

# ACL Injury Prevention

## A Goal Magazine Piece

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### Intro

Over the past 25 years there has been a wonderful rise in the number of females participating in competitive athletics. You can't turn on the television without seeing a cute ad with little girls playing soccer. Women of all ages are gaining respect and self esteem through their efforts in athletic competition. We have come a long way from the days when "ladies don't sweat, they glow". Women are now sweating with pride.

Unfortunately, this increased activity has been paralleled or exceeded by a rise in serious athletic injuries among women. The most common of these serious injuries involve the anterior cruciate ligament in the knee. Estimates are that 250,000 such injuries occur every year, most commonly among 15 - 25 year old females. Female athletes suffer ACL injuries at a rate two to ten times that of males, depending upon the sport. Female soccer players suffer ACL injuries approximately three times as often as males. Professional women basketball players suffer ACL tears at a rate 10 times that of their male counterparts. Fortunately, there is some good news mixed in with the bad. Early medical research indicates that certain training activities can prevent these serious injuries, both in female and male athletes.

### What is an ACL?

The ACL (anterior cruciate ligament) is a short ligament inside the knee connecting upper leg bone (femur) with the larger lower leg bone (tibia). It looks much like a very thick piece of white ribbon with its thin shiny fibers. The ACL maintains knee stability by preventing these bones from moving too far away from each other, either forward or to the side. It can be strained, partially or completely torn. In approximately 1/3 of cases the ACL is completely torn. An intact ACL is very important to knee function in competitive sports like soccer that require a lot of sudden stops, starts and changes of direction. Although athletes who have a torn ACL can sometimes continue to play their sports, their physical ability is markedly reduced because of the instability of that knee. They just can't do the things they used to do. In addition, because of this instability, athletes who have torn an ACL are much more likely to experience another, potentially disabling knee injury. An athlete with a torn ACL must choose between quitting her sport, continuing to play with less ability and the threat of another injury that might permanently disable her or having major surgery hoping to repair the knee. So, tearing an ACL is a serious problem.

Just how serious? We know that ACL injuries are one of the main causes of permanent sports disability. We have new surgical techniques which are much better than a decade ago, when an ACL injury meant the certain end of sports careers for even highly trained and motivated athletes. Unfortunately, these welcome improvements don't erase the problem. The sad fact is that nearly one third of high level competitive female soccer players sustaining ACL injuries give up the sport because of poor function or fear of re-injury. It is even worse for less committed athletes.

### How common is the problem?

ACL injuries are more common among female athletes than male athletes, up to eight times as common in some studies. In descending order, ACL injuries are most common in gymnasts, soccer, basketball and volleyball players. A survey of NCAA athletes from 1989-93 found that female soccer players suffered ACL injuries at a rate three times that of males. ACL injury rates are so high in college female soccer players that they translate (staggeringly) into nearly one ACL injury for every women's NCAA soccer team every year. The only group of college athletes with a greater risk was female gymnasts. The high risk gymnast's face is easy to understand if one imagines a female gymnast with her hyperflexible joints flying through the air at high speeds and then coming to a dead stop with straight legs, as the form of gymnastics requires. It is distressing that female soccer

players are so close behind their risk level.

The rate of ACL injuries increases with the level of competition. The highest rates are among the highest level female athletes. However, even among high school athletes, ACL injuries are the most common serious knee injury with approximately 20,000 occurring every year in the United States.

### **How do ACL injuries occur?**

As you might imagine, a thin fibrous band inside a very small space surrounded by constantly moving bones is vulnerable to getting pinched or torn. In a way, it is a small miracle of design that ACL's don't tear every time we bend and turn. Although injuring an ACL seems simple, the specifics of why one player gets injured at a particular time become much more complex and confusing. Probably the easiest way to understand ACL injuries is to divide them into two types of injury. The first type is ACL injuries occurring as a result of contact with another player and the second is those that don't .

