CURRENT CONCEPTS IN RETURN TO SPORT DECISION MAKING AND APPLICATION OF TESTING

KURT GENGENBACHER, PT, DPT, OCS, SCS, CSCS
DAN STURGEON, PT, DPT, OCS
Disclosures

☐ None
Key Components of Return to Play Testing
What is the #1 predictor of injury?

BREAKING NEWS: Derrick Rose tears ACL while packing for New York

My leg!!!
Key to Success?

KEEP CALM AND DON'T GET HURT

www.keepcalm-o-matic.co.uk
Systemic Review With Video Illustration

Factors Used to Determine Return to Unrestricted Sports Activities After Anterior Cruciate Ligament Reconstruction

Sue D. Barber-Westin, B.S., and Frank R. Noyes, M.D.

Purpose: Anterior cruciate ligament (ACL) reconstruction is commonly performed in athletes, with the goal of return to sports activities. Unfortunately, this operation may fail, and the rates of either reinjuring an ACL-reconstructed knee or sustaining an ACL rupture to the contralateral knee range from 20% to 40%. Consequently, there is a need for information on the factors related to a positive outcome.
264 articles reviewed

- Re-injury rate (5-17 year f/u)
  7-49%

- No measure of RTP criteria reported
  40%

Barber-Westin 2011
### Table 2. Time Allowed Postoperatively for Return to Sports According to Graft Type

<table>
<thead>
<tr>
<th>Time Postoperatively</th>
<th>BPTB Autograft</th>
<th>STG Autograft</th>
<th>QT Autograft</th>
<th>Double-Bundle Grafts</th>
<th>Other Grafts*</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥12 wk</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3-4 mo</td>
<td>1</td>
<td>2</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>2</td>
</tr>
<tr>
<td>4 mo</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>4-5 mo</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4-6 mo</td>
<td>1</td>
<td>3</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>&gt;4 mo</td>
<td>2</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>3</td>
</tr>
<tr>
<td>≥5 mo</td>
<td>1</td>
<td>3</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>3</td>
</tr>
<tr>
<td>5-6 mo</td>
<td>2</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>≥6 mo</td>
<td>45</td>
<td>51</td>
<td>5</td>
<td>8</td>
<td>49</td>
<td>84</td>
</tr>
<tr>
<td>6-7 mo</td>
<td>1</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>6-8 mo</td>
<td>3</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>4</td>
</tr>
<tr>
<td>6-9 mo</td>
<td>5</td>
<td>3</td>
<td>—</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>6-10 mo</td>
<td>2</td>
<td>5</td>
<td>—</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>6-12 mo</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>7-9 mo</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>≥8 mo</td>
<td>2</td>
<td>3</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>4</td>
</tr>
<tr>
<td>8-9 mo</td>
<td>—</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>2</td>
</tr>
<tr>
<td>≥9 mo</td>
<td>4</td>
<td>10</td>
<td>—</td>
<td>—</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>9-10 mo</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>9-12 mo</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>2</td>
</tr>
<tr>
<td>10 mo</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>10-11 mo</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>10-12 mo</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>—</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>≥12 mo</td>
<td>4</td>
<td>4</td>
<td>—</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>

Abbreviations: BPTB, bone–patellar tendon–bone; QT, quadriceps tendon; STG, semitendinosus– gracilis.

NOTE. There were multiple grafts observed in 54 of the 158 studies that provided criteria for time postoperatively.

*Allografts, primary repair, or synthetic ligaments.
Who’s ready?
- 13% used some form of objective data
  - 9% used muscle strength
  - 6% used ROM and/or effusion
  - 4% used single leg hop testing
  - 1 study each used
    - Stability
    - Validated Questionnaire
Who’s ready?
Foundational Elements

- ROM
- Swelling/Effusion
- Strength
- Static Balance
Foundational Elements

- ROM
- Swelling/Effusion
- Strength
- Static Balance
Foundational Elements

- ROM
- Swelling/Effusion
- Strength
- Static Balance
Foundational Elements

- ROM
- Swelling/Effusion
- Strength
- Static Balance
Need to review these?
TKA
## TKA outcomes (Bade 2010)

<table>
<thead>
<tr>
<th></th>
<th>Healthy</th>
<th>Pre-op TKA</th>
<th>1 mo s/p</th>
<th>3 mo s/p</th>
<th>6 mo s/p</th>
<th>Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quad Torque (Nm/kg)</td>
<td>2.1</td>
<td>1.3</td>
<td>0.6</td>
<td>1.1</td>
<td>1.2</td>
<td>42.9%</td>
</tr>
<tr>
<td>SLS (s)</td>
<td>26.6</td>
<td>18.8</td>
<td>14.1</td>
<td>20.9</td>
<td>21.6</td>
<td>19%</td>
</tr>
<tr>
<td>TUG (s)</td>
<td>5.6</td>
<td>9.8</td>
<td>14.6</td>
<td>9.7</td>
<td>9.1</td>
<td>38.5%</td>
</tr>
<tr>
<td>Stair Climbing (s)</td>
<td>8.9</td>
<td>23.1</td>
<td>43.4</td>
<td>18.8</td>
<td>18.2</td>
<td>51.1%</td>
</tr>
<tr>
<td>6 Min Walk (ft)</td>
<td>600.1</td>
<td>414.1</td>
<td>255.4</td>
<td>412.9</td>
<td>432.6</td>
<td>27.9%</td>
</tr>
</tbody>
</table>
## TKA outcomes (Bade 2010)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quad Torque (Nm/kg)</td>
<td>42.9%</td>
</tr>
<tr>
<td>SLS (s)</td>
<td>19%</td>
</tr>
<tr>
<td>TUG (s)</td>
<td>38.5%</td>
</tr>
<tr>
<td>Stair Climbing (s)</td>
<td>51.1%</td>
</tr>
<tr>
<td>6 Min Walk (ft)</td>
<td>27.9%</td>
</tr>
</tbody>
</table>
Hierarchical Approach

Foundational Elements

Functional Movements

Sport Specific Tasks
Foundational Elements

- AROM and PROM equal side to side
- No swelling/effusion
- Strength >90% LSI
- Outcome survey >90%
- Global Rating >90%
Functional Movements

Gait Cycle

Stance | Swing

0 | 60 | 100

ATI
PHYSICAL THERAPY
### Self-Reported Patient Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AROM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strength</th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glut Max</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Glut Med</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Hamstrings</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Gastrocnemius</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Quadriceps (Make Test)</td>
<td>#</td>
<td>#</td>
</tr>
<tr>
<td>QI</td>
<td>Involved = Uninvolved</td>
<td></td>
</tr>
</tbody>
</table>

#### Functional Testing

<table>
<thead>
<tr>
<th>Landing Form Assessment (from 12inch box)</th>
<th>Bilateral</th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Knee flexion at initial contact</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>2. Knee valgus at initial contact</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>3. Trunk side-bend at initial contact</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Width of base of support</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Knee flexion displacement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Trunk flexion at max knee flexion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Knee valgus displacement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Overall impression</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Criteria to perform functional testing:**
  - Effusion
  - Trace/None
  - Full pain-free AROM/PROM
  - QI > 85%

- □ PASS □ FAIL

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**ATI PHYSICAL THERAPY**
“What is wrong with me?”
So your athlete passed the testing…
Case Management

