Return to Sport Testing for the Lower Extremity
Objectives For RTS Breakout

- Briefly review the current rationale and evidence on Return to Sport (RTS) Testing for the lower extremity
- Demonstrate and practice the current RTS guidelines we use at OHSU
- Provide references for developing a program suitable for your athletes
WHY?

Return to sport decisions are an important part of the rehabilitation process as patients integrate back into sports (and work) and ultimately to their pre-injury level of function.
WHO?

**Client Demographic:**
Competitive Athletes - all levels
Professional, Collegiate, and High School Athletes
Recreational Athletes
Industrial Athletes
Tactical Athletes: Military, Law Enforcement, Fire and Rescue, Protective Services, First Responders, and other Emergency Services

**Facilitators:**
Physicians
Physical Therapists/PTA’s
Coaches
Athletic Trainers
Strength and Conditioning Specialists
Tactical Facilitators
WHEN?

The timing of the decision to return to sport can mean the difference between a successful outcome or re-injury.
Incidence of Re-injury

- **After Ankle sprain**
  - Up to 80% will suffer recurrent sprains
  - Up to 72% develop recurrent symptoms or chronic instability

- **After ACL-R**
  - Athletes who return to activity (33-63% after 12 months):
    - Re-tear rate after ACL reconstruction is between 9.6% and 25%

- **After Hip Arthroscopy**
  - Limited studies associated with revision surgery ("re-injury")
    - Most common indications for revision: persistent FAI
Markovic G, Reliability and factorial validity of squat and countermovement jump tests. J Strength Cond Res. 2004


“With high re-tear and re-injury rates and no ideal postoperative assessment tool as yet, there is room for continued investigation into options to create an objective guide for safe return to sport.”


There are no current universal guidelines that have shown a clear advantage in
1. Returning an athlete to previous level of sport
2. Decreasing re-tear rates
3. Preserving long-term joint health.”
Return to Sport Decision

Traditionally, the return-to-sport decision making has relied primarily on

Time Post Injury
Factors used to determine return to unrestricted sports activities after anterior cruciate ligament reconstruction

Barber-Westin SD, et al

- Systematic review
- 264 articles
- Only 13% had an objectively measured criterion other than postop time as part of RTS guidelines.
- Of those 13%, only 1-2 criteria other than time postop were included in most of the studies

Barber-Westin SD, Noyes FR. Arthroscopy 2011
CLINICAL EXAM
Entry Criteria for RTS Testing at OHSU

• Pain 0-1 on 11 pt scale.
• Knee effusion $\leq 1+$
• Range of motion-Full
• Validated subjective questionnaires
• Knee Exam: Lachman’s $< 3$mm, neg Pivot Shift
• No reported giving way
• Normal gait

• Hand held dynamometry/MMT
• Isokinetic muscle strength testing (BIODEX 85% quad peak torque)
<table>
<thead>
<tr>
<th>Lower Extremity Functional Outcome Measures</th>
<th>Hip</th>
<th>Knee</th>
<th>Ankle/Foot</th>
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</thead>
<tbody>
<tr>
<td>Lower Extremity Functional Score (LEFS)</td>
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<tr>
<td>Harris Hip Score</td>
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<tr>
<td>Modified Harris Hip Score</td>
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<td>PSFS (Patient Specific Functional Scale)</td>
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<td>Lower Extremity Functional Score (LEFS)</td>
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<tr>
<td>International Knee Documentation Committee Subjective Knee Evaluation (IKDC)</td>
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<tr>
<td>Foot and Ankle Outcomes Questionnaire</td>
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</table>
Psychological Outcome Measure

Injury-Psychological Readiness to Return to Sport Scale (I-PRRSS)

- 6 questions
- 0-100
- Scores below 50 (moderate confidence)
- Athlete may not be ready psychologically to return to sports and needs more time to recover

Why Functional Testing?
98 pts Cleared vs Not Cleared (based on clinical exam)
Functional testing at 6 months-FMS and Y balance Test
No differences existed between groups on
  Average reach score YBTLOQ
  Reach symmetry for any of the reach directions
  Similar score on the FMS (12.7) compared with the non-cleared group (12.8)
No differences were observed for the number of asymmetries

• Clinical impairment measures do not appear to be related to measured functional ability.

