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

Evidence Based Rehab

ACL Injuries

Introduction

- Over 200,000 ACL injuries annually
- 62-66% sports related, usually non-contact – 70%
- Over 60% in males
- 67% occurs in individuals 15-29 yrs of age
- 26% occurs in 30-44 yrs
- 7% occurs in individuals above 45 yrs of age
**Brophy, Gill, Lyman, et al: AJSM ’09**

- Effect of ACL Reconstruction &/or Meniscectomy on length of career in NFL
- 54 athletes with meniscectomy alone
- 29 ACL reconstruction
- 11 both ACL recon & partial meniscectomy
- History of an isolated meniscectomy not isolated ACL reconstruction shortens career
- Combination (ACL & Meniscus) was most detrimental (~2yrs)

**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

**ACL Injuries**

- 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

Return to Sports

<table>
<thead>
<tr>
<th>After ACL Reconstruction:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Systematic review of 48 studies reporting return to sports of 5770 individuals after ACL reconstruction at mean follow-up of 41.5 months</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Return to</th>
<th>Percentage (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some Form of Sports</td>
<td>82% (73 to 90%)</td>
</tr>
<tr>
<td>Pre-Injury Level of Sports</td>
<td>57% (54 to 71%)</td>
</tr>
<tr>
<td>Competitive Sports</td>
<td>40% (34 to 56%)</td>
</tr>
</tbody>
</table>

Ardern CL et al. 2011

Return to Sports

<table>
<thead>
<tr>
<th>Reasons for reduced sports participation for those that did not return to prior level:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Fear of re-injury (19%)</td>
</tr>
<tr>
<td>• Problems with structure/function of knee (13%)</td>
</tr>
<tr>
<td>• Family commitments or lifestyle changes (11%)</td>
</tr>
</tbody>
</table>

Ardern, BJSM: 2011
**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**

Return 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

---

**ACL Reconstruction**

**Overview**

- ACL injuries are the most common ligamentous injuries of the knee requiring surgery
- 175,000 ACL R performed year 2000
- Total cost of over 2 billion dollars

**Spindler: NEJM ’08**

**Long Term Successful Outcome**
ACL Rehabilitation

Limb Confidence

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 !!

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)

Perturbation Training to Enhance NM Control

Linking Arms & Lower Extremity
Movements & Change of Planes

Lateral Slides

Reactive Lateral Slides

Reactive Lateral Slides on Verbal

Movements with Stabilization
**Movements with Stabilization**

**Frobell et al: NEJM ’10**

- Randomized trial of treatment for acute ACL tears
- 121 young adults, acute ACL injury
- Randomized into 2 groups:
  - Structured rehab & early ACL reconstruction (n=62)
  - Structured rehab & with option of delayed rehab (59)
- Of the 59 in delayed surgery, 23 underwent surgery & 36 Rx with rehabilitation no surgery
- Primary outcome: baseline to 2 yrs post-injury
- **Conclusion:** "a strategy of rehab plus early reconstruction was not superior to delayed surgery"
Paterno, Rauh, et al: AJSM '14

- 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


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

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
Neuroplasticity Following ACL Injury

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

Unbalanced Bar Balance Drills

How Do You Know When Your ACL Patient is Ready to Run? Return to Sports?
How Do You Know When Your ACL Patient is Ready to Run? Return to Sports?

- Test battery Q/H strength & power (conc & ecc) >90%
- Van Grinsven: Knee Surg Spots Traum Arth ‘10
  - 85% or better in ACL patients
- Barber-Westin, Noyes: Arthroscopy ‘11
  - strength: <10% deficit
  - Hop test: <15% deficit
  - Vertical landing: >60% knee separation distance
Post-Op ACL Reconstruction

Functional Screening Test

Return to Play Criteria

Non-Operative Rehab Shoulder Instability

The Weekend Warrior

Knee Injuries - ACL +

The Weekend Warrior

Movements with Poor Stabilization

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)

