Return to play after ACLR: When and What Tests to Do... Safe or Sorry?

AAOS
AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS

Orlando, FL
March 2 2016
ICL271

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I (and/or my co-authors) have something to disclose.

Dr. Darren Johnson does.
Others do not.

Detailed disclosure information is available via:

"My Academy" app;

Printed Final Program; or

AAOS Orthopaedic Disclosure Program on the AAOS website at
http://www.aaos.org/disclosure

Introduction / Functional Assessment: Return to Sports
- Mary Lloyd Ireland, MD, Moderator

Physical Therapist / Athletic Trainer Perspective
- Jay Irrgang, PT, phD, ATC, FAPTA

Basic Science and Gait Analysis Perspective
- Brian Noehren, PT, phD, FACSM

Early Factors in ACL Rehab
- Darren Johnson, MD

Menu

Introduction
Questions
Core Instability DX
Functional Assessment
MOI/FA Videos
Other Tests Videos
Conclusions

Goal ACL return to play after ACLR

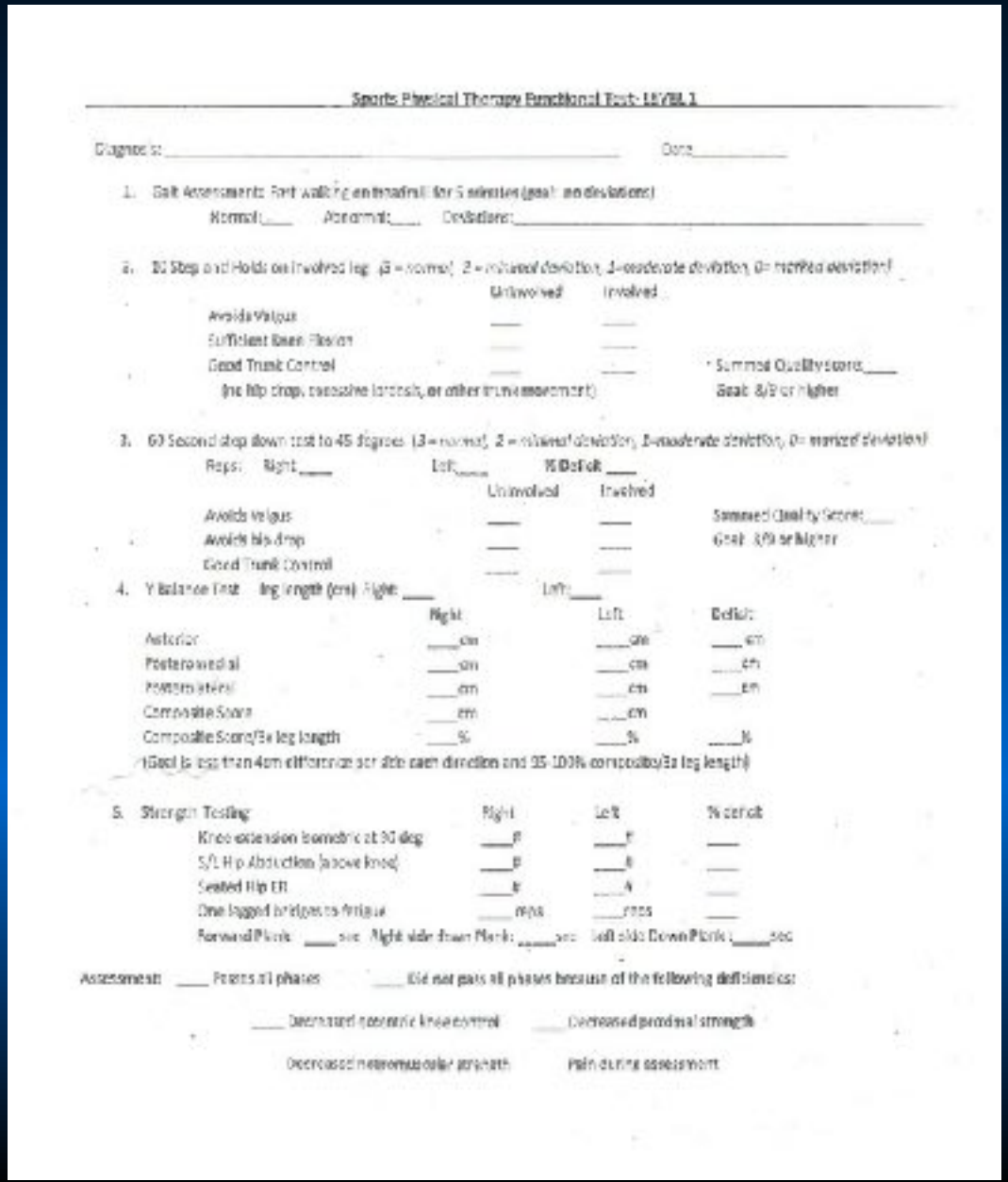
- KNOW YOUR RETURN TO PLAY TEAM.
- Understand the tests that assess strength and movement patterns after ACLR
- Show you the tests performed in functional assessments to determine readiness to RTP.
- Understand what these tests are measuring.
- Review mechanisms of injury and how this relates to safe return to play and prevention programs
- Questions and Discussion

Successful ACLR:

Short term: safer not faster return to play
Long term: prevention of osteoarthritis

- Average return to play 6 months
- Varies with each individual patient age and sport
- Many factors the athlete must overcome prior to return:
- Fear of reinjury
- Reestablishing strength balance hip and knee control

Functional Assessment Level 1



Sports Physical Therapy Functional Test- LEVEL 1

Diagnosis: _____ Date_____

1. Gait Assessment: Fast walking on treadmill for 5 minutes (goal: no deviations)
   Normal:____ Abnormal:____ Deviations:_____

2. 30 Step and Hold on involved leg (3 = normal, 2 = minimal deviation, 1=moderate deviation, 0= marked deviation)

	Uninvolved	Involved	
Avoids Valgus	____	____	
Sufficient Knee Flexion	____	____	
Good Trunk Control	____	____	* Summed Quality score:____
(no Hip drop, excessive lordosis, or other trunk movement)			Goal: 8/9 or higher

3. 60 Second drop down test to 45 degrees (3 = normal, 2 = minimal deviation, 1=moderate deviation, 0= marked deviation)
   Reps: Right:____ Left:____ % Deficit ____

	Uninvolved	Involved	
Avoids Valgus	____	____	Summed Quality Score:____
Avoids Hip drop	____	____	Goal: 8/9 or higher
Good Trunk Control	____	____	

4. Y Balance Test leg length (cm): Right: ____ Left:____

	Right	Left	Deficit
Anterior	____cm	____cm	____cm
Posteromedial	____cm	____cm	____cm
Posterolateral	____cm	____cm	____cm
Composite Score	____cm	____cm	
Composite Score/3x leg length	____%	____%	____%

(Goal is less than 4cm difference per side each direction and 95-100% composite/3x leg length)

5. Strength Testing

	Right	Left	% deficit
Knee extension isometric at 90 deg	____#	____#	____
S/L Hip Abduction (above knee)	____#	____#	____
Seated Hip ER	____#	____#	____
One legged bridges to fatigue	____reps	____reps	____

Forward Plank: ____sec Right side down Plank: ____sec Left side Down Plank: ____sec

Assessment: ____ Passes all phases ____ Did not pass all phases because of the following deficiencies:

____ Decreased isometric knee control ____ Decreased proximal strength

Decreased neuromuscular strength ____ Pain during assessment

Functional Assessment Level 2

Level 2 Functional Test (Clearance for Sporting Activities)

Name:_____ Date:_____ Surgery:_____

Leg Length (cm): R:_____ L:_____ BW:_____

1. Hop Testing (in inches)

Vertical Hop Test (inches)	1	2	3	%deficit max
Uninvolved				
Involved				
Single leg broad jump (in m)				
Uninvolved				
Involved				
Timed 6m hop (in sec)				
Uninvolved				
Involved				
Single leg Triple Jump (in m)				
Uninvolved				
Involved				
Single leg Crossover Jump (in m)				
Uninvolved				
Involved				

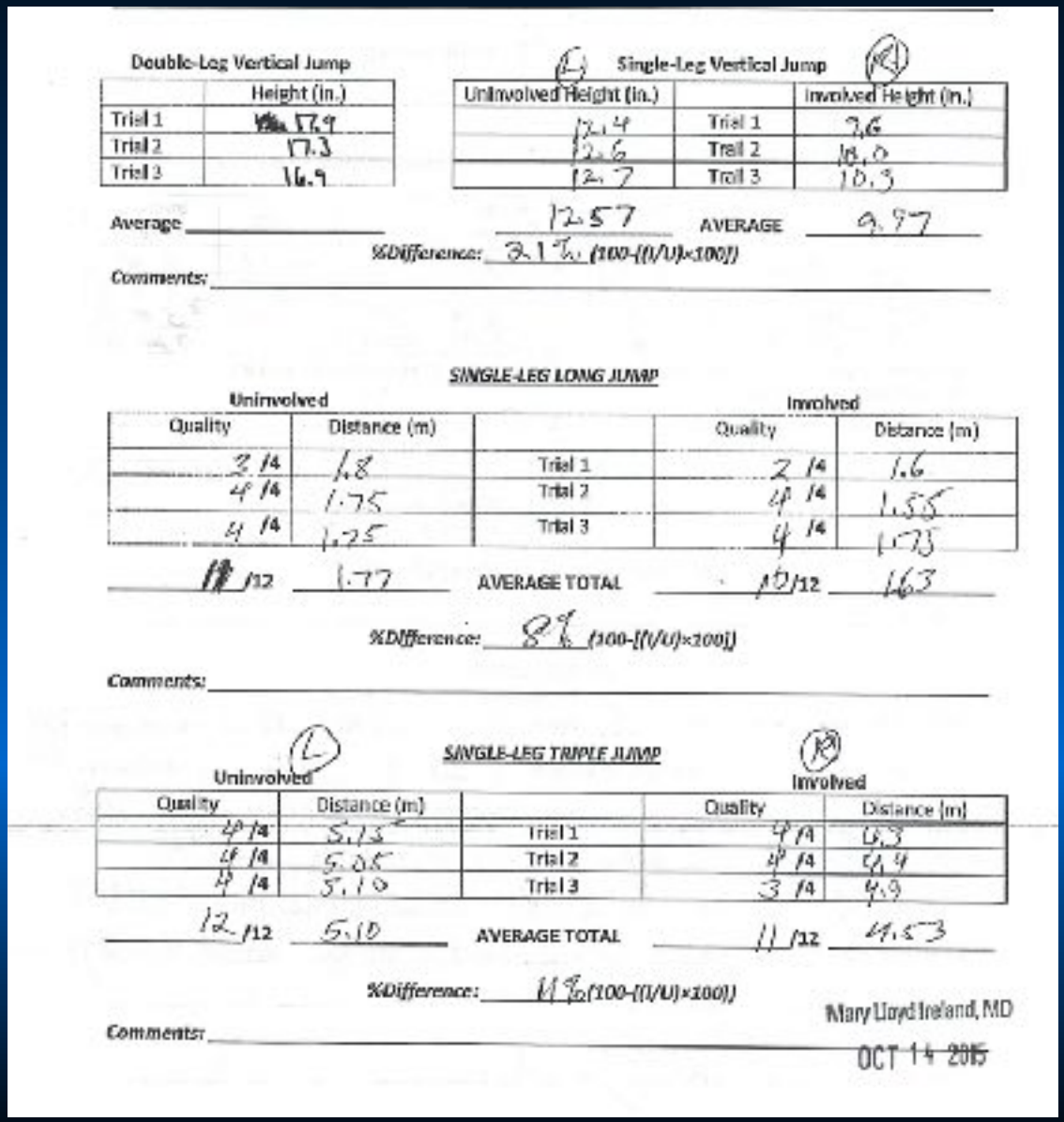
2. Hop Testing Quality Assessment *(3 = normal, 2 = minimal deviation, 1=moderate deviation, 0= marked deviation)*

	Uninvolved	Involved
Good trunk control		
Sufficient knee flexion		
Avoids valgus		
Total Score (Goal is > or = 8/9)		

3. Drop off box to squat jump plyometric performance (Repeat 3-5 times)
(3 = normal, 2 = minimal deviation, 1=moderate deviation, 0= marked deviation)

_____ Feet symmetric and hit together
_____ Symmetric and sufficient knee flexion
_____ Landing is soft
_____ **Total Score (Goal is > or = 14/15)**
_____ Avoid valgus
_____ Landing is balanced

