

ACL Injury Prevention Program For The Competitive Female Athlete

Education, Exercises, and Techniques designed to address the current epidemic of ACL tears in today's young female soccer players.

Parent's Manual Prepared For Cal Blues Soccer Club November 2013



Presented by: **Quinn A. McArthur, PT, OCS**

Owner/Director - Swanson McArthur Physical Therapy
Licensed Physical Therapist

Board Certified Orthopedic Clinical Specialist
NESTA Certified Speed, Agility, and Quickness Specialist
Injury Education Coordinator - Placer United Soccer Club

ACL Injury Prevention Program Director - Woodcreek High School Soccer Program

Swanson McArthur Physical Therapy



Specialists in Orthopedic and Sports Injury Rehabilitation

Thank you for your interest in youth athletics, especially competitive girl's soccer. This handout and the seminar which will accompany it has been designed to educate the parent of a female soccer player. For the reasons which will be explained shortly, our young female athletes often suffer significant injuries, which in some instances can be avoided. The information presented has been collected from prestigious, peer-reviewed, and evidence-based journals. The body of knowledge currently available in the literature is growing and changing. Provided today is what we (medical professionals) feel is the most agreed upon.

Statistics

An estimated **80,000** ACL tears occur annually in the United States, with the higher incidence in individuals **15 to 25** years of age who participate in pivoting sports. Soccer, volleyball, and basketball represent the three sports where the majority of ACL injuries occur in females. ACL injury results in instability of the knee and is associated with meniscal tear in up to **77%** of cases and chondral (cartilage) injury in up to **23%** of cases.

Reconstructive surgery is often utilized to restore an athlete's function and stability. Unfortunately, the re-injury rate following surgery has been reported as high as **11%**. Furthermore, a recent study following athletes after 5 years post-surgery reported the presence of degenerative changes within the repaired knee joint to be **31%**.

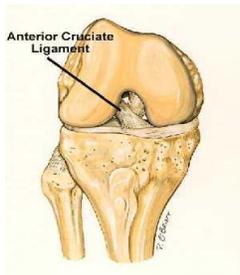
This information tells us that girls are more susceptible to ACL tears due to a number of potential causes. To avoid re-injury after surgery, the athlete needs to overcome not only post-operative issues of pain, swelling, ROM and strength loss, and functional/sports-specific limitations, but also the existing issues that lead to the tear initially. Assessing these factors requires careful evaluation, correction, re-assessment, and repetition. The following information is designed to give the reader a basic understanding of the current ACL injury epidemic that is plaguing female athletics. The information is evidence-based and taken from peer-reviewed journals.

Over the past three decades the number of soccer related ACL injuries has risen significantly in girls. Due in large part to Title IX, which gave girls equal opportunity to academic and sports programs, exposure to the recreational activities once dominated by boys changed. As a result, a progressive increase in serious injuries has occurred. When comparing boys with girls in the same sport (soccer) girls have a far greater number of knee injuries and are 3 times more likely to sustain a **non-contact** ACL injury. In fact, **70%** of all ACL injuries in girls are non-contact...the ligament tears due to the compromised position the athlete puts it in.

Research directed at this issue is extensive and has helped explain why the disparity between the sexes exists. Anatomical, hormonal, and neuromuscular differences have been studied and the results have been both interesting and helpful.

Functional Anatomy

The **ACL** (anterior cruciate ligament) is a thick fibrous band of tissue deep in the knee joint holding the femur (thigh) to the tibia (leg). In girls (women) the ACL is smaller in diameter compared to that of their male counter-parts. Since it is a ligament it receives very little blood flow, and therefore has very poor healing potential if injured. Its function is to prevent the tibia from moving **forward** on the femur. It also resists over-straightening of the knee and twisting.

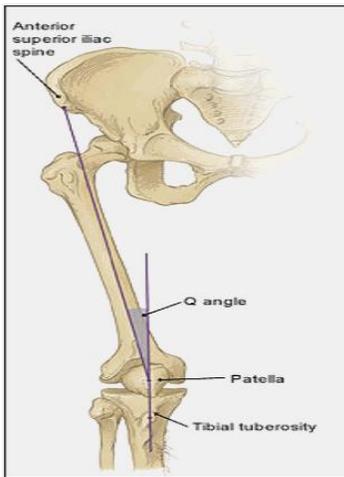


The **intercondylar notch** is the space between the two rounded ends of the femur. In males, the notch is an inverted U-shape, whereas in females, the notch is more of an inverted A-shape. The intercondylar notch is also larger in males than females.