Post-Op ACL Reconstruction
Return to Play Criteria

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

Post-Op ACL Reconstruction
Functional Screening Test

✓ Clearance for running
✓ Clearance for agility drills
✓ Clearance for jumping
✓ Clearance for hoping & cutting
✓ Proceed to the return to sport

Post-Op ACL Reconstruction
Functional Screening Test

• Clearance for Running:
  ✓ 30 Step & holds
  ✓ 10 single leg squats
  ✓ 1 rep max on leg press
  ✓ 15 min of fast treadmill
  ✓ KT testing
  ✓ Isokinetic testing
  ✓ FMS test
  ✓ Y balance test
  ✓ Landing CoG
  ✓ Gait pattern (biomechanical)
  ✓ Vertical Jumping
Post-Op ACL Reconstruction

Functional Screening Test

• Clearance for Running:
  ✓ 30 Step & holds
  ✓ 30 step & holds w/o loss of balance
  ✓ 10 single leg squats
  ✓ 10 consecutive squats to 45 deg
  ✓ 1 rep max on leg press
  ✓ ≥70% 1 RM on leg press
  ✓ 15 min of fast treadmill walking (normal gait)
  ✓ KT testing (specific criteria)
  ✓ Isokinetic testing (specific criteria)

Functional Movement Screen

FMS

Y Balance Test

Post-Op ACL Reconstruction

Functional Screening Test

• Clearance for Agility Drills:
  ✓ 1 rep max on leg press
  ✓ 10 single leg squats with weights
  ✓ Run 1 mile on treadmill
  ✓ KT testing
  ✓ Isokinetic testing
  ✓ Hop test

Post-Op ACL Reconstruction

Functional Screening Test

• Clearance for Agility Drills:
  ✓ 1 rep max on leg press
  ✓ ≥85% of uninvolved side
  ✓ 10 single leg squats with weight to 45 deg
  ✓ ≥75% of uninvolved side
  ✓ Run 1 mile on treadmill
  ✓ normal gait pattern
  ✓ KT testing (specific criteria)
  ✓ Isokinetic testing (specific criteria)
  ✓ Hop testing (85% > of uninvolved side)
Post-Op ACL Reconstruction

Functional Screening Test

• Clearance for Return to Sport:
  ✓ Strength achieves >90%
  ✓ Displays normal running pattern – no pain
  ✓ Has practiced & displays no hesitation or compensation strategies
  ✓ Practiced full effort – no swelling or pain
  ✓ KT test
  ✓ Hop test (90% ≥ uninvolved side)

ACL Injury Return to Sports

• Levels of Sports (Based on Loading/Stress)
  • I: Basketball, Soccer, Volleyball, Gymnastics, Football, Skiing, Lacrosse
  • II: Baseball, Softball, Kickball, Nordic Skiing, Hiking, Bowling
  • III: Golf, Running, Biking, Swimming, Walking

Post-Op ACL Reconstruction

Functional Screening Test

• Clearance to Return to Practice: (additional)
  ✓ vertical drop jump
  ✓ unilateral bridge for time
  ✓ full prone plank
  ✓ running & cutting (running making 90°)
  ✓ running & deceleration (running straight at higher percentage and stop on a dime)

ACL Injuries Introduction

• Usually occurs in “high risk”
sports
  ✓ Football
  ✓ Basketball
  ✓ Volleyball
  ✓ Soccer
  ✓ Skiing
  ✓ Team Handball

ACL Injuries Introduction

• ACL Age Distribution
  ✓ Scandinavian Registry Lind: Acta Orthop ’09
  ✓ Female peak age ~ 15 yrs
  ✓ Male peak age ~ 20 yrs

• Risk of Contralateral ACL Injury
  ✓ Systematic review of 13 prospective studies
  ✓ 2nd Inj Contralateral Risk > than First Time Risk
    Sward et al: KSST ’10
Complete ACL tears in Children