Advanced Functional Assessment



Double-Leg Vertical Jump

	Height (in.)
Trial 1	17.9
Trial 2	17.3
Trial 3	16.9

Average ____ 17.57

(L) Single-Leg Vertical Jump (R)

Uninvolved Height (in.)		Involved Height (in.)
12.4	Trial 1	9.6
12.6	Trial 2	10.0
12.7	Trial 3	10.3

AVERAGE 9.97

%Difference: 21% (100-[(I/U)×100])

Comments: ____

SINGLE-LEG LONG JUMP

Uninvolved Quality	Uninvolved Distance (m)		Involved Quality	Involved Distance (m)
2 /4	1.8	Trial 1	2 /4	1.6
4 /4	1.75	Trial 2	4 /4	1.55
4 /4	1.75	Trial 3	4 /4	1.73
10 /12	1.77	AVERAGE TOTAL	10 /12	1.63

%Difference: 8% (100-[(I/U)×100])

Comments: ____

SINGLE-LEG TRIPLE JUMP

Uninvolved (L) Quality	Uninvolved (L) Distance (m)		Involved (R) Quality	Involved (R) Distance (m)
4 /4	5.13	Trial 1	4 /4	4.3
4 /4	5.05	Trial 2	4 /4	5.4
4 /4	5.10	Trial 3	3 /4	4.9
12 /12	5.10	AVERAGE TOTAL	11 /12	4.53

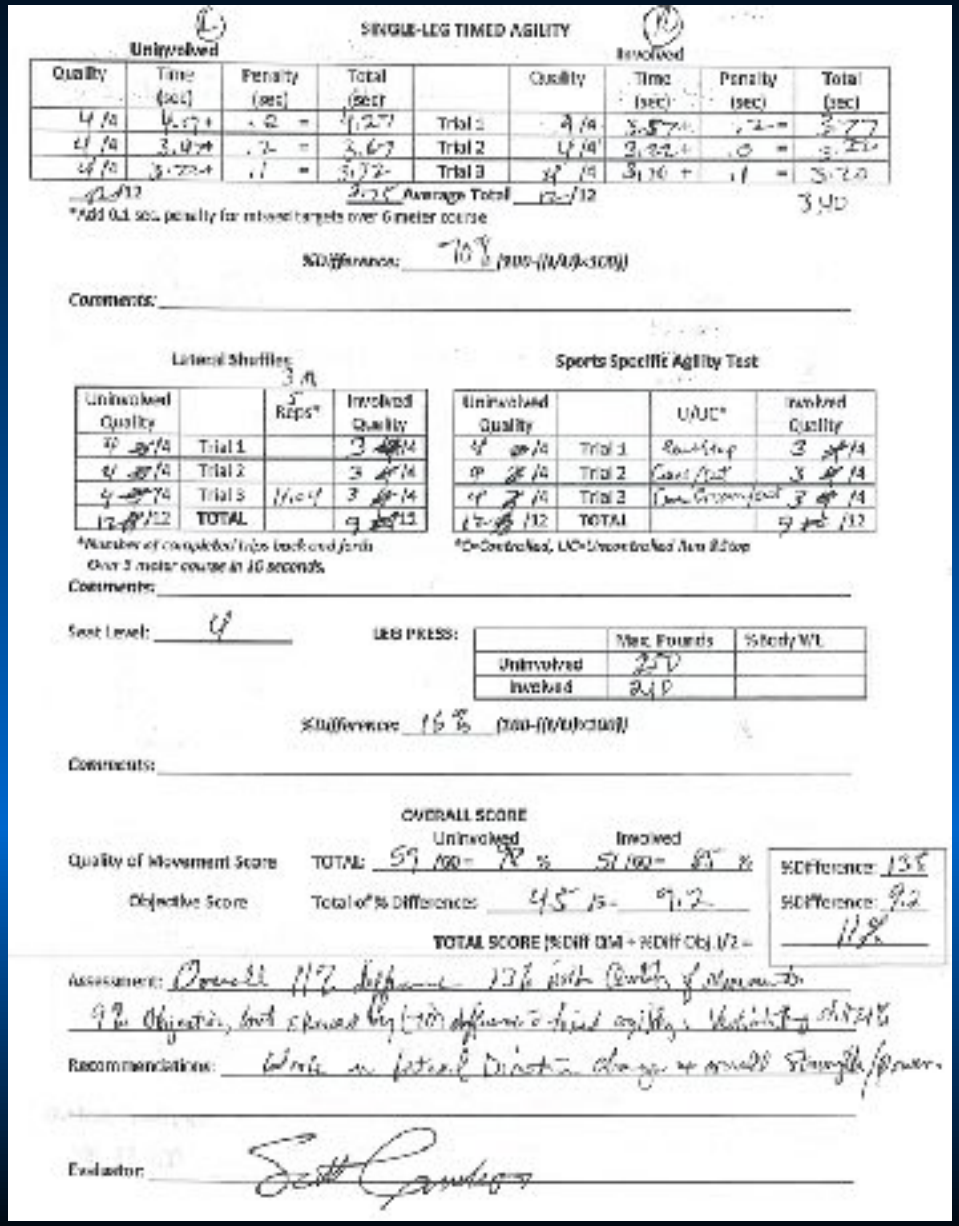
%Difference: 11% (100-[(I/U)×100])

Comments: ____

Mary Lloyd Ireland, MD

OCT 14 2015

Advanced Functional Assessment



SINGLE-LEG TIMED AGILITY

Uninvolved Quality	Time (sec)	Penalty (sec)	Total (sec)		Involved Quality	Time (sec)	Penalty (sec)	Total (sec)
4 /5	4.07	.2 =	4.27	Trial 1	3 /5	3.57	.2 =	3.77
4 /5	3.87	.2 =	4.07	Trial 2	4 /5	3.22	.0 =	3.22
4 /5	3.72	.1 =	3.82	Trial 3	4 /5	3.30	.1 =	3.40
12 /15			3.25 Average Total		11 /15			3.46

*Add 0.1 sec penalty for missed targets over 6 meter course

%Difference: 76 % (100-((U/I)x100))

Comments:

Lateral Shuffles

Uninvolved Quality		5 Reps*	Involved Quality
4 /5	Trial 1		3 /5
4 /5	Trial 2		3 /5
4 /5	Trial 3	11.04	3 /5
12 /15	TOTAL		9 /15

*Number of completed trips back and forth Over 5 meter course in 10 seconds

Sports Specific Agility Test

Uninvolved Quality		UAUC*	Involved Quality
4 /5	Trial 1	Running	3 /5
4 /5	Trial 2	Cone Hit	3 /5
4 /5	Trial 3	Cone Crossover	3 /5
12 /15	TOTAL		9 /15

*Uninvolved, UAC=Uninvolved Arm Action

Comments:

Seat Level: 4

LEG PRESS:

	Max Pounds	%Body Wt.
Uninvolved	250	
Involved	240	

%Difference 16 % (100-((I/U)x100))

Comments:

OVERALL SCORE

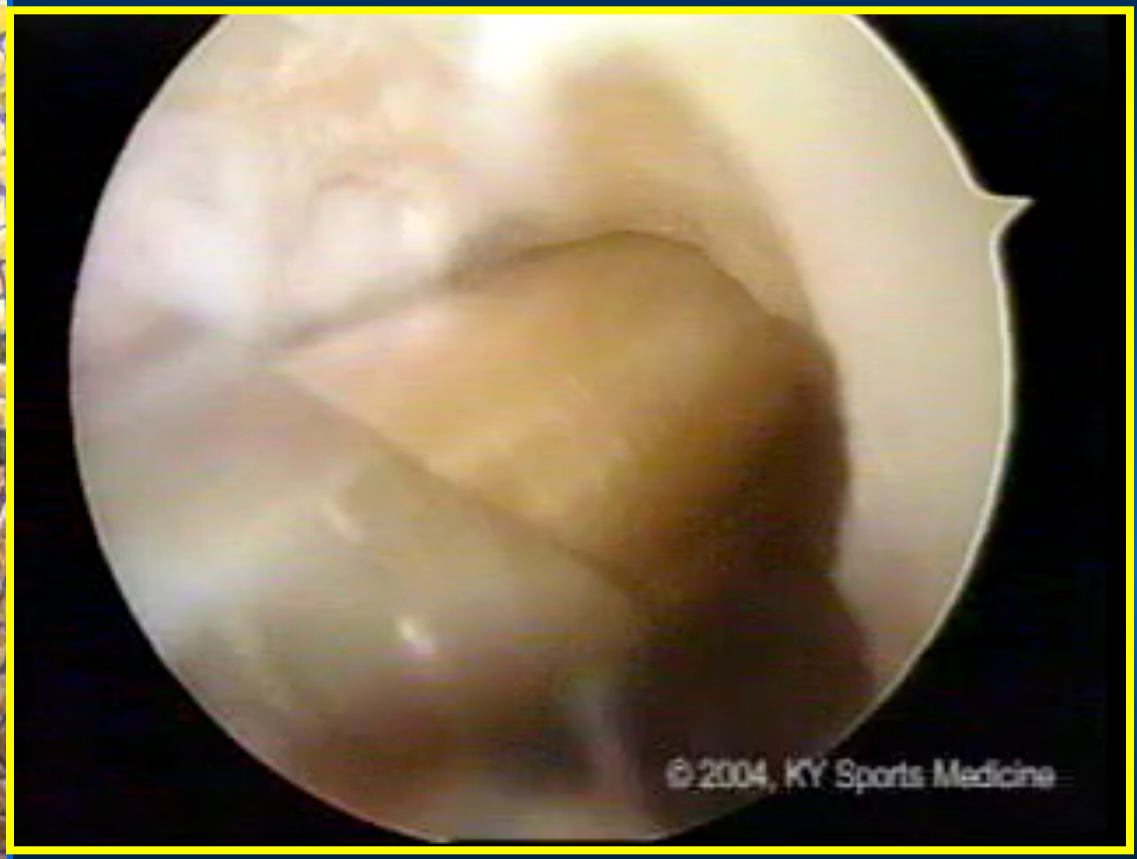
		Uninvolved	Involved	
Quality of Movement Score	TOTAL:	59 /60 = 98 %	51 /60 = 85 %	%Difference 13 %
Objective Score	Total of % Differences:	45 /5 = 9.2		%Difference 9.2
	TOTAL SCORE (%Diff QM + %Diff Obj.)/2 =			11 %

Assessment: Overall 11% difference - 13% with Quality of Movement, 9% Objective, but showed big (76%) difference in lateral agility. Variability 4.8 to 5

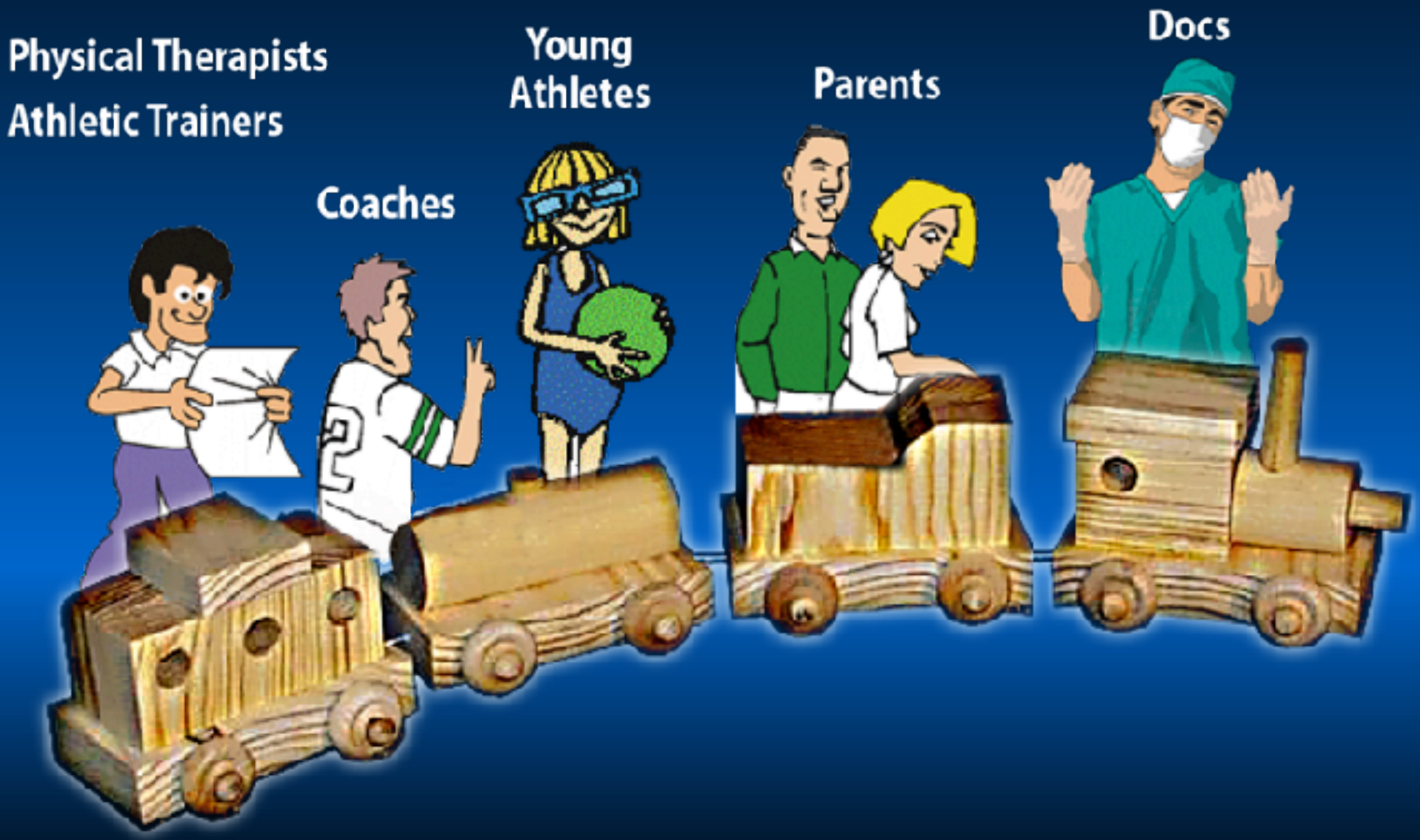
Recommendations: Work on lateral & distance change of direction strength/power.