- Implementation
  - Insurance issues
  - MD expectations
    - Develop a format
    - Have a clear discussion about expectations
    - F/u immediately after testing
Hierarchical Approach

- Foundational Elements
- Functional Movements
- Sport Specific Tasks
Sport Specific Tasks
Lower Quarter Y-Balance Testing
Hx of Y-Balance Test

- Started as SEBT (1995)
  - Gary Gray

- Postural-Control Deficits

- 6 practice and 3 measured
  - Total of 144 trials

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**FIGURE 12.4** Directions of the star excursion balance test (SEBT) for the left support leg and right reaching leg. Note that the directions would be mirror images for the right support leg and left reaching leg.
Gribble, Hertel, and Plisky 2012

- Systematic review of literature

- Redundancy in performance of reach in 8 directions

- Shortened to three directions:
  - Anterior
  - Posterior medial
  - Posterior lateral
Gribble, Hertel, and Plisky 2012

- Good reliability with/without commercially sold kit

- Scores normalized to limb length for comparison

- Gender differences controversial
EMG and Y-Balance

- Anterior reach more quad dominant
- Posterior reaches more hamstring dominant
Variation and Specific Pathology

- ACL Injury
  - Changes in scores in those with ACL deficiency

- PFPS
  - Decrease in anterior reach

Gribble 2012
Variation and Specific Pathology

Ankle Instability

- Anterior medial, Medial, and Posterior medial help detect Chronic Ankle Instability (Hertel et al 2006)
Star Excursion Balance Test as a Predictor of Lower Extremity Injury in High School Basketball Players

Phillip J. Plisky, PT, DSc, OCS, ATC/L, CSCS
Mitchell J. Rauh, PT, PhD, MPH
Thomas W. Kaminski, PhD, ATC, FACSM
Frank B. Underwood, PT, PhD, ECS

Study Design: Prospective cohort.
Objective: To determine if Star Excursion Balance Test (SEBT) reach distance was associated with risk of lower extremity injury among high school basketball players.
Background: Although balance has been proposed as a risk factor for sports-related injury, few researchers have used a dynamic balance test to examine this relationship.
Methods and Measures: Prior to the 2004 basketball season, the anterior, posteromedial, and posterolateral directions were measured on a force plate using the SEBT. The distance covered in the 10-second test was measured for each direction.

The National Federation of State High School Associations reports that nearly 1 million students participate in high school basketball an-
Table 6. Adjusted odds ratios for potential lower extremity injury risk factors among high school basketball players.

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Category</th>
<th>LE Injury AOR‡ (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All players</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normalized composite right reach</td>
<td>≤94.0%</td>
<td>3.0 (1.5, 6.1)</td>
</tr>
<tr>
<td>distance*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior reach distance difference</td>
<td>≥4 cm</td>
<td>2.7 (1.4, 5.3)</td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normalized composite right reach</td>
<td>≤94.0%</td>
<td>6.5 (2.4, 17.5)</td>
</tr>
<tr>
<td>distance*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior reach distance difference</td>
<td>≥4 cm</td>
<td>3.0 (1.1, 7.7)</td>
</tr>
</tbody>
</table>

* Reach distance is reach distance divided by limb length multiplied by 100. Right reach done by standing on left limb and reaching with the right limb.

†Difference between right and left anterior reach distances.

‡ Adjusted odds ratio for gender, grade, previous injury, participation in a neuromuscular training program since initial measurement, and lower extremity tape/brace use.

Potential for future injury...
NCAA Football (Butler et al 2013)

- Composite reach of <89%

3.5x more likely to get injured
Administration of Test

- Named for the stance leg
- Y-Balance Test Kit
- Tape on floor
  - Consider using tissue boxes for assistance
FIGURE 1. Star Excursion Balance Test with reach directions labeled in reference to right stance foot.
Administration of Test

- **Order**
  - Right Anterior
  - Left Anterior
  - Right Posteromedial
  - Left Posteromedial
  - Right Posterolateral
  - Left Posterolateral

- **Errors**
  - Weight placed on indicator
  - Kicking the indicator
  - Loss of balance during the test
  - Hands coming off the hips

http://www.functionalmovement.com/certification/YBTL
Scoring/Outcome

- Composite reach = Anterior + Posterior-medial + Posterior-lateral
  3 x limb length

http://www.functionalmovement.com/certification/YBTL
Why Hop?

- “I already do functional testing. I look at squatting form, bilateral jumping and landing form, and ability to perform agilities without pain or difficulty.”

Myer et al JOSPT 2011

- 18 athletes that returned within s/p 1 year
  - Brought 1-2 teammates as control group
NFL Study

- Double Leg Activities
  - Vertical Jump
  - Broad Jump
  - Long Shuttle
  - Modified Agility T-test
  - Pro Shuttle

- Single Leg Activities
  - Single Hop
  - Crossover Hop
  - Triple Hop
  - 6-meter Timed Hop

Myer 2011
## NFL Study (Limb Symmetry)

<table>
<thead>
<tr>
<th>Double Leg Activities</th>
<th>Control</th>
<th>ACLR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Jump (cm)</td>
<td>49.3</td>
<td>49.9</td>
</tr>
<tr>
<td>Broad Jump (cm)</td>
<td>201.4</td>
<td>213.0</td>
</tr>
<tr>
<td>Long Shuttle</td>
<td>101%</td>
<td>101%</td>
</tr>
<tr>
<td>Modified Agility T-test</td>
<td>101%</td>
<td>100%</td>
</tr>
<tr>
<td>Pro Shuttle</td>
<td>102%</td>
<td>99%</td>
</tr>
</tbody>
</table>

Myer 2011
## NFL Study (Limb Symmetry)

<table>
<thead>
<tr>
<th>Single Leg Activities</th>
<th>Control</th>
<th>ACLR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Hop</td>
<td>100%</td>
<td>92%</td>
</tr>
<tr>
<td>Crossover Hop</td>
<td>100%</td>
<td>91%</td>
</tr>
<tr>
<td>Triple Hop</td>
<td>97%</td>
<td>92%</td>
</tr>
<tr>
<td>6-meter Timed Hop</td>
<td>100%</td>
<td>96%</td>
</tr>
</tbody>
</table>

Myer 2011
Hierarchical Approach

- Foundational Elements
- Functional Movements
- Sport Specific Tasks
Functional Performance Testing After Anterior Cruciate Ligament Reconstruction: A Systematic Review