Our protocol at BCH:

- Pre-operative: Tension 0 or 1
- Stiffness: 0-10
- Correction: 1-2

- Rehabilitation: Early Range of Motion, Strengthening
- Trans-physeal reconstruction
- Physeal-sparing reconstruction

ACL Injuries

Proximal Components
- Femoral adduction
- Femoral internal rotation

Distal Components
- Hyperpronation
- Tibial internal rotation

Not an isolated injury
- Injury affects mechanoreceptors
  - Within 24 hrs after injury
    Lephart: AOSSM '97
  - Deficits may last 6 yrs or more
    Denti: Knee Surg Spots Trauma '00
  - “Quadriceps avoidance gait”
    Andriacchi: CORR '94
    Berechuck: JBJS '90
The Effects of ACL Injury on Lower Limb Proprioception

Unilateral ACL Injury Affects Both Lower Extremities
Wilk: CSM '04

ACL Injuries

• Not an isolated injury
  ✓ Injury affects both extremities
  ✓ Quadriceps weakness & activation failure following ACL injury &/or reconstruction bilaterally
  Hart et al: J Athletic Trn '10
  Chmielewski: J Orthop Res '04
  Farquhar: Muscle Nerve '05
  Holder-Powell: Eur J Appl Physiol 01

ACL Injuries

• Deficits in Balance & Proprioception is Long Term
  ✓ Posture & balance deficits can be present up to 2-3 yrs
  Clark: J Biomech '14 (6-18 mos)
  Howells: Knee Surg Spts Trau ‘11 (systematic review 10 studies – impaired posture at 29 mos)

ACL Injuries

• Not an isolated injury
  ✓ Bone bruises present 71-100% patients
  Potter et al: AJSM ’12
  Spindler: AJSM ’93
  Rosen: Arthroscopy ’91
  Graf: AJSM ’93
  Johnson: AJSM ’98
  • 65% exhibited marrow changes & cartilage thinning 6 yrs after ACL injury
  Faber: AJSM ’99

Potter, Jain, Ma, et al: AJSM ’12

• 42 knees in 40 patients (28 ACLR, 14 non-op)
• MRI at time of initial injury then annually for a maximum of 11 yrs
  ✓ All patients sustained initial chondral injury 100% incidence
  ✓ Risk of cartilage loss doubled from yr 1 for the lateral & medial compartment & 3x for patella
  ✓ By 7 to 11 years: LFC 50x, MFC 19x, & patella 30x
  ✓ Size of the bone bruise associated to degeneration from yr 1 to yr 3
Immediate Stimulation of Receptors

Weight Distribution “Limb Confidence”
SooAeeseesaiens soc cesss Beoseas Bone Brise

Rehabilitation Guidelines:
- Control wt. bearing forces (crutches)
- No early running & jumping
- Cryotherapy & compression
- Train & restore proprioception
- Emphasize unloading programs
- Progress to gradual/progressive loading program
- Pool exercises, bicycle, etc...
- Muscle stimulation to quads
- Motion, motion, motion ...
- Delay compressive loading (running …)

PACE Yourself First –
Before you can go FAST !!!

It’s all about milestones !!!

Reduce Swelling
& Pain

Proprioception & Neuromuscular
Control Drills for the ACL Patient

Dynamic Stabilization
Stages of Motor Control

COGNITIVE STAGE
- Identify Objectives
- Self-talk/Questioning
- ¶ Errors/ Variability
- Instruction/Feedback

ASSOCIATIVE STAGE
- Associate with environmental cues
- Refining/Consistent
- Errors/ Variability
- Identify/Correct Errors

AUTONOMOUS STAGE
- Subconscious/automatic
- Multiple tasks
- ¶ Errors/variability
- ¶ Identify/Correct
- Perfection

Beginner  Expert
Dynamic Stabilization
Stages of Mastery

Unconsciously Incompetent
Consciously Incompetent
Consciously Competent
Unconsciously Competent