Evaluator:

Can we Establish the Former Mosaic of Joint Normality and Homeostasis? NO!

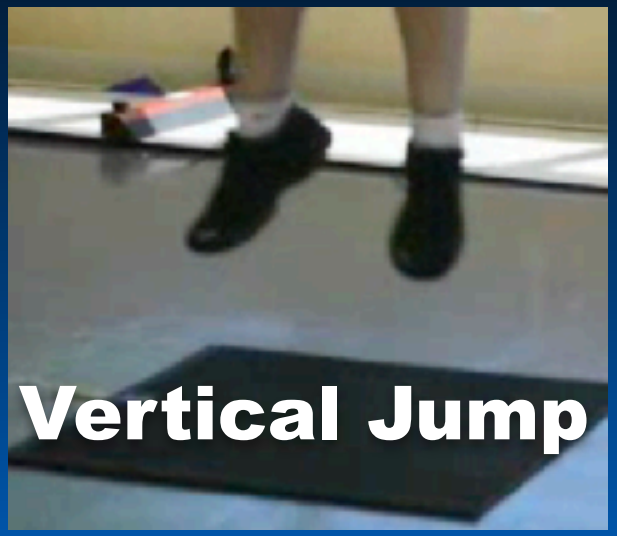


Who is driving the ACLR RTP Train?



Questions from the Audience

Best test(s) to do to predict RTP Safely?



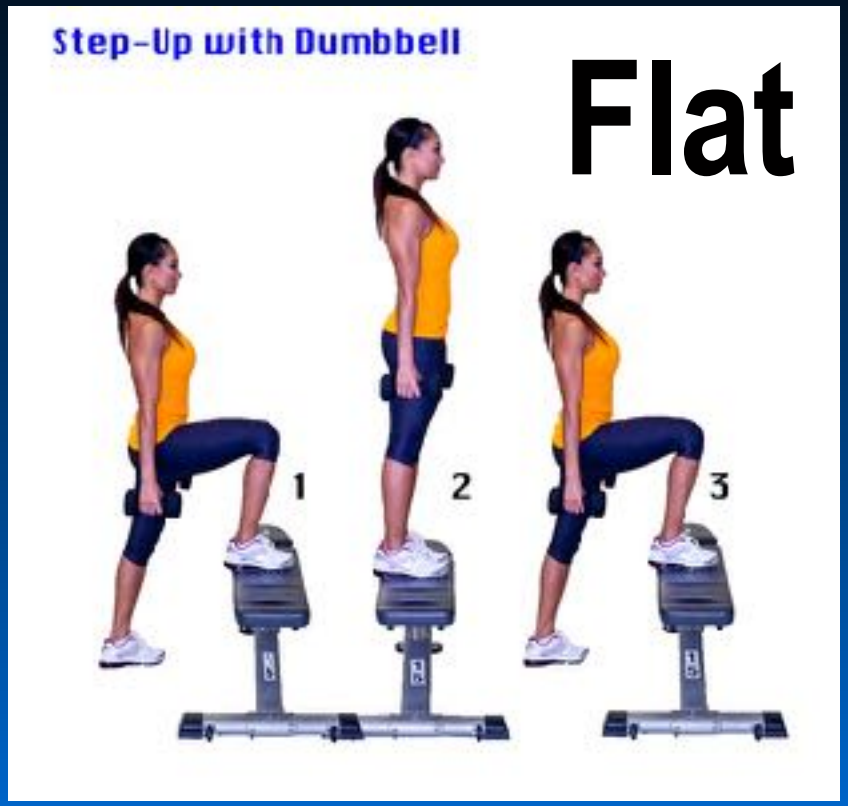
Core:
How do we measure?
Ever too early to start?

How to Get Quadriceps Back?

How to best get Quadriceps Back ….

- Eccentric
- Open Chain
- Safe variations of Eccentric Quad
  - Total Gym with bands early
  - Later Higher Weights

Eccentric Quad – Safe Or Sorry?



Wedge

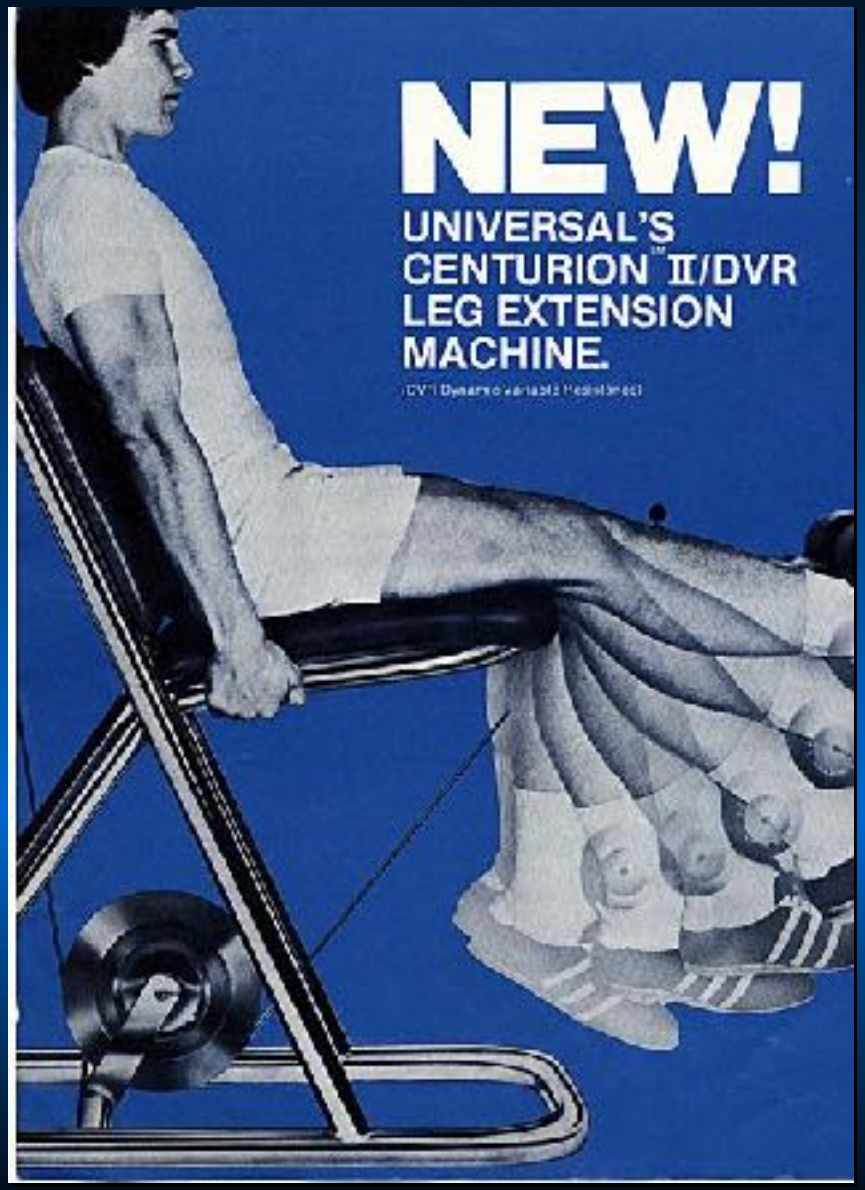
Eccentric Quad – Safe Or Sorry?

Bands

Weight

Open chain Extension Machines Safe or Sorry?

Dynamic Variable Resistance
1976
Dr. Gideon Ariel



Use of ALTER G when to start post ACLR

QUESTIONS???

Motor Ability to fire Quadriceps and Create Anterior Tibial Translation…

Good or Bad?

Voluntary tibial translation: A good habit?

QUESTIONS???

Quadriceps looks normal.
Core is abnormal.

Functional Testing

Fear of Reinjury?

Kineosiophobia Scales

QUESTIONS???

Most Important Factor in Succesful RTP?

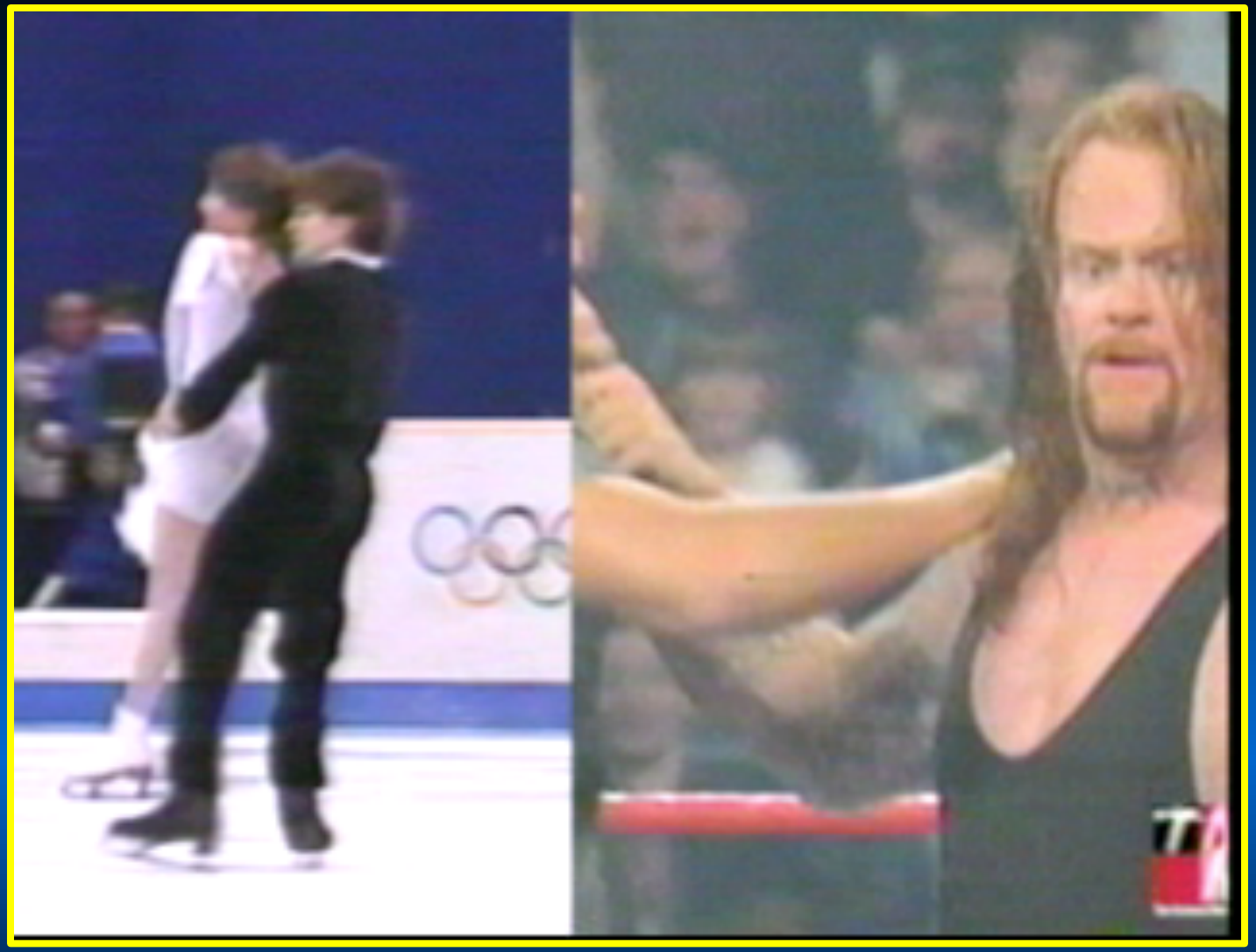
A. Waiting/PreHab
B. Surgery Anatomic Postiton
C. Time to RTP
D. Intrinsic (NonChangeable) Factors
E. Unknown/Don't Know

Sex Differences Return to Play?

