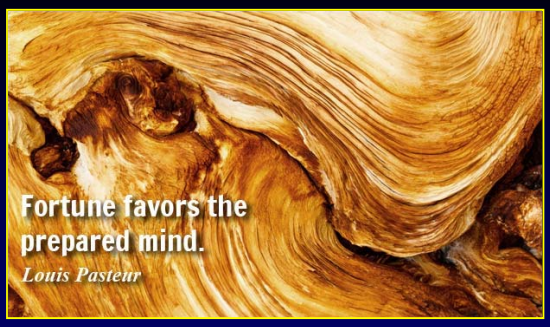
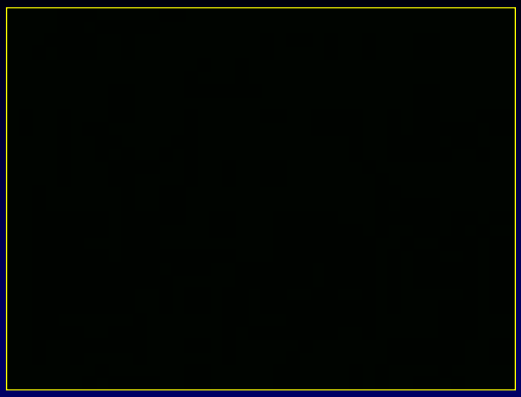
Proprioception & Neuromuscular Control

Drills for the ACL Patient

Kevin E. Wilk, PT, DPT, FAPTA

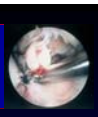






ACL Injuries

Introduction




- Common injury

~200,000 ACL injuries annually

~129,836 ACL Recon Surgeries Annually

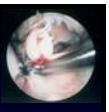
- Occurs in sports & strenuous work activities
  - » *So frequent that seriousness often forgotten*
- *"Athletes' Injury"*
- Often associated with other injuries

Not an isolated injury

Rehab ACL tear –

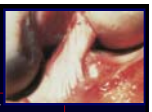
what about the other structures

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

ACL INJURIES
Introduction

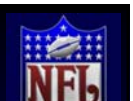


- ✓ 1 in 3,500 people will sustain an ACL injury
  - ✓ *Baer, Harner: Clin Spts Med '07*
- ✓ Estimated 1 million ACL injuries worldwide
- Females are 4-6 times higher risk of ACL injury
- ✓ ACL outcomes (IKDC scores) 61-67 of 100
  Biau et al: CORR '07
- ✓ 40-90% of ACL patients exhibit radio-graphic knee OA 7-12 yrs following surgery
  Pinczewski et al: AJSM '07
  Liden et al: Arthroscopy '08
- ✓ 10x greater rate OA in ACL injured knee
  Fleming et al: JOSPT '03


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
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


Return to Play after ACL Surgery

Re-Injury Rates

Barber-Westin, Noyes: Phys SportsMed '11

- ✓Reinjury rates range from 3 to 49%
- ✓Systematic review of 12 studies
- ✓Re-injury rates of the reconstructed ACL ranged from 0 to 24%
- ✓Injury to the contra-lateral knee ranged from 2-15%

Shah, Andrews, Fleisig, Lemak: 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 Play after ACL Surgery

Overview

Arden et al: AJSM '11

- ✓at 12 months only 1/3 were back to pre-injury level

Arden et al: Br J Sports Med '11

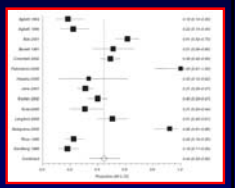
- ✓Meta-analysis of 48 studies & 5,770 patients
- ✓63% returned to pre-injury level
- ✓44% returned to competitive sports

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**

Return to Some Form of Sports	82% (95% CI 73 to 90%)
Return to Pre-Injury Level of Sports	63% (95% CI 54 to 71%)
Return to Competitive Sports	44% (95% CI 34 to 56%)



Ardern CL et al. 2011

Return to Sports

- Reasons for reduced sports participation for those that did not return to prior level:
  - ✓Fear of re-injury (19%)
  - ✓Problems with structure/function of knee (13%)
  - ✓Family commitments or lifestyle changes (11%)

Ardern, BJSM: 2011

Kinesiophobia

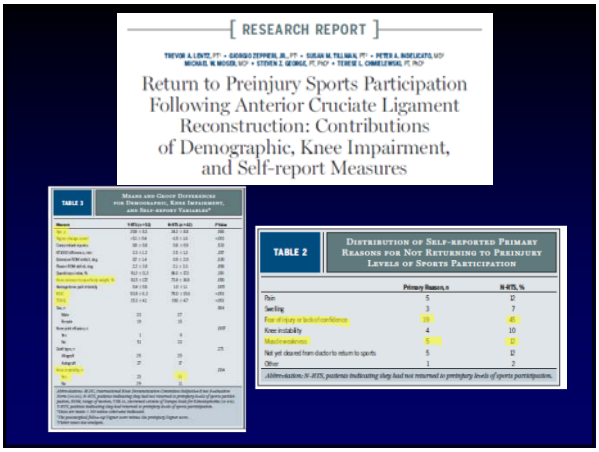
- Fear of movement/reinjury
  - *"I'm afraid that I might injure myself if I play a sport or exercise"*
  - *Tampa scale for kinesiophobia*
    - *Woby et al: Pain '05*
- Interventions which improve self efficiacy may improve knee function short term
  - *Chmielewski et al: JOSPT '08*
  - *Chmielewski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


[RESEARCH REPORT]

The Association of Pain and Fear of Movement/Reinjury With Function During Anterior Cruciate Ligament Reconstruction Rehabilitat

[RESEARCH REPORT]

Return to Preinjury Sports Participation Following Anterior Cruciate Ligament Reconstruction: Contributions of Demographic, Knee Impairment, and Self-report Measures


[RESEARCH REPORT]

Return to Preinjury Sports Participation Following Anterior Cruciate Ligament Reconstruction: Contributions of Demographic, Knee Impairment, and Self-report Measures

TABLE 2 Distribution of Self-Reported Primary Reasons for Not Returning to Preinjury Levels of Sports Participation

	Primary Reason, n	N-RTS, %
Pain	5	12
Feeling	3	7
Fear of injury or lack of confidence	19	45
Knee instability	4	10
Muscle weakness	5	12
Not yet cleared from doctor to return to sports	5	12
Other	1	2

Abbreviation: N-RTS, patients indicating they had not returned to preinjury levels of sports participation.