Contact ACL injuries occur when a player is hit from behind or on the outside of the knee. They are one reason referees should not hesitate to pull out a card when fouls of this nature occur. It doesn't just look bad and hurt, it can end a player's career. ACL injuries from contact occur at a similar frequency in male and female soccer players.

Non-contact ACL injuries result from sudden changes in direction, particularly while slowing down at the same time, and from landing on a straight knee. Either of these movements can shear the ligament practically instantaneously if performed the wrong way at the wrong time.

Non-contact ACL injuries are the reason for the massive difference in ACL injury rates between male and female soccer players. Nearly 80% of ACL injuries in females occur without contact, while non-contact ACL injuries represent a minority of injuries in males. Some studies have shown as much as a four-fold difference in non-contact ACL injury rates between females and males.

One of the factors believed to increase non-contact ACL injuries is the interaction between soccer shoes and the playing surface. In other words, cleats getting caught in the turf and poorly maintained fields can contribute to these injuries. Indoor soccer has a significantly higher rate of ACL injuries than outdoor soccer. It may be that the tendency of artificial turf to grab onto the shoes could lead to ACL injuries. In that case, the newer indoor surfaces, which appear not to catch players' shoes so easily, may be safer surfaces for indoor play. More research is needed for definitive answers to these questions.

### **Why are women at greater risk?**

This question could stump "Who Wants to be a Millionaire" winners. Faced with an epidemic of serious injuries with long-term consequences, we have been trying to understand what can be done to prevent ACL injuries. Many answers have been proposed and probably all of them play some part.

Angle of knee: Because women's hips are wider, the upper leg bone comes down to the knee at a sharper angle, placing additional stress on the ACL

Anatomy of the notch inside the knee: Some people have smaller spaces inside the knee, but whether there is a difference between males and females is controversial.

Hormonal variations: Estrogen makes ligaments looser. One small study found a higher rate of ACL tears around mid-cycle (days 10-14) when estrogen levels peak.

Loose ligaments: Women generally have looser ligaments, possibly increasing ACL risk.

Weaker hamstrings: The smart money is riding on this theory as the most important factor. The big leg muscles, the quads in the front of the thigh and the hamstrings in the back, also help stabilize the knee. When the stress is too great these muscles can't counteract the force. If the stress then

exceeds the strength of the ligament, it suddenly tears. Men have stronger hamstrings than women. Men use their stronger hamstrings when they land from a jump. This appears to be an important preventive factor because recent studies of a training program, which markedly reduced the rate of ACL injuries, also showed considerable improvement in hamstring strength and knee stability.

The point of all this guesswork about "why" is to help us learn how to prevent ACL injuries. It looks like we are getting there.

### **How to prevent ACL injuries**

The first study of any size to show a reduction in ACL injury rates was conducted with 600 Italian male semi-professional soccer players. They found that proprioceptive training reduced ACL injury rates by over 700%.

Proprioception is the ability to locate the extremities in space without looking. Although it may be surprising, loss of proprioception is an extremely common cause of re-injury following knee and ankle injury. The athlete slightly mis-steps and sprains an ankle or knee, even though the joint is strong. These soccer players spent 20 minutes a day (2-6 days a week) of balance training during 4-6 weeks of preseason. They would balance on a balance board for 2-5 minutes on each leg four times a day. During the season they did this three times every week.

Although they used fancier and much more expensive equipment, you can make an adequate balance board by purchasing a 12" round of plywood and gluing 1/2 of a softball to the middle of it. If you've seen the Ajax youth training videos you'll remember their players practicing by standing on such a board while juggling a soccer ball inside a net (to save the furniture).

The biggest and best studies were recently conducted here in the USA by Hewitt on female athletes, including soccer players. Their intervention utilized a six week preseason program of muscles, nerves and coordination, owing much to plyometric jump training. They taught subjects to work on technically perfect jumping landing quietly with a toe to heel rock and bent knees. They also taught the subjects to recoil instantly, preparing for the next jump using images like "straight as an arrow", "light as a feather", "recoil like a spring" and "be a shock absorber." Trained study participants had a rate of ACL injury 3.6 times less than controls. They also found average increases in hamstring strength of 44% and jump height by 1.5 inches. One subject increased her vertical jump by six inches!