Are Female Athletes Different?

No!

- Desire to Compete and Win
- Treatment by Health Care Professionals



Core:
How do we measure?
Ever too early to start?

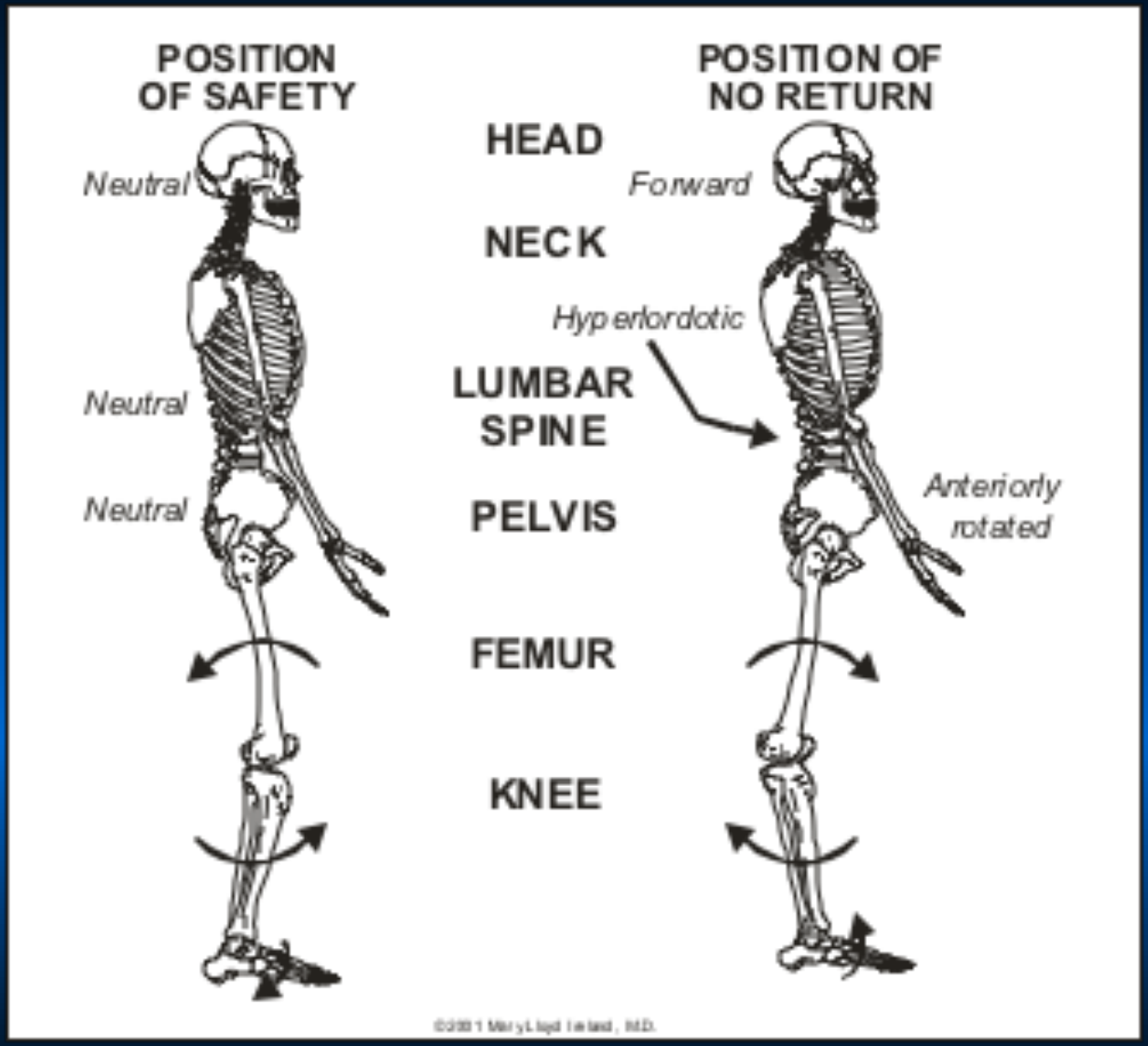
Single Leg Mini Squat

How Many Step Downs in 60 sec?

ACLR Side	31.8	
		p=.008
“Normal Side”	36	
		p=.026
Normal Control	40	

Noehren B. et al work in progress

Alignment Proximal control / Core stability



Simple Single-Leg Squat

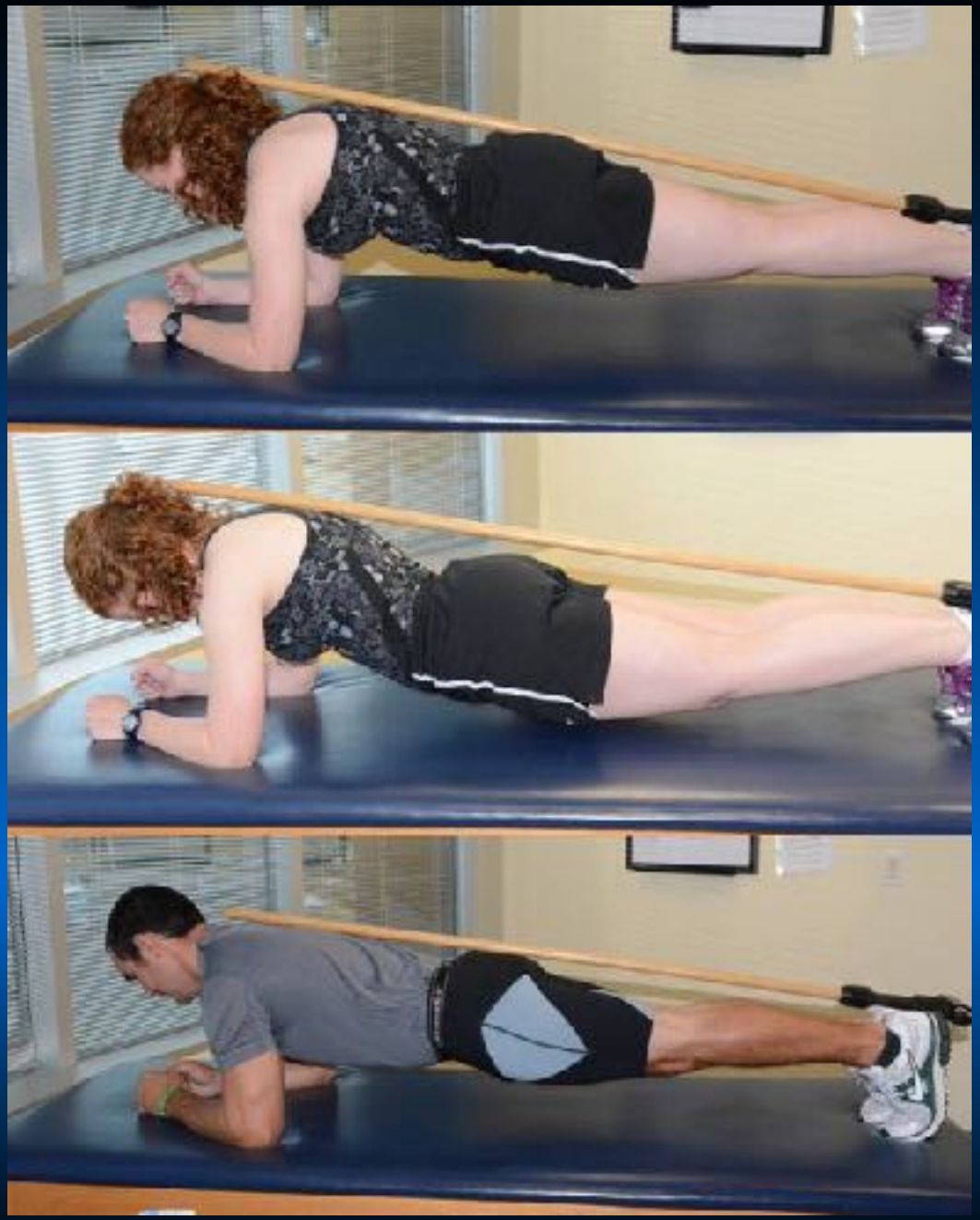
Give clinicians information on neuromuscular control

Plank Test

- Measures lumbar and pelvic control in side or sagittal plane
- Can see excessive lumbar lordosis

Observe in Fatigue and Non-fatigue states

Ireland ML, Durbin T, Bolgla Lori.
Gender Differences in Core Strength and Lower Extremity Function During Single Leg Squat.
In: ACL Injuries in the Female Athlete:
Causes, Impacts, and Conditioning Programs
Noyes FR, Barber-Westin SD Eds, Springer-Verlag,
Berlin Heidelburg, 2012.



What we test:

- **Trunk control:** through side plank, plank test
- **Knee control:** Repeated step downs- assess frontal and Sagittal plane control
- **Knee strength:** Isometric quadriceps strength test
- Through these functional tests we aim to better quantify, qualitative assessments of neuromuscular control that we feel may predispose someone to a subsequent injury.

Functional Assessment Tests

- Basic vs. Advanced
  - Strength – leg press
  - Balance
  - Timed agilities
  - Sport-specific dry-land testing to show athlete level of readiness to return to field of competition

What are the tests done to determine readiness for return to play?

Functional Assessment Level 1

- Gait assessment
- Single leg step and hold ×10
- Y Balance
- Strength testing
- Knee extension isometric 90°
- Hip abduction and seated external rotation
- One leg at bridges to fatigue
- Plank

Grading scale

- 3 equals normal
- To equals minimal deviation
- One equals moderate deviation
- Zero equals marked deviation
- Assessment
- Passes all phases did not pass all phases because of the following deficiencies
- Pain
- Decreased eccentric knee control neuromuscular strength proximal strength

Functional Assessment Level 2: Return to play

- Hop testing in inches
- Vertical hop
- Single-leg brought jump
- Timed 6 m hop
- Single-leg triple jump
- Single-leg crossover jump
- Hop testing quality assessment
- Good trunk control sufficient knee flexion avoid valgus

Level to clearance for sports

- Drop-off box to squat jump plyometric repeat 3-5 times graded on 0-3
- Feet symmetrical and hit together
- Symmetric insufficient knee flexion
- Landing is soft
- Avoid valgus
- Landing is balanced

