

EVIDENCE BASED REHAB AFTER ACL REPAIR

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COURSE DESCRIPTION

- This course is a lecture course with use of images, charts, and videos for reinforcement of learning objectives.
- This course will give an overview of evidence and trends related to ACL injury and rehab in particular after reconstruction. It will provide a framework to the clinician to facilitate effective clinical reasoning for rehab of the patient after ACL repair in a way that allows individualized care while respecting standard rehab protocols. This course will provide rehab considerations for the clinician and will propose considerations to challenge the traditional model of rehab after ACL repair.
- This course is ideal for Physical Therapists, Athletic Trainers, Physical Therapy Assistants, and Strength and Conditioning Coaches

Instructional Level - Intermediate

Course Time = 2 hrs

OBJECTIVES

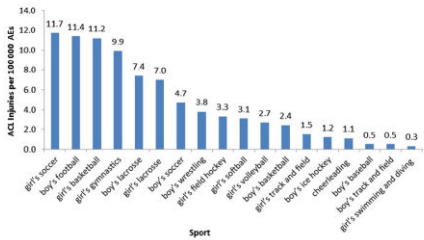
1. Identify and screen for risk factors associated with ACL injuries (20 min)
2. Describe the most common surgical techniques for ACL repair and list their specific rehab considerations for each. (20 min)
3. Describe the clinical reasoning for neuromuscular and coordination training during ACL rehab (35 min)
4. Create an adaptable rehab program for ACL rehab from prehab until 1-2 years after repair. (45 min)

STATISTICS

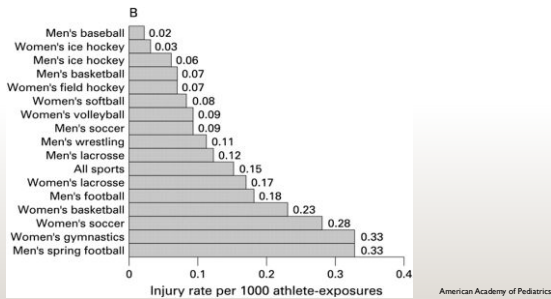
- Common sports injury
- Over 250,000 injuries per year
- 1 in 4 age 25 or younger return to high risk sports after ACL Reconstruction (ACLR) - Soccer, Basketball, Volleyball, etc
- Females 2 to 8 times more likely than males
- OA occurs 10 times

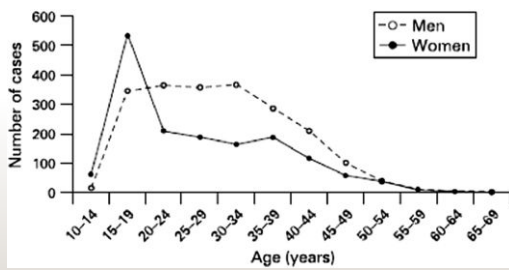
Wiggin AJ, Grands RK, Schneider DK, Saifullah D, Webster KE, Payer GD. Risk of secondary injury in younger athletes after anterior cruciate ligament reconstruction: a systematic review and meta-analysis. *Am J Sports Med.* 2016; 44: 1881-1876.

High School ACL injury rates per 100,000 athlete exposures (AEs) by sport



American Academy of Pediatrics





CAUSE

- More Non-contact vs contact injuries (75%)
- Caused by a proximal tibia shear in sagittal plane combined with valgus moment. (Medial Knee Collapse)
- **A Mix of hip adduction, hip internal rotation, and tibial anterior translation**
- **Loss/Lack of strength and control** in the lower extremity.

Boden BP, Sheehan FT, Torg JS, Hewett TE. Non-contact ACL Injuries: Mechanisms and Risk Factors. *The Journal of the American Academy of Orthopaedic Surgeons*. 2010;18(9):520-527

RISK FACTORS

- Genetics
- Hormonal Factors
- Previous Injury
- Age and Gender
- Anatomical Factors
- Neuromuscular Factors

GENETICS?