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*


[EDITORIAL]

JOSPT 2014

We Can Do Better

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Typically, the goal of any rehabilitation program is to return the patient/athlete to the preinjury level. This is the frequently used benchmark reported in the literature when determining rehabilitation goals or describing the outcomes following anterior cruciate ligament (ACL) injury or reconstruction.[1,8,10-13,17] Additionally, it is often used in characterizing almost any other type of body functional ability. The rehabilitation program should identify, address, and correct all specific predisposing factors that may lead to another injury by addressing the physical, biomechanical, environmental, and psychological factors of the whole person during the rehabili-

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

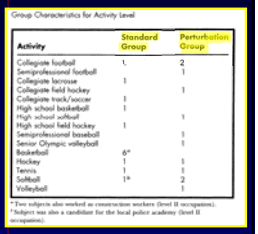
Must gradually progress to skill level drills !!

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 & pertubation training

✓ Results: *91%* pertubation group return to play (6 months)

50% standardized group return to play (6 months)



Group Characteristics for Activity Level

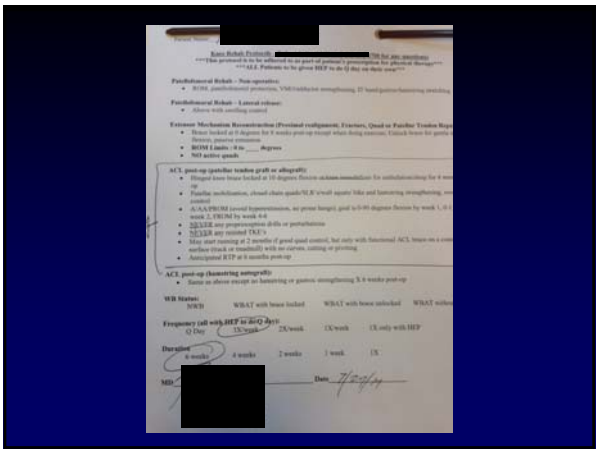
Activity	Standard Group	Perturbation Group
Collegiate football	1	2
Semiprofessional football		1
Collegiate lacrosse	1	
Collegiate field hockey		1
Collegiate track/soccer	1	
High school basketball	1	
High school softball		1
High school field hockey	1	
Semiprofessional baseball		1
Senior Olympic volleyball		1
Basketball	6*	
Hockey	1	1
Tennis	1	1
Softball	1*	2
Volleyball		1

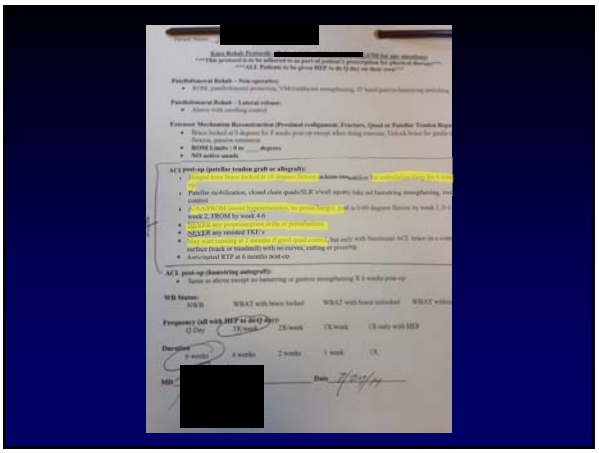
Perturbation Training to Enhance NM Control

Linking Arms & Lower Extremity

Movements & Change of Planes

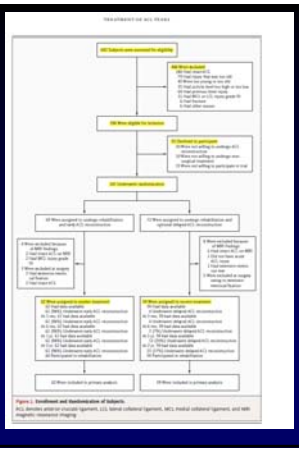
Movements with Stabilization

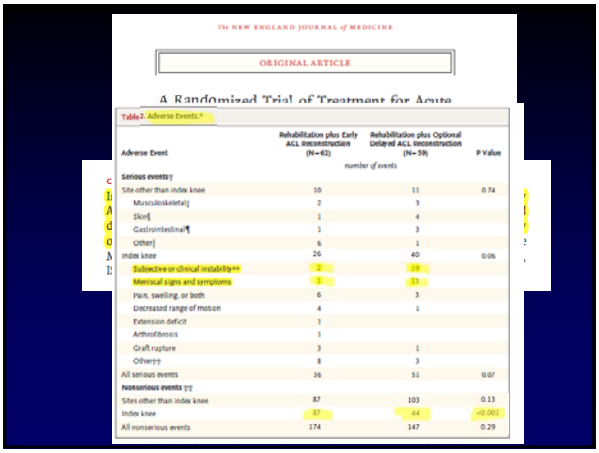




Frobell et al: NEJM '10

- 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

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?


Post-Op ACL Reconstruction

Where did the 80% of opposite side come from ?

Netter: Knee Surg Spts Traumatol Arthrosc '06

- ✓Test battery Q?H strength & power (conc & ecc)
- ✓≥90%

Van Grinsven: Knee Surg Spts 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

- ✓ 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 w
  - ✓ KT testing
  - ✓ Isokinetic testing
  - ✓ FMS test
  - ✓ Y balance test
  - ✓ Landing CoG
  - ✓ Gait pattern (biomechanical)
  - ✓ Vertical Jumping

Post-Op ACL Reconstruction

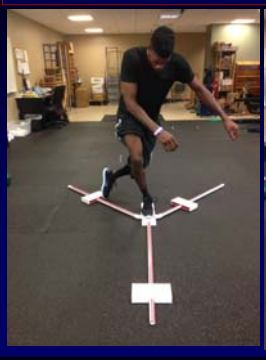
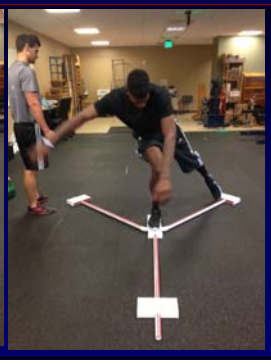
Functional Screening Test

- 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


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)

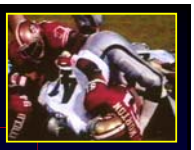
Post-Op ACL Reconstruction

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 Injuries
Introduction

- Usually occurs in *"high risk"* sports
  - ✓ Football
  - ✓ Basketball
  - ✓ Volleyball
  - ✓ Soccer
  - ✓ Skiing
  - ✓ Team Handball



