


AUGUST 7, 2021

The Anterior Cruciate Ligament Tear: Why does it happen and can we prevent it?

An evidence-based review of risk factors and prevention principles for ACL tears

**SPORTS MEDICINE
CENTER**

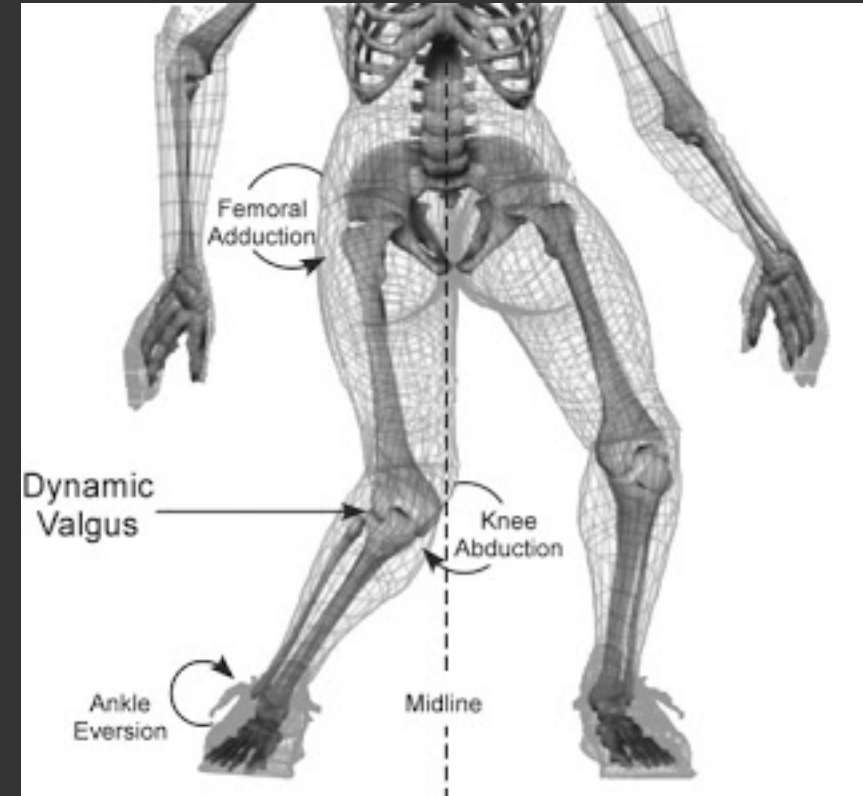
 Children's Hospital Colorado

Objectives

- 1 Describe common mechanism for ACL tears
- 2 Identify modifiable and non-modifiable risk factors for ACL tears
- 3 Understand basic principles of injury prevention
- 4 Identify principles specific to ACL injury prevention
- 5 Be aware of evidence-based programs used for injury prevention

Mechanism

1. Non-contact: >70% of injuries
 - Most common during landings or lateral pivoting
 - Anterior shear force at the proximal end of the tibia (strong quadriceps contraction) combined with a knee valgus moment stressed ACL most compared to other mechanisms (Shimokochi 2008)



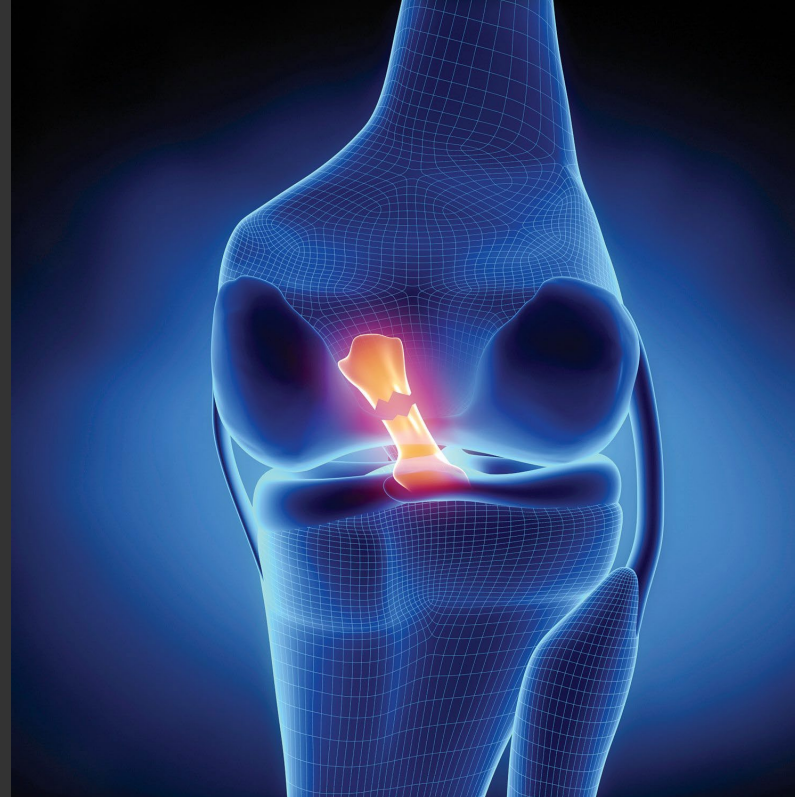
2. Contact:



Risk Factors

Intrinsic: inherent to athlete

- **Non-modifiable**
 - Previous ACL injury
 - Genetics
 - Narrow intercondylar notch
 - Generalized joint laxity
- **Modifiable**
 - Poor landing mechanics
 - Impaired muscle recruitment
 - Imbalance between hamstrings and quadriceps strength
 - Decreased ability to control trunk displacement after perturbations (lack of core stability)
 - Single-leg postural control deficits



Risk Factors

Extrinsic: outside the control of the athlete

- Playing surface
- Weather
- Sport participation
- Sport level



Why is the female athlete at an increased risk?

- Ligament dominance
- Quadriceps dominance
- Limb dominance
- Core dysfunction
- Greater lateral trunk displacement and overall trunk motion
- Greater landing forces and force loading rates
- Lower hamstring to quadriceps torque ratios
- Decreased relative hamstring strength
- Different hip muscular recruitment strategies
- Generalized joint laxity
- Genu recurvatum
- Hormonal effects of estrogen on ACL



Impact of ACL Injury

Physical

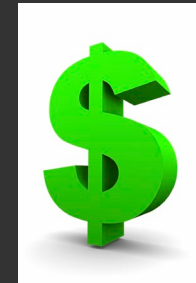
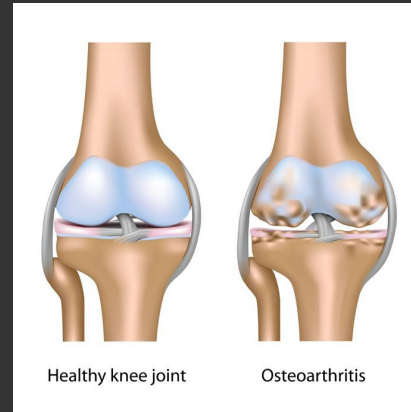
- Articular cartilage destruction
- Increased risk of osteoarthritis as early as 10 years after injury

Social/Emotional

- Isolation from friends, teammates
- Potential for inability to return to pre-injury level of sports

Financial

- Loss of scholarship
- Average cost of surgery: \$12,000; long term societal impact up to \$38,000



Estimated costs for treatment for all ACL injured patients annually in the United States: **3 billion dollars**

This is why prevention is so important!

Prevention Programs

Primary goal: To influence the neuromuscular system via a multicomponent exercise program to prevent injury

Secondary goal: Enhance athletic performance through improved strength, power, and coordination

Effectiveness: Overall 50% reduction in ACL injury in all athletes, 67% reduction for non-contact injuries in females (Webster, Hewett 2018)

Use: Only 13%–20% of female high school teams use NMT prevention programs nationally; only 4% in rural areas (Petushek 2019)

Demonstrates need to educate athletes, coaches, parents, and administrators!

Six Principles of Prevention

1. Age
2. Biomechanics
3. Compliance
4. Dosage
5. Feedback
6. Exercise Variety

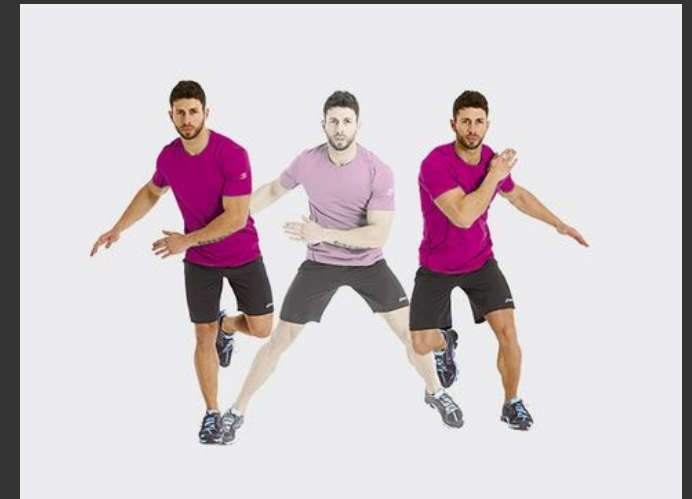
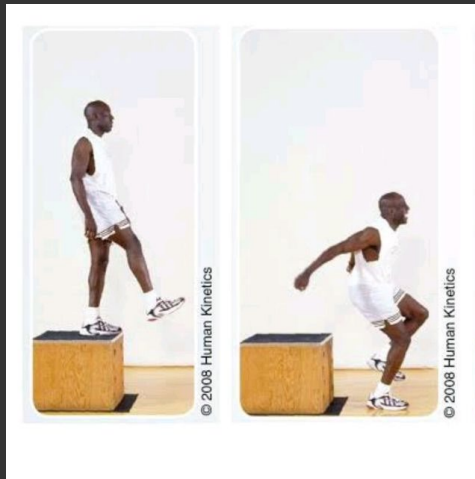