Last year I used Hewitt's techniques with my U-10 Class I girl's team. I was very interested to observe that the non-dominant leg of each girl would shake on landing. This shaking is a sign of weakness and one of the technical failures Hewitt's group teaches to avoid. You can learn more about Hewitt's program by purchasing their Cincinnati Sportsmetrics video (contact Cincinnati Sportsmedicine Research and Education Foundation).

Another recent study suggests that simply encouraging basketball players to come to a stop over three steps (perhaps too restrictive in soccer) and to keep the knees bent when turning can reduce knee injuries in female athletes.

Finally, because quadricep-hamstring strength imbalance appears so important, athletes must also work to maintain flexibility of both of these muscle groups. As muscles are strengthened, flexibility can be lost unless athletes conscientiously cool down and stretch at the end of the workout..

### **The bottom line is:**

ACL injuries are a big problem

ACL injuries are a bigger problem for females

ACL injuries are preventable

Every serious female soccer player (of ANY age) should

- Practice proprioceptive training

  - (a good idea for competitive male soccer players as well)

- Strengthen hamstrings by

  - Jump training and/or leg curls

Avoid turning and landing with straight legs  
Cool down and stretch after exercise

These measures can help prevent serious injury and will almost certainly improve performance to boot. Sorry about the pun. I just couldn't resist.

***The Santa Monica Orthopaedic and Sports Medicine Research  
Foundation***

**The PEP Program: Prevent injury and Enhance Performance**

This prevention program consists of a warm-up, stretching, strengthening, plyometrics, and sport specific agilities to address potential deficits in the strength and coordination of the stabilizing muscles around the knee joint. It is important to use proper technique during all of the exercises. The coaches and trainers need to emphasize correct posture, straight up and down jumps without excessive side-to-side movement, and reinforce soft landings. This program should be completed 3 times a week.

The field should be set up 10 minutes prior to the warm-up. This will allow for a smooth transition between the activities. A sample field set-up has been included in your packet.

This program should take approximately 15 – 20 minutes to complete. Along side each exercise you will notice a box with the approximate amount of time that should be spent on each activity. This will serve as a guideline to you in order to conduct your warm-up in a time efficient manner.

**1. Warm-up:** Warming up and cooling down are a crucial part of a training program. The purpose of the warm-up section is to allow the athlete to prepare for activity. By warming up your muscles first, you *greatly reduce* the risk of injury.

A. ***Jog line to line*** (cone to cone):

Elapsed Time: 0 - .5 minute

*Purpose:* Allows the athletes to slowly prepare themselves for the training session while minimizing the risk for injury. Educate athletes on good running technique; keep the hip/knee/ankle in straight alignment without the knee caving in or the feet whipping out to the side.

*Instruction:* Complete a slow jog from near to far sideline

B. ***Shuttle Run*** (side to side)

Elapsed Time: .5 to 1 minute

*Purpose:* engage hip muscles (inner and outer thigh). This exercise will promote increased speed. Discourage inward caving of the knee joint.

*Instruction:* Start in an athletic stance with a slight bend at the knee. Leading with the right foot, sidestep pushing off with the left foot (back leg). When you drive off with the back leg, be sure the hip/knee/ankle are in a straight line. Switch sides at half field.

C. ***Backward Running***

Elapsed Time: 1 – 1.5 minutes

*Purpose:* continued warm-up; engage hip extensors/hamstrings. Make sure the athlete lands on her toes. Be sure to watch for locking of the knee joint. As the athlete brings her foot back, make sure she maintains a slight bend to the knee.

*Instruction:* Run backwards from sideline to sideline. Land on your toes without snapping the knee back. Stay on your toes and keep the knees slightly bent at all times.