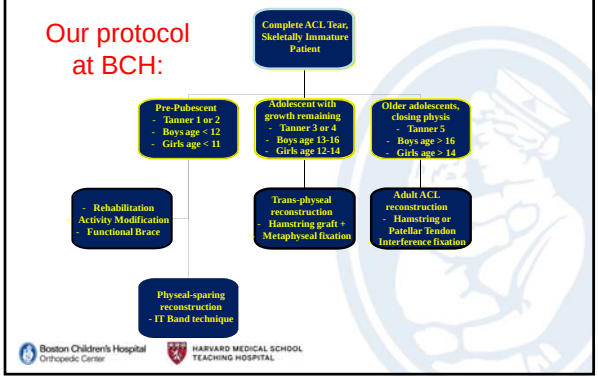

ACL Injuries
Overview

- *Typical patient*
  - » Athlete
  - » 15-29 yrs of age
  - » Male - Female



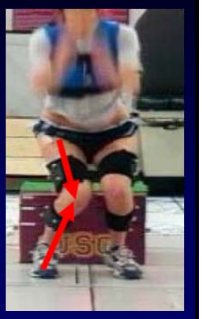

Complete ACL tears in Children

Our protocol at BCH:

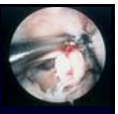


ACL Injuries
Dynamic Q Angle

- ✓Proximal Components
  - ✓Femoral adduction
  - ✓Femoral internal rotation
- ✓Distal Components
  - ✓Hyperpronation
  - ✓Tibial internal rotation



ACL Injuries



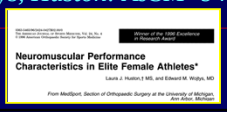
- ✓***Not an isolated injury***
  - Injury affects mechanoreceptors
    - Within 24 hrs after injury
      Lephart: AOSSM '97
    - Deficits may last 6 yrs or more
      Denti: Knee Surg Spts Trauma '00
    - "Quadriceps avoidance gait"
      Andriacchi: CORR '94
      Berechuck: JBJS '90

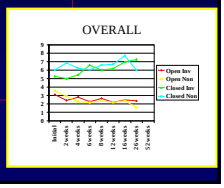
The Effects of ACL Injury on Lower Limb Proprioception

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

ACL Injuries

- ***Not an isolated injury***
  - ✓*Injury affects both extremities*
  - ✓For at least 3.6 mos
    Wilk, et al: CSM '03
  - ✓Alters firing mechanism
    Wojtys, Huston: AJSM '94





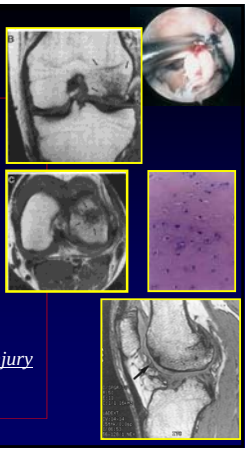
ACL Injuries

- ***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

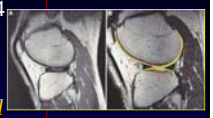
ACL Injuries



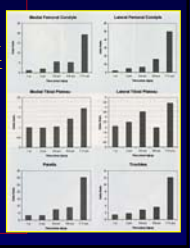
- **Not an isolated injury**
  - Bone bruises present 71-100% patients
    - *Potter et al: AJSM '12*
    - *Spindler: AJSM '93*
    - *Rosen: Arthroscopy '91*
    - *Graf: AJSM '93*
    - *Johnson: AJSM '98*
  - *65% exhibited marrow changes & cartilage thinning 6 yrs after ACL injury*
    - *Faber: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

Potter, Jain, Ma, et al: AJSM '12

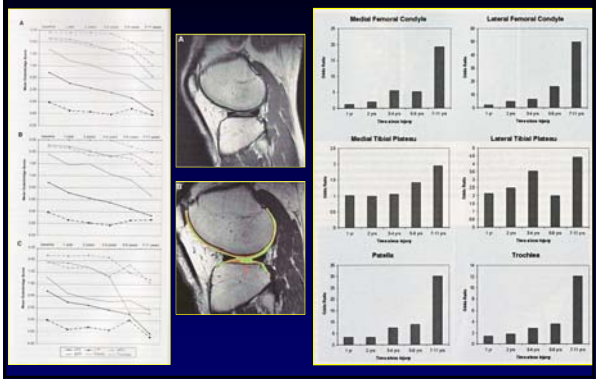
- 42 knees in 40 patients (28 ACLR, 14 non-op)
- MRI at time of initial injury then annually for a maximum of 11 yrs



- ✓ *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



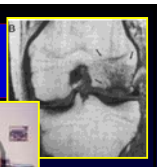
Potter, Jain, Ma, et al: AJSM '12



Immediate Stimulation of Receptors

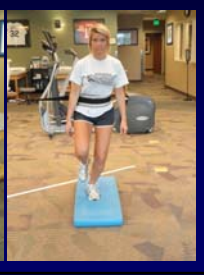
Weight Distribution
"Limb Confidence"

Treat The Osseous Lesion
Bone Bruise



- ***Rehabilitation Guidelines:***
  - *Control wt. bearing forces (crutches)*
  - *No early running & jumping*
  - *Cyrotherapy & 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…)*

Proprioception & Neuromuscular Control Drills for the ACL Patient



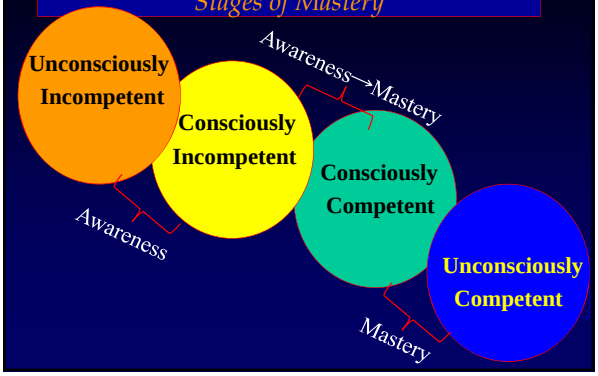
Dynamic Stabilization
Stages of Motor Control

Fitts & Posner

COGNITIVE STAGE	ASSOCIATIVE STAGE	AUTONOMOUS STAGE
• Identify Objectives • Self-talk/ Questioning • ↑Errors/Variability • Instruction/ Feedback	• Associate with environmental cues • Refining/Consistent • ↓Errors/Variability • Identify/Correct Errors	• Subconscious/ automatic • Multiple tasks • ↓↓Errors/ variability • ↑↑Identify/Correct • Perfection

Beginner → Expert

Dynamic Stabilization
Stages of Mastery



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

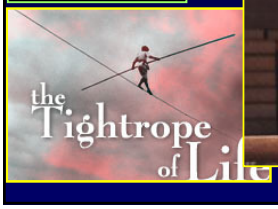
Co-Activation to Enhance Dynamic Stability