The **quadriceps** and **hamstrings** are groups of muscles covering the front and rear of the thigh which offer support and function to the knee. When the quadriceps contract the tibia is pulled **forward**. As the hamstrings contract, the tibia is pulled **backward**. Therefore, one of the hamstrings' functions is supporting the ACL, and offsetting the vigorous forward pull of the quads.



Due to a wider pelvis, girls (adolescent-age) develop a greater **Q-Angle** (quadriceps angle) (see illustration) and a tendency towards **valgus** or “knock-knees”.



This angle averages 11 degrees in men and 15 degrees in women. During puberty the angle increases in girls from a value close to that of boys to that stated above, as the pelvis widens. The increase in the Q-angle has been linked to a variety of foot, ankle, and knee injuries.

Studies have shown that girls and boys perform soccer related movements such as cutting and jumping in similar ways prior to musculoskeletal maturation (puberty). Following puberty, girls demonstrate an **inability to control the position of the knee**. As a result, the knee moves inward excessively and reinforces the tendency toward the knock-knee posture. This position puts the knee at risk for serious injury.

Hormonal factors may exist as well. During ovulation, estrogen levels peak and ligaments are more lax, making ligaments more prone to injury. The research, however, is inconclusive relative to how at risk an athlete is during ovulation to ACL injury.



Soccer-Specific Movement Science

Running, cutting, and jumping are movements vital to the game of soccer. Inherent within these movements is the potential for injury if they are performed incorrectly. Noncontact ACL injuries often occur with knee slightly bent and in a **valgus** position. With highly skilled athletes playing longer seasons at a higher competitive level, the stresses at the knee can be significant. The research indicates that **differences** exist between boys and girls in the way they run, cut, jump, and decelerate. In assessing electrical muscle activity, force plate values, and video analysis, girls have been found to:

- **run** both forward and backward in a more upright position
- **cut**, standing more upright with the outside/planted leg, in valgus (caving in)
- land firmly from a **jump** more flat-footed, with less knee flexion (bend), and less hip flexion (bend)
- over utilize the quads when **squatting** and **running**
- underutilize the hamstrings when **running, cutting, and decelerating**
- **decelerate** more with dominate quads in a more upright trunk position
- have weaker hamstrings in the non-dominant leg

Putting It Together

If one reviews the **biomechanics** we see that the combination of muscular weakness in the hamstrings and gluteals with the over utilization of the quads puts girls at risk. The hamstrings are unable to counteract the quads forward pull on the tibia. Since the hamstrings and gluteals are weak they don't support a softer landing or a safer cutting motion. As a result the athlete is more upright and in a knock-knee position...further putting her at risk. When these are combined with the **anatomical disadvantages** described previously, as well as the potential hormonal issues, one begins to understand the high incidence of ACL tears in female athletes.

What Can Be Done to Reduce the Risks Inherent in Girls Competitive Soccer?

The research points to 4 potential reasons for ACL failure

- Anatomical
- Hormonal
- Proprioceptive
- Neuromuscular

Since we have no control over anatomical or hormonal factors, our focus must be on re-educating the most important structures in and around the knee. This can be achieved through **neuromuscular** and **proprioceptive** training.

A recent study found specific neuromuscular and proprioceptive training exercises reduced non-contact ACL injuries by **74%**. This “prevent injury and enhance performance” program (as well as others) teaches proper running, jumping, and stopping. The program focuses on injury awareness and avoidance techniques (education) lower extremity and trunk strength/stability, flexibility, progressive plyometrics, and sports-specific agilities.

Proprioception is our ability to sense where we are in space. We rely on our inner ear for equilibrium, our eyes for visual awareness, and our muscles and joints for limb position and effort. We can, with proper training, use these systems to learn how to properly move, balance, and coordinate actions.



Neuromuscular training is our ability to consciously choose to move in a specific way. We teach our muscles and joints how to perform an activity or movement pattern through biofeedback or instruction. We rely on proprioception (where we are in space) to perform new movements/skills or relearn old, poorly performed movements/skills. Basically, we can train ourselves how to move...properly.

We must teach our soccer players the techniques of how to run, jump, land, and move prior to teaching endless numbers of drills and exercises.

Soccer Training Implications

Since girls possess a tendency to overuse their quads when landing and decelerating, we **must** teach through neuromuscular re-education, how to use alternative and more supportive muscles. In essence, female athletes must learn to move in a way that will reduce the risk of injury. Studies have shown that adding proprioceptive and neuromuscular training exercises to the training regimen can reduce the number of ACL injuries by 2-4 times.