Orthopaedic Journal of Sports Medicine 2014 2:
DOI: 10.1177/2325967113518305

The online version of this article can be found at:
http://ojs.sagepub.com/content/2/1/2325967113518305
4927 patients
Primary ACLR
No differences noted between graft types
<table>
<thead>
<tr>
<th>Follow-up, mo</th>
<th>6</th>
<th>9</th>
<th>12</th>
<th>18</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-leg press(^1,99)</td>
<td>85</td>
<td>—</td>
<td>95</td>
<td>—</td>
<td>97 ± 1</td>
</tr>
<tr>
<td>Single-leg press MVIC(^5,30,89)</td>
<td>93 ± 6</td>
<td>—</td>
<td>98 ± 0</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Leg press rate of force development at 30%/50%/90% MVIC(^5)</td>
<td>80/79/72</td>
<td>—</td>
<td>97/92/90</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Open chain knee flexion</td>
<td>93 ± 1</td>
<td>—</td>
<td>98 ± 2</td>
<td>—</td>
<td>95 ± 5</td>
</tr>
<tr>
<td>Hamstring autograft(^29)</td>
<td>—</td>
<td>—</td>
<td>99</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Mixed graft(^1,50,99)</td>
<td>—</td>
<td>—</td>
<td>96</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Isokinetic knee flexion peak torque at 60/120/180/240 deg/s</td>
<td>89 ± 8/97 ± 14/92 ± 7/92 ± 1</td>
<td>95 ± 4/—/—/95/—</td>
<td>92 ± 6/90 ± 14/96 ± 4/94 ± 3</td>
<td>95 ± 6/—/100/95</td>
<td>98 ± 3/100/96 ± 7/94 ± 5</td>
</tr>
<tr>
<td>BPTB autograft(^b)</td>
<td>91 ± 6/87 ± 14/92 ± 7/92 ± 1</td>
<td>—</td>
<td>97 ± 2/80/99 ± 2/96 ± 0</td>
<td>95 ± 6/—/100/95</td>
<td>97 ± 3/—/100/98</td>
</tr>
<tr>
<td>Hamstring autograft(^c)</td>
<td>84 ± 11/—/89 ± 8/—</td>
<td>—</td>
<td>87 ± 4/—/91 ± 1/—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Allograft(^d)</td>
<td>98/—/—/93</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Mixed graft(^2,7,8,11,16,26,32,33)</td>
<td>91 ± 5/96/95/92</td>
<td>96/—/—/95/—</td>
<td>97 ± 4/100/99 ± 1/91</td>
<td>—</td>
<td>98 ± 3/100/100/91</td>
</tr>
<tr>
<td>Isokinetic knee extension peak torque at 60/120/180/240 deg/s</td>
<td>75 ± 9/74 ± 4/84 ± 6/79 ± 3</td>
<td>73 ± 3/—/—/79/—</td>
<td>86 ± 6/87 ± 8/88 ± 5/89 ± 2</td>
<td>89 ± 6/—/84/89</td>
<td>93 ± 5/100/96 ± 4/91 ± 2</td>
</tr>
<tr>
<td>BPTB autograft(^d)</td>
<td>73 ± 6/74 ± 4/84 ± 6/79 ± 0</td>
<td>—/—/79/—</td>
<td>84 ± 3/81/86 ± 2/89 ± 3</td>
<td>86 ± 6/—/—/89</td>
<td>91 ± 3/—/93/89</td>
</tr>
<tr>
<td>Hamstring autograft(^e)</td>
<td>77 ± 14/—/86 ± 4/—</td>
<td>—</td>
<td>87 ± 6/—/89 ± 4/—</td>
<td>—</td>
<td>—/—/—/96/—</td>
</tr>
<tr>
<td>Allograft(^f)</td>
<td>65/—/—/73</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Mixed graft(^f)</td>
<td>78 ± 13/—/75/84</td>
<td>73 ± 3/—/—/79/84</td>
<td>88 ± 7/93/91 ± 8/90</td>
<td>94/—/84/—</td>
<td>95 ± 6/100/100/92</td>
</tr>
<tr>
<td>Isokinetic knee internal rotation at 30/60/90/120 deg/s(^2,90)</td>
<td>—</td>
<td>—</td>
<td>90 ± 1/95/95/90</td>
<td>—</td>
<td>97/97/96</td>
</tr>
<tr>
<td>Isokinetic knee external rotation at 30/60/90/120 deg/s(^2,90)</td>
<td>—</td>
<td>—</td>
<td>98 ± 0/97/98/99</td>
<td>—</td>
<td>98/98/97</td>
</tr>
<tr>
<td>Time to peak torque flexion at 60/240 deg/s (BPTB autograft)(^103)</td>
<td>100/100</td>
<td>—</td>
<td>95/94</td>
<td>95/100</td>
<td>—</td>
</tr>
<tr>
<td>Time to peak torque extension at 60/240 deg/s (BPTB autograft)(^103)</td>
<td>91/90</td>
<td>—</td>
<td>98/100</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>
## Summary

<table>
<thead>
<tr>
<th>Months from Surgery</th>
<th>6</th>
<th>12</th>
<th>24</th>
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</thead>
<tbody>
<tr>
<td>Single Leg Press</td>
<td>85</td>
<td>95</td>
<td>97</td>
</tr>
<tr>
<td>Isokinetic Knee Flexion</td>
<td>89</td>
<td>92</td>
<td>98</td>
</tr>
<tr>
<td>Isokinetic Knee Extension</td>
<td>75</td>
<td>86</td>
<td>93</td>
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<tr>
<td>Functional Test</td>
<td>Follow-up, mo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>---------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Single-leg hop&lt;sup&gt;b&lt;/sup&gt;</td>
<td>87 ± 6</td>
<td>90 ± 2</td>
<td>92 ± 3</td>
</tr>
<tr>
<td>Cross-over hop&lt;sup&gt;c&lt;/sup&gt;</td>
<td>90 ± 4</td>
<td>91 ± 3</td>
<td>92 ± 3</td>
</tr>
<tr>
<td>Triple hop&lt;sup&gt;d&lt;/sup&gt;</td>
<td>90 ± 4</td>
<td>92</td>
<td>95 ± 3</td>
</tr>
<tr>
<td>6-meter timed hop&lt;sup&gt;e&lt;/sup&gt;</td>
<td>90 ± 7</td>
<td>96</td>
<td>94 ± 5</td>
</tr>
<tr>
<td>Single-leg hop height&lt;sup&gt;1,8,11,96,39,47,70,76,99&lt;/sup&gt;</td>
<td>80 ± 5</td>
<td>89</td>
<td>91 ± 2</td>
</tr>
<tr>
<td>Fatigue single-leg hop&lt;sup&gt;6&lt;/sup&gt;</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Side hops in 30 seconds&lt;sup&gt;1,99&lt;/sup&gt;</td>
<td>76</td>
<td>—</td>
<td>86</td>
</tr>
<tr>
<td>Stair hop&lt;sup&gt;1,39,54-86,99&lt;/sup&gt;</td>
<td>84 ± 6</td>
<td>—</td>
<td>91 ± 5</td>
</tr>
<tr>
<td>Stair hopple&lt;sup&gt;7,83&lt;/sup&gt;</td>
<td>87</td>
<td>—</td>
<td>88</td>
</tr>
<tr>
<td>Vertical jump&lt;sup&gt;72&lt;/sup&gt; cm</td>
<td>—</td>
<td>50/36&lt;sup&gt;f&lt;/sup&gt;</td>
<td>—</td>
</tr>
<tr>
<td>Broad jump&lt;sup&gt;72&lt;/sup&gt; cm</td>
<td>—</td>
<td>213/160&lt;sup&gt;f&lt;/sup&gt;</td>
<td>—</td>
</tr>
<tr>
<td>10-step stair climb&lt;sup&gt;5&lt;/sup&gt; s</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Step-hop&lt;sup&gt;8&lt;/sup&gt; s</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Step up and over&lt;sup&gt;62&lt;/sup&gt;</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

<sup>a</sup>Values are expressed as Limb Symmetry Index values (in percentages; mean ± standard deviation) unless otherwise indicated. Where no error measurement is presented, not enough data were present to calculate a standard deviation. A dash indicates no data were available. ACLR, anterior cruciate ligament reconstruction.
Single-Legged Hop Tests as Predictors of Self-Reported Knee Function After Anterior Cruciate Ligament Reconstruction