Dynamic Stabilization

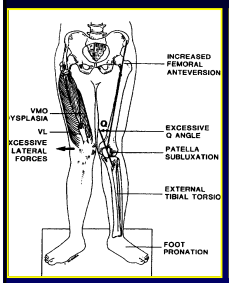
Co-Activation Drills

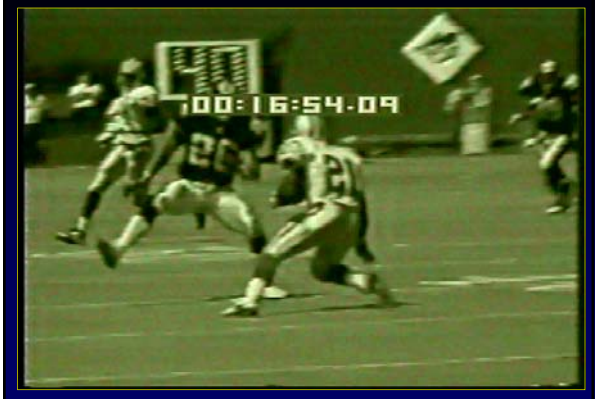
Co-Activation to Enhance Dynamic Stability

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



Stimulation to Uninjured Extremity

Train the Uninjured Extremity Too!!


ACL Rehabilitation
Dynamic Stabilization Phase

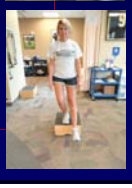
- Maintain knee motion
- ✓ *Normalize unilateral muscle ratio*
- ✓ *Enhance stabilization proximal & distal*
  - *Wilk et al: JOSPT '12*
- Improve proprioception & NM control




Dynamic Stabilization
Overview

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





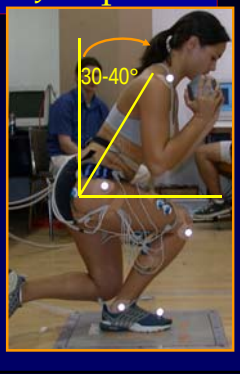

Step Down Test

Lower Extremity Assessment
Step Down Test

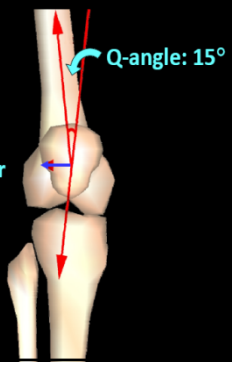

Drop Vertical Jump

Drop Vertical Jump


Drop Vertical Jump

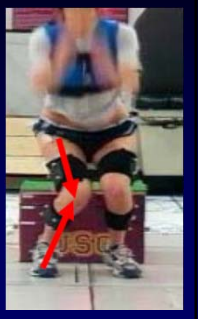



Lower limb alignment & lateral forces on the patella



ACL Injuries
Dynamic Q Angle

- ✓Proximal Components
  - ✓Femoral adduction
  - ✓Femoral internal rotation
- ✓Distal Components
  - ✓Hyperpronation
  - ✓Tibial internal rotation

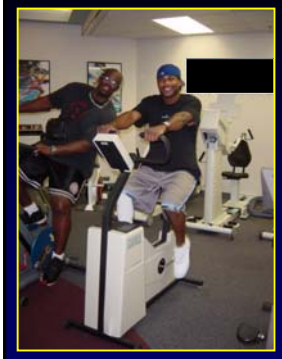


RDL Test

ACL Rehabilitation
Dynamic Stabilization Drills

- Maintain full motion
  - » Supine LLLD stretches
  - » Maintain knee flexion of 135^0
  - » **associated MCL injuries –* ***extra motion!!***

