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Anterior Cruciate Ligament (ACL) Injuries

The anterior cruciate ligament (ACL) is one of the most injured ligaments of the knee and there are more than 200,000 ACL surgical reconstructions performed each year in the US. The incidence of ACL injury is higher in people who participate in high-risk sports such as soccer, basketball, football and skiing; however, injuries may occur by other mechanisms such as automobile accidents or work-related injuries. The rate of ACL injury is greater in females than males, especially in younger individuals. As the number of females participating in competitive and recreational sports has increased, so has the number of females sustaining ACL injuries. Approximately 70 percent of ACL injuries are non-contact (no collision with another athlete or object) in nature and almost always occur as the body undergoes rapid deceleration while performing planting and cutting maneuvers or landing from a jump. Females are up to 8 times greater risk for sustaining an ACL injury during non-contact mechanisms when compared to males competing in the same sport. It has been proposed that this gender-related phenomenon is due to differences in muscular strength, balance and neuromuscular control. Other hypothesized causes for this difference include pelvis and leg alignment, knee anatomy, increased ligamentous laxity and the effects of female hormones on ligament properties.

What is the ACL?

The ACL (anterior cruciate ligament) is one of the four main ligaments in the knee and is the primary stabilizer for rotational control. It connects the thighbone (femur) to the shinbone (tibia) in the center of the knee. The knee is essentially a hinged joint that is held together by the medial collateral (MCL), lateral collateral (LCL), anterior cruciate (ACL) and posterior cruciate (PCL) ligaments. The ACL runs diagonally in the middle of the knee, preventing the tibia from sliding out in front of the femur as well as providing rotational stability to the knee (Figure 1). The weight-bearing surface of the knee is covered by a layer of articular cartilage. On both sides of the joint, between the cartilage surfaces of the femur and tibia, are the medial meniscus and lateral meniscus. The menisci act as shock

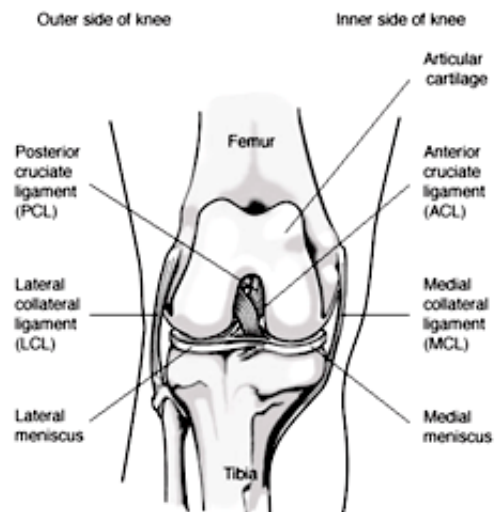


Figure 1. Diagram of the knee.

absorbers and work with the cartilage to reduce the stresses between the tibia and the femur. Without an ACL, the knee may be unstable during activities that involve running, jumping or twisting and injuries to the cartilage or menisci may occur in >70% of patients. It is estimated that 50 percent of ACL tears are accompanied by meniscus tears, and up to 30 percent involve other ligament damage. Given the significant short and long-term detrimental effects of ACL injuries, ACL injury prevention programs are strongly recommended for young athletes, especially females participating in sports that involve jumping, cutting and pivoting.

ACL Tears

Immediately after an ACL injury, patients usually experience pain and swelling and the knee feels unstable. Within a few hours after a new ACL injury, patients often have a moderate to large amount of knee swelling, loss of full range of motion, pain or tenderness along the joint line and discomfort while walking. 75% of athletes who develop a large, swollen knee after suffering a sports-related knee injury with a “pop” will have a torn ACL.

During the evaluation for a knee injury, the medical provider will often perform a physical examination to see if the ACL is intact. If the ACL is torn, the examiner will feel increased forward (upward or anterior) movement of the tibia in relation to the femur (when compared to the normal leg) and a soft endpoint when this movement ends. X-rays and MRIs are often ordered to confirm the diagnosis and rule out other injuries.