The Delaware-Oslo ACL Cohort Study

David Logerstedt,*† PT, PhD, MPT, SCS, Hege Grindem,‡ PT, MSc, Andrew Lynch,§ PT, PhD, DPT, Ingrid Eitzen,‡ PT, PhD, Lars Engebretsen,‖ MD, PhD, May Arna Risberg,‡ PT, PhD, Michael J. Axe,¶ MD, and Lynn Snyder-Mackler,† PT, ScD, SCS, ATC, FAPTA

Investigation performed at University of Delaware Physical Therapy Clinic, Newark, Delaware, and Hjelp24 Norwegian Sports Medicine Clinic (Hjelp24 NIMI), Ullevaal, Oslo, Norway

Background: Single-legged hop tests are commonly used functional performance measures that can capture limb asymmetries in patients after anterior cruciate ligament (ACL) reconstruction. Hop tests hold potential as predictive factors of self-reported knee function in individuals after ACL reconstruction.
- 120 patients
- Regular participants in level I or II activities
- Results of hop tests at six months predicts self-reported function at 1 year
  - 6-m and Crossover hop were strongest
Reliability – Knee hop tests

Reid et al. 2007

Munro & Herrington 2011
Hop Testing Provides a Reliable and Valid Outcome Measure During Rehabilitation After Anterior Cruciate Ligament Reconstruction

Andrea Reid, Trevor B Birmingham, Paul W Stratford, Greg K Alcock, J Robert Giffin

Background and Purpose
Although various hop tests have been proposed as performance-based outcome measures following anterior cruciate ligament (ACL) reconstruction, limited reports of their measurement properties exist. The purpose of this study was to investigate the reliability and longitudinal validity of data obtained from hop tests during rehabilitation after ACL reconstruction.
Reid et al. 2007

At 24 weeks LSI = 88.5%
... equated to LEFS score of 69.3pts

Self reported moderate difficulty with:

- Running on both even and uneven ground
- Making sharp turns while running fast
- Usual hobbies, recreational or sporting activities
- Hopping
Score

- Limb Symmetry Index
  Distance hops (single, cross over, triple)  
  \[(\text{involved} / \text{uninvolved}) \times 100\]  

6m-timed hop
  \[(\text{uninvolved} / \text{involved}) \times 100\]
Scoring cut off

Noyes 1991
recommend ≥85%

Munro & Herrington 2011
recommend ≥90%
The Ability of 4 Single-Limb Hopping Tests to Detect Functional Performance Deficits in Individuals With Functional Ankle Instability

Lateral ankle sprains, which are primarily caused by an inversion stress to the joint, account for 34% of all injuries in athletics. Additionally, up to 40% of individuals report a sense of instability after an initial sprain that may lead to recurrent instability. Functional ankle instability (FAI) is described as a feeling of “giving way” in the ankle joint, which may or may not occur in the presence of laxity of the lateral ligaments. How these subjective feelings of giving way affect actual functional performance or sport participation remains an area of debate. While it seems inherent that those with FAI will have “functional” deficits, this has not been consistently reported in the literature.

Developed with the intentions of tracking rehabilitation and determining return to play criteria, functional tests...
Figure of Eight

- Complete the course two times
  - 95% reliability
  - MDC = 4.59 sec

Figure-of-Eight Hop Test
Side Hop

- Performed 10 repetitions
  - Over and back is one repetition
  - 85% reliability
  - MDC = 5.82sec
6-Meter Crossover Hop

- Must completely clear 15cm line each time
  - 96% reliability
  - MDC = 1.03sec

6-Meter Crossover Hop Test
Square Hop

- Complete the square five times
  - Direction:
    - Right Clockwise
    - Left Counter Clockwise
  - 90% reliability
  - MDC = 3.88sec

Square Hop Test
- 30 with FAI and 30 without FAI
- Series of 4 tests
- No difference between limbs for control
- Side and Figure 8 hop detected side to side difference in FAI group
- Square and 6m Crossover did not detect difference
LAB

Figure-of-Eight Hop Test  Side Hop Test  6-Meter Crossover Hop Test  Square Hop Test
Score

- Limb Symmetry Index

All are time based:

\[(\text{uninvolved} / \text{involved}) \times 100\]
Return to sport following hip injury

Pete Draovitch • Robert A. Maschi • Jessica Hettler

Published online: 29 February 2012
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Abstract Returning to both recreational and competitive sport requires the patient demonstrate the ability to perform their activity without pain, without compensation and without apprehension. The primary focus of this article will be to provide progressive weight bearing phased treatment solutions and both objective and empirical return to play testing suggestions. In addition to satisfactorily completing the test battery with maximum effort, the patient must demonstrate the ability to meet the demands for competing within their respective sport specific environment. Returning to competition will most likely include early phase movement screen-

Introduction

Returning to the competitive arena provides challenges for both the athlete and all those responsible for overseeing the transition from the training room to the field of play. The initial discussions at the time of injury must include what will be physically required before returning to play and what will be the safest and most effective avenues to ensure a progressive return. The primary focus of this article will be to provide progressive weight bearing phased treatment solutions and both objective and empirical return to play...
Important to utilize return to sport testing

Talks about the use of hop testing

No specific recommendation regarding valid and reliable tools
Dancers with FAI

- Timed 6-Meter Crossover Hop Test

- New tests proposed:
  - Medial Triple Hop
  - Lateral Triple Hop
FURTHER LOWER EXTREMITY TESTING

- LESS
- Tuck Jump Assessment
- T-Test
- VAIL Sport Test
# References


3. Barber-Westin SD and Noyes FR. Factors used to determine return to unrestricted sports activities after ACL reconstruction. *Arthroscopy.* 2011; 27: 1697-1705.


References


Upper Quarter Return to Sport Testing
Return to Sport UE

- Goals
  - Discuss current options for UE return to play (RTP) assessment
  - Review current literature regarding RTP
  - Create consistency in RTP assessment to improve communication with MD, ATC, coaches, and parents
TOMOHIRO ANRAKU, 16-YEAR-OLD JAPANESE PHENOM, THROWS 232 PITCHES IN ONE GAME

March 29, 2013 By Ben Badler

National high school tournaments are a major affair in Japan.

Daisuke Matsuzaka and Yu Darvish thrived on the big stage. Masahiro Tanaka, a 24-year-old righthander who is the top pitcher in Japan’s Nippon Professional Baseball and may head to the major leagues next season, first emerged as a high school pitching sensation when he broke Matsuzaka’s high school strikeouts record.
LOOK: Pitcher throws 222 pitches in a single day for two complete-game wins

Tanner Dahl’s arm probably isn’t fond of him today

If you ever find yourself yearning for an argument while surrounded by baseball fans, the surest way to scratch that sore is by bringing up pitch counts. Everyone -- or almost everyone -- has a hot take or two festering inside that’s just waiting to ooze. On that pleasant note, here’s a story sure to inspire some lively, reasoned chatter.