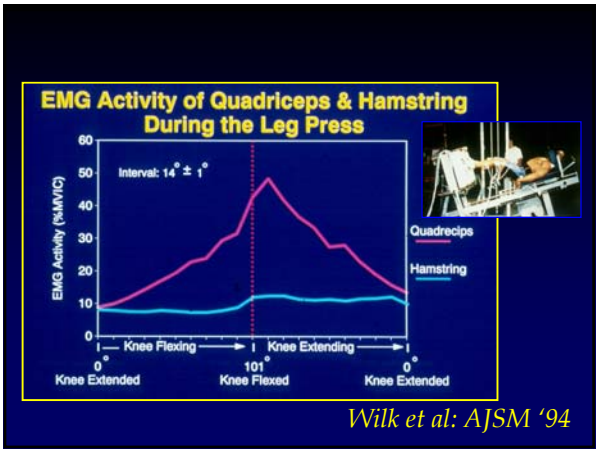


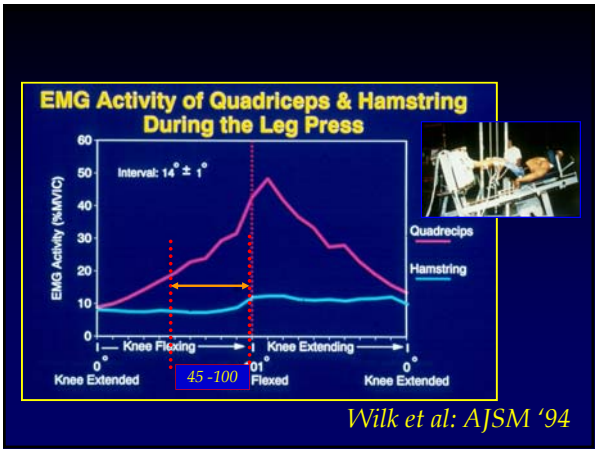

ACL Rehabilitation
Dynamic Stabilization Drills

- 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

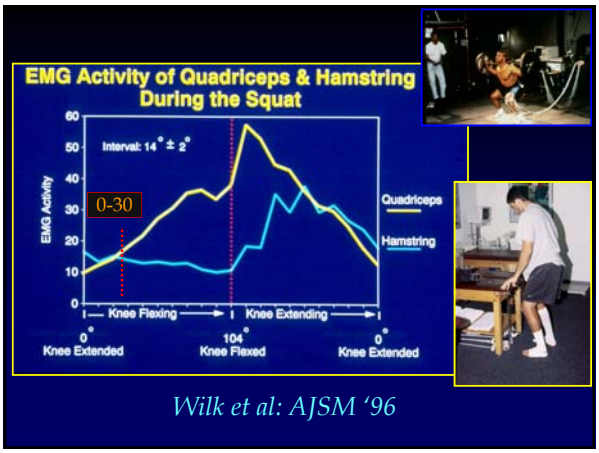


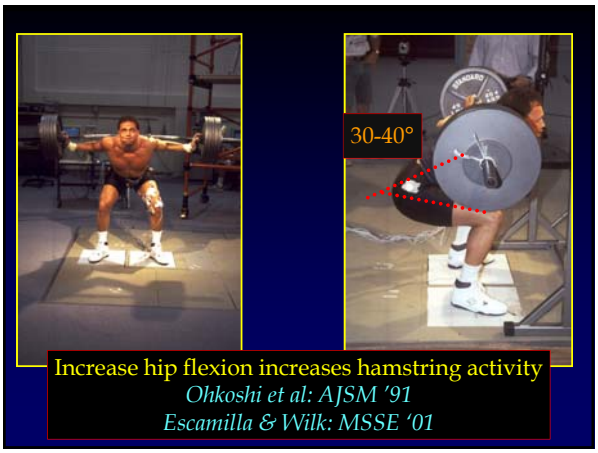



Wilk et al: AJSM '94

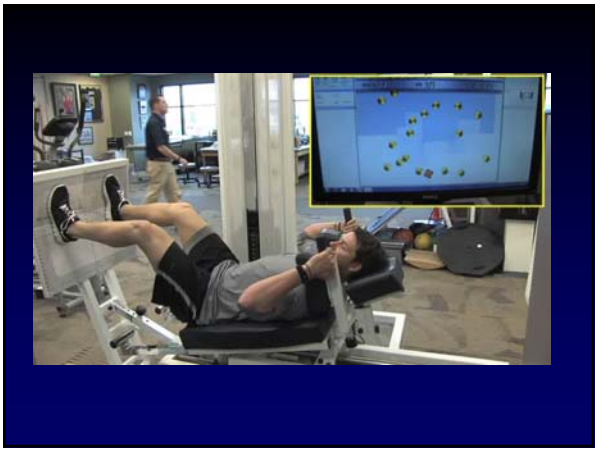


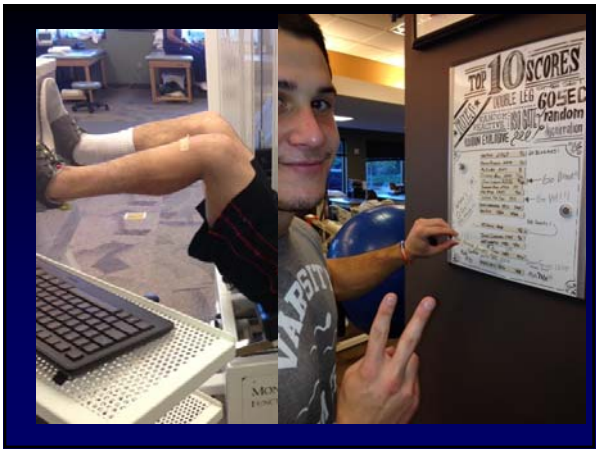
Wilk et al: AJSM '94

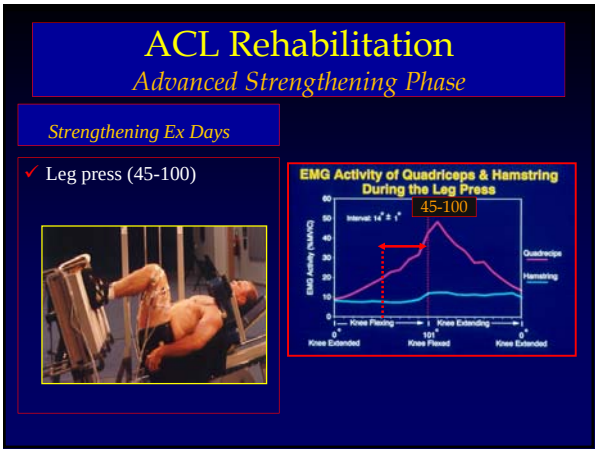

EMG Activity of Quadriceps & Hamstring During the Squat
Interval: 14° ± 2°
EMG Activity
0-30
Quadriceps
Hamstring
Knee Flexing
Knee Extending
0° Knee Extended
104° Knee Flexed
0° Knee Extended
Wilk et al: AJSM '96


30-40°
Increase hip flexion increases hamstring activity
Ohkoshi et al: AJSM '91
Escamilla & Wilk: MSSE '01


Escamilla & Wilk: JOSPT '08



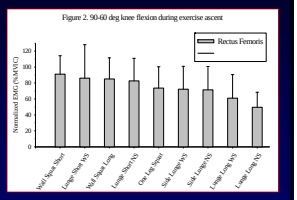



ACL Rehabilitation
Advanced Strengthening Phase
Strengthening Ex Days
✓ Leg press (45-100)
EMG Activity of Quadriceps & Hamstring During the Leg Press
45-100
Quadriceps
Hamstring

ACL Rehabilitation
Advanced Strengthening Phase

Strengthening Ex Days

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



Wall Squat Long & Short

Nagura : J Appl Biomech '06
Nisell: AJSM '89

Escamilla & Wilk: MSSE'09

Escamilla & Wilk: JOSPT '08

ACL Rehabilitation
Advanced Strengthening Phase

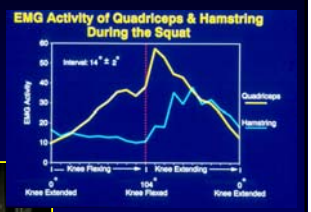
Strengthening Ex Days

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

ACL Rehabilitation
Advanced Strengthening Phase

Strengthening Ex Days

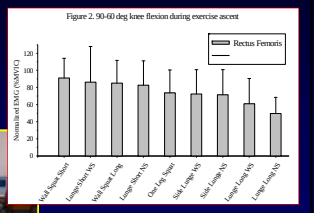
- ✓ Leg press (45-100)
- ✓ Wall Slides (0-75)
- ✓ Step downs
- ✓ Squats