Types of Exercise: Plyometrics

Goal: focus on proper technique and mechanics while improving power generation and force attenuation

Examples:

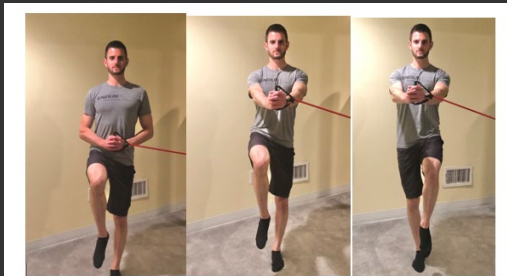
- Drop landings
- Jump/hop and holds



Types of Exercise: Neuromuscular Training

Goals:

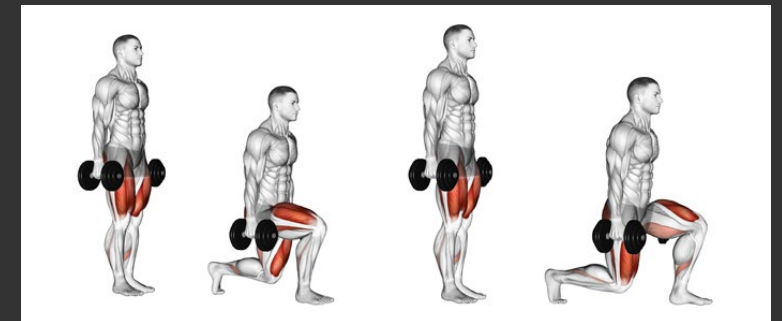
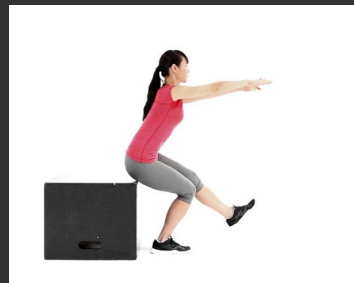
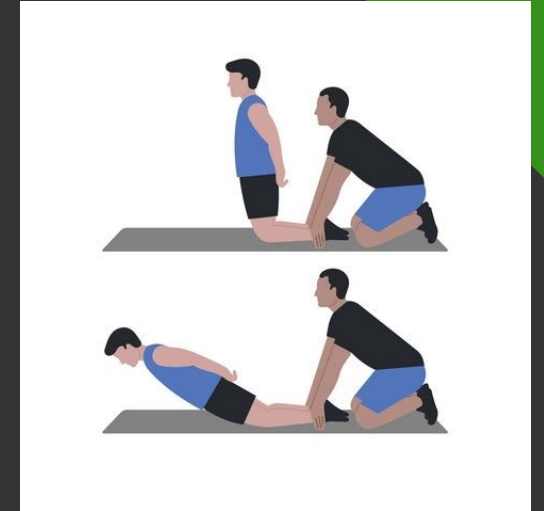
- Improve the ability to generate optimal muscle firing patterns
- Increase dynamic joint stability
- Safely perform movement patterns and skills necessary during sport



Types of Exercise: Strength Training

Muscle groups to include:

- Hamstrings
- Quadriceps
- Hip
- Core
- Calf



Outline of Program

1. Warm up
2. Combination of plyometrics, neuromuscular control, and strengthening exercises
3. Sports specific agility, running, cutting

Individual vs. team-based considerations

FIFA 11+

- Injury prevention program specifically designed to prevent soccer injuries
 - Significantly prevents non-contact injuries in soccer in males and females
 - Decreased rate of injury in male elite basketball players (Longo 2012)
- 20 minutes to complete, 3 components
 - Part 1: running exercises at a slow speed combined with active stretching and controlled partner drills - 8 minutes
 - Part 2: strength, plyometrics, and balance exercises with 3 levels of increasing difficulty - 10 minutes
 - Part 3: running exercises at moderate/high speed combined with planting/cutting- 2 minutes
- Designed to be done at least 2x/week as a warm up
- No specific equipment needed
- 11+ Kids (<14 years old)

