**ACL INJURIES**

**Introduction**

- ACL injuries common in sports & strenuous work
  - So frequent that the seriousness is often forgotten
- Totally disrupted more than any other knee ligament
- 200,000 ACL injuries annually
  - Fu: *AJSM* ’99
- 148,714 ACL surgeries in 2013
- 19 yrs: 58% increase in number ACL surgeries
  - Wilk: *JOSPT* ’15
- Rehab has changed in the past 10 yrs

**Criteria to Return to Play**

- Evidence Based Rehab
- Return to Normal Function

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**Carey et al: AJSM ’06**

- Effects of ACL injury on running backs & wide receivers in the NFL players (N=33)
  - 80% returned to NFL play
  - Performance of those returning – performance was reduced by 1/3

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**ACL Injuries**

**Return to Play**

- 78% of NBA players returned to play following ACL surgery
- Of the players returning: 44% experienced a decrease in in standard statistical categories & player efficiency ratings
  - Busfield et al: *Arthroscopy* ’09
Shah, Andrews, Fleisig: AJSM ‘10

- 49 NFL players underwent ACL/PTG
- 63% returned to NFL play (31/49)
- Average length of time to return 10.8 mos
- Age, position & number of procedures not a factor in return rate
- Players who had more than 4 yrs of experience higher rate of return
- Players drafted in first 4 rounds – higher rate of return to play
How Do You Know When Your ACL Patient is Ready to Run? Return to Sports?

Post-Op ACL Reconstruction

Functional Screening Test

Return to Play Criteria

Sport Specific Testing LE

1990's ACL Testing

- Subjective Patient Assessment
- KT Test
- Isokinetics
- Hop testing
- Agility Runs

Sport Specific Testing LE

- Subjective Patient Assessment
- KT Test
- Isokinetics
- Hop testing
- Agility Runs
- Front step down
- Jump down
- Agility L run
- 4 corners
- Y balance
- FMS (Q)
- Shuffles runs
Isokinetic Testing
Interpretation Data: 180°/s & 300°/s

- **Q PT / BW ratio:** (180°/sec)
  - Males: 60-65%
  - Females: 50-55%
- **H/Q ratio:** (180°/sec)
  - Males: 66-72%
  - Females: 75% >
- **HPT / BW ratio:** (180°/sec)
  - Males: 40-43%
  - Females: 37-40%

- **Endurance ratio (3000/sec)**
  - Extensors: 12% or less
  - Flexors: 9% or less
- **Acceleration rates (180°/sec):**
  - QPT at .2 sec
  - 80% or greater PT
- **Acceleration rates (180°/sec):**
  - HPT at .2 sec (females)
**Return to Sports**

**After ACL Reconstruction:**
- Systematic review of 48 studies reporting return to sports of 5770 individuals after ACL reconstruction at mean follow-up of 41.5 months

<table>
<thead>
<tr>
<th>Return to Preinjury Level of Sports</th>
<th>63% (95% CI 54 to 71%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return to Competitive Sports</td>
<td>44% (95% CI 34 to 56%)</td>
</tr>
<tr>
<td>Return to Some Form of Sports</td>
<td>82% (95% CI 73 to 90%)</td>
</tr>
</tbody>
</table>

- Men > Woman
- Seasonal Sports > Year Round

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**What’s New in ACL Rehabilitation**

- Kinesiophobia

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**Kinesiophobia**

- Fear of movement/reinjury
  - "I’m afraid that I might injure myself if I play a sport or exercise"
  - Tampa scale for kinesiophobia
    - Woby et al.: Pain '05
  - Interventions which improve self efficacy may improve knee function short term
    - Chmielewski et al.: JOSPT '08
    - Chmielewski et al.: Phys Ther '11
    - Lentz et al.: JOSPT '12

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**Return to Preinjury Sports Participation Following ACLR**