Jumping

The research indicates it is essential that girls land from a jump **softly** on the balls of their feet, then fall to the mid-foot, and then heel. They must bend their knees and maintain a knee position in line with their ankles and second toes. The knees must **never** extend over the foot, **never** hyperextend, and the hips should flex to further absorb shock.

Cutting and Pivoting

These soccer-specific motions must occur with flexed knees, while maintaining knees over the ankles and avoiding a “caving in” of the knees or the tendency toward knock-knee positioning. Flexing the knees properly **teaches** the hamstrings and gluteals to assist the action, counteracting the forward pull of the dominant quads, and reducing ACL stresses.

Running

Girls must run less upright with slightly bent knees, avoid the knock knee position, and stay flat-footed. They should be on their toes when sprinting. Backward running must occur with bent knees while the athlete stays on her **toes** and leans forward (while maintaining a straight back). She will be better balanced and able to change directions safely. Keeping the knees bent and maintaining a lower position will reduce ACL stresses.

Decelerating

The athlete must stay low with the knees over the ankles (not caving in) and the weight off the heels.

Girls can, with the help of a PT, trainer, or coach, learn through neuromuscular re-education techniques how to move more effectively, more safely, and more appropriately. This will reinforce proper movements in a game situation, and **reduce** the risk of ACL injury.

Training

The following training program has been adapted from the Santa Monica ACL Prevention Project. It has been established and modified to reduce the risks previously described. It has been designed as a warm-up, should take only 15-20 minutes, and has been proven, in two studies, to reduce ACL injuries by 74%-88%. It should be performed 2-3 times per week during the season and modified by a trainer as needed. I have found it helpful to perform the program in its entirety once per week with a shorted, more condensed version utilized prior to game play. **Proper form must be emphasized and corrected if needed.**

ACL Injury Prevention Program

The ACL Injury Prevention Program is a highly specific 20-minute training session that replaces the traditional warm-up. Once again, the program goal is to teach players strategies to avoid injury by:

1. Avoiding vulnerable positions
2. Increasing flexibility
3. Increasing strength
4. Including plyometric exercises in training
5. Increasing proprioception

Specific Program Elements consist of:

- Warm-Up
- Dynamic Stretching
- Strengthening
- Plyometrics
- Sport-specific Agilities
- Cool Down
- Static Stretching

Optimally the program should be performed at least 2-3 times per week during the season. This program consists of a warm-up, dynamic stretching, strengthening, plyometrics, and sport specific agility training, and static stretching. It is important to use proper technique during jumping moves (jump straight up and down jumps without excessive side-to-side movement), decelerating (knees bent and the body low), and aim for **soft landings**.

This program should take approximately 20 minutes to complete. **Alongside each exercise you will notice 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.

Warm-up: Warming up and cooling down are crucial parts 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.

1. **Jog line to line** (side to side/near to far sideline):

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

2. **Shuttle Run** (near to far sideline)

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.

3. **Backward Running** (near to far sideline)

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.

Dynamic Stretching: Seven movements designed with the athletes in two parallel lines, moving together. The stretches engage hamstring, calf, groin, gluteal, quad, and hip flexor musculature. Modifications can be made to challenge the athletes and encourage more sport-specific motions.

Strengthening: The strengthening phase of the program focuses on increasing lower extremity strength. This will lead to increased muscle strength to all of the muscles surrounding the knee which will ultimately contribute to its stability. Technique is everything; close attention must be paid to the performance of these exercises in order to avoid injury.

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

- *Elapsed Time: 6.5 - 7.5 min*
- **Purpose:** Strengthen the thigh (quadriceps) muscle.
- 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 your front knee from caving inward.
- If you cannot see your toes on your leading leg, you are doing the exercise incorrectly.

2. **Hamstrings** (Russian Hamstrings) (3 sets x 10 reps)

- *Elapsed Time: 7.5 - 8.5 min*
- **Purpose:** Strengthen hamstrings muscles.
- Kneel on the ground with hands at your side.
- Have a partner hold firmly at your ankles.
- With a straight back, lean 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.

3. **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.
- 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.

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. Although these exercises are basic, it is critical to perform them correctly. **Please take the time to ensure safe and correct completion of these exercises.**

*U11 and U12 coaches: see the addendum page.

1. **Lateral Hops over Cone** (20 reps)

- *Elapsed Time: 9.5 - 10 min*
- **Purpose:** Increase power/strength emphasizing neuromuscular control.
- 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 and hips).
- Repeat this exercise hopping to the right.