Co-Activation to Enhance Dynamic Stability

Co-Activation to Enhance Dynamic Stability

Co-Activation to Enhance Dynamic Stability

Co-Activation to Enhance Dynamic Stability
Co-Activation to Enhance Dynamic Stability

Dynamic Stabilization
Co-Activation Drills

Co-Activation to Enhance Dynamic Stability

Stabilization From ABOVE & BELOW

Establish Proper Foot Position
**ACL Rehabilitation**

*Immediate Post-injury*

- Train *uninjured extremity* immediately
  - Single leg balance Biodex
  - Single leg bicycle Unicam
  - Lateral step-down / front

---

**Train the Uninjured Extremity Too!!**

---

**ACL Rehabilitation**

*Dynamic Stabilization Phase*

- Maintain knee motion
  ✓ *Normalize unilateral muscle ratio*
  ✓ *Enhance stabilization proximal & distal*
  *Wilk et al: JOSPT ‘12*
- Improve proprioception & NM control

---

**Dynamic Stabilization**

*Overview*

- Proprioception
- Kinesthesia
- Neuromuscular control
- Functional stability
- Dynamic stabilization

---

**Step Down Test**
Lower Extremity Assessment

*Step Down Test*

Drop Vertical Jump

ACL Injuries

*Dynamic Q Angle*

- Proximal Components
  - Femoral adduction
  - Femoral internal rotation
- Distal Components
  - Hyperpronation
  - Tibial internal rotation
Wilk- ACL Proprioception & NM Control Exercises

2017

ACL Rehabilitation
Dynamic Stabilization Drills

• Maintain full motion
  » Supine LLLD stretches
  » Maintain knee flexion of 135°
  » *associated MCL injuries – extra motion!!

ACL Rehabilitation
Dynamic Stabilization Drills

• Progress strengthening program
  ✓ Leg press 40-100 deg
  ✓ Wall squats 0-70 deg
  ✓ Decline squats
  ✓ Lateral step-ups
  ✓ Front step-downs
  ✓ Knee extensions 90-40 deg
  » Hip & hamstrings
  » Calf muscles

RDL Test

Wilk et al: AJSM '94
Increase hip flexion increases hamstring activity.

Ohkoshi et al: AJSM '91
Escamilla & Wilk: MSSE '01

Escamilla & Wilk: JOSPT '08
ACL Rehabilitation
Advanced Strengthening Phase

Strengthening Ex Days

✓ Leg press (45-100)
✓ Wall Slides (0-75)
✓ Step downs

Wall Squat Long & Short

Nagura: J Appl Biomech '06
Nisell: AJSM '89
Escamilla & Wilk: MSSE'09

ACL Rehabilitation
Advanced Strengthening Phase

Strengthening Ex Days

✓ Leg press (45-100)
✓ Wall Slides (0-75)

Nagura: J Appl Biomech '06
Nisell: AJSM '89
Escamilla & Wilk: MSSE'09

ACL Rehabilitation
Advanced Strengthening Phase

Strengthening Ex Days

✓ Leg press (45-100)
✓ Wall Slides (0-75)

Escamilla & Wilk: JOSPT '08

ACL Rehabilitation
Advanced Strengthening Phase

Strengthening Ex Days

✓ Leg press (45-100)
✓ Wall Slides (0-75)

Escamilla & Wilk: JOSPT '08
ACL Rehabilitation
Advanced Strengthening Phase

Strengthening Ex Days
- Leg press (45-100)
- Wall Slides (0-75)
- Step downs
- Squats
- Lunges

Escamilla & Wilk: JOSPT '08
Escamilla & Wilk: Clin Biomech '08

ACL Rehabilitation
Advanced Strengthening Phase

Strengthening Ex Days
- Leg press (45-100)
- Wall Slides (0-75)
- Step downs
- Squats
- Lunges
- Leg Extensions 90-40