ACL Rehabilitation
Advanced Strengthening Phase

Strengthening Ex Days

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



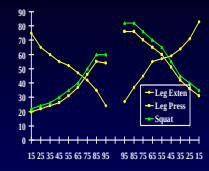
Escamilla & Wilk: JOSPT '08

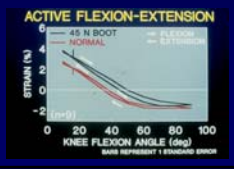
Escamilla & Wilk: Clin Biomech '08

ACL Rehabilitation
Advanced Strengthening Phase

Strengthening Ex Days

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

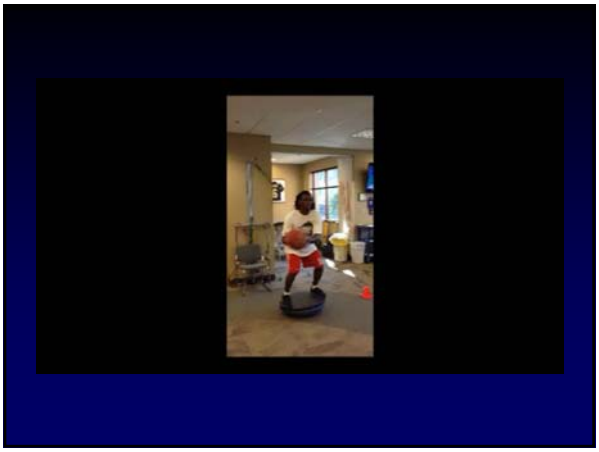


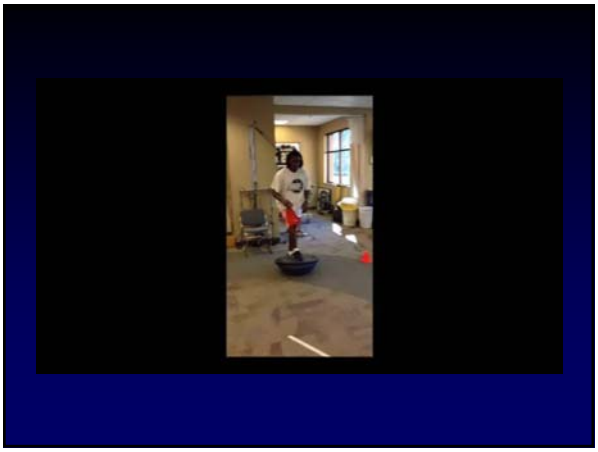


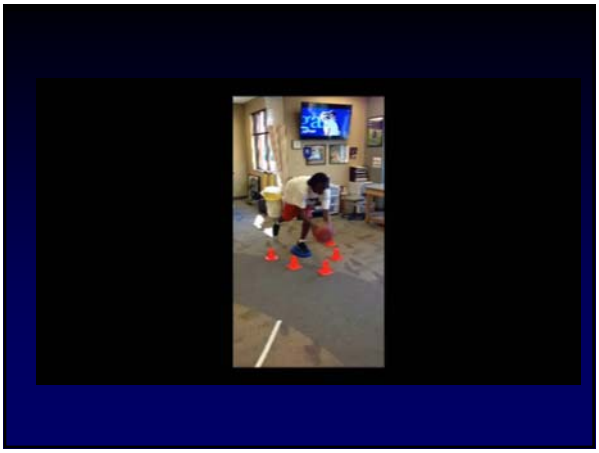
RDLs

Establish Hip Control

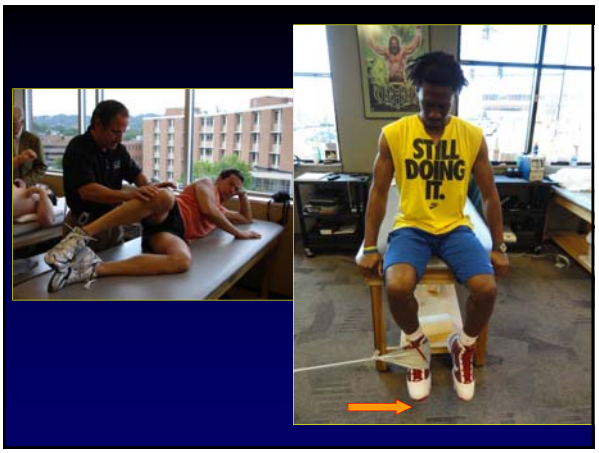
Stabilization Above & Below





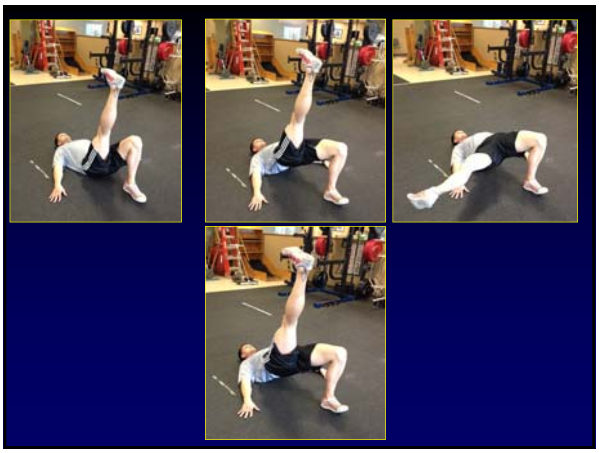


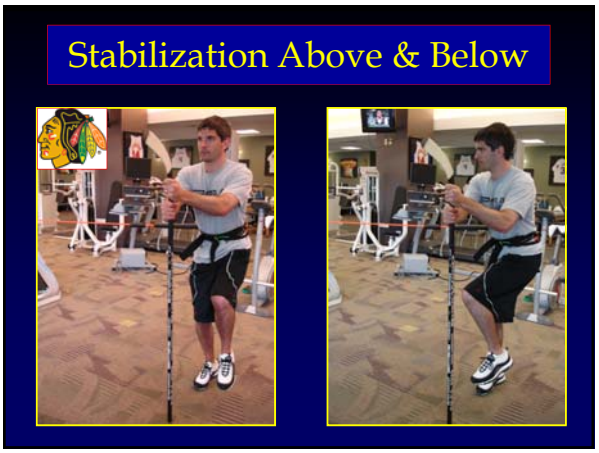

I'M
THAT
DUDE.

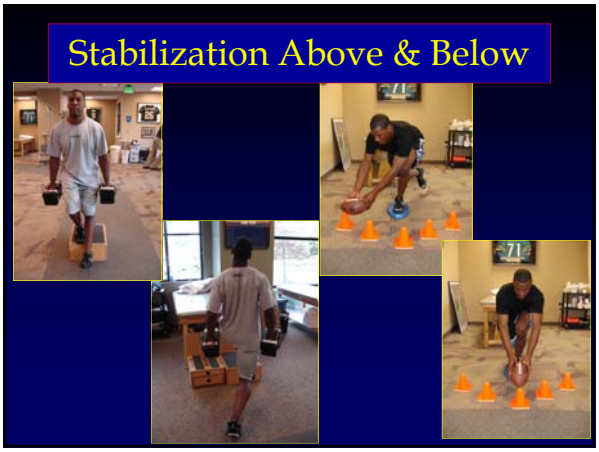


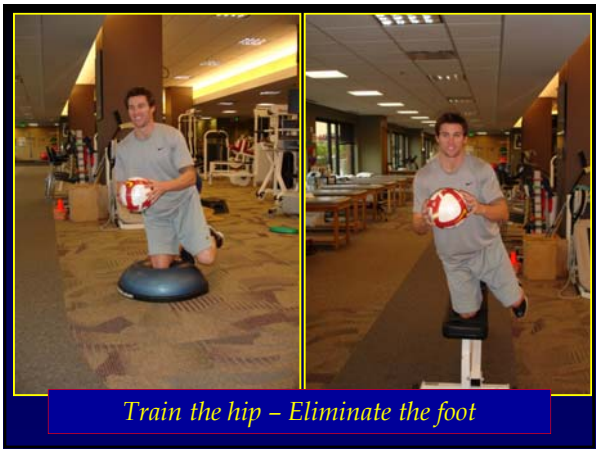
My Favorite Hip Exercises

- ✓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




Stabilization Above & Below


Stabilization Above & Below


Train the hip – Eliminate the foot

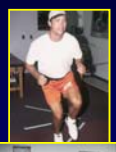

Stabilization Above & Below

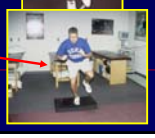
Stabilization Above & Below


ACL Deficient Knee Rehab

II: Dynamic Stabilization Phase (weeks 4-7)