**2. Stretching:** It is important to incorporate a short warm-up prior to stretching. Never stretch a “cold muscle”. By doing the exercises outlined here, you can improve and maintain your range of motion, reduce stiffness in your joints, reduce post-exercise soreness, reduce the risk of injury and improve your overall mobility and performance.

- Do a large muscle warm-up such as brisk walking for five to 10 minutes before stretching.
- Don't bounce or jerk when you stretch. Gently stretch to a point of tension and hold.
- Hold the stretch for 30 seconds. Concentrate on lengthening the muscles when you're stretching.
- Breathe normally. Don't hold your breath.

**A. *Calf stretch*** (30 seconds x 2 reps)

Elapsed Time: 1.5 to 2.5 minutes

*Purpose:* stretch the calf muscle of the lower leg

*Instruction:* Stand leading with your right leg. Bend forward at the waist and place your hands on the ground (V formation). Keep your right knee slightly bent and your left leg straight. Make sure your left foot is flat on the ground. Do not bounce during the stretch. Hold for 30 seconds. Switch sides and repeat.

**B. *Quadricep stretch*** (30 seconds x 2 reps)

Elapsed Time: 2.5 to 3.5 minutes

*Purpose:* stretch the quadricep muscle of the front of the thigh

*Instruction:* Place your left hand on your partner's left shoulder. Reach back with your right hand and grab the front of your right ankle. Bring your heel to buttock. Make sure your knee is pointed down toward the ground. Keep your right leg close to your left. Don't allow knee to wing out to the side and do not bend at the waist. Hold for 30 seconds and switch sides.

**C. *Figure Four Hamstring stretch*** (30 sec x 2 reps)

Elapsed Time: 3.5 – 4.5 min

*Purpose:* To stretch the hamstring muscles of the back of the thigh.

*Instruction:* Sit on the ground with your right leg extended out in front of you. Bend your left knee and rest the bottom of your foot on your right inner thigh. With a straight back, try to bring your chest toward your knee. Do not round your back. If you can, reach down toward your toes and pull them up toward your head. Do not bounce. Hold for 30 seconds and repeat with the other leg.

**D. *Inner Thigh Stretch*** (20 sec x 3 reps)

Elapsed Time: 4.5 – 5.5 min

*Purpose:* Elongate the muscles of the inner thigh (adductor group)

*Instruction:* Remain seated on the ground. Spread you legs evenly apart. Slowly lower yourself to the center with a straight back. You want to feel a stretch in the inner thigh. Now reach toward the right with the right arm. Bring your left arm overhead the stretch over to the right. Hold the stretch and repeat on the opposite side.

**E. Hip Flexor Stretch** – (30 sec x 2 reps)

Elapsed Time: 5.5- 6.5 min

*Purpose:* Elongate the hip flexors of the front of the thigh.

*Instruction:* Lunge forward leading with your right leg. Drop your left knee down to the ground. Placing your hands on top of your right thigh, lean forward with your hips. The hips should be square with your shoulders. If possible, maintain your balance and lift back for the left ankle and pull your heel to your buttocks. Hold for 30 seconds and repeat on the other side.

- 3. Strengthening:** This portion of the program focuses on increasing leg strength. This will lead to increased leg strength and a more stable knee joint. *Technique is everything;* close attention must be paid to the performance of these exercises in order to avoid injury.

**A. Walking Lunges** (3 sets x 10 reps)

Elapsed Time: 6.5 – 7.5 min

*Purpose:* Strengthen the thigh (quadriceps) muscle.

*Instruction.* Lunge forward leading with your right leg. Push off with your right leg and lunge forward with your left leg. Drop the back knee straight down. Make sure that you keep your front knee over your ankle. Control the motion and try to avoid you front knee from caving inward. *If you can't see your toes on your leading leg, you are doing the exercise incorrectly.*

**B. Russian Hamstring** (3 sets x 10 reps)

Elapsed Time: 7.5 –8.5 min

*Purpose:* Strengthen hamstrings muscles

*Instruction:* Kneel on the ground with hands at your side. Have a partner hold firmly at your ankles. With a straight back, lead forward leading with your hips. Your knee, hip and shoulder should be in a straight line as you lean toward the ground. Do not bend at the waist. You should feel the hamstrings in the back of your thigh working. Repeat the exercise for 3 sets of 10, or a total of 30 reps.

