

# **Anterior Cruciate Ligament Injuries:**

## **A Guide For Patients**

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## ANATOMY

Ligaments are dense connective tissue struts which connect bone to bone. There are four (4) major ligaments within the knee joint. The side struts which connect the femur (thigh bone) and tibia (shin bone) are called the medial collateral ligament (MCL) and lateral collateral ligament (LCL). Within the knee joint there are two (2) crossing ligaments called the anterior cruciate ligament (ACL) and the posterior cruciate ligament (PCL). The function of ligaments is to provide stability. The anterior cruciate ligament (ACL) is the most important ligament within the knee joint and may be the most commonly injured. Historically, this has been a commonly underdiagnosed or unrecognized injury.

## INJURY CHARACTERISTICS

Clinically, ACL injuries most commonly occur in football and skiing, although these injuries may be seen in volleyball, tennis, wrestling, basketball and all contact sports. Classically, the description of the “unhappy triad”, namely, injuries to the medial collateral ligament, medial meniscus and anterior cruciate ligament resulted from a clipping injury in football. More commonly, we see patients who have only injured the ACL (“isolated ACL”). Presently, with new advances in ski boot design and bindings, there is an epidemic of ACL injuries. Approximately 25% of all reported major ski-slope knee injuries now involve the ACL. There are several mechanisms that may result in an injury to the anterior cruciate ligament. The injury may result from a contact or non-contact mechanism of injury. A blow from the side or from the front, or a non-contact decelerating twisting injury may result in an ACL injury.

Approximately 40% of patients will hear an audible “pop” at the time of injury. The vast majority of patients will appreciate marked swelling of the knee joint within three hours after the injury. Early tense swelling within the knee joint is most commonly indicative of an anterior cruciate ligament injury, but peripheral tears of the cartilage (menisci) or an intra-articular fracture must be differentiated. Generally, patients are unable to continue their participation in their activity at the time of the initial injury. A sensation of instability is commonly present. Historically, individuals have often sought medical attention, and commonly the Emergency Room scenario is that the patient has been told that “there are no fractures”, and that “you have a mild sprain”. Perhaps 50% of all ACL injuries result in a delay in diagnosis. Once torn, the ACL will not heal and patients are susceptible to recurrent instability with running-cutting and jumping-landing activities.

After the initial injury, patients will gradually improve so that they can resume most activities, regardless of an initial period of treatment, splint immobilization or cast immobilization. Commonly, patients are seen following a recurrent episode of knee instability. Similar clinical symptoms may be noted. At the time of the initial injury, 25 to 40% of patients will have a tear in at least one of the two menisci (cartilage). With repeated episodes of instability, up to 70% of patients may have a meniscal tear. The meniscal tears may present with joint line tenderness, intermittent swelling, locking, buckling or instability and, therefore, the orthopedist must differentiate between meniscal pathology and instability

secondary to ACL insufficiency. Commonly, patients may have a combination of symptoms. For example, patients commonly may present with a locked knee, secondary displaced “bucket handle” meniscal tear, which is often associated with insufficiency. Because of the increased translation in the anterior-posterior (forward-backward) direction of the knee, the menisci are at great risk for subsequent injury and partial or complete tears are very frequent (25-70%).

Patients may have increasing episodes of instability or giving way, and may clinically describe this with what is called a “two-fisted” sign. This is often described as the knee is “coming apart”, or that the knee feels like it is dislocated. The orthopedist must differentiate these symptoms from recurrent dislocations of the patella (kneecap) or cartilage tears. The patient often develops a predictable instability in that he/she may be aware of certain activities or maneuvers that may result in “buckling” or “giving way” of the knee. Over a period of time, with repeated episodes of instability and further stretching of the “secondary restraints” (other ligaments, capsule or menisci) of the knee, the patient may progress to an unpredictable instability. At this point, activities of daily living may be affected; for example, some patients have episodes of buckling while walking stairs or turning while walking. These are patients who recognize their patterns of instability and, with activity modification, are able to minimize their episodes of instability.