Intervention Approach

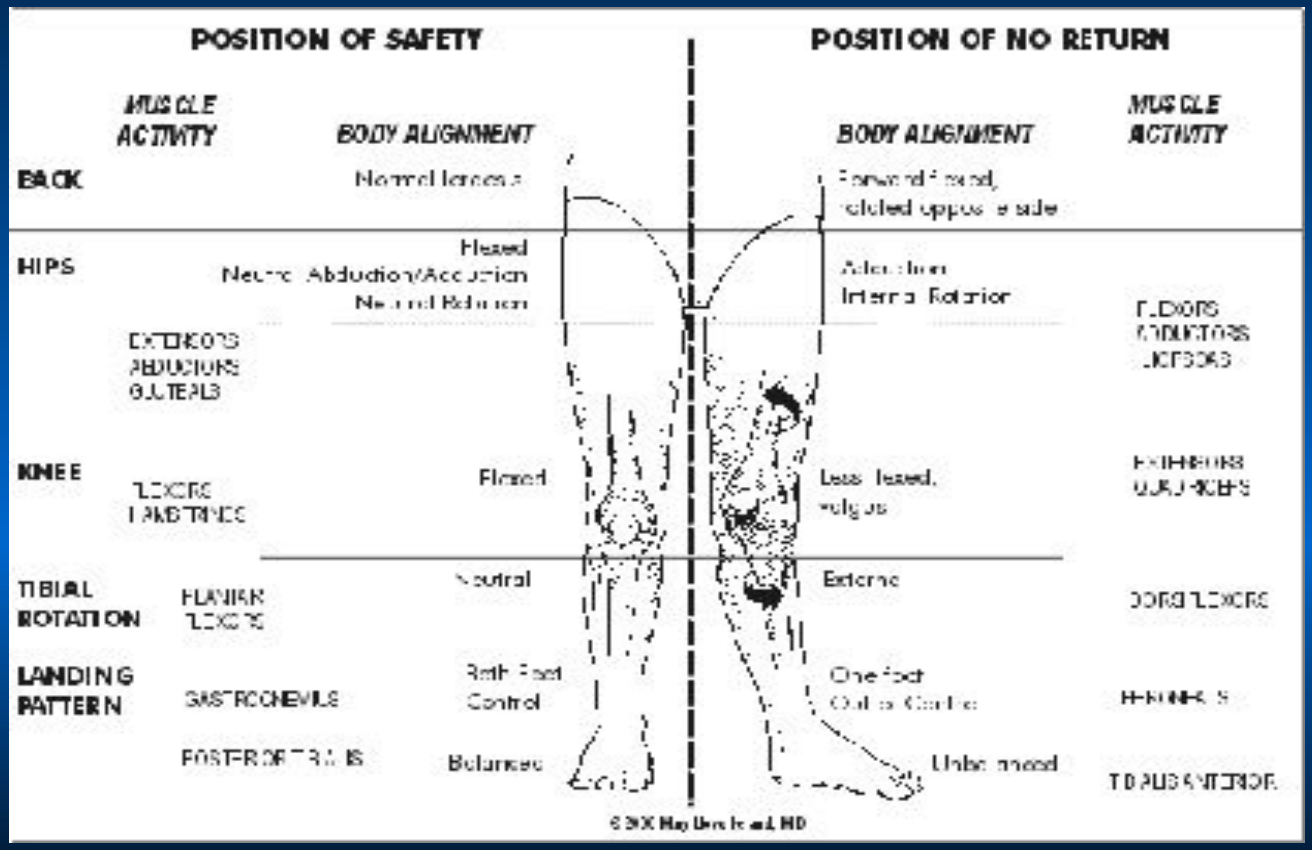
- Emphasize hip abduction and external rotation
- Proper body position
  - Back, hip and knees
- Integration of core musculature to functional activities

What the Prevention Programs have in common?

- Emphasize safe landing positions
- Neuromuscular recruitment
- Should be sport-specific
- Program must be done properly and participation documented
- Look at all lower extremity injury rates, not just ACL tears

What I Have Observed

- Mechanism of Injury
  - High risk vs. low risk landing position



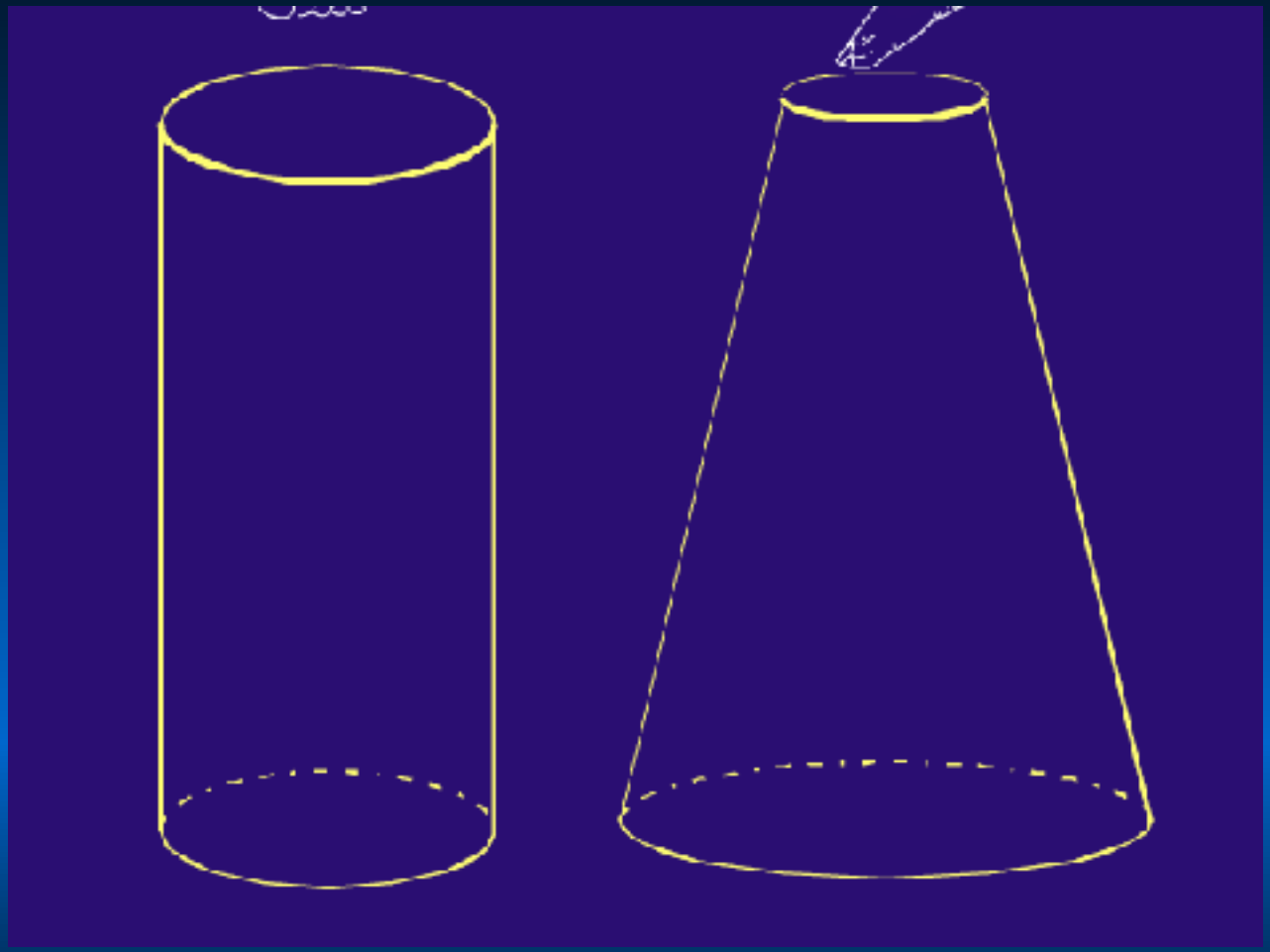
VROOM . . .

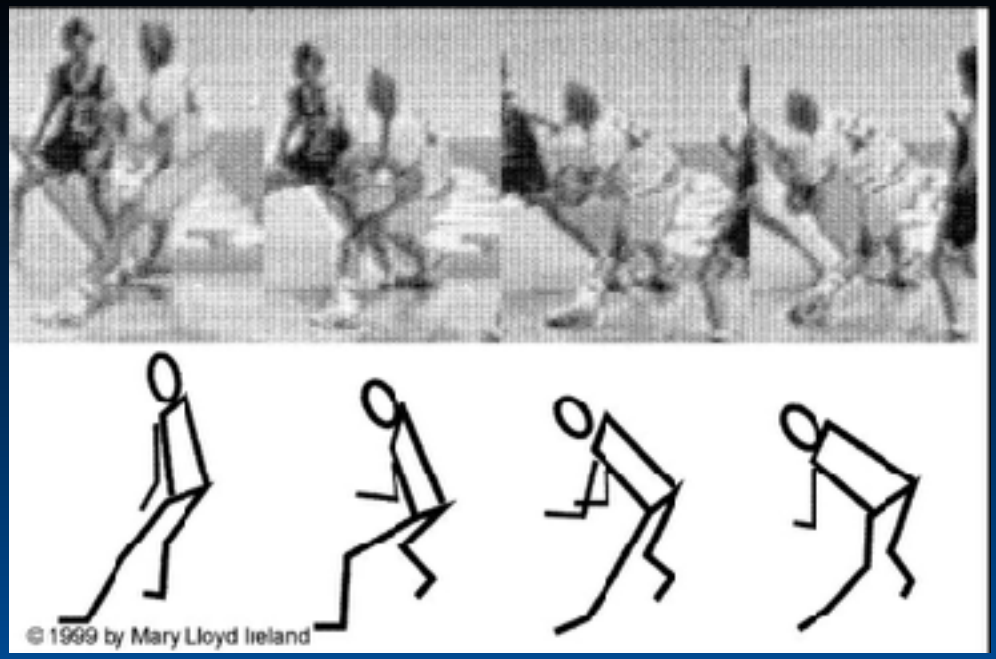
- Valgus
- Rotation
- Out
- Of control
- Movement

It takes 70 milliseconds to tear the ACL

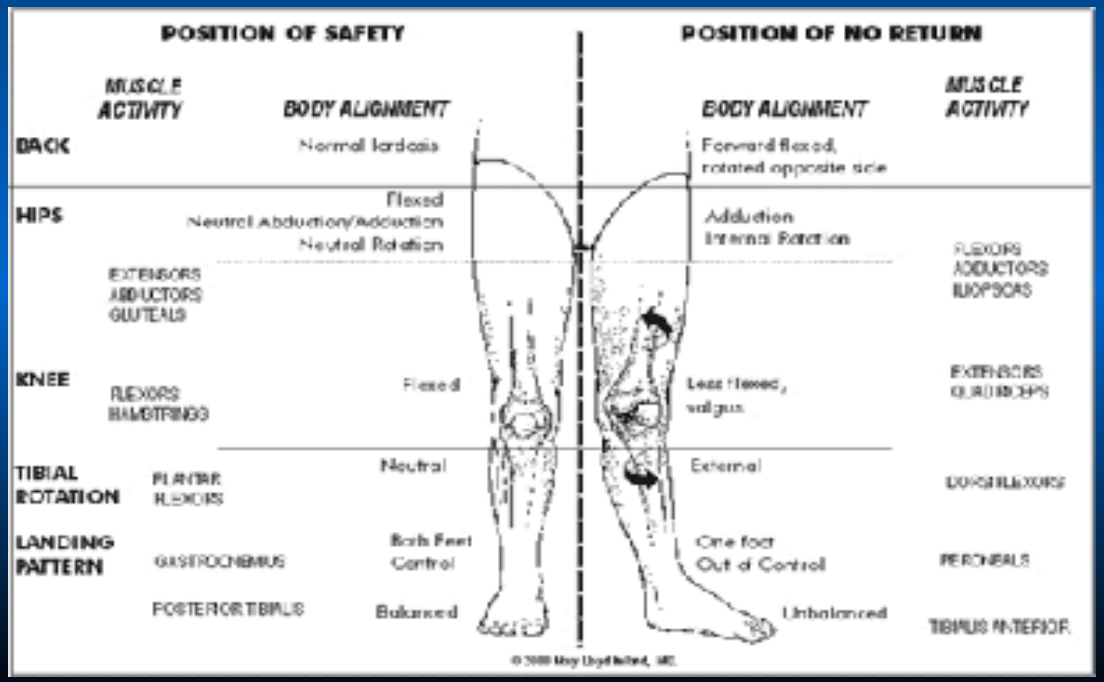
Basketball

Knee: Cone of Stability





How do we teach athletes to land in a safe position?