Prospective Study:

-Prescreened two sets of twins in high risk sports

-3D analysis looking at

- landing
- hams/quad strength
- joint laxity

-Those later injured demonstrated multiple risk factors during prescreening

More research to be done



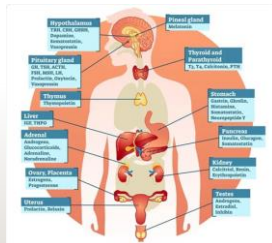
HORMONES

Controversial

-Estrogen and progesterone receptors in ACL

-Knee more lax (0.5mm) mid menstrual cycle

-However injuries tend to cluster near beginning of cycle when hormone impact on laxity is less



PREVIOUS INJURY

- Female soccer players with a previous ACLR are 4.82 times more likely to sustain a new ACL injury compared to healthy controls
- Prior knee injury = risk factor for the early onset of knee OA. (Faltstrom et al)
- Younger athletes are more likely to return to sport
- Females 10-20 years old are twice as likely to re-tear. Males are highest at this age as well.
- Reinjury is early in the return to play period (Wiggins et al - Syst Rev)



PREVIOUS INJURY

- Female athletes were 4 times more likely to suffer a second ACL injury
- 6 times more likely to suffer a **contralateral injury** than male athletes
- Female athletes suffer contralateral ACL injuries at a higher rate than male athletes and seem to suffer contralateral ACL injuries more frequently than graft re-tears. (Paterno, 2017)



AGE AND GENDER

Females 2-8 times more likely to be injured

Age 12-13 in girls

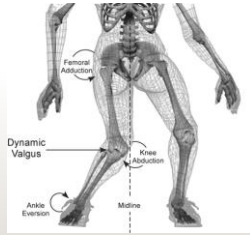
Age 14-15 in boys

*Females age 15-20 account for largest numbers



ANATOMICAL FACTORS

- BMI > 1 Standard Deviation above average
- Narrow intercondylar notch (mixed conclusions)
- Overpronation at the foot
- Generalized joint laxity
- Longer limbs = more torque on joints



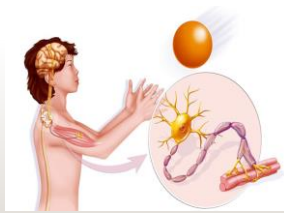
NEUROMUSCULAR FACTORS

This is where we will spend some time.

TAKE HOME POINT:

Strength alone (although important) is not sufficient for rehab after ACL repair.

Timing, coordination, and control are essential for full recovery and return to sport



MECHANISM



RG3 INJURY VIDEO

[HTTPS://YOUTU.BE/F4RGHXPTYA?T=52](https://youtu.be/F4RGHXPTYA?T=52)



GO BACK IN TIME...



-Hip internally rotates

-The foot is planted

-Knee is near full extension or in hyperextension

-The body is decelerating



DIAGNOSIS

Clinical:

Lachman's test

-Good accuracy in acute and chronic

-Sn 86% Sp 91%

Anterior Drawer:

Sn 49% SP 58% (acute), Higher in chronic injury

Pivot Shift:

Sn 32% Sp 98% (Best under anesthesia)



SURGICAL REPAIR

Double Bundle or Single Bundle

- Double bundle better rotational stability?
- Similar long term clinical outcomes

Bone Patellar Tendon Bone

- Strong graft, slower rehab?
- Pain with kneeling
- Younger athletic individuals

Hamstrings Graft

- Higher revision rate
- Less Pain
- Quicker Rehab?

Quads Tendon Graft

- comparable strength qualities with others

Allografts?

Malesis GB, et al. Age-Related Risk Factors for Revision Anterior Cruciate Ligament Reconstruction: A Cohort Study of 21,304 Patients From the Kaiser Permanente Anterior Cruciate Ligament Registry. *Am J Sports Med.* 2016 Feb;44(2):331-4.