**C. Single Toe Raises** (30 reps x 2 reps)

Elapsed Time: 8.5 – 9.5 min

*Purpose:* This exercise strengthens the calf muscle and increases balance.

*Instruction:* Stand up with your arms at your side. Bend the left knee up and maintain your balance. *Slowly* rise up on your right toes with good balance. You may hold your arms out ahead of you in order to help. Slowly repeat 30 times and switch to the other side. As you get stronger, you may need to add additional repetitions to this exercise to continue the strengthening effect of the exercise.

**4. Plyometrics** – These exercises are explosive and help to build, power, strength and speed. The most important element when considering performance technique is the landing. *It must be soft!* When you land from a jump, you want to softly accept your weight on the balls of your feet slowly rolling back to the heel with a bent knee and a straight hip. These exercises are basic, however, it is critical to perform them correctly. Please take the time to ensure safe and correct completion of these exercises.

- A. Lateral Hops over Cone** (20 reps) Elapsed Time: 9.5 – 10min  
*Purpose:* Increase power/strength emphasizing neuromuscular control  
*Instruction:* Stand with a 6” cone to your left. Hop to the left over the cone softly landing on the balls of your feet land bending at the knee. Repeat this exercise hopping to the right.
- B. Forward/Backward Hops over cone** (20 reps) Elapsed Time: 10 – 10.5 min  
*Purpose:* Increase power/strength emphasizing neuromuscular control  
*Instruction:* Hop over the cone/ball softly landing on the balls of your feet and bending at the knee. Now, hop backwards over the ball using the same landing technique. Be careful not to snap your knee back to straighten it. You want to maintain a slight bend to the knee. Repeat for 20 reps.
- C. Single Leg hops over cone** (20 reps) Elapsed Time: 10.5 – 11 min  
*Purpose:* Increase power/strength emphasizing neuromuscular control.  
*Instruction:* Hop over the cone/ball landing on the ball of your foot bending at the knee. Now, hop backwards over the ball using the same landing technique. Be careful not to snap your knee back to straighten it. You want to maintain a slight bend to the knee. Repeat for 20 reps. Now, stand on the left leg and repeat the exercise. Increase the number of repetitions as needed.
- D. Vertical Jumps with headers** (20 reps) Elapsed Time: 11 – 11.5 min  
*Purpose:* Increase height of vertical jump.  
*Instruction:* Stand forward with hands at your side. Slightly bend the knees and push off jumping straight up. Remember the proper landing technique; accept the weight on the ball of your foot with a slight bend to the knee. Repeat 20 times and switch sides.
- E. Scissors Jump** (20 reps) Elapsed Time: 11.5 – 12 min  
*Purpose:* Increase power and strength of vertical jump.  
*Instruction:* Lunge forward leading with your right leg. Keep your knee over your ankle. Now, push off with your right foot and propel your left leg forward into a lunge position. Be sure your knee does not cave in or out. It should be stable and directly over the ankle. Remember the proper landing technique; accept the weight on the ball of your foot with a slight bend to the knee. Repeat 20 times.

## **5. Agilities**

### **A. *Shuttle run with forward/backward running***

Elapsed Time 12 – 13 min

*Purpose:* Increase dynamic stability of the ankle/knee/hip complex

*Instruction:* Starting at the first cone, sprint forward to the second cone, run backward to the third cone, sprint forward to the fourth cone (etc...).

### **B. *Diagonal runs* (3 passes)**

Elapsed Time 13 – 14 min

*Purpose:* To encourage proper technique/stabilization of the outside planted foot to deter the position from occurring.