*Why Didn’t They Return to Sports (n=42)*

- Kinesiophobia* - more present in low level athletes – elite athletes
- Instability*
  - 31 patients responded they had instability 68%
- Quad PT/BW ratio*
  - important test parameter
  - quads are shock absorbers
  - Wilk et al.: JOSPT '94 correlation b/w QPT/BW
- IKDC scores (15 pts difference)*
- Knee effusion (present in 9 pts)* - 21%
- Pain scale difference*
- Tegner scale differences

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**We Can Do Better**

*JosPT 2014*
ACL Rehabilitation
Limb Confidence

What's New in ACL Rehabilitation

- Kinesiophobia
- Perturbation Training

Perturbation Training to Enhance Neuromuscular Control

- Various levels of dynamic stability
  - Stability ➔ Mobility ➔ Controlled Mobility ➔ Skill
- Perturbation skill one of highest level
- Improves clinical outcomes
  - Wilk: J Athl Trn '99
  - Fitzgerald: Phys Ther '00

Must gradually progress to skill level drills!!

Perturbation Training to Enhance NM Control

Fitzgerald, Axe, Snyder-Mackler: Phys Ther '00

- Perturbation training ACL deficient knee patients (athletes)
- 26 patients isolated ACL rupture
- Randomly assigned to group:
  - A standardized program
  - Standardized program & perturbation training
- Results: 91% perturbation group return to play (6 months)
  - 50% standardized group return to play (6 months)
Non-Operative Rehab Shoulder Instability

Knee Injuries - ACL +

Movements with Poor Stabilization

What’s New in ACL Rehabilitation

- Kinesiophobia
- Perturbation Training
- Linking LE & UE

Linking Arms & Lower Extremity

What’s New in ACL Rehabilitation

- Kinesiophobia
- Perturbation Training
- Linking LE & UE
- Movements – Changing Directions
Movements & Change of Planes

- Lateral Slides

What’s New in ACL Rehabilitation

- Kinesiophobia
- Perturbation Training
- Linking LE & UE
- Movements – Changing Directions
- Reactive Drills

Reactive Drills

Reactive Lateral Slides

Reactive Lateral Slides on Verbal

Movements with Stabilization
Movements with Stabilization

4 Stages of Motor Skill Development

- **Cognitive:** new tasks & drills are introduced
- **Associative:** time spent thinking about new tasks
- **Autonomous:** automatic & efficient & develop skill
- **Refining:** refines the task to level of perfection


Want to Reduce Re-Injury Rates

4 Things You Can Do!

- **Reduce Re-Injury Rate by 84%**
- **Strict Criteria to Return to Sports**


- Can we reduce re-injury rates in ACLR pts
- Delaware-Oslo ACL Cohort Study
- 106 patients ACLR – 2yr FU
  - 30% pts returning Level I sustained re-injury, 8% returning to a lower level (4x higher reinj rate)
  - Every month delayed returned to sports until 9mos – rate of re-injury was reduced 51%
  - More symmetrical quadriceps strength prior to return to sports sign. Reduced re-injury rate

- ACL reinjury rate following ACLR
- 78 subjects underwent ACLR – return to sports
  ✓ 15x greater 2nd ACL in subjects with ACLR if they return to sports during the first year
  ✓ 6x greater 2nd ACL injury in subjects returning to sports within 12-24 mos
  ✓ Females ACLR 4x greater rate of injury 24 mos.
  ✓ 2x more likely to tear opposite knee ACL
  ✓ 30% athletes sustained 2nd ACL inj – 21% on contralateral side 9% opposite side

Functional Movement Screen

FMS

Functional Movement Screen

FMS

Y Balance Test

Post-Op ACL Reconstruction

Return to Play Criteria

✓ 3 P Program:
  ✓ Performance
  ✓ Practice
  ✓ Play

Post-Op ACL Reconstruction

Return to Play Criteria

✓ 3 P Program:
  ✓ Performance Training:
    ✓ performance training – sport specific drills
    ✓ plyometrics
    ✓ agility drills
    ✓ speed drills
    ✓ sport specific drills (cutting, deceleration, etc)
Post-Op ACL Reconstruction

