

# Prevention of ACL injuries

## 1. Introduction

Good evening. Thank you for coming to our sports seminar tonight. I would like to thank Dr Sol and Valley Care Hospital for putting this together for us. As you may know we are in the process of creating a sports medicine program for Valley Care Hospital and the community at large. Sports Medicine as a concept not only involves diagnosis and treatment, but also involves issues of prevention and conditioning. You will hear about a combination of these issues tonight.

**Questions:** what is ACL? Do you someone who has had an ACL injury? Can you do something to prevent it? Neuromuscular control? Proprioception?

2. I am here tonight to talk to you about Prevention of Anterior Cruciate Ligament Injuries. The impact of Anterior Cruciate Ligament injuries (or as we say ACL injuries) is tremendous. An estimated 100,000 anterior cruciate ligament tears occur every year in this country, with the majority of these knee injuries happening in the 15 – to 25 year-olds. To the society, the cost of repairing these injuries is almost 1.5 billion dollars a year. To the individual there are both short and long-term consequences that we can talk about.

The short-term consequences are obvious with a player losing many hours of participation and game time, the long term consequences are that the player stands a higher chance of getting arthritis in the future.

**3.** In the last few years the ACL injuries have been a very common problem that we have seen in the young athlete. And one area of concern is that girls appear to be more susceptible to this injury. Several studies have identified increased incidence of ACL injuries in the female athlete, and in some of the studies the incidence can be anywhere between 2 to 8 times greater. As a result people have begun to ask the question: why this occurs?

The point of my talk tonight is not to talk about how we diagnose it, or how we treat it, but to talk about how this injury occurs and is there something we can do to prevent it?

#### **4. Knee Anatomy**

Before we go on lets review the normal healthy knee. This is a schematic diagram looking at the knee, and this is the right knee. And we are looking directly into the knee. We have the patella (which is commonly called the knee cap), the femur (which is the major thigh bone), the tibia (which is the lower leg bone), and the fibula (which is the small bone in the leg).

The other important structures are the structures that overly the bones, and they include the articular cartilage (which essentially covers the ends of the bones), including the femur and the tibia. The meniscal cartilages, of which you have two, one on the inside and one on the outside part of the knee. The major ligaments, the posterior curciate ligament and the anterior cruciate ligament or as we call it the ACL. And this is the major ligament that we are concerned with, as we understand the anatomy of the knee.

**5.** The function of the knee as the athlete runs, pivots, cuts, and jumps is determined by the integrity of the bones, the articular cartilage, the meniscal cartilages, as well as the ligaments and muscles that control the knee.

When the athlete runs, the load bearing occurs through the articular and meniscal cartilages. The major function of the meniscal

cartilage is to distribute force. The ligaments provide the tightness of the knee. They are the primary stabilizers of the knee. The muscles provide control of the knee and additional stability; these are the secondary stabilizers of the knee.

So when there is an injury to the ACL, there is a loss of the ability to bear load, pivot, cut, jump, and land, which are all critical to sports performance.

## **6. Mechanism of Injury**

Now let's talk about the Biomechanical aspects of the knee. The Anterior Cruciate Ligament's major function is to restrict the lower leg (the tibia and fibula) from moving to the front, or anteriorly on the femur. So when the athlete cuts, pivots and jumps, as they plant the leg, the ACL is engaged in such a way to keep the knee stable, while the foot is planted on the ground.

**7.** Now that we understand the normal anatomy and normal function, let's talk about what happens when the athlete gets injured.

These athletes run, jump and pivot down the field, whatever they do, they do without thinking about it. It is amazing how the human body works. A complex array of nerves, muscles, bones, ligaments and cartilages all work to optimize what we know as performance in the athlete. This is what is referred to as neuromuscular control of the body. *Neuromuscular control* is essentially unconscious control of our body's movements and muscles by the brain. *Proprioception* is our body's ability to know where our knees, ankles, and feet are in space. Both of these functions occur unconsciously at the brain stem level, without the athlete even thinking about it.

**8.** But what happens in that one in a million times that the athlete cuts, pivots or lands a jump and the ligament tears. Something happens to the ligament that results in a tear, this is usually referred to as a significant knee injury, in which the ACL can tear, the meniscal cartilages can tear and the articular cartilage can become injured. So these are the injuries that we are most concerned about.

## **9. What causes ACL injuries?**

### **Primary risk factors.**

How do these injuries occur? We know from studies done on population of athletes, that most commonly, about 70% of these injuries, occur when there is no contact whatsoever. When the athlete is left by themselves and no one else is around, and the ACL can become torn. How does this occur?

This question has been extensively studied by a group of clinicians who have had the opportunity to review many videotapes, looking at these injuries. And the feeling is that the most common factor that determines the Anterior Cruciate Ligament tear is what we know to be the biomechanical factors.

What are we talking about?

We are talking about a **body position** that is associated with increased risk of injury.