2. **Forward/Backward Hops over Cone** (20 reps)

- *Elapsed Time: 10 - 10.5 min*
- **Purpose:** Increase power/strength emphasizing neuromuscular control.
- 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.

3. Single Leg hops over Cone (20 reps)

- *Elapsed Time: 10.5 - 11 min*
- Purpose: Increase power/strength emphasizing neuromuscular control.
- 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.

4. Vertical Jumps with Headers (20 reps)

- *Elapsed Time: 11 - 11.5 min*
- Purpose: Increase height of vertical jump.
- 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.

5. Scissors Jump (20 reps)

- *Elapsed Time: 11.5 - 12 min*
- Purpose: Increase power and strength of vertical jump.
- 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.

Sport-specific Agilities: Agility exercises challenge the body's ability to move and change direction and position quickly. This must be performed effectively and while under control. One's agility comes with proper performance of activities which challenge timing, tempo, speed, quickness, and alertness. As the body learns through improvements in balance and neuromuscular control, the athlete begins to move quickly, economically, and safely.

1. Forward/Backward running (3 passes)

- *Elapsed Time: 12 - 13 min*
- **Purpose:** Increase dynamic stability of the ankle/knee/hip complex.
- Starting at the first cone,
- sprint forward to the second cone,
- run backward to the third cone,
- sprint forward to the fourth cone (etc.).

2. 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.
- 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.

3. **Bounding run (44 yds)**

- Elapsed Time: 14 - 15 min
- **Purpose:** To increase hip flexion strength/increase power/speed.
- 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.

Option: Combine a variety of agility exercises including ladders, cones, and box drills to include the various elements of the prevention program, while changing the routine. This will keep the athletes engaged and limit staleness.

Cool Down: Cooling down is essential to the program and shouldn't be skipped. It allows the muscles that have been working hard throughout the training session to elongate and deters the onset of muscle soreness. It is helpful to drink water during the cool down. The cool down takes about 10 minutes. It includes light strength training and stretching exercises. **This should be performed after soccer training.**

1. **Bridging with Alternating Hip Flexion (30 reps)**

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

2. **Planks (3x 30 seconds)**

- **Purpose:** Build core strength
- Support your body on forearms and toes
- Keep your trunk level and your buttocks level and hold
- Progress to single leg lifts with the plank

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

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

4. **Double Knee to Chest (30 sec x 2 reps)**

- **Purpose:** Elongate the low back muscles.
- Lie on your back.
- Bring your knees toward your chest and hug firmly.
- You should feel a stretch along your low back and into your buttocks.
- Hold the stretch for 30 seconds.
- If you feel any pain in the low back, discontinue the stretch and inform your coach/trainer.

5. Piriformis stretch- supine (30 sec x 2 reps)

- **Purpose:** Elongate the rotators of the hip.
- 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 gluteal 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.

Static Stretching: The warm up before stretching is very important to decrease the risk of injury. The following exercises help improve range of motion, reduce stiffness, reduce post-exercise soreness, **reduce the risk of injury**, and improve overall mobility and performance. Don't bounce but gently stretch to a point of tension and hold. Hold the stretch for **30 seconds** (don't hold your breath).

1. Calf stretch (30 seconds x 2 reps)

- *Elapsed Time: 1.5 to 2.5 minutes*
- **Purpose:** Stretch the calf muscle of the lower leg.
- 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.

2. Quadriceps stretch (30 seconds x 2 reps)

- *Elapsed Time: 2.5 to 3.5 minutes*
- **Purpose:** Stretch the quadriceps muscle of the front of the thigh.
- Place your left hand on your partner's left shoulder – if needed.
- 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.
- Do not allow knee to wing out to the side and do not bend at the waist.
- Hold for 30 seconds and switch sides.

3. Hamstring stretch (30 seconds x 2 reps)

- *Elapsed Time: 3.5 - 4.5 min*
- **Purpose:** To stretch the hamstring muscles of the back of the thigh.
- 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.

4. Inner Thigh Stretch (30 seconds x 2 reps)

- *Elapsed Time: 4.5 - 5.5 min*
- **Purpose:** Elongate the muscles of the inner thigh (adductor group).
- 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.

5. Hip Flexor Stretch (30 seconds x 2 reps)

- *Elapsed Time: 5.5 - 6.5 min*
- **Purpose:** Elongate the hip flexors of the front of the thigh.
- 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 reach back for the left ankle and pull your heel to your buttocks.
- Hold for 30 seconds and repeat on the other side.