Tanner Dahl, a right-handed pitcher of the Moorhead Brewers, who play in the Minnesota Baseball Association, threw two complete games on Friday. He needed 222 pitches to do it:
Pitch Counts

- IHSA (Illinois High School Association)
- Adopted 9/2016
  - Limited to 115 pitches in a game
  - Need 4 day rest if pitched 76-115 pitches
  - Need 3 day rest if pitched 61-75 pitches
  - Need 2 day rest if pitched 46-60 pitches
  - Need 1 day rest if pitched 31-45 pitches
Overhead Athlete

- High Demands
  - Speed
  - Torque generated
  - Requires neuromuscular control, strength, flexibility
Overhead Athlete

- Do coaches know how to progress athletes who...
  - 6 months out in a SLAP protocol
  - Report 70% improvement
  - Demonstrate significant strength deficits
Return to Sport UE

- Do physical therapists know how to...
  - Progress a 5 month post-op OH thrower who reports pain with throwing
  - Justify continued care for a young athlete with full ROM and strength but an obvious need for continued care
  - Communicate remaining deficits to patients, parents, coaches
Return to Sport UE

- Objective measures and tests are sorely lacking for RTP for the overhead athlete.
- Very few published guidelines and high level evidence to support our decision making.
- Poor case closure for athletes can increase risk of future injuries and leave athletes without direction. Often, athlete’s progression is left to coaches who lack experience with rehab from injury.
Hierarchical Approach

Foundational Elements

Functional Movements

Sport Specific Tasks
Return to Sport UE

GIRD vs. TRM
Glenohumeral Internal Rotation Deficit (GIRD)

- Loss of glenohumeral joint internal rotation (IR) of the throwing arm of 20° or more as compared to the non-throwing arm.
- IR is tested with scapula stabilized in 90° abduction.
- Athletes more prone to injury when GIRD is greater than 20°.
- Stretching program for the posterior glenohumeral joint has been shown to be effective treatment for GIRD.
Total Rotational Motion (TRM)

- Total glenohumeral external rotation and internal rotation at 90° of abduction are added
Total Rotational Motion (TRM)

- Total of throwing shoulder and non-throwing shoulder should be within 5° range
  - 2.5x more likely to be injured
- Recent Wilk study has shown that a TRM >176° also increases risk for injury
  - Increased TRM may increase demands for dynamic and static stabilizers
Return to Sport UE
GIRD vs. TRM

Example (GIRD and TRM deficit):

<table>
<thead>
<tr>
<th></th>
<th>ER</th>
<th>IR</th>
<th>TRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>110</td>
<td>35</td>
<td>145</td>
</tr>
<tr>
<td>Left</td>
<td>95</td>
<td>62</td>
<td>157</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Lack 27</strong></td>
<td><strong>Lack 12</strong></td>
<td></td>
</tr>
</tbody>
</table>
GIRD vs. TRM

- Example (GIRD alone):

<table>
<thead>
<tr>
<th></th>
<th>ER</th>
<th>IR</th>
<th>TRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>115</td>
<td>35</td>
<td>150</td>
</tr>
<tr>
<td>Left</td>
<td>95</td>
<td>58</td>
<td>153</td>
</tr>
</tbody>
</table>

**Lack 23**

Lack 3
GIRD vs. TRM

Example (TRM deficit alone):

<table>
<thead>
<tr>
<th></th>
<th>ER</th>
<th>IR</th>
<th>TRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>94</td>
<td>35</td>
<td>129</td>
</tr>
<tr>
<td>Left</td>
<td>93</td>
<td>47</td>
<td>140</td>
</tr>
</tbody>
</table>

Lack 12  Lack 11
Example (GIRD and excessive TRM):

<table>
<thead>
<tr>
<th></th>
<th>ER</th>
<th>IR</th>
<th>TRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>127</td>
<td>39</td>
<td>166</td>
</tr>
<tr>
<td>Left</td>
<td>88</td>
<td>62</td>
<td>150</td>
</tr>
</tbody>
</table>

Current evidence suggests that GIRD should be treated with posterior capsule stretching but avoid increasing TRM > 176°
Return to Sport UE

- Humeral Retroversion
  - Boney adaptations to repeated stress
  - Humeral Retroversion (Crocket et al.)
    - Throwing side: 40 degree
    - Non-Throwing side: 23 degree
    - 17 degree difference
  - Important to determine cause of tightness. Is it boney adaptation or ligamentous tightness
Measuring Humeral Retroversion

- If TRM is equal from non-throwing to throwing arm, then it can be deduced that ER difference is amount of retroversion.
  - Throwing arm: ER 135 deg + IR 45 deg = 180 deg
  - Non-throwing arm: ER 110 deg + IR 70 deg = 180 deg
    - 25 deg difference in ER can be considered retroversion

- Via Mike Reinold
Measuring Humeral Retroversion

- If TRM is not equal, then measure difference in resting ER when supine with shoulder horizontal adduction

  ▪ Via Mike Reinold
Return to Sport UE

- TRM Take Home Message
  - Stretch if TRM is less than 5 deg than non-throwing side
  - If GIRD, assess posterior capsule mobility before stretching, you may be stretching too much
  - Keep TRM to around 180 deg
  - If more than 180 deg of TRM, strengthen as hyperlaxity is also a major concern
Strength

- Internal rotation vs. external rotation strength
  - OH athletes typically present with strong internal rotation strength relative to external rotators
  - External rotators important for deceleration phase of throwing
  - ER to IR ratios run from 0.83 to 1.05 but typically look for a 1:1 ratio
Strength

- Injury risk
  - External rotation weakness has been correlated to increased risk of injury
  - Also, supraspinatus weakness has been correlated to increased risk of injury
Return to Sport UE

- Kinetic Chain
  - Trunk strength
  - Hip strength and mobility
  - Can the athlete generate force through the LE?
LAB

ROM and Strength
Return to Sport UE

- Foundational Elements
  - Full, pain-free AROM
  - Strength >90% versus non-involved side
  - DASH/Quick DASH ADL <10%
**Quick Dash Sport Specific**

**SPORTS/PERFORMING ARTS MODULE (OPTIONAL)**

The following questions relate to the impact of your arm, shoulder or hand problem on playing your musical instrument or sport or both. If you play more than one sport or instrument (or play both), please answer with respect to that activity which is most important to you.

Please indicate the sport or instrument which is most important to you: _______________________________

- [ ] I do not play a sport or an instrument. (You may skip this section.)

Please circle the number that best describes your physical ability in the past week.