TIMING OF SURGICAL REPAIR FOR ACL

Various studies suggest:

- Waiting 3 weeks to prevent arthrofibrosis
- "Quiet knee"
- Importance of preoperative quad strength

Multifactorial

- pre-op status of knee, family, school, work, athletics, mental preparation

PREHAB

- Quad strength deficits persist for many years after surgery
- Patients with quad strength deficits > 20% before surgery still presented with deficits 2 years following surgery
- Recommend quad strength deficits to be < 20% of the unaffected limb before surgery



PREHAB

- Preoperative rehab program consisting of strengthening and neuromuscular training
- Patients who participated had
 - higher score on IKDC
 - higher score on KOOS
 - higher rates of return to sport (Soccer has highest incidence)

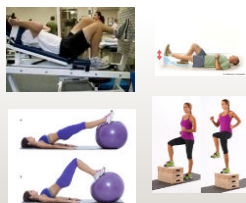


PREHAB EXERCISES

ROM Exercise

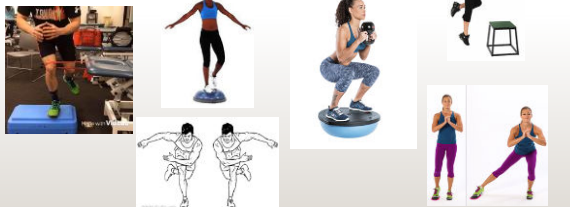


Quad/HS/Glute Strengthening



PREHAB EXERCISES

Neuromuscular training



REHAB PRINCIPLES

REHAB

Goals:

- I. Quads and Hamstrings Strength & Ratios (Local)
 - a. Limb Symmetry Index of 90%
 - b. Include eccentric focus
- II. Glute Activation (Regional)
 - a. The knee is a sandwich of the tibia/Fibula and femur
- 3. Neuromuscular Training (Global)
 - a. Trunk/center of mass control
 - b. Jump/Landing/Cutting training

REHAB PHASE I (1-3 WEEKS)

- No aggressive passive motions (grade 2 mobs)
- Isometrics and Russian Current
- Glutes strengthening ("Isolated" hip exercises to begin)
- Despite significant improvement in hip strength no change seen in mechanics of runners (Willy et al. 2011)
- Trunk endurance exercises
- Low load prolonged stretch into extension
- Active flexion exercises



NMES

- Beneficial in early post surgical treatment (6 weeks)
- Labanca et al 2018
 - NMES + STSTS movement as early as 15 days after surgery
 - Stronger at 60th day from surgery as well as 6 months out
- Moran et al 2019
 - FES during walking
 - FES group more effective in recovering quad strength than NMES group after 4 weeks

REHAB PHASE 2 (3-6 WEEKS)

- Closed Kinetic Chain exercises
- Balance and vestibular training
- Full extension and passive stretching
- Prevention strategies for reinjury



REHAB PHASE 2 (3-6 WEEKS)



- Heel to toe walking
- Normal Gait training
- High Marching
- Mini Squats (start at 0-30 degrees)
- Leg Press (start at 0-30 degrees)
- Lateral lunge
- Squat and rock side to side

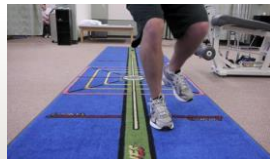
QUICK EXERCISES VIDEO

[HTTPS://YOUTU.BE/ODVQGx4UJIM](https://youtu.be/ODVQGx4UJIM)



REHAB PHASE 3 (7 WKS - 4 MONTHS)

- Varied surfaces with perturbation and balance exercises
- Hopping
- Open Kinetic Chain Strengthening
 - Hip abductors (glute med and min, tensor fascia latta)
- Kicking a soccer ball
- Full ROM (Use it as you gain it)
- Strengthening Hamstrings, Glutes, Quads, Hip external rotators



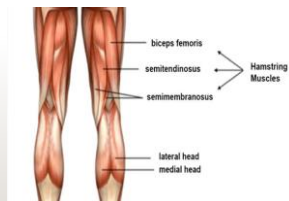
REHAB PHASE 3 (7 WKS - 4 MONTHS)

A note about the Hamstrings:

-Include progressive strengthening for hamstrings as well.