### **TREATMENT ADVANCES**

Marked advances have occurred during the past decade in our understanding of the ACL. Improvements in physical examination techniques and in diagnostic techniques have occurred, and we now have an instrumented machine (KT-1000 arthrometer) that can measure knee laxity and quantitate instabilities. Our understanding of the biomechanics of the ACL has vastly improved, and concept of primary and secondary “ligamentous restraints” has emphasized teaching that “a little instability means a lot of injury”. Our understanding of the tenuous blood supply of the ACL and its poor ability to heal by itself is now better understood. The natural history, as previously described, of ACL insufficiency with increasing likelihood of meniscal injury and the possibility of early degenerative joint disease must be stressed. Marked changes in our surgical treatment of ACL insufficiency, has resulted in predictably good and excellent functional results. Our rehabilitation of ACL injured knees is much different than a decade ago. For example, we now recognize that quadriceps strengthening is an antagonist for the healing ACL repair, whereas hamstring strengthening “protects” the ACL deficient or ACL repaired knee. Experienced ligament surgeons are becoming increasingly more aggressive with early post-operative motion of the repaired ACL injured knee, whereas previously the knee was immobilized in a plaster long leg cast. We now use hinged, prefabricated knee braces which allow a prescribed range of motion to the knee. Historically, the rehabilitation of the ACL injured knee was a short course of quadriceps strengthening exercises.

## **WHO NEEDS SURGERY?**

In light of the demanding surgical techniques for ACL repair, and the equally demanding rehabilitation placed upon the patient, a commonly asked question is “who should have an ACL reconstruction”? In general, a well-performed history and physical examination should provide the clinician with a reasonable diagnosis of anterior cruciate insufficiency. There are times, however, with associated injuries, that an MRI may be recommended to rule out the possibility of an associated meniscal tear. There are some patients whose pattern of meniscal tear may warrant a repair rather than excision, therefore, these radiographic imaging studies provide useful information to the surgeon. In some situations, the physical examination is equivocal and examination under anesthesia may provide extremely important information and a more definitive clinical diagnosis. Some orthopedists feel strongly that an arthroscopic diagnosis of ACL insufficiency should be made at the time of an initial injury, to document concomitant meniscal injuries, so that the patient may be adequately counseled.

## **TIMING OF SURGERY**

After sustaining an acute anterior cruciate ligament injury, in contrast to historical recommendations regarding acute with primary repairs of the torn anterior cruciate ligaments, the current trends are to establish the diagnosis and begin early rehabilitation and recovery of motion before surgical reconstruction is performed. Direct suture repair of the acutely torn ACL historically yielded unpredictable results, hence most procedures today either augment these torn tissues (e.g. hamstrings tendons), or excise the torn ACL tissue and replace (reconstruct) with tissues as strong, if not stronger, than the original ACL tissue. Several studies have demonstrated that by deferring early surgical reconstruction to between 3 and 6 weeks after injury, the postoperative incidence of knee stiffness or knee motion problems requiring subsequent arthroscopic surgery are diminished. We have primarily reconstructed patients as early as one week after their injury provided that knee motion is near normal, but in general, we defer surgical reconstruction for several weeks.

## **TREATMENT OPTIONS**

With conservative therapy alone and an aggressive rehabilitation program emphasizing hamstring strengthening, supplemented by an ACL brace, approximately one-third of patients will do well and not require additional surgery. Approximately one-third of patients treated conservatively will have continued episodes of buckling and may warrant operative reconstruction. An additional third of patients will have increased symptoms, regardless of their rehabilitation program, and will require either arthroscopic procedures for meniscal tears or a reconstructive stabilization. There are clearly patients who should be treated conservatively and, equally clearly, patients who should be operatively stabilized. For example, the low demand recreational athlete may function very well with a conservatively treated, appropriately rehabilitated knee. On the other end of the spectrum, the high demand recreational athlete

should have operative reconstruction of the torn ACL. In knees where there are concomitant ligament injuries, operative stabilization is preferred.