<table>
<thead>
<tr>
<th>Did you have any difficulty:</th>
<th>NO DIFFICULTY</th>
<th>MILD DIFFICULTY</th>
<th>MODERATE DIFFICULTY</th>
<th>SEVERE DIFFICULTY</th>
<th>UNABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. using your usual technique for playing your instrument or sport?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. playing your musical instrument or sport because of arm, shoulder or hand pain?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. playing your musical instrument or sport as well as you would like?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. spending your usual amount of time practising or playing your instrument or sport?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Hierarchical Approach

- Foundational Elements
- Functional Movements
- Sport Specific Tasks
Functional Movements

- Symmetrical Scapular Rhythm
- Pain free push up
  - For protective strength
OKC versus CKC Testing

OKC Testing
- Include:
  - Strength tests
  - Throwing for accuracy
  - Throwing for power
- Measure:
  - Mobility
  - Speed
  - Power

CKC Testing
- Include:
  - Single arm hop test
  - CKC UE Stability Test
  - Upper Quarter Y Balance Test (YBT-UQ)
- Measure:
  - Mobility
  - Power
  - Endurance
  - Core Strength
OKC Testing

- Seated Single Arm Shot Put
  - Test for power
  - Seated with legs elevated and trunk stabilized
  - Submaximal warm-up followed by 3 maximal throws
  - Average distance and compare to norms or a 10% difference in bilateral comparison
OKC Testing

- **Functional Throwing Performance Index (FTPI)**
  - Line on floor 15 feet from wall
  - 1 foot by 1 foot square target that is 4 feet from floor
  - Warm up, then count total number and number of accurate throws in 30 seconds
  - Total number/accurate throws x 100 = %score
  - Norms: 47% males, 29% female
OKC Testing

- Open Chain Test
  - Backward, OH, Medicine Ball throw (BOMB) Throw
    - 15# med ball, performed standing, bilateral
  - Underkoffler Overhand Softball Throw
    - Overhand throw with crow hop for distance
    - 4 warm ups, 3 max throws, record average
  - Compare to normative values or test-retest
    - Data is old
CKC Testing

- Single Arm Hop Test
  - Push up position with other arm behind back
  - 4 inch step beside testing UE
  - Hop on/off laterally as quickly as possible 5 times
  - Record time to complete, 2 trials with rest between
CKC Testing

- Closed Kinetic Chain Upper Extremity Stability Test
  - Tests stability, power, and endurance
  - Does not take into account mobility or end-range stability
  - Lines 36 inches apart on the floor
  - Males in push-up position, females in modified push-up
  - Start with one hand on each line, touch one line with opposite hand as many times as possible in 15 seconds.
  - 2 trials and average score
CKC Testing

- Closed Kinetic Chain Upper Extremity Stability Test
  - Normative Values
    Males 21 touches
    Females 23 touches
  - Collegiate Athletes
    Males 26 touches
    Females 21.8 touches
  - Normative Values are available by sport
Return to Sport UE

Lab
CKC UE Stability Test

- Lines 36 inches apart on the floor
- Males push-up position, females modified push-up
- Start one hand on each line, touch one line with opposite hand as many times as possible in 15 seconds
  - 2 trials and average score
Y Balance Test-Upper Quarter

- Measure arm length from C7 spinous process to tip of longest finger in 90 deg of abduction
- Shoes off
- Subject reaches in all 3 directions (medial to inferolateral to superolateral) with the free hand while maintaining push up position and feet shoulder width apart without touching the ground with free hand between each direction
- Testing stopped if subject falls out of push up position, foot moved, or free hand was used for support
Return to Sport UE

Starting Position YBT-UQ

Medial YBT-UQ reach

Inferolateral YBT-UQ reach

Superolateral YBT-UQ reach
Y Balance Test-Upper Quarter

- Tests stability, power, and endurance
- Does take into account mobility and end-range stability
- Medial, inferolateral, and superolateral reaches named for stable arm
- The inferolateral and superolateral reaches are 135 degrees from the medial reach
Y Balance Test-Upper Quarter

- 1 practice for each UE
- 3 trials for each UE
- Record the maximum distance in each direction and divide that by arm length for normalized data

**Table 1.** Average Upper Quarter Y Balance Test scores, reported as a percentage of limb length (%LL) for all reach directions and the composite. The SEM and minimal detectable difference (MDD, 95%) are also reported in centimeters.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Men (n = 51)</th>
<th>Women (n = 45)</th>
<th>Reliability</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (%LL)</td>
<td>Mean (%LL)</td>
<td>Raters</td>
<td>Days</td>
<td>SD (cm)</td>
</tr>
<tr>
<td>Medial</td>
<td>97.2</td>
<td>95.2</td>
<td>1.00</td>
<td>0.92</td>
</tr>
<tr>
<td>Superolateral</td>
<td>70.9</td>
<td>70.4</td>
<td>1.00</td>
<td>0.94</td>
</tr>
<tr>
<td>Inferolateral</td>
<td>84.2</td>
<td>82.7</td>
<td>1.00</td>
<td>0.95</td>
</tr>
<tr>
<td>Composite</td>
<td>85.1</td>
<td>83.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## UE Y Balance Normative Data

<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>Study Design</th>
<th>Reference Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westrick et al., 2012</td>
<td>Active Males (19–47 years old)</td>
<td>Descriptive Laboratory Study</td>
<td>Percent of Limb Length: Med = 97.2%, SL = 70.9%, IL = 84.2%, Composite = 85.1%</td>
</tr>
<tr>
<td>Westrick et al., 2012</td>
<td>Active Females (19–47 years old)</td>
<td>Descriptive Laboratory Study</td>
<td>Percent of Limb Length: Med = 95.2%, SL = 70.4%, IL = 82.7%, Composite = 83.9%</td>
</tr>
<tr>
<td>Westrick et al., 2012</td>
<td>Young Adults (Average age = 19.5, 18.8)</td>
<td>Descriptive Laboratory Study</td>
<td>Dominant: Med = 86.0, SL = 58.2, IL = 82.5 cm, Composite = 85.7%</td>
</tr>
<tr>
<td>Westrick et al., 2012</td>
<td>Young Adults (Average age = 19.5, 18.8)</td>
<td>Descriptive Laboratory Study</td>
<td>Non-Dominant: Med = 86.5, SL = 61.2, IL = 83.5 cm, Composite = 87.6%</td>
</tr>
<tr>
<td>Westrick et al., 2012</td>
<td>Young Males (Average age = 19.5)</td>
<td>Descriptive Laboratory Study</td>
<td>Dominant: Composite = 86.5%, Non-Dominant: Composite = 88.1%</td>
</tr>
<tr>
<td>Westrick et al., 2012</td>
<td>Young Females (Average age = 18.8)</td>
<td>Descriptive Laboratory Study</td>
<td>Non-Dominant: Composite = 82.9%, Non-Dominant: Composite = 85.2%</td>
</tr>
<tr>
<td>Taylor et al., 2015</td>
<td>Female Collegiate Athletes (Average age = 19.2)</td>
<td>Descriptive Laboratory Study</td>
<td>Dominant: Composite = 91.7%, Non-Dominant: Composite = 92.1%</td>
</tr>
<tr>
<td>Taylor et al., 2015</td>
<td>Male Collegiate Athletes (Average age = 19.3)</td>
<td>Descriptive Laboratory Study</td>
<td>Dominant: Composite = 101.4%, Non-Dominant: Composite = 101.8%</td>
</tr>
</tbody>
</table>
Return to Play Expectations

- Foundational Elements
  - Full, pain-free AROM
  - Strength >90% versus non-involved side
    - For Overhead Athlete 1:1 ER:IR ratio
  - DASH/Quick DASH ADL <10%

- Functional Movements
  - Symmetrical Scapular Rhythm
  - Pain free push up
  - YBT-UQ within norms
Return to Sport UE

- Conclusion
  - The perfect test is non-existing
  - Need combined information of UE open chain and closed chain tests as well as ROM and strength measures to improve accuracy of return to sport decision
  - Be aware of sport specific needs
  - Use these tests to communicate with MD, parents, ATCs, coaches about possible RTP.
Case Management

- Special cases
  - Insurance issues
  - MD communication/Protocol development
  - Parent communication
  - Coach communication
References

- Crockett H, et al. Osseous adaptation and range of motion at the glenohumeral joint in professional baseball pitchers. AJSM. 2002 Jan-Feb; 30(1):20-6
Return to Play: Golf