*Instruction:* Face forward and run to the first cone on the left. Pivot off the left foot and run to the second cone. Now pivot off the right leg and continue onto the third cone. Make sure that the outside leg does not cave in. Keep a slight bend to the knee and make sure the knee stays over the ankle joint.

### **C. *Bounding run* (44 yds)**

Elapsed Time 14 – 15 min

*Purpose:* To increase hip flexion strength/increase power/speed

*Instruction:* Starting on the near sideline, run to the far side with knees up toward chest. Bring your knees up high. Land on the ball of your foot with a slight bend at the knee and a straight hip. Increase the distance as this exercise gets easier.

## **6. Alternative Exercises – Warm Down and Cool Down**

We all know how imperative a cool down is. Please don't skip it. It allows the muscles that have been working hard throughout the training session to elongate and deters the onset of muscle soreness. Please emphasize the importance of adequate fluid intake (optimally water). Athletes should have a water bottle by their side during the cool down. The cool down should take approximately 10 minutes. It should begin with a slow jog to allow the heart rate to come down before stretching. This should be followed by some light strength training exercises. We are recommending two strengthening exercises (see below). Finally, stretch the hamstrings, calves, inner thigh, quadriceps, and low back (all of these are explained in the protocol). In addition to those basic stretches, we are offering some additional stretches to target 3 muscle groups that are often forgotten.

### **A. *Bridging with Alternating Hip Flexion* (30 reps)**

*Purpose:* Strengthen outer hip muscles (Hip abductors, flexors) and buttocks

*Instruction:* Lie on the ground with your knees bent with feet on the ground. Raise your buttocks up off the ground and squeeze. Now, lift your right foot off the ground and make sure that your right hip does not dip down. Lower your right foot and now lift your left foot making sure your left hip does not dip down. Repeat 30 times on each side. As you get stronger, you will place your feet on top of a ball and repeat the exercise.

**B. Abdominal Crunches** (30 reps x 2 reps)

*Purpose:* Strengthen the abdominals (rectus abdominus, obliques)

*Instruction:* Lie on the ground with your knees bent. Place your hands behind your head with your elbows out wide. Support your neck lightly with your fingers. Take a deep breath in and slowly contract your abdominal muscles as you exhale. Repeat 30 times. Drop your legs off to the right side. Slowly crunch up with your elbows out wide. You should feel your oblique muscles working on the side of your waist. Repeat 30 times and switch to the other side.

**C. Single and Double Knee to Chest** (supine) (30 sec x 2 reps)

*Purpose:* Elongate the low back muscles

*Instruction:* Lie on your back. Bring your right knee toward your chest and hug firmly. Keep your left leg out straight in front of you. You should feel a stretch along your low back and into your buttocks. Hold the stretch for 30 seconds and switch sides. Now bring both knees to chest. If you feel any pain in the low back, discontinue the stretch and inform your coach/trainer.

**D. Figure Four Piriformis stretch-** supine (30 sec x 2 reps)

*Purpose:* Elongate the rotators of the hip.

*Instruction:* Lie on your back and bend both of your knees. Fold your left ankle over your right knee. Place your hands behind your right thigh and pull your right knee to chest. You should feel a good stretch in the left gluteals region and the side of the thigh. Hold for 30 seconds and repeat on the other side. If you experience and low back pain with this stretch, slowly lower your legs down and let your coach/trainer know.

**E. Seated Butterfly stretch** - seated (30 sec x 2 reps)

*Purpose:* Elongate the inner thigh muscles (adductors).

*Instruction:* Sit up bringing your feet in so that the soles of your feet are touching. Gently place your elbows on your knees and slowly push down. You should feel a good stretch of the inner thigh. Hold this for 30 seconds and repeat 2 to 3 times.

***If you have any questions or concerns regarding this program, please contact Holly Silvers, MPT at (310) 315-0292 ext. 1283 or via email: HollySilversPT@aol.com.***