ACL Rehabilitation
Advanced Strengthening Phase

Strengthening Ex Days
- Leg press (45-100)
- Wall Slides (0-75)
- Step downs
- Squats
- Lunges
- Leg Extensions 90-40

RDLs

RDLs
Star Drill - RDLs

RDLs on Balance Beam

Establish Hip Control

Stabilization Above & Below
My Favorite Hip Exercises

- Sidelying clams with manual resistance
- Seated theraband ER
- RDLs
- Single leg front step downs
- Star drill
- Instant Replay
- Single leg bosu ball catches
- Planks with hip abduction & ext

Bridging Exercises
Lateral Slides
Stabilization Above & Below

Train the hip – Eliminate the foot
**ACL Deficient Knee Rehab**

*II: Dynamic Stabilization Phase (weeks 4-7)*

- Enhance stabilization proximal & distal
  - Lateral lunges
  - Lateral / front step downs
  - Hip strengthening
  - Lunges on foam
  - Balance beam
  - Strengthening ankle / foot

**Establish Core Stability**

**Hamstring/Core Muscle Training**
**Core Stabilization & Training**

- Improve proprioception & NM control
  - Retrograde stepping
  - Unilateral restrict movements
  - Front & back lunges
  - Tilt board squats
  - Balance drills

**ACL Rehabilitation**

**Dynamic Stabilization Drills**

- Improve proprioception & NM control
- Gradually increase strength
- Promote endurance
- Improve core stability
- Gradually increase applied loads

**Neuromuscular Activity Drills**

- Enhance neuromuscular control
- Gradually increase strength
- Promote endurance
- Improve core stability
- Gradually increase applied loads

**Tilt Board Progression**

- 2 legged squats → with taps
- Single leg stance “balanced” → with taps
- 2 legs throws → with holds
- 1 leg stance throws “balanced” → with taps
- 1 leg stance throws rotation → with taps

3 levels to the Tilt Boards
Perturbation Training to Enhance NM Control

Dynamic Warm-Up

- Meta-analysis of 144 articles
- Overwhelming evidence
- Static stretching before exercise has a pronounced effect on muscle performance, explosive and strength values (isometric)
- Regardless of age, gender or status
- Static stretch 30-45s
Challenge the Neuromuscular System

Gradually Increase the Neuromuscular Challenges
**ACL Rehabilitation**
*Return to Activity Phase*

- **Running & agility program:**
  - backward run → lateral movements
  - lateral movements → forward running
  - jogging → jog / stops
  - jogging → run / stops
  - running → yo-yos
  - cutting drills → 45 deg. → 90 deg.

---

**Proprioception & NM Control**
*Progressive WB Loading*
Agility Drills

ACL Rehabilitation
Running & Functional Drills
- Running straight line first
- Running – deceleration – stop – go again
- Then progress to 45 deg. cutting
- Then progress to 90 deg. cutting
- Initiate drills at 50-60% then progress to 60-75% then to 75-90% then lastly 100%
  Progression is based on signs & symptoms

Initiation of the Running Program
- Reduced body weight running:
  - 50-60% BW depends on condition articular surfaces & associated pathologies
- Interval running:
  - Gradually increase WB forces:
    - 60-75%
    - 75-90%
    - 100%
- Running progression designed to advance without pain/set backs

ACL Rehabilitation
Agility Drills – Running Drills
- Backward Running
- Forward Run
- Side slides (low)
- Cariocas
- Start/stops
- Acceleration ladders
- Reaction drills
- Combinations

Running Drills – (Hallway)
ACL Rehabilitation

Agility Drills – Run/Cutting Drills
- Forward running
- 45 deg zig zag
- Shuttle run
- 90 deg hard cuts
- Backward run turn & go (run)
- Sport specific drills

Agility Drills – Ladder Drills
- Forward & Backward Drill
- Side to side Drills

Agility Drills – Ladder Drills
- Quick Feet Drill

Agility Drills – 4 Corner Drill
- Side Shuffle
- Back Peddle
- Forward Run
- Cariocas
Agility Drills

ACL Rehabilitation
Agility Drills – 4 Corner Reactive Drill

Start/Finish

On Demand
Reactions

ACL Deficient Knee Rehab
IV: Return to Activity Phase (weeks 12? 16 weeks?)