The natural history of an ACL injury without surgical intervention varies from patient to patient and depends on the patient's age, activity level and goals, degree of injury and instability symptoms. Complete ACL ruptures generally do not have a favorable outcome. After a complete ACL tear, most patients are unable to participate in cutting or pivoting-type sports, while others have instability during even normal activities such as walking. There are some individuals who can participate in sports after completion of a prolonged rehab protocol, but this is less common. This variability is related to the severity of the original knee injury (the degree of meniscus, cartilage and other ligament damage) as well as the physical demands and goals of the patient. For patients choosing non-surgical treatment, secondary knee damage may occur from repeat episodes of instability due to ACL deficiency. With chronic (long-term) instability, the abnormal stresses on the joint eventually lead to nearly all patients having meniscus tears and 70% progressing to areas of full thickness cartilage loss.

Treatment

Some people with a completely torn ACL can build their muscle strength enough to resume normal activities without surgery. While activities of daily living may be possible without an

ACL, it is unlikely that patients will be able to return to cutting and twisting sports or activities. An untreated ACL may leave the patient unable to trust the stability of the knee. It may also continue to buckle and give-way, which increases the risk for further injury to other knee structures and may cause cartilage damage that can lead to the premature onset of osteoarthritis. Having surgery or forgoing surgery is a personal choice. Those who are older and not very active may choose a non-operative strengthening program with physical therapy instead of surgery, since the injury is not likely to interfere with their daily activities. Non-operative rehab programs focus on maximizing the knee stabilizing muscles from the core, hips and leg and takes four to five months to complete.

Active, athletic and younger people are more likely to opt for surgery. The goal of surgery is to reconstruct the torn ligament and rehabilitate the leg to enable a return to previous activities. Because the menisci, articular surfaces, and other restraining structures around the knee are susceptible to injury during recurrent episodes of instability, it is generally accepted that ACL reconstruction should be considered for active patients who desire to return to sports or are at high risk for having recurrent knee instability.

The goal of ACL reconstruction is to restore normal knee stability and when deciding on surgical intervention, the orthopaedist and patient/family need to determine which graft choice best accomplishes this goal. The ideal graft is one that retains strength at least equivalent to that of the normal ACL, allows for secure fixation, enables early and unrestricted rehabilitation, and is associated with minimal graft harvest morbidity (pain, complications or problems from the “donor” site). Graft site harvest morbidity and complications are summarized in the chart below.

Historically, most orthopaedic surgeons have used autografts (harvested from another site in the patient), however, modern techniques have shown that cadaver tissue (allografts) can have equivalent results. For decades the patellar tendon (including bone blocks harvested from the patella and tibia) has been the most used autograft source and remains the gold standard that all other grafts are compared against. However, given the associated morbidity, complications and problems related to the patella tendon graft harvest site, many surgeons have turned to alternative autografts (harvesting hamstring or quadriceps tendon tissue with or without a bone block) or allografts (cadaver donor tissue) due to similar outcomes with fewer complications.

The advantage of using the hamstring tendon autografts and allografts over patellar tendon and quadriceps (with bone plug) autografts is preservation of the extensor (kneecap) mechanism and utilization of smaller, cosmetically pleasing incisions. As a result, postoperative problems such as patellar fracture, patellar tendon rupture, patellofemoral pain and knee stiffness are minimized. Patellofemoral (anterior knee) pain, pain with

kneeling and patellofemoral joint arthritis have been observed in up to 50% of patients when patellar tendon autografts are used.

Hamstring autografts increased in popularity due similar outcomes with less harvest site morbidity compared to patella tendon autografts. Downsides to hamstring autografts include muscle weakness after harvesting 2 of the tendons that provide knee flexion strength and the possibility of a small graft size available from smaller patients. Research on neuromuscular control has documented quadriceps muscle dominance in female athletes (relative to weaker hamstrings) as one of the mechanisms contributing to increased ACL tears. This has led to concerns that harvesting the hamstring tendons in females may exacerbate the quadriceps/hamstring strength ratio imbalance, which may contribute to a higher chance of hamstring autograft failure rates, especially when smaller grafts are used in younger patients.

