT, CSCS, Daniel W. Green, MD, MS, and Frank A. Cordasco, MD, MS.
 Sample Programs Following Strategies

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<tr>
<td><strong>Action</strong></td>
<td>Jump and land forwards or backwards, left or right</td>
</tr>
<tr>
<td><strong>Cue</strong></td>
<td>Verbal instruction; jump forwards, backwards left or right</td>
</tr>
<tr>
<td><strong>Open random task (sport aligned):</strong></td>
<td>Catching ball in flight, initially single direction progress to multiple partners to alter incoming ball direction. Heading a ball for soccer is an alternative</td>
</tr>
<tr>
<td><strong>Open random task (perturbation):</strong></td>
<td>With bungee cord around waist coach pulls on cord whilst the athlete is in flight</td>
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</tbody>
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<tr>
<th>Bilateral Jump Landing (with rotation)</th>
<th>Sample Programs Following Strategies</th>
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<tr>
<td><strong>Action</strong></td>
<td>Jump and land body facing 90 or 180 degrees from start direction, jumping to clockwise or counter-clockwise</td>
</tr>
<tr>
<td><strong>Cue</strong></td>
<td>Verbal instruction; jump 90 or 180, clockwise or counter-clockwise (random combinations)</td>
</tr>
<tr>
<td><strong>Open random task (sport aligned):</strong></td>
<td>Catching ball in flight, initially single direction progress to multiple partners to alter incoming ball direction. Heading a ball for soccer is an alternative</td>
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<tr>
<th>Bilateral Box Jump Landing</th>
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</thead>
<tbody>
<tr>
<td><strong>Action</strong></td>
<td>Jump on and off boxes of varying heights (10-40cm) going in forwards or sideways direction</td>
</tr>
<tr>
<td><strong>Cue</strong></td>
<td>None</td>
</tr>
<tr>
<td><strong>Open random task (sport aligned):</strong></td>
<td>Catching ball in flight, initially single direction progress to multiple partners to alter incoming ball direction. Heading a ball for soccer is an alternative</td>
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<tr>
<td><strong>Action</strong></td>
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Comfot, Paul, MSc, Herrington, Lee C., PhD.  Guy Mothersole, MSpEx, John B. Cronin, PhD, and Nigel K. Harris, PhD.
Thank You

• Questions?

• Prevention Programs:
  – Prevent Injury and Enhance Performance (PEP)
  – ACL Female Jump Landing Program

• E-mail: BlakeS@uognj.com
• Website: UOGNJ.com
References

- Hewett T, N Am J Sports Phys Ther 2010:5(4) 234-