- Plyometric program
  floor → boxes
  side to side → diagonal
  2 legged → 1 legged
  straight → rotational
  “Sportmetrics Program”

Gradually increase box height
Pool Plyos

ACL Rehabilitation

Summary

• Similar rehab as for the reconstructed ACL patient
• Emphasize proprioception & NM control training
  ➢ Building blocks – one step at a time
  ➢ Perturbation training
  ➢ Enhance NM control
• Promote unilateral muscle ratios
• Prevent negative effects to mechanoreceptors
• Train contralateral extremity immediately
• Requires 10-12 weeks before sports
• Is it effective for the ACL deficient patient ??
• Depends on type of patient
  Competitive Athlete --- Recreational Athlete --- Non-athlete

Thank You !!!!
<table>
<thead>
<tr>
<th>Exercise</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Knee Lab</strong></td>
<td></td>
</tr>
<tr>
<td>Proprioception &amp; NM Control</td>
<td></td>
</tr>
<tr>
<td>Stability Position (30-45°)</td>
<td>✓ standing on floor</td>
</tr>
<tr>
<td></td>
<td>✓ standing on floor (eyes closed)</td>
</tr>
<tr>
<td></td>
<td>✓ standing catching a ball</td>
</tr>
<tr>
<td></td>
<td>✓ standing with ball up &amp; down</td>
</tr>
<tr>
<td></td>
<td>✓ standing on foam</td>
</tr>
<tr>
<td></td>
<td>✓ standing on floor then foam side to side overhead</td>
</tr>
<tr>
<td></td>
<td>✓ standing on floor cross drill</td>
</tr>
<tr>
<td></td>
<td>✓ standing on foam cross drill</td>
</tr>
<tr>
<td>Lateral Lunges (30-45°)</td>
<td>✓ straight no cord</td>
</tr>
<tr>
<td></td>
<td>✓ straight with cord straight</td>
</tr>
<tr>
<td></td>
<td>✓ diagonal (30° angles)</td>
</tr>
<tr>
<td></td>
<td>✓ diagonal with rotation</td>
</tr>
<tr>
<td></td>
<td>✓ lateral straight foam</td>
</tr>
<tr>
<td></td>
<td>✓ lateral straight on foam fast</td>
</tr>
<tr>
<td></td>
<td>✓ ball catches/throws</td>
</tr>
<tr>
<td></td>
<td>✓ lunges onto rocker board</td>
</tr>
<tr>
<td>Stepping Drills (Cones or Cups)</td>
<td>✓ forward/backward</td>
</tr>
<tr>
<td></td>
<td>✓ speed --- slow, fast &amp; slow</td>
</tr>
<tr>
<td></td>
<td>✓ stepping with ball drills</td>
</tr>
<tr>
<td></td>
<td>✓ stepping with foam</td>
</tr>
<tr>
<td></td>
<td>✓ step over hurdle with rotation</td>
</tr>
<tr>
<td>RDLs</td>
<td>✓ unweighted</td>
</tr>
<tr>
<td></td>
<td>✓ weighted</td>
</tr>
<tr>
<td></td>
<td>✓ weighted with shoulder flexion &amp; trunk ext</td>
</tr>
<tr>
<td></td>
<td>✓ CLX RDL</td>
</tr>
<tr>
<td></td>
<td>✓ star drill</td>
</tr>
<tr>
<td></td>
<td>✓ cones/cups</td>
</tr>
<tr>
<td></td>
<td>✓ tape on floor</td>
</tr>
<tr>
<td></td>
<td>✓ standing on box</td>
</tr>
<tr>
<td></td>
<td>✓ RDL into knee to chest</td>
</tr>
<tr>
<td>Hip Abduction &amp; ER Strengthening</td>
<td>✓ clams</td>
</tr>
<tr>
<td></td>
<td>✓ RDLs</td>
</tr>
<tr>
<td></td>
<td>✓ Star</td>
</tr>
<tr>
<td></td>
<td>✓ Side plank</td>
</tr>
<tr>
<td></td>
<td>✓ Side plank with hip abduction</td>
</tr>
<tr>
<td></td>
<td>✓ side plank with hip abduction against wall</td>
</tr>
<tr>
<td></td>
<td>✓ side plank w/ hip abd against wall with Tband</td>
</tr>
<tr>
<td></td>
<td>✓ side plank hip abduction wall with IR</td>
</tr>
<tr>
<td>Hamstring Training Drills</td>
<td>✓ stability ball bilateral</td>
</tr>
<tr>
<td></td>
<td>✓ stability ball unilateral</td>
</tr>
<tr>
<td></td>
<td>✓ stability ball bilateral ECCENTRICS</td>
</tr>
<tr>
<td></td>
<td>✓ stability ball theraband</td>
</tr>
<tr>
<td></td>
<td>✓ TRX bands</td>
</tr>
<tr>
<td></td>
<td>✓ Norwegian eccentric hamstrings</td>
</tr>
<tr>
<td></td>
<td>✓ with manual resistance</td>
</tr>
<tr>
<td></td>
<td>✓ Fast speed hamstrings standing w/ theraband</td>
</tr>
</tbody>
</table>
**Knee Lab**