More recently, Quadriceps Tendon autografts (with or without a bone plug) have received increased attention as more studies compare modern quadriceps graft harvest techniques to the other autograft choices. The goal of using Quadriceps autograft is to minimize the downside complications and risks associated with Patella and Hamstring Tendon autograft harvest. Historically, Quadriceps Tendon autografts have been used far less commonly, which is likely due to previously published poor results related to antiquated graft harvest techniques. With modern surgical techniques, Quadricep grafts allow for a more predictable graft size but may also have a negative effect on quadriceps strength and the knee extensor mechanism. Research continues on quadriceps autografts and as long-term outcome studies become available quadriceps autograft use will continue to increase.

Cadaver grafts (allograft) have the advantage of avoiding the additional larger harvest site incisions and the morbidity, complications and problems associated with all the autograft choices. Allografts also allow for less post-operative pain, less narcotic pain medication usage and a quicker earlier functional recovery for return to work and school. Historically, both transmission of disease from the donor and graft rejection from the recipient were concerns but with modern techniques and testing protocols by MTF Biologics, there has not been a document case for more than 30 years and in over 9 million implanted allografts. Recent research has shown that the failure rates (re-tearing) for autograft (patella tendon and hamstrings) and allograft tissues are similar, even in younger patients, due to modern graft preparation techniques that avoid the use of radiation and harsh chemical processing. Multiple large studies have confirmed no difference in graft failure rates comparing autograft vs non-irradiated allografts in patients >25yo. Old studies suggesting a higher failure rate in allografts in younger patients (<25yo) have been linked to grafts that were processed with harsh chemicals and radiation. More recent studies confirm no difference in failure rates with non-irradiated grafts compared to autografts in

patients <25yo. As a result, non-irradiated allografts for ACL reconstruction have become more popular due to similar outcomes (with modern graft prep techniques) and have the advantages of smaller incisions, less pain/narcotics and earlier return to activities without the morbidity, complications and short and long-term problems associated with the harvesting of kneecap or hamstring tissue.

There is not a perfect graft choice; otherwise only one graft would be universally used. It is important for the patient/family and surgeon to discuss the pros and cons of each graft option and choose the most suitable graft for each patient-specific situation with consideration of age, activity goals and occupation.

ACL Graft Morbidity and Complications

Graft Type	Allograft	Hamstrings	Quadriceps-soft tissue	Quadriceps-with bone	Bone-Patella tendon-Bone
Kneecap Pain and Arthritis				+	+
Numbness		+			+
Quadriceps Weakness			+	+	+
Hamstring Weakness		+			
Post-op Pain and Narcotics	↑	↑↑	↑↑	↑↑↑	↑↑↑
Patella Fracture				+	+
Tendon Rupture					+
Hematoma		+	+	+	+
Total Incision Size	↑	↑↑	↑↑	↑↑↑	↑↑↑↑

Post-op Rehab

Rehabilitation following surgery usually takes a minimum of six-nine months and up to a year or more. Rehabilitation is demanding and requires a commitment of at least 45 minutes, three days a week and consistent visits with a physical therapist. The success rate is favorable and allows most people to return to their previous active lifestyles after ACL reconstruction. Clearance to return to full activity and sports participation requires time for graft healing but more importantly, objective testing and documentation of lower extremity strength and knee control. Research has shown that patients having bone-tendon-bone autografts require a significantly longer time than soft-tissue autografts and allografts to achieve the objective return to sport strength and performance testing criteria.

There is now a significant focus on ACL injury prevention and prevention of re-injury, especially in young athletes. 2nd ACL tears occur in approximately 25% of all patients and 34% of female soccer players. Research has shown that by performing a focused exercise/warm-up program, athletes can decrease the chance of an ACL injury as well as prevent a re-injury after ACL reconstruction by 50-88%. Further, patients who return to sport prior to 9 months after ACL surgery and do not correct strength deficits have a 7 times increased chance of re-injury. Injury prevention program exercises should be an integral part of the post-operative return-to-sport physical therapy program with a goal of protecting the reconstructed ACL and minimize the risk of tearing the other ACL.

YOUR ACL JOURNEY GUIDE: TREATMENT DECISION

This guide does not replace medical advice.

All rehab journeys should be individualised. Please use this guide with your rehab professional.