Position of No Return

- Is it really knee valgus?
  - Seen from frontal plane, YES, but NOT from sagittal plane
  - Injury – Landing Pivot Shift
  - Knee: Anterior subluxation of tibia
  - Hip: Internal Rotation and Adduction
- Femoral rotation
  - First internal, then external
- Anterior tibial translation = "valgus collapse"

Injury Prevention-ACL Tear

Simple as: ABC's

- **A**gility
- **B**alance
- **C**ore
- **S**trength

Lower Extremity Injury Prehab Program

Message: Performance enhancement, not injury prevention

Youtube.com/ukyortho

http://goo.gl/ivMHcx

Functional Tests: Triple Jump

Functional Assessment

Functional Assessment

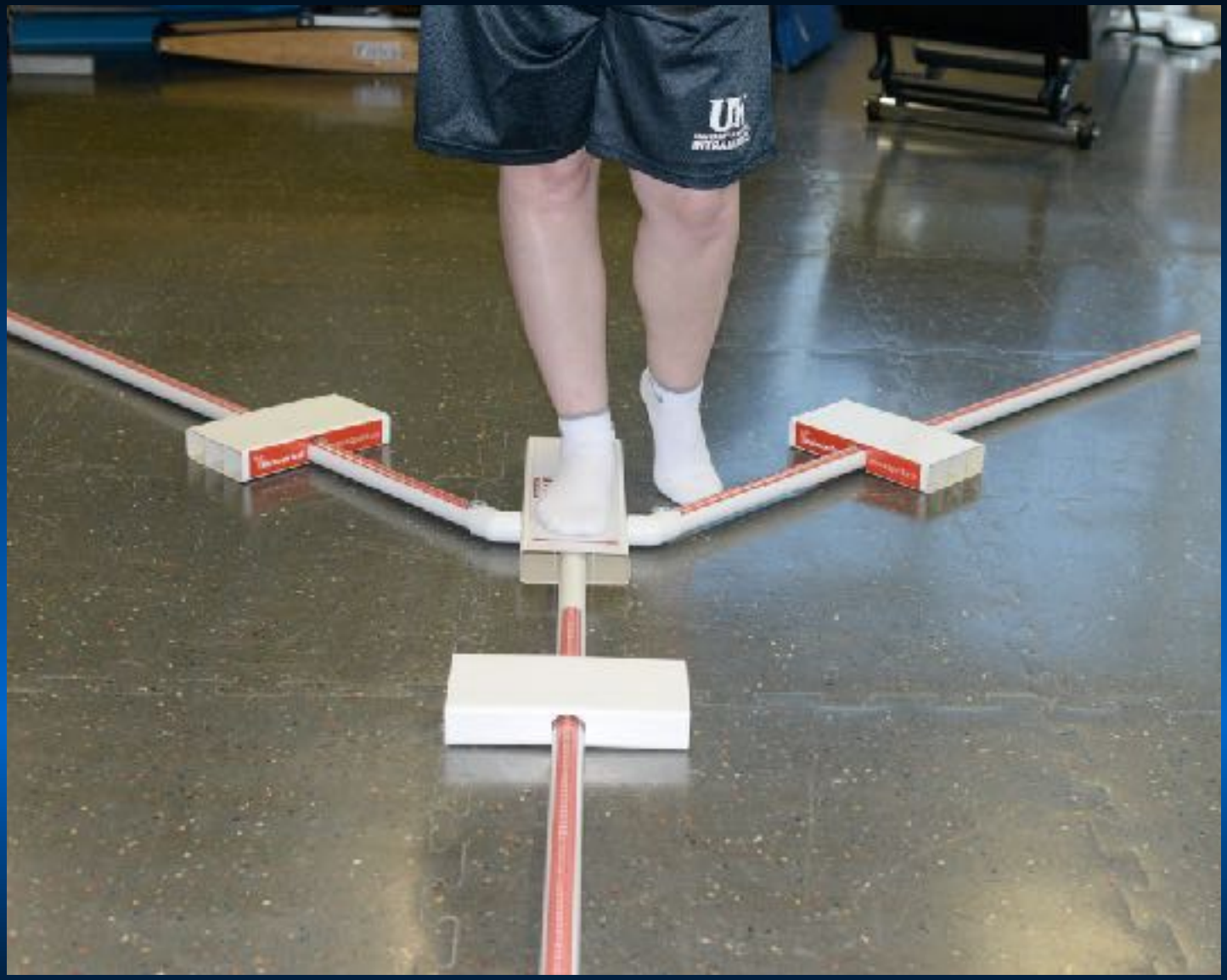
Functional Tests: Cuts

Functional Tests: TRX

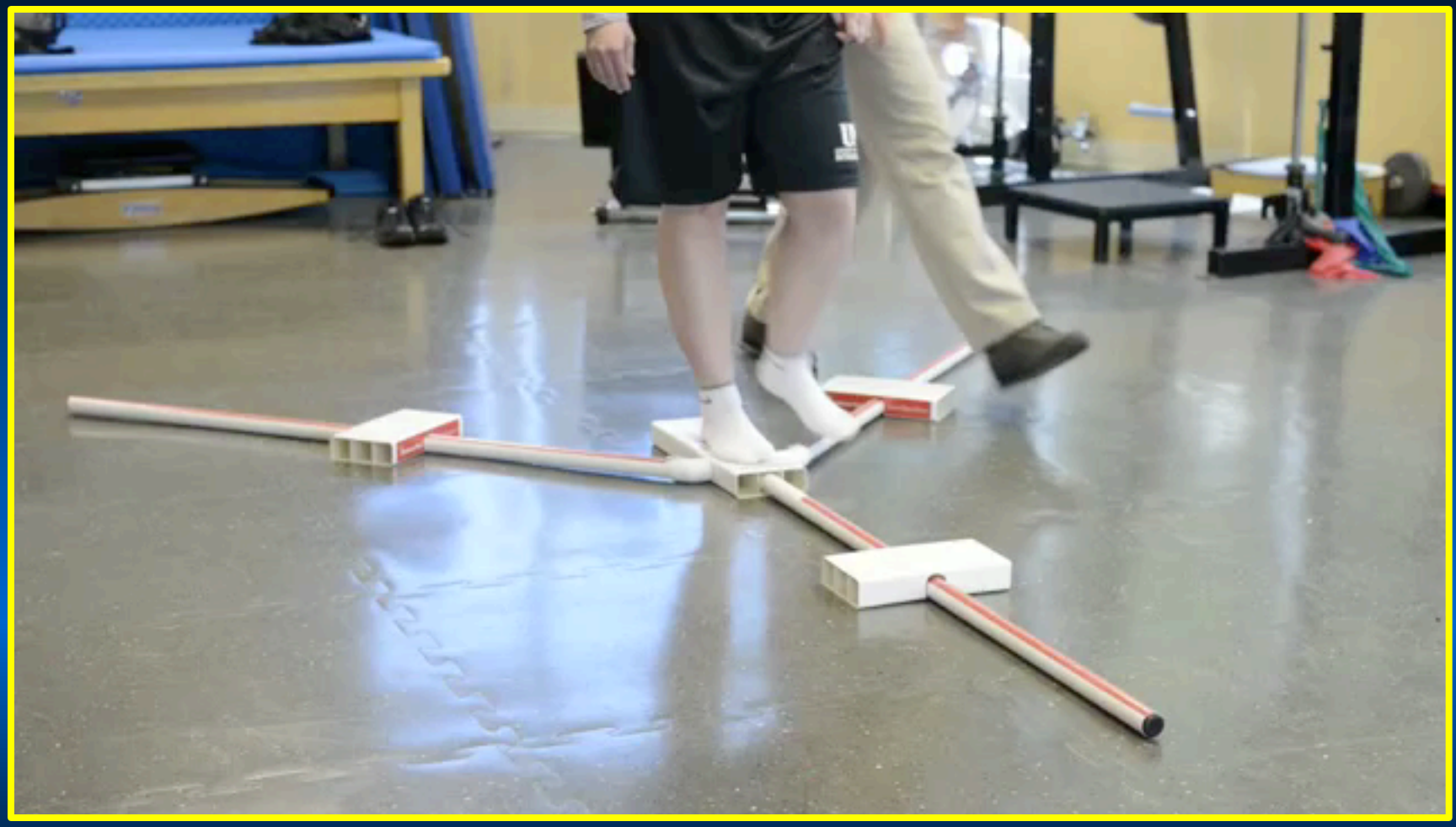
Trunk Control

Trunk Control Test

Front and Side Planks



Functional Tests: Y Balance

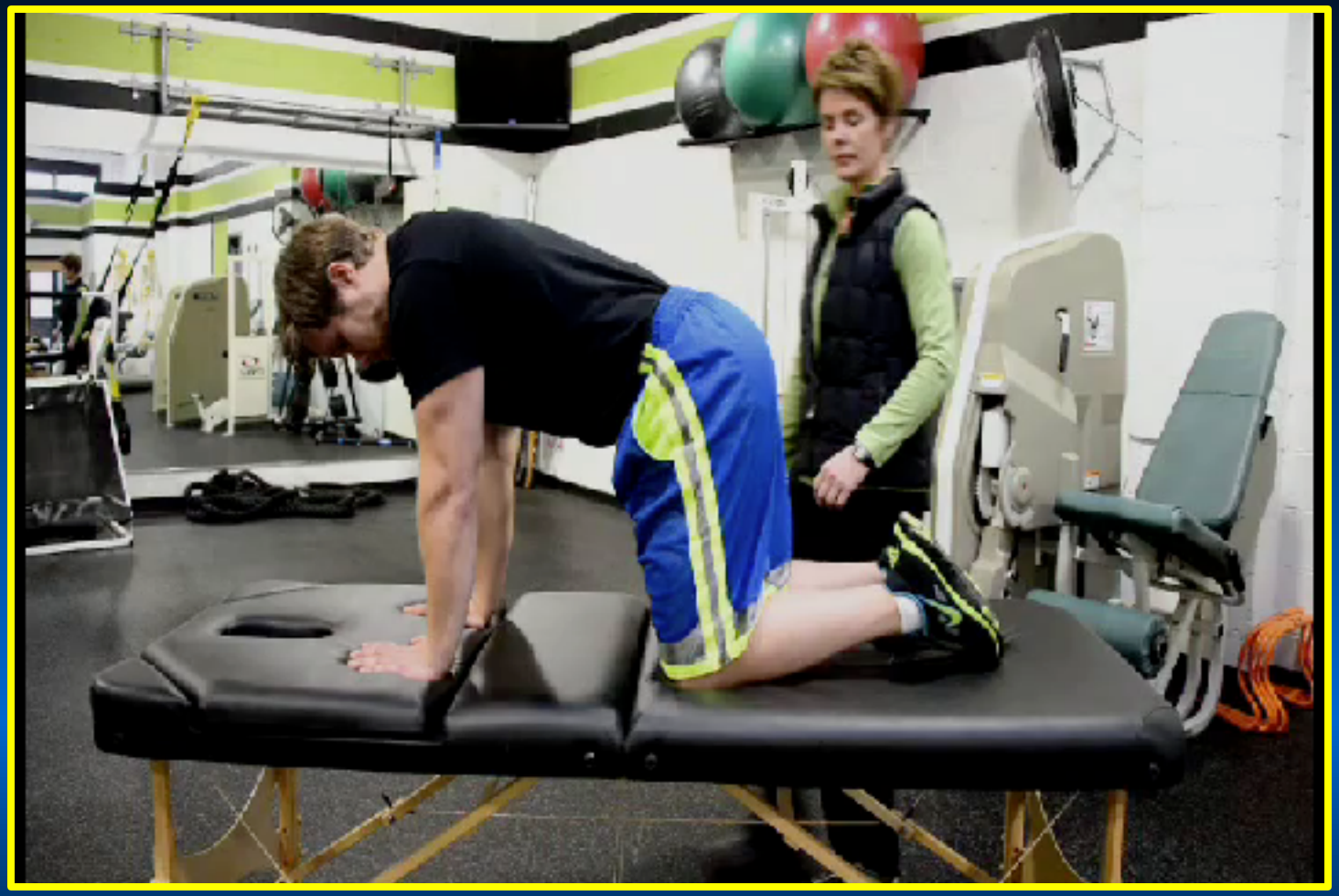


Functional Tests: Vertical Jump

Functional Tests: Heiden Board

Single Leg Balance Foam Hip ER

Bird dog Pointer Trunk / Core Control



Jump and Run

Single Leg Balance Catch

Appropriate Use Criteria Adopted by AAOS October 2015

AAOS Now

NOVEMBER 2015

The Official Member Newsmagazine of the AAOS

aaosnow.org

Two New ACL AUC, Checklists Now Available

Full scope of prevention and management of ACL injury covered

TERRY STANTON

Both prevention and treatment of anterior cruciate ligament (ACL) injuries can be confusing given the diversity of injured patients—from skeletally immature youth to older adults, low- and high-risk athletes playing a variety of sports, and patients with and without arthritis," acknowledged Robert H. Quinn, MD, Appropriate Use Criteria (AUC) Section Leader on the AAOS Committee on Evidence-Based Quality and Value.

In light of that diversity, the AAOS is making available a new suite of online resources to guide orthopaedic surgeons in the management of these injuries as well as in counseling patients about

> SEE ACL AUC ON PAGE 39

The two new AUC include prevention programs given the athletes and are accompanied by checklists for Postoperative Rehabilitation and Return to Play.