- Case Study
  - 52 y/o male
  - Gradual worsening of LBP as summer progressed
  - Plays roughly 36 holes per week
  - Pain worsens during round
  - Pain typically better between rounds
Return to Play: Golf

- ROM
  - Lumbar spine: Moderate restriction lumbar extension, B lumbar rotation, L>R
  - B hip extensors 4/5
  - Moderate thoracic hypomobility
Return to Play: Golf

- What information is missing?
Return to Play: Golf

- Thoracic ROM
- Hip ROM and flexibility
- Trunk strength/stability
Return to Play: Golf

- Focus on decreasing acute pain first
- Find root cause of LBP
  - Pain will return once patient returns to the course
- LBP often bears the brunt of poor mobility and strength in hips and thoracic spine
Return to Play: Golf

- Thoracic spine mobility
  - Quadruped trunk rotation
  - S/L trunk rotation
  - Planks with rotation
  - Woodchops, reverse woodchops
Return to Play: Golf

- Hip rotation/strength
  - Seated hip IR
  - Prone hip IR
  - Hip IR on foam roll
  - Figure 4 stretch
  - Quadruped hip ER
  - Planks and the multiple variety of planks
Return to Play: Golf

- Hip rotation/strength
  - Lunges
    - Rotation, with med balls, multi-planar
  - Medball throws
    - OH throwing
    - Woodchop

- Golf is not a sagittal plane activity, do not train in the sagittal plane!
# Return to Play: Golf

<table>
<thead>
<tr>
<th>Swing Phase</th>
<th>Classic Swing</th>
<th>Modern Swing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Address</strong></td>
<td>Similar to Modern</td>
<td>Similar to Classic</td>
</tr>
<tr>
<td><strong>Backswing</strong></td>
<td>Body Moves in Relative Unison</td>
<td>Separate Hips and Shoulders</td>
</tr>
<tr>
<td><strong>Top of Backswing</strong></td>
<td>Shoulder/hip Rotation Relatively Same  &lt;br&gt; Body sway to trail side</td>
<td>X-Factor (shoulder/hips separate as much as possible)  &lt;br&gt; Pivot on Trail Leg</td>
</tr>
<tr>
<td><strong>Downswing</strong></td>
<td>Entire body starts downswing as 1 unit</td>
<td>Hips start downswing, followed by shoulders and then arms</td>
</tr>
<tr>
<td><strong>Impact (Acceleration)</strong></td>
<td>Shoulder/Hip stay relatively equal  &lt;br&gt; Minimal trunk flexion toward trail side</td>
<td>Hips &gt; shoulders open to target  &lt;br&gt; Increased lateral trunk flexion toward trail side</td>
</tr>
<tr>
<td><strong>Follow Through</strong></td>
<td>Lumbar Spine Neutral</td>
<td>Reverse C (Lumbar Hyperextension)</td>
</tr>
</tbody>
</table>
Return to Play: Golf

Takeaway  Backswing  Downswing  Acceleration  Follow-through
# Return to Play: Golf

<table>
<thead>
<tr>
<th></th>
<th>Monday</th>
<th>Wednesday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Week 1</strong></td>
<td>10 Putts 10 Chips 5-min Rest 15 Chips</td>
<td>15 Putts 15 Chips 5-min Rest 25 Chips</td>
<td>20 Putts and 20 Chips 5-Min Rest 20 Putts and 20 Chips 5-Min Rest 10 Chips 10 Short Irons</td>
</tr>
<tr>
<td><strong>Week 2</strong></td>
<td>20 Chips 10 Short Irons 5-Min Rest 10 Short Irons 15 Medium Irons (5-Iron off Tee)</td>
<td>20 Chips 15 Short Irons 10-Min Rest 15 Short Irons 15 Chips Putting 15 Medium Irons</td>
<td>15 Short Irons 20 Medium Irons 10-Min Rest 20 Short Irons 15 Chips</td>
</tr>
</tbody>
</table>
# Return to Play: Golf

| Week 3 | 15 Short Irons  
20 Medium Irons  
10-Min Rest  
15 Short Irons  
15 Medium Iron  
5 Long Irons  
10-Min Rest  
20 Chips | 15 Short Irons  
15 Medium Irons  
10 Long Irons  
10-Min Rest  
10 Short Irons  
10 Medium Irons  
5 Long Irons  
5 Wood | 15 Short Irons  
15 Medium Irons  
10 Long Irons  
10-Min Rest  
10 Short Irons  
10 Medium Irons  
10 Long Irons  
10 Wood |
|-------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| Week 4 | 15 Short Irons  
15 Medium Irons  
10 Long Irons  
10 Drives  
15-Min Rest  
Repeat | Play 9 Holes | Play 9 Holes |
| Week 5 | Play 9 holes | Play 9 Holes | Play 18 Holes |
References

- Grimshaw PN, Burden AM, Case Report: reduction of low back pain in a professional golfer. Medicine & Science in Sports & Exercise. 2000; 1667-1673
Return to Contact Sports
Hierarchical Approach

- Foundational Elements
- Functional Movements
- Sport Specific Tasks
Foundational Elements

- ROM: Equal to uninvolved
- Strength: >90% Limb symmetry index
- Outcome survey >90%
- Global Rating >90%
Foundational Elements

- Knee  Effusion (None to trace)

- Shoulder:  TRM within 5 degrees
  IR <20 degrees from uninvolved
Functional Movements

- Upper Quarter:
  - Symmetrical scapular rhythm
  - Pain-free push up
  - CKC UE Stability Test > normative value
    - Males 21 and Females 23
  - Y-Balance test > 80% composite reach
    - May be greater depending on normative data
Functional Movements

- Lower Quarter:
  - Symmetrical gait
  - Pain-free squat with good form
  - Y-Balance test > 90% composite score
    - May changed as normative data is further discovered
  - Hop Testing > 90% limb symmetry
Concussion protocol

- Step 1: Light Aerobic Activity
- Step 2: Moderate Activity
- Step 3: Heavy Non-Contact Activity
- Step 4: Practice & Full Contact
- Step 5: Competition
Sport Specific Tasks

- Cardiovascular Training
- Individual Drills
- Team Drills
- Scrimmage
- Full return to live play
Sport Specific Tasks - Basketball

Cardiovascular Training
- Running, Biking, Swimming

Individual Drills
- Agility drills, Shooting drills, Dribbling drills

Team Drills
- Shadow/mirror drill, Offense/defense schemes with breaks

Scrimmage
- Gradually increasing in time and intensity

Full return to live play
- Gradually increasing time
BREAKING NEWS: Derrick Rose tears ACL while packing for New York

My leg!!!
Psychosocial Issues

- Confidence
- Fear
- Anxiety
How do we know?

- Confidence
- Fear
- Anxiety

[Diagram: Relationship between Anxiety & Performance]
How do we know?
ASK THE ATHLETE!!!!

- Use survey to track progress
How to convince them?