*Proprioception & NM Control*

- **Perturbations**
  - tilt board squats
  - tilt board squats with ball catches
  - tilt board ball catches with perturbations
  - single leg stability position w/ ball catches
  - single leg stab position w/ ball & perturbation
  - bosu ball ball catches
  - tremor board (?)
  - foam with theraband perturbations

- **Step downs**
  - box
  - box with theraband
  - box with ball catches
  - box with ball catches with theraband
  - box with perturbations of theraband
  - box with foam with ball & theraband
  - **Front Step Downs vs. Lateral Step Downs**

- **Bridging**
  - bilateral bridging
  - unilateral bridging
  - bridging on stability ball
  - stability ball with theraband
  - floor bridging with hip abduction
  - floor bridging w/ manual resistance

- **Lateral Slides**
  - without resistance band
  - with resistance band (thighs)
  - with resistance bands (ankles)
  - with CLX
  - with CLX with ball catches
  - with CLX & reactive drills with ball catch
  - with CLX four corners

- **Clams**
  - movement
  - with resistance band
  - with manual resistance
    - concentric
    - concentric/eccentric
    - cone/ecc with RS
  - side plank with clams

- **Functional Drills - Running**
  - backward running
  - lateral slides
  - forward
  - run fwd – deceleration - starts
  - cutting
  - zig zags
  - functional drills
Knee Lab

Proprioception & NM Control

- Ladder Agility Drills
  - 2 feet forward
  - 2 feet sideways
  - front foot in lateral
  - back foot out lateral
  - Ickey shuffle
  - combination drills
  - reverse drills
  - combination & reverse drills
  - ladders with CLX

- Vertical Drop Jump
  - 2 legged jump
  - 1 leg jump
  - 2 legged jump onto foam

Knee Lab

Proprioception & NM Control

- Functional Drills - Sports
  - QB drills
    - lateral slides with CLX & FB
    - lateral slider with CLX & FB w/ reactions
  - Volleyball Drills
    - CLX jumps
    - CLX jumps into push ups

- Functional Drills - Sports
  - Windmill Softball Pitching Drills
    - CLX resistance windmill motion
    - CLX resistance for shoulder flexion
  - Golfer’s Drills
    - Back shoulder ER w/ lead leg abd (CLX)
    - Lead shoulder acceleration phase with back leg

Advanced Drills