In patients who have increasing instability, such that their activities of daily living are affected, surgical stabilization should be considered. For recreational athletes who contemplate playing basketball, volleyball or skiing, surgical stabilization is recommended. In patients who have a documented peripheral meniscal tear, many orthopedists feel strongly that the anterior cruciate ligament should be reconstructed to help protect the repaired meniscus. In some cases, this can be performed simultaneously, but occasionally staged repairs of the meniscus and subsequently the ACL are performed

## **SURGICAL RECONSTRUCTION**

There are currently many reconstructive procedures available for the ACL injured knee. Currently, the gold standard is using the central third of the *patellar tendon*, as a graft, to replace the anterior cruciate. Laboratory testing has revealed that this tissue is stronger than the normal anterior cruciate ligament. Other tissues are commonly used with excellent results. For example, the *semitendinosus* (hamstring tendon) is often used as an ACL graft. Cadaver grafts (*allografts*) are used in certain circumstances, such as multiple ligament injuries, previous failed surgery, multiple scars, and patients with degenerative joint disease in whom possible motion problems could occur postoperatively. In general, the current experiences with *synthetic* grafts have been disappointing and are only rarely recommended for revision ACL reconstruction. Early results of “arthroscopy assisted” ACL reconstruction have been encouraging. However, it must be stressed that there are very few long-term studies (>10 years) regarding ACL reconstruction other than central third patellar tendon repairs.

## **ARTHROSCOPICALLY ASSISTED ACL RECONSTRUCTION**

“Arthroscopically assisted” anterior cruciate ligament reconstruction has received considerable attention among nationally recognized ligament surgeons. Although, technically more difficult than a formal “open” surgical reconstruction, there are several advantages of this procedure. The use of the arthroscope allows simultaneous treatment of meniscal tears that may require partial removal or repair. “Arthroscopic assistance” precludes an arthrotomy (surgical opening into the joint) thereby decreasing postoperative pain and swelling, encouraging early rehabilitation and minimizing patellar pain symptoms which may follow an arthrotomy. Precise identification for anatomic drill holes for passage of the “new” ligament is facilitated by the arthroscopic assisted technique. The “new ligament” is then secured with two titanium interference screws. Occasionally, other forms of fixation may be used to secure the graft. Another less important advantage is that the surgical incisions used for obtaining and placement of the graft are less extensive than the formal open procedures. As indicated, long term studies of the technique are limited, although the “open” technique which utilizes the same patellar tendon ligament tissue to anatomically replace the former ACL can eliminate the “pivot shift phenomenon” characteristic of ACL

insufficiency in over 90% of patients if proper rehabilitation techniques are followed. The use of this “arthroscopically assisted” technique is generally not recommended in conjunction with acute multiple ligament injuries of the knee, and an open reconstruction may be recommended.

## **RESULTS OF ACL RECONSTRUCTION**

We have had the opportunity recently to clinically review 97 of 147 patients who represented our initial experience with the double incision arthroscopic-assisted ACL reconstruction using patellar tendon. These patients underwent surgery between 1987 and 1991 and were evaluated at a minimum of 5 years and a maximum of nine years following reconstruction. Over 90% of the patients had clinically stable knees by physical examination and 95% of patients had stable knees by objective quantification via KT-1000 arthrometer. The patient’s subjective satisfaction with this procedure was extremely high with 94% satisfied with their operative result. Functional tests, such as a vertical jump, single leg jump for distance and a single leg timed six meter hop averaged less than a 2% difference between the reconstructed and uninvolved knee. In this group, there were no postoperative surgical infections, patellar tendon ruptures or patellar fractures. There was a 5% reoperation rate for either retears of cartilage or minor motion problems. Since July 1, 1990, with a modification or rehabilitation program emphasizing immediate early extension of the knee, we have reduced the reoperation rate to 2%.

We are actively involved in clinical and basic science research involving knee ligament injury problems. We have conducted clinical follow-up studies on our initial patient population who underwent surgical reconstruction between 1987 and 1989, in patients over the age of 35 who desired reconstruction, and in patients whose ACL in each knee was reconstructed.