- Objective measures
  - Strength measures
  - Effusion
Rehab Team
Sport Specific Tasks - Football

**Cardiovascular Training**
- Running, Biking, Swimming

**Individual Drills**
- Agility drills, Catching from machine, Throwing at targets

**Team Drills**
- Route running as unit, Blocking scheme practice

**Scrimmage**
- 7 on 7 practice, Against scout team, 2 minute drill

**Full return to live play**
- Gradually increasing time
Return to Throwing
Return to Play: Baseball

- **Case Study**
  - 19 y/o baseball player
  - Insidious onset of sx which started last season
  - Pain only with long toss at a fall season workout
  - Relative rest last 6 weeks between seasons decreased pain
  - Pain is reported superior and anterior shoulder
Return to Play: Baseball

- ROM (R hand dominant)
  - ER PROM at 90/90: R 88 deg, L 97 deg
  - IR PROM at 90/09: R 57 deg, L 75 deg

- Strength (IR/ER tested prone)
  - L UE 5/5
  - R GH flex, abd 4+/5
  - R ER 4/5, IR 5/5
  - R mid trap, low trap, rhomboids 4/5
Return to Play: Baseball

- What information is still needed?
Return to Play: Baseball

- Position?
Return to Play: Baseball

- LE/Core Strength
- Any previous injuries
- Pain with any other activities
- Cross training
Return to Play: Baseball

- Restore ROM
  - Joint mobilization
  - Soft Tissue Mobilization
  - Stretching
    - Sleeper Stretch vs Horizontal Add Stretch
Return to Play: Baseball

- Strengthening (Not an exhaustive list)
  - IR/ER strength focus on 1:1 ratio
    - 90/90 prone, with tubing
  - Scapular strengthening
    - I, Y, T prone, on SB, sustained holds
    - Punches, bearhugs, CKC strengthening
  - Rotator Cuff Strengthening
    - Dynamic stability
    - Ball on wall, wall dribbles
Return to Play: Baseball

- Other strengthening and concerns
  - Hip extension, hip abduction
  - Planks and any variety of planks
  - Hip rotation ROM
Return to Play: Baseball

- Return to Throwing Program
  - Good communication with MD, ATC, parents, patient
  - Consider position
    - Outfielder may need max long throw
    - Infielder may need to throw without trunk
    - Catchers often throw more than pitchers
Return to Play: Baseball


- Throw Like a Pro App

- Thrower’s Ten
Return to Play: Baseball

- Crow Hop
  - Increase use of hip and LE to power long throws and decrease stress on UE.
  - The player should have their head down to watch the ball into the mitt. The ball should be fielded from glove side. Momentum should be moving forward.
Crow Hop

As momentum moves forward, the non-dominant leg is slightly flexed and pushing off while dominant hip and knee is moving into flexion. The hands begin coming together to initiate transfer to throwing arm.
Crow Hop

The hands will come together to transfer the baseball to the throwing arm as momentum continues to move the player forward. The non-dominant leg has pushed off for the hop, and the dominant leg is coming forward, with external rotation, to plant and initiate maximum power output. The player should have both feet off the ground.
Return to Play: Baseball

- Crow Hop
  - The dominant leg is planted and externally rotated with weight entirely on back leg. Momentum will move forward as the non-dominant leg is preparing to accept weight. Slight knee flexion should be used to generate forward power while absorbing a landing.
Crow Hop

- The arms are separated, and the throwing arm is entering in the early cocking phase. The front foot should be pointed directly at the target, as weight is transferring from the back foot towards the front, with parallel shoulders and hips.
Crow Hop

- The non-dominant foot has landed and should be pointing towards target. The arm is now in the acceleration phase, so the hand must be above the elbow with the chest over the plant leg. The player should be lined up in the frontal plane with minimal lateral trunk and head tilt.
Return to Play: Baseball

- Crow Hop
  - The ball has been released, so the arm is in deceleration phase with maximum pronation. Bodyweight is quickly transferred forward. It’s important to have slight knee flexion in order to decrease the risk of hyperextension due to forward momentum. The dominant leg should continue moving forward in an attempt to make hips and shoulders parallel.
Return to Play: Baseball

- No easy answer on when to return player back to sport
- Need good communication with everyone involved
- Focus on proximal control as well as distal control
- Educate!
Hierarchical Approach

- Foundational Elements
- Functional Movements
- Sport Specific Tasks
Foundational Elements

- ROM: Equal to uninvolved
- Effusion: None or Trace
- Strength: >80% Limb symmetry index
Functional Movements

- Symmetrical pain-free gait
- Good form single leg squat to 45deg knee flexion
Sport Specific Tasks

JUST DO IT!
## Sport Specific Tasks

- **Running progression**

<table>
<thead>
<tr>
<th>Walk</th>
<th>Jog</th>
<th>Times</th>
<th>Total Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 minutes</td>
<td>1 minute</td>
<td>3</td>
<td>12 minutes</td>
</tr>
<tr>
<td>2 minutes</td>
<td>2 minutes</td>
<td>3</td>
<td>12 minutes</td>
</tr>
<tr>
<td>1 minute</td>
<td>3 minutes</td>
<td>3</td>
<td>12 minutes</td>
</tr>
<tr>
<td>1 minute</td>
<td>5 minutes</td>
<td>2</td>
<td>12 minutes</td>
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<tr>
<td>1 minute</td>
<td>7 minutes</td>
<td>2</td>
<td>16 minutes</td>
</tr>
<tr>
<td>1 minute</td>
<td>9 minutes</td>
<td>2</td>
<td>20 minutes</td>
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<tr>
<td></td>
<td>12 minutes</td>
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<td></td>
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<tr>
<td></td>
<td>15 minutes</td>
<td></td>
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## Sport Specific Tasks

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soreness during warm up that continues during run</td>
<td>2 days off, drop down 1 step</td>
</tr>
<tr>
<td>Soreness during warm up that goes away during run</td>
<td>Stay at current step</td>
</tr>
<tr>
<td>Soreness during warm up, goes away, and returns during run</td>
<td>2 days off, drop down 1 step</td>
</tr>
<tr>
<td>Soreness day after running</td>
<td>1 day off, do not advance</td>
</tr>
<tr>
<td>No soreness</td>
<td>Advance 1 step/week</td>
</tr>
</tbody>
</table>
Sport Specific Tasks

- Specificity of training
## Sport Specific Tasks

**INTERNAL CUE**
- “Keep hip slightly abducted”
- “Land with more flexed knees”

**EXTERNAL CUE**
- “Don’t cross over the lane line”
- “Land softer”

*Wulf 2010*
Sport Specific Tasks

- Specificity of training

Noehren 2010
Trends in running
Why change?
Why are you stopping?
Direction of running...
"I run 5x/week, that means I don’t have to do my HEP, right? Cause my muscles are already strengthening with running."

"I need to make sure to get my mileage in so I can’t strength train."
Strength Training – WHY?

- Concurrent strength training improves running economy
- Running economy is a better predictor of performance than O2 max

Piacentini 2013
## My Recommendation

- Use well founded principles to set up program
  - DOMS
  - Adequate recovery time

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<thead>
<tr>
<th>Monday</th>
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<th>Saturday</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Middle distance pace run</td>
<td>Short distance form run</td>
<td>Off day</td>
<td>Speed workout</td>
<td>Middle distance form run</td>
<td>Long distance for mileage</td>
<td>Short distance recovery run</td>
</tr>
<tr>
<td>Strength training</td>
<td></td>
<td></td>
<td>Strength training</td>
<td></td>
<td></td>
<td>Light agilities</td>
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</tbody>
</table>
References


Questions

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Dan.Sturgeon@atipt.com