• The typical patient in both clinically cleared and non cleared groups would be at a greater risk of lower extremity injury, based on currently published research.
Patients cleared for RTS based on postop time and clinical criteria

Compared with age-matched controls

Had persistent limb asymmetry in
  - Single-legged hop height
  - Vertical ground-reaction forces

Isokinetic and Hop Testing

• Both have construct validity
• Often used to make the determination of when a patient is ready to return to sport.
• May not be sensitive enough to be predictive of subsequent injuries

Importance of Targeted Return-to-Sport Rehabilitation and Testing

4 predictive factors for secondary injury risk with excellent specificity (88%) and sensitivity (92%):

- Uninvolved hip rotation net moment impulse during landing
- Frontal-plane knee motion during landing
- Sagittal plane knee moment asymmetries at initial contact
- Deficits in postural stability on the reconstructed limb
- All predictors were modifiable in nature

Factors Predictive of Secondary ACL Tear in Youth

• 56 athletes cleared for RTS
• 3D biomechanical analyses during landing (DVJT) and postural stability testing
• Prospectively followed for 1 year to document the movement characteristics predictive of secondary ACL injuries
• 13% had second ACL tear

Focus of Today’s Breakout

Functional Testing at OHSU

Return to Sport:
- Core Stability
- Y-Balance or SEBT
- Functional Movement Screen (FMS)
- Vail Sport Test
- Drop Vertical Jump Test (LESS)
- Noyes Hop Tests

Advanced Specific Return to Sport Tests:
- T-Test
- Advanced Agility-3 cone, shuttle runs
- Power: broad jump, vertical jump
- Speed- 40 yard dash
Y- Balance or SEBT

We will discuss and practice this in the small groups
Summary of Y Balance Studies

Reliability:

<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>Type</th>
<th>ICC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hannon et al, 2014</td>
<td>UCL Injured Baseball Players (Average age= 18.5)</td>
<td>Inter-Rater Reliability</td>
<td>0.86-0.99</td>
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<tr>
<td>Garrison et al, 2013</td>
<td>UCL Injured &amp; Asymptomatic Baseball Players (Average age= 18.5)</td>
<td>Inter-Rater Reliability</td>
<td>0.86-0.99</td>
</tr>
<tr>
<td>Shaffer et al, 2013</td>
<td>Military (18-35 years old)</td>
<td>Intra-rater Reliability</td>
<td>0.85-0.93, 0.80-0.85</td>
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<tr>
<td>Plisky et al, 2009</td>
<td>Male collegiate soccer players</td>
<td>Intra-rater Reliability</td>
<td>0.88-0.99</td>
</tr>
</tbody>
</table>

Normative Data:

<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>Study Design</th>
<th>Reference Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hannon et al, 2014</td>
<td>UCL Injured Baseball Players, Pre-surgical (Average age= 18.5)</td>
<td>Lead limb Composite: 90.2%, Stance limb: 89.4%</td>
<td></td>
</tr>
<tr>
<td>Hannon et al, 2014</td>
<td>UCL Injured Baseball Players, 3 months post-op (Average age= 18.5)</td>
<td>Lead limb Composite: 93.6%, Stance limb: 94.9%</td>
<td></td>
</tr>
<tr>
<td>Garrison et al, 2013</td>
<td>UCL Injured Baseball Players (Average age= 18.5)</td>
<td>Lead limb Composite: 89.1%, Stance limb: 88.2%</td>
<td></td>
</tr>
<tr>
<td>Garrison et al, 2013</td>
<td>Asymptomatic Baseball Players (Average age= 19.0)</td>
<td>Lead limb Composite: 95.9%, Stance limb: 95.4%</td>
<td></td>
</tr>
<tr>
<td>Butler et al, 2012</td>
<td>Professional Soccer Players</td>
<td>Descriptive Laboratory Study</td>
<td>Percent of Leg Length: Ant: 72.2%, PL: 114.7%, PM: 118.5%, Composite = 101.8%</td>
</tr>
<tr>
<td>Butler et al, 2012</td>
<td>Collegiate Football Players</td>
<td>Descriptive Laboratory Study</td>
<td>Percent of Leg Length: Ant: 72.8%, PL: 114.6%, PM: 115.2%, Composite = 100.9%</td>
</tr>
<tr>
<td>Butler et al, 2012</td>
<td>High School Soccer Players</td>
<td>Descriptive Laboratory Study</td>
<td>Percent of Leg Length: Ant: 76.2%, PL: 108.2%, PM: 111.0%, Composite = 98.4%</td>
</tr>
</tbody>
</table>