-Along with ACL, the Semimembranosus and Semitendinosus help prevent anterior tibial translation

Buckthorpe et al (2020) found only 46% had LSI of 90% at 6 months post op vs 67% in those with patellar graft repair.



REHAB PHASE 4 (4 TO 6+ MONTHS)

- Jogging
- Sports Specific Training
- Continued Strengthening
- Plyometric training
- 6 months - 1 year Return to Sport?



RETURN TO SPORT PREP AND TESTING

TIME TO RUN

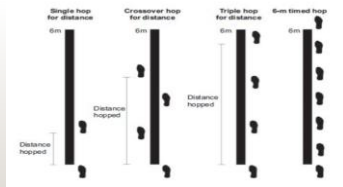
Return to Running:

- ★ Pain < 2/10
- ★ Knee flexion ROM 95% of uninjured side
- ★ Full knee extension actively
- ★ No swelling
- ★ Hamstring and quads strength 70% of uninjured side
- ★ Single limb hop test 70% of uninjured side



Rambaud A et al 2018

SINGLE LEG HOP TESTS



SINGLE LIMB HOP TESTS VIDEO

[HTTPS://YOUTU.BE/SSFJ53LVJK](https://youtu.be/SSFJ53LVJK)

LOOK AT THE NUMBERS (AND BEYOND)

- Look at:
- Fear Avoidance
 - Control
 - Hesitation
 - Time spent on the ground
 - Landing mechanics
- Limb Symmetry Index = 85-90% historically
- Some promote 90-95% now
 - 347 **healthy** young athletes performed hop tests
 - Each athlete scored 95% on one or more of the tests individually but...
 - Less than half achieved 90% on all four tests together.

Greenberg et al. Orthop | Sports Med. 2019

YO-YO TEST



NORMS FOR ADULT MEN

rating	meters	level
elite	> 2400	> 20.1
excellent	2000-2400	18.7-20.1
good	1520-1960	17.3-18.6
average	1040-1480	15.7-17.2
below average	520-1000	14.2-15.6
poor	< 520	< 14.2

NORMS FOR ADULT WOMEN

rating	meters	level
elite	> 1600	> 17.5
excellent	1320-1600	16.6-17.5
good	1000-1280	15.6-16.5
average	680-960	14.6-15.5
below average	320-640	13.1-14.5
poor	< 320	< 13.1

YO-YO INTERMITTENT TEST VIDEO

[HTTPS://YOUTU.BE/PLCBXF9MXHS](https://youtu.be/PLCBXF9MXHS)



COWBOY TEST

1. SLS 60 seconds
2. SLS BOSU 60 seconds
3. SL squat 60 seconds
4. SL squat BOSU 60 seconds
5. SL Quad hop
 - clockwise, counter clockwise
1. SL hop for distance
2. 6m SL hop test
3. 3 hop test distance



EPIC (ESTIMATED PRE-INJURY CAPACITY)

More sensitive in predicting 2nd acl injuries than limb symmetry index (LSI)

-compared injured leg to uninjured leg 1.5-2 months post injury LSI

-compared injured leg to uninjured leg 6 months post op

11 of 70 patients sustained 2nd ACL injury

8 out of 11 passed LSI criteria

6 out of 8 did not pass EPIC



RETURN TO SPORT PREP AND TESTING

- Risk of ACL tear in contralateral knee is twice the risk (11.8%) of tear in ipsilateral knee (5.8%) after 5 years from ACL repair.
-Wright et al. 2011
- Female athletes have a higher incidence of a second ACL injury than males.
-4x on same limb
-6 times on contralateral limb
-Paterno et al
- 1 in 4 young athletes who return to sport will sustain another ACL injury (most often during the return to play period)
-Wiggins et al. 2016
- When the triple hop test was normalized for body height, you're better able to identify high risk groups.
-Paterno et al