**10.** The next time that you are on the field or on the court pick five kids on the field and observe the way they run, pivot, jump and change direction. You will notice that some of these kids look different when they are doing these activities. Some kids appear to be more agile, they run, jump, and pivot in a more **crouched position**, hips and knees are bent. Their center of gravity appears to be directly over their feet. Some appear more awkward; they run, jump and land in a more **upright position**. Their center of

gravity appears to be behind the knee. They may appear to be more flat footed when they land a jump.

We are talking about the athlete that tends to land a jump or decelerate with the knees and hips straight, and with the feet flat on the ground. Female athletes have been shown to maintain some of these distinct biomechanical characteristics, even at elite competitive levels.

**11.** So when we look at the position of the body during the landing, cutting, or pivoting , what we find is that the hips and knees are straight and when the athlete is landing the feet are flat. And what we have realized is that when the athlete has this certain body position, this puts the ACL at risk.

In comparison, when the athlete is on his/her toes, the knees are bent, and the hip is flexed, the risk of ACL injury is minimized.

**12.** One final biomechanical factor that is important is the *balance of power* and the *recruitment pattern* of the muscles that control the knee. The quadriceps muscles are ACL antagonists that place excessive stress on the ACL, and the Hamstring muscles are ACL agonists that, protect the ACL. So if the hamstrings are too weak and the quadriceps are too strong, this tends to put the ACL at risk. Female athletes tend to be *Quadriceps dominant*, that means that when a stress is applied to the knee, they tend to fire their quadriceps first; whereas male athletes respond to the same stress by firing the hamstrings first, (*hamstring dominant*). Many have suggested that athletes should focus on a *balance of strength* between the hamstrings and the quadriceps, And that the hamstrings should be at least 60% to 80% as strong as the quadriceps. Many of the plyometric jumping drills accomplish just that.

### **13. Other risk factors**

Other researchers have looked at other factors which can potentially cause the anterior cruciate ligament injury, and have

broken these down to anatomic, environmental, and hormonal factors.

**14.** The first is the anatomic factors. There have been several studies that have related the cause of ACL injuries to the size of this structure which we call the Intercondylar notch. The studies state that perhaps it is the size of the notch being too small that leads to Anterior Cruciate ligament injury. However there appears to be insufficient evidence to establish a relationship between notch width and ACL injury. Also others have looked at the size of the ligament, as well as the alignment of the lower leg as the potential cause, but once again we believe that these are not the most important factors causing injury.

**15.** Secondly, environmental factors have been looked at. Studies have looked at fields and the quality of the fields, as well as shoe design, And there has only been one study showing that in American Football, that in fact there may be some association between cleat design in shoes and anterior cruciate ligament injuries.

**16.** The third cause is hormonal factors. One hypothesis is that hormones such as estrogen, which can relax soft tissues, can predispose the female athlete to ACL tears. At this point this research is still in its infancy and there is not enough information from which to draw any conclusions.

### **17. Moment of Injury**

When the injury occurs, what the athlete feels most of the time is a loud pop. The ligament tears, the tibia subluxes forward and pops back in.

Instantaneously, the athlete will feel pain. At that point he or she should just feel comfortable, lie down on the turf, wait for the coaches and trainers to come out and help you off the field.

At that point it is best to consult your physician, who will listen to exactly what happened, the history; do a physical examination, get some X-rays and an MRI, leading to an Arthroscopic Surgery, if in fact the ACL has been injured.

On a good note, once the ACL is arthroscopically reconstructed and this is coupled with a good sports rehab program, most athletes return to sports anytime between 6 to 9 months, and some up to a year depending on the situation.

**18.** The reason we want to understand what causes ACL injuries is so we can put together a prevention strategy, and it appears that biomechanical factors are the most critical element. Over the last few years several landmark studies have in effect incorporated *Neuromuscular* and *Proprioceptive* programs into their pre-season and in-season conditioning, and have shown dramatic reduction in the incidence of ACL tears.

These include **plyometric jump-training** and **balance drills** that essentially retrain the athlete's unconscious mind about their body position.

**19.** The major studies include the PEP program by Dr Mandelbaun in Santa Monica, in which over 3000 girls playing soccer ages 14 to 18 were involved with the study. There was approximately an 80% reduction in ACL injuries. Dr Caraffa's program in Italy, in which 600 male soccer players were involved with the study in which *balance training* was primarily emphasized, and Dr Hewett's program in Cincinnati in which more than 1200 athletes were involved, and *plyometric jump training* was emphasized. These studies as well showed a significant (6 to 7 fold) reduction in ACL tears in those who received the Neuromuscular training methods.

**20.** The PEP program (**P**revent Injury and **E**nhance **P**erformance) is simple and can be done without any major equipment, it can be performed at the beginning of soccer, volleyball or basketball practice. It should be done 2 to 3 times a week. It is important to remember that you are trying to retrain *your body positioning in space*. This is a simple issue and it is about prevention. Just imagine preventing the injury, spending more time participating and playing, less time on the bench, and more time in the game, which is the bottom line.