FIFA 11+

Performance Benefits

- Improved neuromuscular control (Impellizzeri 2013)
- Improved functional balance (Steffen 2013)
- Enhanced knee hamstring/quadriceps strength ratios and superior static and dynamic balance and agility (Daneshjoo 2012, 2013)
- Improved jumping and agility skills (Brito 2010, Reis 2013)

Implementation

- Coach is key, must motivate players to learn and perform exercises regularly (compliance is key factor in efficacy)
- RCT evaluation different delivery methods: Preseason coaching workshop > unsupervised delivery



Taken from The 11+ Manual

FIFA 11+ - Part 1

The 11+

PART 1 RUNNING EXERCISES · 8 MINUTES



1 RUNNING STRAIGHT AHEAD

The course is made up of 6 to 10 pairs of parallel cones, approx. 5-6 m apart. Two players start at the same time from the first pair of cones. Jog together all the way to the last pair of cones. On the way back, you can increase your speed progressively as you warm up. 2 sets



2 RUNNING HIP OUT

Walk or jog easily stopping at each pair of cones to lift your knee and rotate your hip outwards. Alternate between left and right legs at successive cones. 2 sets



3 RUNNING HIP IN

Walk or jog easily stopping at each pair of cones to lift your knee and rotate your hip inwards. Alternate between left and right legs at successive cones. 2 sets



4 RUNNING CIRCLING PARTNER

Run forwards as a pair to the first set of cones. Shuffle sideways by 90 degrees to meet in the middle. Shuffle an entire circle around one other and then return back to the cones. Repeat for each pair of cones. Remember to stay on your toes and keep your centre of gravity low by bending your hips and knees. 2 sets



5 RUNNING SHOULDER CONTACT

Run forwards in pairs to the first pair of cones. Shuffle sideways by 90 degrees to meet in the middle then jump sideways towards each other to make shoulder-to-shoulder contact.
Note: Make sure you land on both feet with your hips and knees bent. Do not let your knees buckle inwards. Make it a full jump and synchronize your timing with your team-mate as you jump and land. 2 sets



6 RUNNING QUICK FORWARDS & BACKWARDS

As a pair, run quickly to the second set of cones then run backwards quickly to the first pair of cones keeping your hips and knees slightly bent. Keep repeating the drill, running both cones forwards and one cone backwards. Remember to take small, quick steps. 2 sets



11 SQUATS WITH TOE RAISE

Starting position: Stand with your feet hip-width apart. Place your hands on your hips if you like. **Exercise:** Imagine that you are about to sit down on a chair. Perform squats by bending your hips and knees to 90 degrees. Do not let your knees buckle inward. Descend slowly then straighten up more quickly. When your legs are completely straight, stand up on your toes then slowly lower down again. Repeat the exercise for 30 sec. 2 sets



11 SQUATS WALKING LUNGES

Starting position: Stand with your feet at hip-width apart. Place your hands on your hips if you like. **Exercise:** Lunge forward slowly at an even pace. As you lunge, bend your leading leg until your hip and knee are flexed to 90 degrees. Do not let your knee buckle inward. Try to keep your upper body and hips steady. Lunge your way across the pitch (approx. 10 times on each leg) and then jog back. 2 sets



11 SQUATS ONE-LEG SQUATS

Starting position: Stand on one leg, loosely holding onto your partner. **Exercise:** Slowly bend your knee as far as you can manage. Concentrate on preventing the knee from buckling inward. Bend your knee slowly then straighten it slightly more quickly, keeping your hips and upper body in line. Repeat the exercise 10 times on each leg. 2 sets



12 JUMPING VERTICAL JUMPS

Starting position: Stand with your feet hip-width apart. Place your hands on your hips if you like. **Exercise:** Imagine that you are about to sit down on a chair. Bend your legs slowly until your knees are flexed to approx. 90 degrees, and hold for 2 sec. Do not let your knees buckle inward. From the squat position, jump up as high as you can. Land softly on the balls of your feet with your hips and knees slightly bent. Repeat the exercise for 30 sec. 2 sets