RETURN TO SPORT PREP AND TESTING

Use Functional Training:

- "Just because I can do it doesn't mean I can control it."
- "Remember that risk level does not equal readiness."
- Limb Asymmetries found in squatting, landing and jumping even 2 years following ACL reconstruction

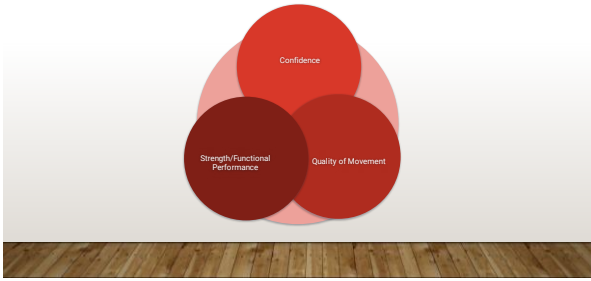
Paterno et al CJSM 2007, JOSPT 2011

Notzkel et al Clinical Biomechanics 2002

COMPONENTS OF ATHLETIC PERFORMANCE

- Eccentric
- Rotary Motion (multiplanar)
- Speed
- Timing
- Jumping
- Motor Control
- Counter Rotation
- Weight Bearing
- Confidence increase and fear reduction

COMPONENTS OF ATHLETIC PERFORMANCE



HOW CAN WE BREAK THE CYCLE

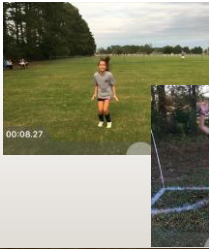


PREVENTION

- Most of these injuries are non-contact injuries (75%)
- Strength is great but timing of muscle contraction is critical.
- Most ACL tears occur in the month of August



PREVENTION



PEP Program
Caraffa et al and Hewitt et al
600 and 1200+ soccer players over 3 and 1 years
-80% reduction in knee valgus
-Greatest change in 13-18 year old girls (as young as 10 yrs old)

PEP PROGRAM

Section I: Warm-up

- A. Jog line to line
- B. Shuttle run
- C. Backward run

Section II: Strengthening

- A. Walking lunges (1 minute)
- B. Russian hamstring (1 minute)
- C. Single calf raises (1 minute)

Section III: Plyometrics

- A. Lateral hops over cone
- B. Fwd/back hops over cone
- C. Single leg hops over cone
- D. Vertical jumps
- E. Scissor jumps

Section IV: Agilities

- A. Fwd run with 3 step deceleration
- B. Lateral diagonal runs (3 passes)
- C. Bounding run (44 yards)

Begin practice. After practice is completed, resume PEP program at Section V.

Section V: Stretching

- A. Calf stretch (30sec)
- B. Quad stretch (30 sec)
- C. Figure 4 hamstring stretch (30sec)
- D. Inner thigh stretch (30sec: each position)
- E. Hip flexor stretch (2x20sec)

Alternative Warm Down Exercise

- A. Bridge w/ alternating hip flexion (1min)
- B. Abdominal crunch (1min)
- C. Single leg double knee to chest (2x30sec)
- D. Figure 4 piriformis stretch (30 sec)
- E. Seated butterfly stretch (2x30sec)

Addendum for Younger Athletes

For athletes under the age of 12, make the following modifications:
• plyometrics should be performed over visual line or flat cone with emphasis on landing technique - not height of jump
• Plyometrics should be performed with two legged landing
• Emphasis on form, not repetitions
• To be completed at BEGINNING of practice to avoid fatigue

PEP TRAINING VIDEO

[HTTPS://YOUTU.BE/7LAG8UNU6AQ](https://youtu.be/7LAG8UNU6AQ)