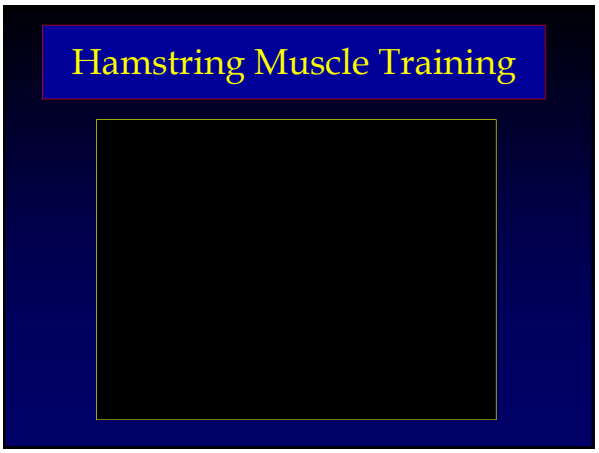
- Enhance stabilization proximal & distal
  - » Lateral lunges
  - » Lateral / front step downs
  - » Hip strengthening
  - » Lunges on foam
  - » Balance beam
  - » Strengthening ankle /foot

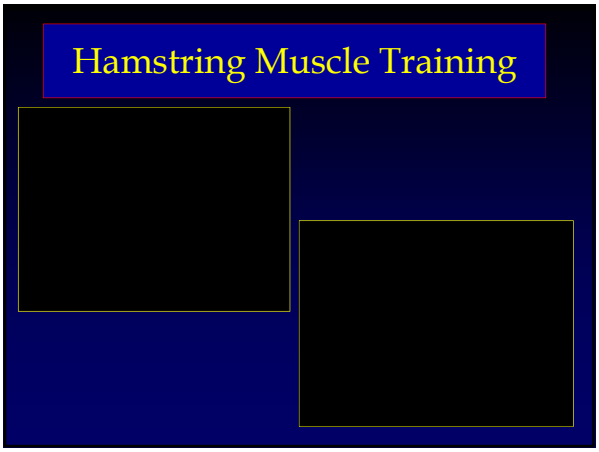


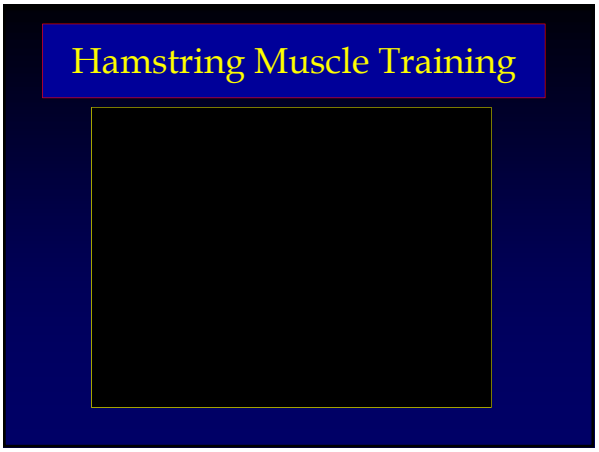



Core Stabilization


Establish Core Stability


Hamstring Muscle Training


Hamstring Muscle Training


Hamstring Muscle Training


Hamstring Muscle Training


ACL Rehabilitation
What You Need to Know
Hamstrings, Hamstrings & Hamstring Control

Core Stabilization & Training

Tilt Board Progression

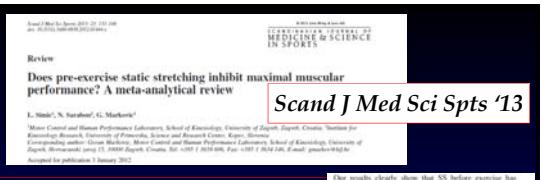
2 legged squats → with taps
Single leg stance "balanced" → with taps
2 legs throws → with holds
1 leg stance throws "balanced" → with taps
1 leg stance throws rotation → with taps

3 levels to the Tilt Boards



Perturbation Training to Enhance NM Control

Dynamic Warm-Up



Review

Does pre-exercise static stretching inhibit maximal muscular performance? A meta-analytical review

Scand J Med Sci Spts '13

- 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

Research on Dynamic Vs. Static

The effects of stretching on strength performance

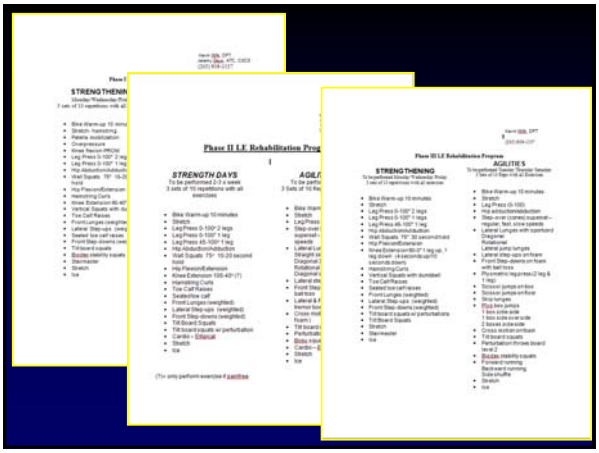
Sports Medicine, 37, 213-224
Rubini, E.C., Costa, A.L., & Gomes, P.S. (2007)

Conclusion: 23 of 29 studies demonstrated decreases in strength following static stretching

167 studies demonstrated decreased performance LE

Challenge the Neuromuscular System

Challenge the Neuromuscular System



Gradually Increase the Neuromuscular Challenges

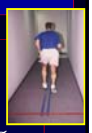
ACL Rehabilitation
Neuromuscular Activity Drills