COURTESY OF [illegible]

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American Association of Orthopaedic Surgeons

FEATURES

6 OTA Annual Meeting

Coverage begins with reports on the use of topical vancomycin, early weight bearing after intramedullary fixation, and vitamin D in trauma patients.

ACL Reconstruction Surgery

-Patient Return to Play Checklist-

Clip this checklist to the patient chart and upon completion, insert in file.

Patient's Name: _____

Medical Record Number: _____

Date of Birth: ____/____/____

(Apply patient sticker over header if available)

Date of Surgery: ____/____/____

Post-operative anterior cruciate return-to-play protocol:

☐ Patient's graft incorporation and graft strength has been considered

☐ Patient's functional range of motion is restored

☐ Patient has a stable knee with no pivot

☐ Functional return of patient's core, hip, quadriceps and hamstring strength has occurred, as determined by clinician discretion (can be measured by a variety of methods)

☐ Patient's functional balance restored

☐ Patient attests or surgeon observes functional skills are performed adequately

☐ Patient is confident that they are ready to return to sport of interest

☐ Patient has been advised to participate in an ongoing ACL-prevention/ movement-retraining program

Clinician Signature: _____

Date/Time: _____

AAOS

Six to Twelve Month Post ACLR: Strength, Step Down, Functional Tests, & Gait Analysis

HOW ARE WE DOING?

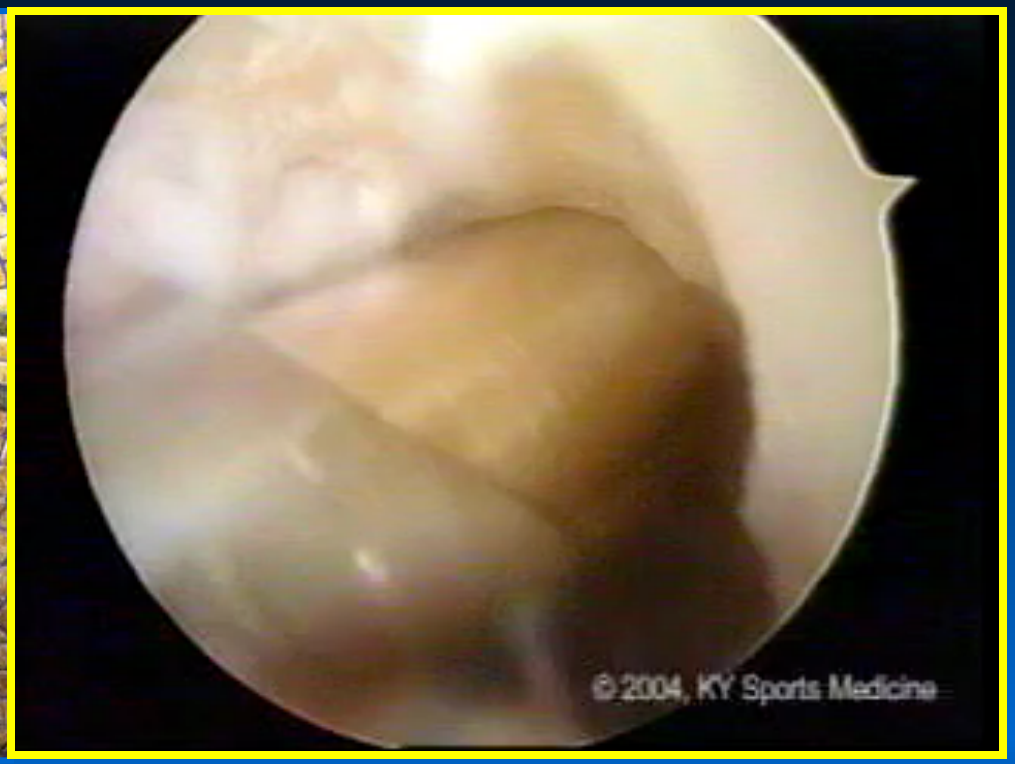
Not So Well… Cleared to play!
Results of Gait studies 6-8 Months post ACLR:

- Compared to Control Significant Differences:
  - Hip ER weakness
  - Poorer Testing in:
    - Single Leg Step Down 60 seconds
    - Hop Tests:
      - Single, Triple, Crossover
- What to compare to?
  - Is the uninjured side normal?
  - Should matched controls be used?

Not So Well..

- Not Differences in Hip Extension, Hip abduction, or Knee Extension Strength
- More Objective Measures Must be Used for Functional Assessments
- Should develop Risk of Reinjury Scales:
  - Based on Strength, Gait and Balance Tests
  - Also include Kinesiophobia Test

Orthopaedic Surgeons Can Stabilize the Knee, but not restore it to pre injury state.



Timing of Return to Play?