FIFA 11+ WARM UP

- Dynamic Warm-up Program
- Reduction of injuries in athletes
- 39% overall injury risk reduction when done 2x/wk
- Need coach buy in
- Can be done in beginning or end of practice

FIFA 11+

PART 1: RUNNING EXERCISES - 8 MINUTES

- 1. RUNNING STRAIGHT AHEAD**
The player runs straight ahead for 30 seconds. The coach counts the number of steps taken. The player then runs back to the start and repeats the exercise.
- 2. RUNNING HIP OUT**
The player runs in a circle for 30 seconds. The coach counts the number of steps taken. The player then runs back to the start and repeats the exercise.
- 3. RUNNING HIP IN**
The player runs in a circle for 30 seconds. The coach counts the number of steps taken. The player then runs back to the start and repeats the exercise.
- 4. RUNNING CIRCLING PARTNER**
The player runs in a circle for 30 seconds. The coach counts the number of steps taken. The player then runs back to the start and repeats the exercise.
- 5. RUNNING SHOULDER CONTACT**
The player runs in a circle for 30 seconds. The coach counts the number of steps taken. The player then runs back to the start and repeats the exercise.
- 6. RUNNING QUICK FORWARDS & BACKWARDS**
The player runs forward for 15 seconds and backward for 15 seconds. The coach counts the number of steps taken. The player then runs back to the start and repeats the exercise.

PART 2: STRENGTH - PLYOMETRICS - BALANCE - 10 MINUTES

- 1. THE BENCH STATIC**
The player lies on their back on a bench with their feet flat on the floor and their arms extended upwards. They hold this position for 30 seconds.
- 2. THE BENCH ALTERNATE LEGS**
The player lies on their back on a bench with their feet flat on the floor and their arms extended upwards. They lift their right leg and hold it for 15 seconds, then their left leg and hold it for 15 seconds. They repeat this sequence for 30 seconds.
- 3. THE BENCH ONE LEG LIFT AND HOLD**
The player lies on their back on a bench with their feet flat on the floor and their arms extended upwards. They lift their right leg and hold it for 15 seconds, then their left leg and hold it for 15 seconds. They repeat this sequence for 30 seconds.
- 4. SIDEWAYS BENCH STATIC**
The player lies on their side on a bench with their feet flat on the floor and their arms extended upwards. They hold this position for 30 seconds.
- 5. SIDEWAYS BENCH RAISE & LOWER HIP**
The player lies on their side on a bench with their feet flat on the floor and their arms extended upwards. They lift their hip and hold it for 15 seconds, then lower it and hold it for 15 seconds. They repeat this sequence for 30 seconds.
- 6. SIDEWAYS BENCH WITH LEG LIFT**
The player lies on their side on a bench with their feet flat on the floor and their arms extended upwards. They lift their leg and hold it for 15 seconds, then lower it and hold it for 15 seconds. They repeat this sequence for 30 seconds.

FIFA 11+ VIDEO

[HTTPS://YOUTU.BE/XSYYUNLZZBC](https://youtu.be/xsyyunlzzbc)

ARE WE MOVING TOO FAST?

- If nearly $\frac{1}{3}$ of individuals will have a second ACL injury in the first two years should we wait longer?
- Summarize evidence of achievement of baseline joint health at 2 years post op.
 - Healing of bone bruises (80% prevalence) 11-16 months
 - Biological recovery of graft and surrounding tissues
 - Mechanoreceptor and proprioceptive strategy takes longer
 - Graft maturity occurs at 24 months
 - More time for symmetrical strength recovery

-Nagelle et al 2017

IS IT WORTH IT?

FUTURE CONSIDERATIONS

- Blood Flow Restriction Training
- Comparison and unifications of rehab guidelines
- Challenge the Open Chain Timing

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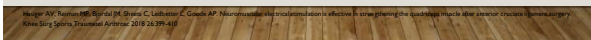
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