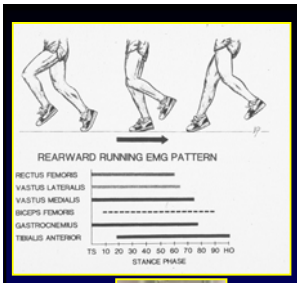
- *Gradually increase applied loads*
  - » Running in pool
  - » *Plyometric program*
    leg press → pool → floor → boxes
  - » Jump lunges
  - » Scissors jumps

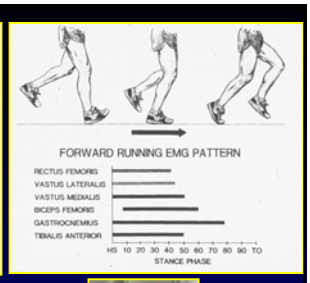


ACL Rehabilitation
Return to Activity Phase

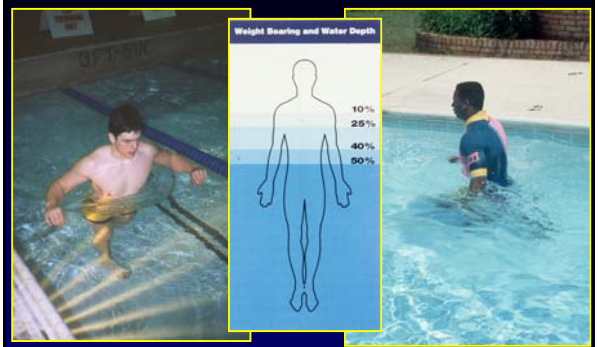
- *Running & agility program:*
  backward run → lateral movements
  lateral movements → forward running
  jogging → jog / stops
  jogging → run / stops
  running → yo-yos
  cutting drills → 45 deg. → 90 deg.






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

ACL Rehabilitation
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*

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*

ACL Rehabilitation
Agility Drills – Ladder Drills

Forward & Backward Drill

Start/Finish

ACL Rehabilitation
Agility Drills – Ladder Drills

Side to side Drills

Start/Finish

ACL Rehabilitation
Agility Drills – Ladder Drills

Quick Feet Drill

Start/Finish

ACL Rehabilitation
Agility Drills – 4 Corner Drill

Side Shuffle

Back Peddle

Forward Run

Cariocas

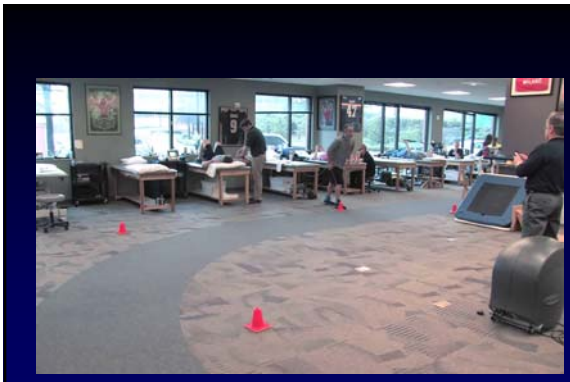
Start/Finish

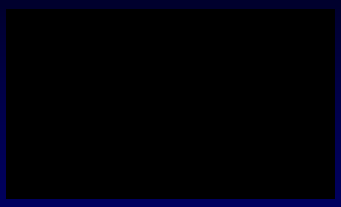
ACL Rehabilitation
Agility Drills – 4 Corner Reactive Drill

Start/Finish

On Demand Reactions

Agility Drills



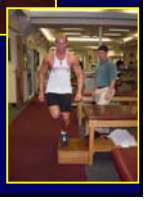


ACL Deficient Knee Rehab

IV: Return to Activity Phase (weeks 12>)

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

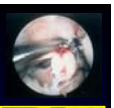
Gradually increase box height



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



Knee Lab
Proprioception & NM Control

- ✓ Stability Position (30-45°)
  - ✓ standing on floor
  - ✓ standing on floor (eyes closed)
  - ✓ standing catching a ball
  - ✓ standing with ball up & down
  - ✓ standing on foam
  - ✓ standing on floor then foam side to side overhead
  - ✓ standing on floor cross drill
  - ✓ standing on foam cross drill

1

Knee Lab
Proprioception & NM Control

- ✓ Lateral Lunges (30-45°)
  - ✓ straight no cord
  - ✓ straight with cord straight
  - ✓ diagonal (30° angles)
  - ✓ diagonal with rotation
  - ✓ lateral straight foam
  - ✓ lateral straight on foam fast
  - ✓ ball catches/throws
  - ✓ lunges onto rocker board

2

Knee Lab

Proprioception & NM Control

- ✓ Stepping Drills (Cones or Cups)
  - ✓ forward/backward
  - ✓ side to side
  - ✓ speed --- slow, fast & slow
  - ✓ stepping with ball drills
  - ✓ stepping with foam
  - ✓ step over huddle with rotation

3

Knee Lab

Proprioception & NM Control

- ✓ RDLs
  - ✓ unweighted
  - ✓ weighted
  - ✓ weighted with shoulder flexion & trunk ext
  - ✓ CLX RDL
  - ✓ star drill
    - ✓ cones/cups
    - ✓ tape on floor
    - ✓ standing on box
  - ✓ RDL into knee to chest

4

Knee Lab

Proprioception & NM Control

- ✓ Hip Abduction & ER Strengthening
  - ✓ clams
  - ✓ RDLs
  - ✓ Star
  - ✓ Side plank
  - ✓ Side plank with hip abduction
  - ✓ side plank with hip abduction against wall
  - ✓ side plank w/ hip abd against wall with Tband
  - ✓ side plank hip abduction wall with IR

5

Knee Lab

Proprioception & NM Control

- ✓ Hamstring Training Drills
  - ✓ stability ball bilateral
  - ✓ stability ball unilateral
  - ✓ stability ball theraband
  - ✓ TRX bands
  - ✓ Russian eccentric hamstrings
  - ✓ Fast speed hamstrings standing w/ theraband

6

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 & perturbat
  - ✓ bosu ball ball catches
  - ✓ tremor board (?)
  - ✓ foam with theraband perturbations

7

Knee Lab

Proprioception & NM Control

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

8

Knee Lab

Proprioception & NM Control

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

9

Knee Lab

Proprioception & NM Control

- ✓ 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 CLX four corners

10

Knee Lab

Proprioception & NM Control

- ✓ Clams
  - ✓ movement
  - ✓ with resistance band
  - ✓ with manual resistance
    - ✓ concentric
    - ✓ concentric/eccentric
    - ✓ conc/ecc with RS
  - ✓ side plank with clams

11

Knee Lab

Proprioception & NM Control

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

12

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

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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

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Knee Lab

Proprioception & NM Control

- ✓ 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

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