Return to Play Criteria

✓ 3 P Program:
✓ Practice situations:
  ✓ control practice
  ✓ gradual increase time, intensity, reps
  ✓ lower intensity to begin gradually increase intensity
  50-60% → 75% → 80-90% → 100%
  ✓ return to practice game (game simulation)

✓ 3 P Program:
✓ Play:
  ✓ return to competition
  ✓ game situation
  ✓ 100% effort

POST-OP ACL RECONSTRUCTION

Return to Play Criteria

What’s New

CATAPULT SPORTS DATABASE

• Acceleration 80
• Velocity 80
• IMA (inertial movement analysis) 80
• Player Load 70
• Metabolic 70
• Heart Rate 80

• TOTAL 300-400 data points per player per day

GPS Tracking

• Total distance
• Max velocity
• Player load
• Explosiveness
• High-speed yards
• Inertial movement analysis (IMA)
• Other (metabolic, HR)
McGuine et al: AJSM ‘17

- Sport specialization association with increased risk of lower extremity injuries in adolescent athletes
- 1544 participants (Grades 9-12) 29 Wisc HS
- 2843 athletic seasons (2015-16)
  - 15% sustained LE injuries (n=235)
  - Ankle 34%, Knee 25%, Upper Leg Inj 12%
  - Sprains 41%, Strains 25%
- Athletes with moderate to high sport specialization were more likely to sustain LEI

Reduce Re-Injury in Throwers

- Slower to Return to Play
- More Submax Throwing
- More time in ITP
- Mechanics
- Strict Criteria to RTP
- Objective Functional Testing
- *%#

Failla, Logerstedt, Grindem et al: AJSM ‘16

- Does extended Pre-Op Rehab Influence Outcomes 2 years after ACLR
- MOON & Delaware-Oslo ACL Cohorts
- 150 patients in each group
- Criteria based when reconstruction is performed
  - DOC group: strength training, ROM & NM drills
  - The DOC group had significantly higher Return To Sports rate at 2 yrs
  - 12-15% higher scores (IKDC, KOOS)
  - DOC pre-op average

Neuroplasticity Following ACL Injury

- Rehab Implications:
  - Dual tasking
  - Blindfolded
  - Eyes closed
  - Stroboscope glasses
  - Visual elements

What’s New in ACL Rehabilitation

- Kinesiophobia
- Perturbation Training
- Linking LE & UE
- Movements – Changing Directions
- Reactive Drills
- Neuroplasticity
Neuroplasticity Following ACL Injury

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What’s New in ACL Rehabilitation

- Kinesiophobia
- Perturbation Training
- Linking LE & UE
- Movements – Changing Directions
- Reactive Drills
- Neuroplasticity
- Unbalanced Balance Training

Unbalanced Bar Balance Drills
What's New in ACL Rehabilitation

- Kinesiophobia
- Perturbation Training
- Linking LE & UE
- Movements – Changing Directions
- Reactive Drills
- Neuroplasticity
- Unbalanced Balance Training
- Motion Capture
What’s New in ACL Rehabilitation

- Kinesiophobia
- Perturbation Training
- Linking LE & UE
- Movements – Changing Directions
- Reactive Drills
- Neuralplasticity
- Unbalanced Balance Training
- Motion Capture
- Proprioception & Neuromuscular Control
- Train Bilateral

ACL Injuries

- Not an isolated injury
  - Injury affects both extremities
  - For at least 3.6 mos
  - Alters firing mechanism
  
Wilk, et al: CSM ’03

Wojtys, Huston: AJSM ’94

Train the Uninjured Extremity Too!!

Hamstring Exercises
What’s New in ACL Rehabilitation

- Kinesiophobia
- Perturbation Training
- Linking LE & UE
- Movements – Changing Directions
- Reactive Drills
- Neuroplascity
- Unbalanced Balance Training
- Motion Capture
- Proprioception & Neuromuscular Control

Immediate Stimulation of Receptors

Co-Activation to Enhance Dynamic Stability

Stabilization From ABOVE & BELOW

Stimulation to Uninjured Extremity
Train the Uninjured Extremity Too!!

Step Down Test

Drop Vertical Jump

Thank You !!!