Injury Prediction:

<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>Study Design</th>
<th>Cut Point</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>+LR/DR</th>
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</thead>
<tbody>
<tr>
<td>Smith et al, 2014</td>
<td>NCAA Division 1 Athletes</td>
<td>Prospective Cohort</td>
<td>Anterior right/left reach distance difference &gt; 4 cm</td>
<td>59.00%</td>
<td>72.00%</td>
<td>2.3</td>
</tr>
<tr>
<td>Butler et al, 2013</td>
<td>Collegiate Football Players</td>
<td>Prospective Cohort</td>
<td>Anterior right/left reach distance difference &gt; 4 cm</td>
<td>89.6% Composite Score</td>
<td>100.00%</td>
<td>71.70%</td>
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<tr>
<td>Plisky et al, 2006</td>
<td>High School Basketball Players</td>
<td>Prospective Cohort</td>
<td>Anterior right/left reach distance difference &gt; 4 cm</td>
<td>- -</td>
<td>- -</td>
<td>2.5</td>
</tr>
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<td>Plisky et al, 2006</td>
<td>High School Basketball Players</td>
<td>Prospective Cohort</td>
<td>94.0% Composite Score</td>
<td>- -</td>
<td>- -</td>
<td>6.5</td>
</tr>
</tbody>
</table>
Y Balance or Modified SEBT

- Instrumented vs tape on floor
- Push indicator or toe tap
- Stance foot remains stationary (M-SEBT) or can move (Y Balance)
- No loss of balance, setting foot down, kicking indicator
- Must return to start under control
- 4 Practice trials
- 3 recorded trials each R then L in Anterior, Posteromedial
- and Posterolateral direction with reference to stance leg
- Barefoot in reliability research
- >4 cm difference or >5% difference
Noyes Hop Tests
We will discuss and practice this in the small groups

Lower Limb Symmetry Index (from Ross, Langford, and Whelan, 2002 (3))

- Single hop for distance
- Triple hop for distance
- Crossover hop for distance
- 6-m hop for time

6-m
Noyes Hop Tests

• Set up:
• 6 m long tape/15 cm wide
• Footwear that they would typically use
• Toe starts on the starting line
• 3-4 trials-start with 25% of maximum ability, then 50%, then 75% then full as the warm up trials progress
• For test to count
  • The patient has to hold the landing for 2 seconds
  • Not touch down the contralateral lower extremity
  • Not touch down the contralateral upper extremity
  • Not perform an extra hop
  • Have no losses of balance
• Test uninvolved side first, then involved
Noyes Hop Tests

- Toe on line to start and then measure to heel with distance tests
- Time from start (when heel leaves) to end
- Rest 30 seconds between trials and 2 min between each test
- Can take best distance or average of 2-3 trials
- Values are recorded in absolute distances and can record limb symmetry index
  - Limb symmetry index = [involved/uninvolved] x 100
  - Over the first few test occasions (eg different sessions of PT) the absolute values will increase, but limb symmetry values will not.
- Can also normalize to leg length
  - Leg length = ASIS to medial malleoli
- Absolute distance/leg length = normalized hop
Noyes Hop Tests

• Standard error of measurement is about ± 5%
• Minimum detectable change is 7-12%
• Notes:
  • Related to GROC, LEFS, KOOS and other measures of subjective function
    • With 88% LSI the corresponding score on the LEFS is 70/80
  • Most researched outcomes are related to the knee
    • Note altered movement strategies with PFPS
• Related to strength and power
• Reliable, valid, but does not provide injury risk cutoff scores
• Every healthy individual should score at least >90% of LSI on all 4 tests
  • Average 98 to 101%
• At 2 years out ACL reconstruction patients reach about 95% symmetry, but they aren’t there at the 6 month mark
Vail Sport Test™ or Sports Test