## **NEW ADVANCES – SINGLE INCISION ENDOSCOPIC RECONSTRUCTION**

Based on the results of this retrospective clinical follow-up study, we embarked on an even more aggressive rehabilitation program and modified the surgical technique in July of 1990, so that only one incision over the front part of the knee was used to perform the surgical procedure. An “endoscopic” single incision technique currently represents the “cutting edge” of new ligament surgery. This is a technically demanding operation that should only be performed by experienced knee ligament surgeons. We have been very pleased with our early results using the endoscopic technique, which is effectively a modification of the double incision ACL reconstruction procedure that we performed between 1986 and 1991. One of the major advances with the endoscopic technique is an even quicker recovery of range of motion, and, we have noted that well over 90% of patients have been reconstructed on an outpatient basis. In January, 1998, we published the results of our minimum 2-year follow-up study to evaluate the effectiveness of the one incision endoscopic technique. We clinically reviewed 103 of 128 patients who met the criteria for the study. Over 90% of the patients had clinically stable knees by physical examination and over 95% of patients had stable knees by objective quantification via KT-1000

arthrometer. Functional tests showed 4%-6% differences in side-to-side comparisons for a timed single legged hop, single legged hop for distance and vertical jump. There was a 5% reoperation rate for minor motion problems. Most recently we have emphasized early extension of the knee, thus, reducing the reoperation rate to 2%. Ninety-three percent of the patients reported that they were “mostly” or “completely” satisfied, and 95% would recommend the procedure to others. As of July 1998, Dr. Bach has performed over 1,100 knee ligament reconstructions, and, together, Drs. Bach and Bush-Joseph, have performed over 2,000 reconstructions – it is very important to have an experienced knee ligament surgeon perform your surgery to minimize potential complications and help optimize your outcome.

### **REHABILITATION IS CRUCIAL**

If surgery is contemplated by the patient, he/she must be aware of the extreme importance of rehabilitation. We now understand that the injured ligament may take between six months and one year to completely heal, and that an aggressive rehabilitation program over a four to six month period is critical. This requires a complete commitment on the part of the patient in an attempt to maximize the clinical result. However, this can be briefly summarized. In general, surgery is performed on an outpatient basis or on rare occasion a “23 hour admission”. During this time, the patient’s knee is stabilized in a hinged knee brace, which allows motion over a prescribed range of motion. Alternatively, we may use a knee immobilizer which may be removed for motion exercises. We no longer use the continuous passive motion machines which were part of our rehabilitation protocols from 1986 until 1993. Ninety percent of patients were discharged on the first postoperative day during 1993. Since 1994 we have been able to routinely discharge patients on an outpatient basis performing over 700 outpatient ACL’s consecutively. Patients are allowed to weight bear as tolerated immediately following surgery. Some patients do not use crutches at all and most have discontinued using crutches by 7 to 10 days. The immediate postop brace or immobilizer is used during the first six weeks. The knee is kept straight in the brace for weight-bearing and while sleeping. Otherwise motion is allowed as tolerated. Particular emphasis is directed at achieving full extension (straightening) of the knee as soon as possible. By two weeks, an aggressive rehabilitation program is started. Initial rehabilitation is directed towards obtaining and maintaining motion, with knee extension being emphasized more so than knee flexion. A different functional brace is worn between 12 weeks and 12 months postoperatively for sports activities. Rehabilitation activities are progressed during the two to six week post-op period, and bicycling, hamstring strengthening exercises and stairmaster exercises are instituted. By 8-12 weeks postoperatively, the patient is allowed to begin jogging. By four to six months postoperatively, the patient is selectively allowed to return to athletic activities using their functional ACL brace until one year postoperatively. During the first season, patients may desire a post-operative ACL functional derotation brace, but this is not essential. Patients are seen in the office at six-week intervals postoperatively until six months postoperatively, at 9 and 12 months postoperatively, and on an annual basis thereafter.

## **GOALS OF SURGERY**

Our goals of surgical reconstruction are to stabilize the knee, maintain normal motion, appropriately rehabilitate the thigh musculature and to return the patient to sports activities unbraced.

## **SUMMARY**

The goals of this patient education paper are to highlight the natural history of the ACL injured knee, to describe the characteristic clinical history and findings of these injured knees, to emphasize the high likelihood of meniscal injury, to explain the marked advances in knee surgery and to emphasize the non-surgical options available to appropriate individuals.

Given the techniques available, surgical stabilization to eliminate the “pivoting” or collapsing in ACL insufficient knees can be achieved in over 90% of patients. Careful patient selection, appropriate surgical technique selection, meticulous surgical execution of the operative procedure and dedicated rehabilitation can consistently yield excellent long term surgical results that will provide a stable knee able to meet all athletic demands.