12 JUMPING LATERAL JUMPS

Starting position: Stand on one leg with your upper body bent slightly forwards from the waist, with knees and hips slightly bent. **Exercise:** Jump approx. 1m sideways from the supporting leg on to the free leg. Land gently on the ball of your foot. Bend your hips and knees slightly as you land and do not let your knees buckle inward. Maintain your balance with each jump. Repeat the exercise for 30 sec. 2 sets



12 JUMPING BOX JUMPS

Starting position: Stand with your feet hip-width apart. Imagine that there is a cross marked on the ground and you are standing in the middle of it. **Exercise:** Alternate between jumping forwards and backwards, from side to side, and diagonally across the cross. Jump as quickly and explosively as possible. Your knees and hips should be slightly bent. Land softly on the balls of your feet. Do not let your knees buckle inward. Repeat the exercise for 30 sec. 2 sets

FIFA 11+ - Part 2

FIFA 11+ - Part 3

PART 3 RUNNING EXERCISES • 2 MINUTES



13 RUNNING ACROSS THE PITCH

Run across the pitch, from one side to the other, at 75-80% maximum pace.
2 sets



14 RUNNING BOUNDRING

Run with high bounding steps with a high knee lift, landing gently on the ball of your foot. Use an exaggerated arm swing for each step (opposite arm and leg). Try not to let your leading leg cross the midline of your body or let your knees buckle inward. Repeat the exercise until you reach the other side of the pitch, then jog back to recover. 2 sets

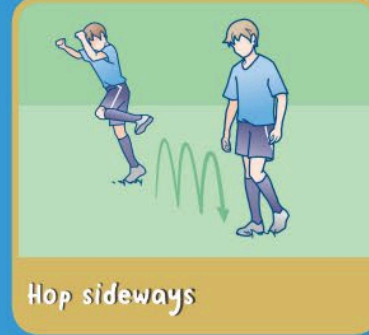
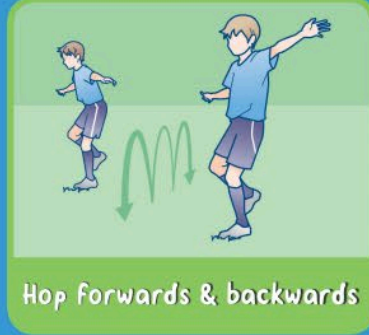


15 RUNNING PLANT & CUT

Jog 4-5 steps, then plant on the outside leg and cut to change direction. Accelerate and sprint 5-7 steps at high speed (80-90% maximum pace) before you decelerate and do a new plant & cut. Do not let your knee buckle inward. Repeat the exercise until you reach the other side, then jog back. 2 sets

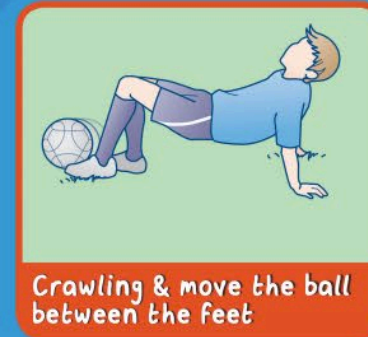
EXERCISE 5 ONE LEG HOPS

- 2x, 5 hops on right leg and 5 hops on left leg
- 2x, 5 hops on right leg and 5 hops on left leg
- 2x, 5 hops on right leg and 5 hops on left leg
- 2x, 5 hops on right leg and 5 hops on left leg
- 2x, 5 hops on right leg and 5 hops on left leg



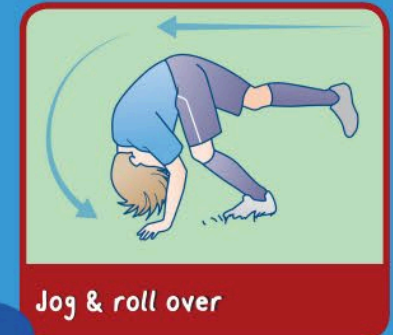
EXERCISE 6 SPIDERMAN

- 3x à 15 seconds
- 3x à 15 seconds
- 3x over 5-10 meters
- 3x over 5-10 meters
- 3x over 5-7 meters



EXERCISE 7 ROLL OVER

- 5-7x per side
- 5-7x per side
- 5-7x per side
- 5-7x per side
- 5-7x per side



The PEP Program

“Prevent injury and Enhance Performance”

Components

- Warm up
- Stretching
- Strengthening
- Plyometrics
- Sports-specific agility

15-20 minutes to complete



Barriers to Implementation

1. Motivation
2. Time requirements
3. Facilitator skill requirements
4. Compliance
5. Cost



How to implement in clinic?

All about your exercise selection! Use the principles of prevention learned today and include these in your daily treatments with your patients!



THANK YOU!

Resources

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