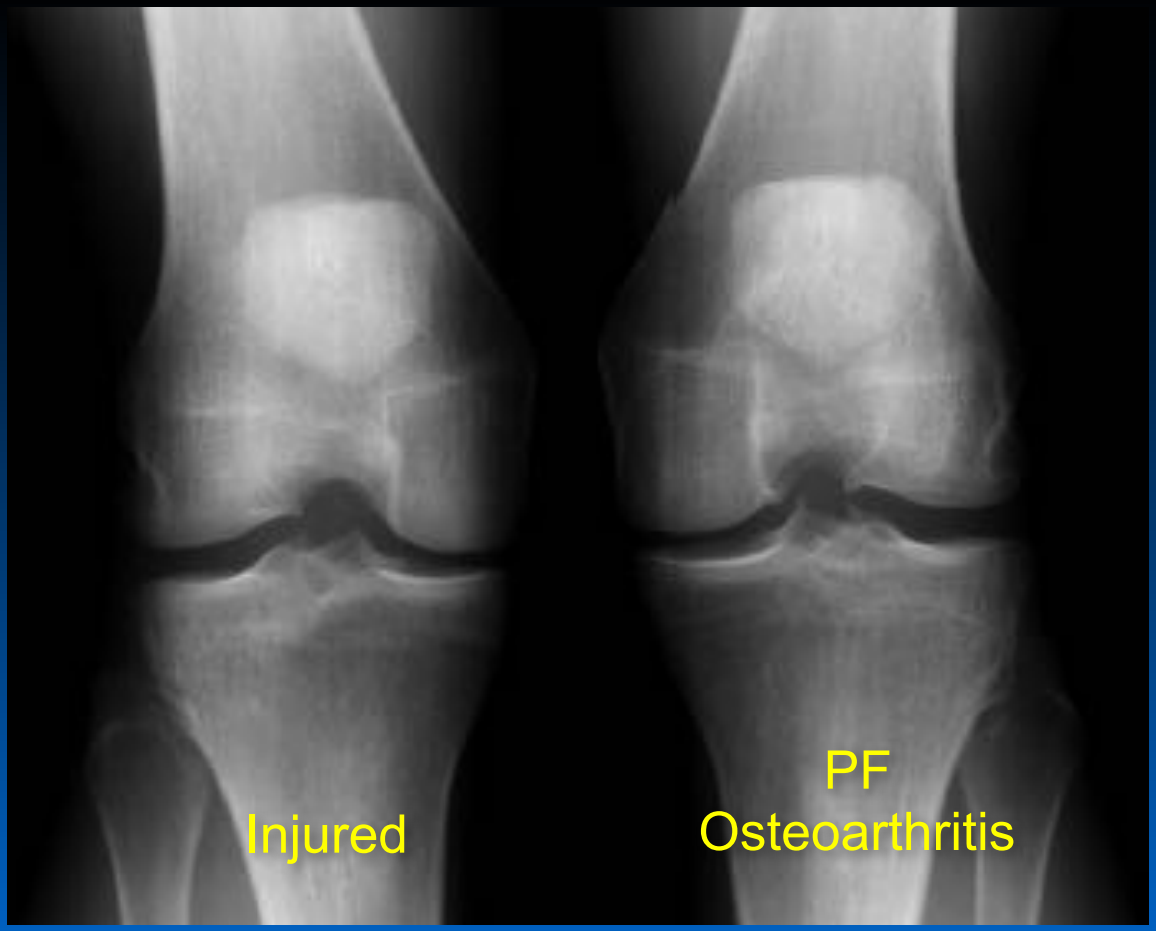
Rethink Biologic Healing

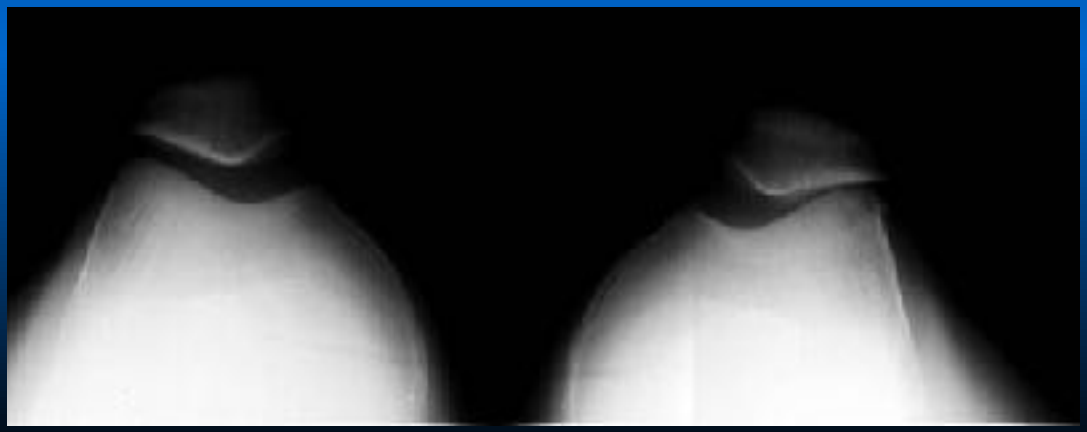
Variable due to Multiple Factors……

36YO Female

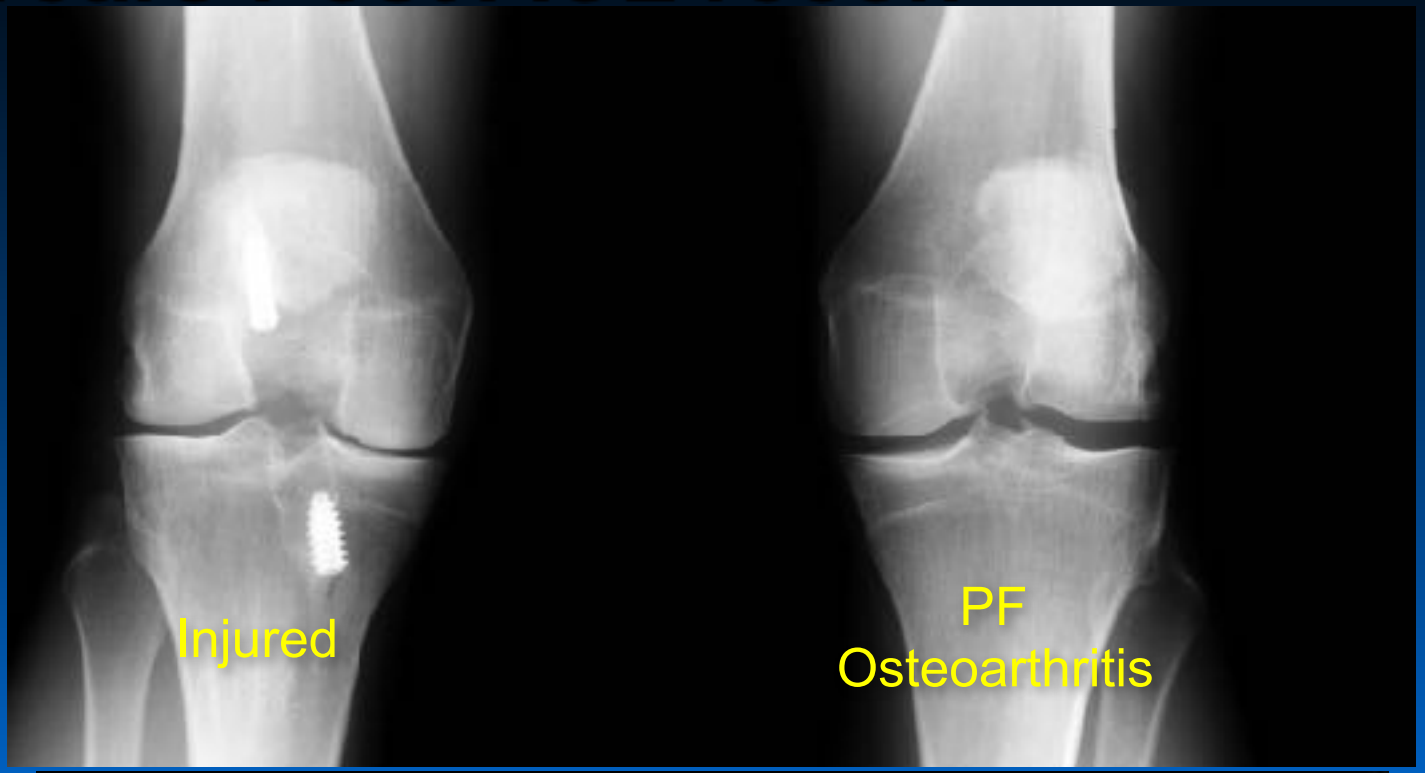
Professional basketball athlete

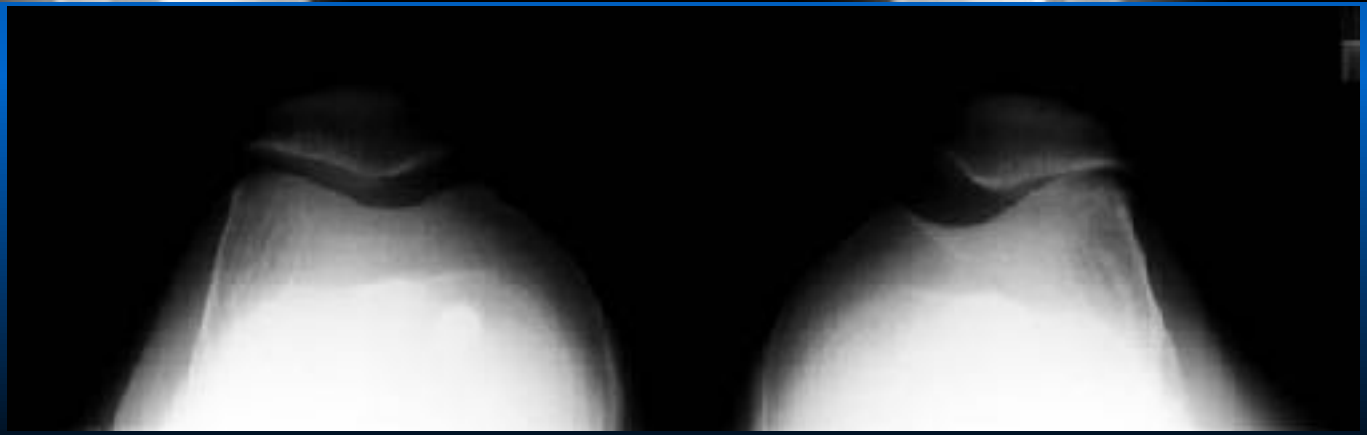
Allograft ACL reconstruction



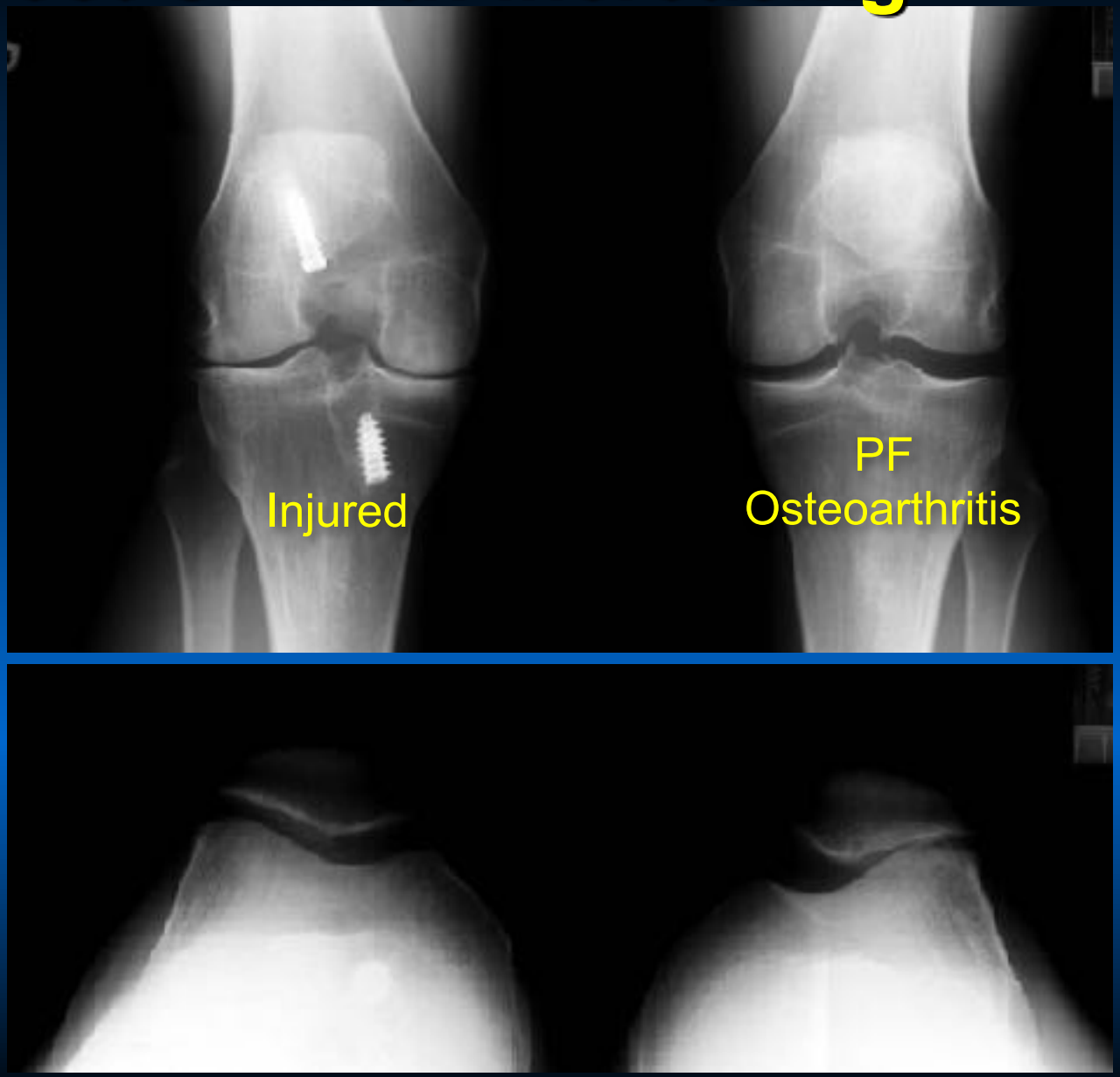


2 Years Post ACL recon





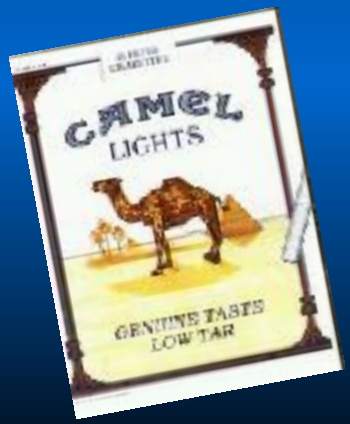
3.5 years Post OP with increasing knee pain.



Knee “pack-years” as in smoking: Additive effects of years of participation in basketball. . .

- Pack-years of smoking on **lungs**
- Pack-years of activity on **knees**

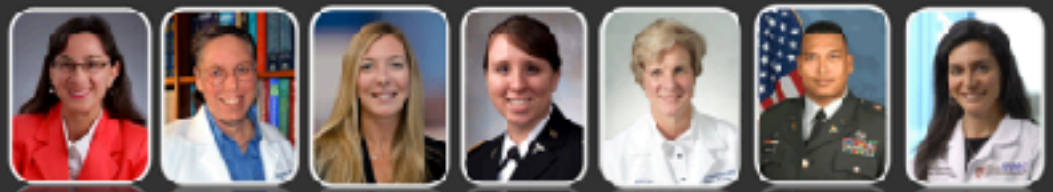
? Too many pack years of basketball ?



Landing is EVERYTHING!

Sex Based Considerations in Caring for Common Sports Injuries

Laura M. Bruse Gehrig, MD
Margaret M. Baker, MD
Cordelia W. Carter, MD
Christy Hylden, MD
Mary Lloyd Ireland, MD
Anthony Johnson, MD
Elizabeth G. Matzkin, MD



AAOS

American Academy of Orthopaedic Surgeons

Women's Health Issues Advisory Board

The AAOS Women's Health Issues Advisory Board (WHIAB) seeks to advocate, advance, and serve as a resource on sex and gender differences in musculoskeletal health.

Females suffer from injury/disease in different ways than males. Recognizing sex-related differences is critical to optimizing patient care.

www.aaos.org/women

ACL Injuries and Management

Epidemiology

- **Highest Female:Male rate differences:** Basketball and Team Handball[1]
- **Prevention and post ACLR rehab programs:** No sex differences[1]
- **Mechanisms of injury:** No sex difference in noncontact mechanism; difference in weight bearing pivot shift[1]

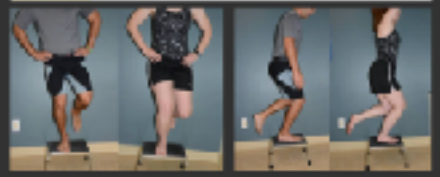
Intrinsic Risk Factors

- **Hormonal / Joint Laxity:** Data are insufficient to make any conclusive statement regarding menstrual cycle or knee laxity and the rate of ACL injury in females[1]
- **The COL5A1 Gene is Associated With Increased Risk of ACL Tears in Females:**[1] Gene that encodes alpha1 chain of type 1 collagen. ACL tears type 5 collagen. Achilles tendon injuries. Hypermobility (excessive joint laxity) associated with increased incidence of musculoskeletal injury[1]
- **Notch Sign:** No Sex Differences; Smaller Notch and Ridges = Greater ACL Tear Rate
- **Tibial Plateau Geometry:**
  - Hidden Difference:[14]
  - Medial Plateau: Medial Tibial Slope and Medial Tibial Depth
  - Lateral Plateau: Lateral Tibial Slope and Lateral Tibial Depth
  - Lateral Plateau Posterior Tuberosity: 5 mm & 10 mm and 1° & 7° posterior slope: Females: 3.08 / Males: 4.18

Extrinsic Risk Factors

- **Kinematics:** Valgus Collapse and increased knee adduction moment[1]
  - 205 female athletes. 9 ACL tears: Greater adduction moment predicted ACL injury p<0.001
- **Biomechanical/Neuromuscular:**[12] Proximal Control
- **Mini Squat, Normal Subjects:**

	Male	Female
Pelvis	Level	Contralateral Drop
Hip	No Rotation	Internal Rotation and Adduction
Knee	0° Varus/Valgus	Valgus
Tibia	Neutral	External Rotation
Foot	Flat	Pronation
Back	Flat	Lordotic
Pelvis	Neutral	Anterior Tilt



Surgical Management

- **Graft Choice:** No sex difference; do not change based on cosmetic concerns
- **Pearls:** For the smaller, shorter patient: Adjust femoral fixation; Use suspension or bioabsorbable devices; Avoid iatrogenic ITB syndrome

Outcomes

- **Graft Failure/Future Surgeries:**[13] Meta Analysis 13 studies – no sex differences in Graft Failure (R); Contralateral ACL Rate (T); Laxity Post OP (R)
- **Return to Play/Activity Level:** Moon Study[14]
  - 300 active athletes (150 M/150 F); female
  - Average age 14.3 years
  - 2 year follow-up; IKDC and pivoting
  - Females more likely to have ACL Surgery (Active 95 pt CI)
  - Older athletes and females are less likely to RTP (p<0.01)
  - 2 Year RTP: Female slower activity (Modified)[14]
- **Development of Osteoarthritis:**
- **Longer term Registry follow up needed:**[15]
- **Swedish ACL Registry:**[15]
  - 96 female soccer players w/1 injuries
  - 10 year follow up
  - 42% Osteoarthritis, Knee OA
  - 35% Osteoarthritis affected OAL
  - No difference in osteoarthritis rate compared to those who had not

Thank you!

Around here,
being the best is kind of our thing.
Providing nationally ranked orthopaedic care to athletes of all ages.
That's why we're here.
NCAA
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U.S.News
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ORTHOPEDICS
2012-13
UK Albert B. Chandler Hospital is now ranked the No. 1 hospital in Kentucky by U.S. News & World Report. We ranked in the top 50 nationwide for providing