• Quality Factors:
  • Quality of movement
  • Strength against Sport Cord Resistance
  • Muscle strength endurance in LE
  • No pain
• The ability to effectively push off limb
• A controlled landing described as absorption
  • Lateral direction
  • Diagonal/Rotational direction (hip)
• Ability to flex and extend in a lunge position
• Without pain, fatigue or compensation
Vail Sport Test™ or Sports Test

Knee Version
• Single Leg Squat-3 min
• Lateral Bounding-90 sec
• Forward Jogging- 2 min
• Backward Jogging -2 min

•54 point scale

Hip Version
• Single Leg Squat-3 min
• Lateral Bounding-100 sec
• Diagonal Bounding-100 sec
• Forward Box Lunge-2 min

•20 point scale
Single Leg Squat: 3 Minutes
Lateral Bounding/Agility: 100 Seconds
Forward Jogging: 2 minutes
Backward Jogging: 2 minutes
Drop Vertical Jump Test-LESS

- To complete tests participant jumps from a 30 cm box to ground, landing on both feet approx. half of body distance away and then immediately jumping vertically as high as possible

- A high score = poor landing technique, higher risk of injury

- Intra- & Inter rater reliability is good to excellent

- Test is sensitive
The Landing Error Scoring System

- Landing Error Scoring System (LESS) is a reliable and valid test for assessment of jump-landing techniques.
- Poor technique (more errors) during jump-landing tasks = different lower extremity kinematics and kinetics than those individuals who demonstrate excellent technique (fewer errors).
- May identifies patients at high-risk for ACL injury.
- Identifies faulty movement patterns during a dynamic task.

Video Drop Vertical Jump

- ACL reconstruction, male and female, RTS
- Demonstrated involved limb asymmetries in peak VGRF during landing from a bipedal task.
- Deficits increase the risk of future injury

Effects of sex on compensatory landing strategies upon return to sport after anterior cruciate ligament reconstruction.

Reliability of FMS

• Systematic Review of 12 studies determined there was ‘Moderate' evidence that raters can achieve acceptable levels of inter-rater and intra-rater reliability of composite FMS scores when using live ratings. (video
Scoring of the FMS

1. Unable to perform pattern
2. Perform pattern with compensation/imperfection
3. Perform pattern as directed

- Pain with pattern regardless of quality

The Functional Movement Screen

NAME
ADDRESS
CITY, STATE, ZIP
SCHOOL/AFFILIATION
SEX
HEIGHT
WEIGHT
AGE
GENDER
PRIMARY SPORT
PRIMARY POSITION
HAND/LEG DOMINANCE
PREVIOUS TEST SCORE

<table>
<thead>
<tr>
<th>TEST</th>
<th>L</th>
<th>R</th>
<th>FINAL SCORE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEEP SQUAT</td>
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<tr>
<td>HURDLE STEP</td>
<td>L</td>
<td>R</td>
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<tr>
<td>INLINE LUNGE</td>
<td>L</td>
<td>R</td>
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<tr>
<td>SHOULDER MOBILITY</td>
<td>L</td>
<td>R</td>
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<tr>
<td>IMPINGEMENT CLEARING TEST</td>
<td>L</td>
<td>R</td>
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<tr>
<td>ACTIVE STRAIGHT-LEG RAISE</td>
<td>L</td>
<td>R</td>
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<tr>
<td>TRUNK STABILITY PUSHUP</td>
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<td>PRESS-UP CLEARING TEST</td>
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<tr>
<td>ROTARY STABILITY</td>
<td>L</td>
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<tr>
<td>POSTERIOR ROCKING CLEARING TEST</td>
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<td>TOTAL</td>
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Row Score: This score is used to denote right and left side scoring. The right and left sides are scored in five of the seven tests and both are documented in this space.
Final Score: This score is used to denote the overall score for the test. The lowest score for the row score (each side) is carried over to give a final score for the test. A person who scores a three on the right and a two on the left would receive a final score of two. The final score is then summarized and used as a total score.
Refer to Functional Movement Systems for more information regarding the Y-Balance test and the Functional Movement Screen

www.functionalmovement.com
Thank You!