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(Editor’s Note: The article on the anterior cruciate ligament and its rehabilitation, written by Dr. Mladen Maksic and published in the past issue -issue N.3, July/August 2003-, was so well received, with requests for more information on this topic, that we invited other doctors to discuss this devastating injury.)

The anterior cruciate ligament (ACL) is the site of one of the most common sports injuries. Twisting the knee with the foot firmly planted on the ground can sever this important ligament. The normally strong, rope-like 1.5-inch ligament crosses through the middle of the knee joint and keeps the shinbone from sliding too far forward on the thighbone. Unlike the hip, with its deeply contoured ball-and-socket arrangement, the knee depends almost entirely on soft tissue-ligaments and tendons—for stability. The knee connects the two rounded surfaces (condyles) of the large thighbone (femur) with the lower leg bone (tibia). An elaborate system of ligaments, the anatomical equivalent of bungee cords, holds the joint together. Two ligaments (the collateral) bind the knee on the inside and outside borders, while anterior and posterior cruciate ligaments cross inside the joint to hold it in place. In the course of any athletic movement, when the knee is accidentally rotated too far and the ligaments are stretched even slightly beyond their length, they will often rupture with a sickening “pop.” Most often it’s the anterior cruciate ligament (ACL), and such a devastating injury usually requires reconstructive surgery followed by extensive rehabilitation with weights. It’s now estimated in the United States that there is 1 ACL tear per 3,000 people in a general population, with 25 to 50 percent eventually undergoing surgical reconstruction. International statistics are not available. Prior to the introduction of arthroscopic knee surgery in the early 1970s, an ACL tear was often a career-ending injury for an athlete.

Women are especially vulnerable to ACL injuries. The wider female pelvis, for instance, often produces thighs that angle inward, from hip to knee, at a sharper angle than in men. This Q-angle, or quadriceps angle, often predisposes a woman to more knee injuries than a male. In addition, a woman’s joints are slightly more lax than a male. The joints typically have more hyper-elasticity or mobility and it’s this hyper-looseness that predisposes a woman’s anterior cruciate ligament to more injury. Hormonal factors, leg strength, and the particular geometry of the female knee joint also may be factors to predispose one to increased risk of rupture.

MECHANISM
Mechanisms of an ACL tear (eight times more common in women and probably due to the female “Q” angle) without involving direct contact include:
1. Violent hyperextension of the knee.
2. Violent abduction, flexion, and internal rotation of the tibia on the femur.

DIAGNOSIS
An ACL tear/deficiency can be diagnosed and classified according to the history of the mechanism of the injury; an evaluation of stability; and through X-ray, MRI scan, or an arthroscopic examination performed under general anesthesia.

The physical examination of knee joint stability and the ACL should include the following stress tests (both knees should be available for examination to allow comparison):

1. The pivot shift test, which is performed by causing anterior displacement of the tibia in 15-20° of flexion with the patient lying supine. Using one hand on the anterior aspect of the distal femur and the second hand behind the proximal tibia, try to displace the tibia forward from the femur. A positive Lachman occurs when either more than 5 mm of anterior displacement of the tibia is noted or no endpoint is encountered. Note that this is difficult to perform on obese patients if the doctor has small hands.
2. The anterior drawer test, which indicates tear of the anterior/medial bundle of the ligament. When performed with the tibia internally or externally rotated, it provides extra information about the posterior/lateral aspect of the knee. The anterior drawer test is performed in both flexion and extension.
3. The valgus (abduction) test and the varus (adduction) test which are performed by causing external rotation and internal rotation of the tibia respectively.

The “key tests” for the physical examination of the tear/deficiency...
of the ACL ligament are:

a. The Lachman-Noulis test (with evaluation of the endpoint).
b. The pivot shift test.

When performed by experienced examiners, the evaluation of the stability of the ligament may provide a precise diagnosis of the tear/deficiency in 90 percent of the cases, even though the clinical evaluation itself isn’t always enough to reveal partial tears (mainly of the anterior/medial bundle of the ACL).

MRI testing should not be overused but may be useful when doubt arises from the physical examination. The MRI’s sensitivity and precision in revealing recent and old tears is higher than any other tests (92-98 percent) but when it comes to differentiation between partial and total tear, it’s not higher than 50 percent.

Controversy arises from the fact that an ACL tear inevitably leads to the “beginning of the end of the knee joint.” Researchers point to deficiency of the ligament, functional incapacity and symptomatic instability of the knee joint, and finally osteoarthritis of the knee. On the other hand, one can never be certain of the number of patients that will suffer in the future from chondral degeneration. This depends on:

- The degree of the injury to the ligament.
- The associated osseous, ligamentous, meniscal, and chondral injuries.
- The associated injuries and the post-traumatic degree of recovery of the secondary restraint to the anterior translation of the knee.
- The demands, needs, and expectations of the patients.

**TREATMENT CONSIDERATIONS**

Surgical or no surgical treatment must be selected depending on factors such as:

1. The patient’s age.
2. The activity demands and willingness to modify them.
3. Compliance of the patient with the postoperative rehabilitation Program.
4. The laxity of the joint and the instability grade.
5. The associated osseous, ligamentous, meniscal, and chondral Injuries.
6. The willingness of the patient to be treated surgically.

Patients with an ACL tear should be well informed in regards to the following:

- The untreated ACL tear, as well as the untreated meniscal tear (which is expected and common due to the instability of the knee) greatly increases the odds of developing osteoarthritis. A meniscectomy, doubles these findings when compared with “healthy” individuals of the same age (1-2 percent).

- The ACL tear that is treated conservatively and has a long follow-up time is thought to be related to osteoarthritis in 57 percent of the patients < 35 years old and in 87 percent of the patients > 35 years old.

- When primary repair of the ligament is performed with a long term follow-up period the rate of degenerative arthritis is 13 percent in patients with intact menisci, 31 percent in those with a lateral meniscectomy, 37 percent in those with a medial meniscectomy, and 40 percent in those with a bilateral meniscectomy. The importance of the condition of the menisci during ligamentous reconstruction, as well as the protective value of the repair of the ligament, is more than obvious.

- Patients with primary repair of the ligament seem to suffer less degenerative lesions of the tibiofemoral joint when compared with the ones with late reconstruction (The best possible repair should be done without delay).

- Primary repair is not the panacea of the ACL tear as:
  a. It can provide a solution to the mechanical problem of instability that results from the deficiency of the ligament, but
  b. Cannot restore the proprioceptive function of the ligament and its protective role.
  c. The success rate is 85-95 percent and the improvement of stability on a long-term basis appears in 66 percent of the patients, whereas the functional ability improves in 70 percent of the patients.
  d. The failure rate is 8 percent with a recurrence of the knee instability and can be followed by complications such as:

1. Loss of movement of the knee joint (15 percent) either as a loss of the extension rate (more than 5-10 percent) or as a total movement range (less than 125 degrees).
2. Persistent postoperative effusion (10 percent).
3. Septic arthritis (0.3 - 1.3 percent) etc.

The surgical treatment that is strongly recommended in young athletes is either arthroscopic or open reconstruction of the ligament (followed by meniscal repair or partial meniscectomy of the meniscal tears). This should be performed right after the relief of the acute symptoms (usually three weeks later). Acute repair might be considered only when the Tibial insertion of the ligament has been avulsed with a fragment of bone.

**GRAFTS**

In reconstruction of the ligament, the grafts that can be used are:

- Autografts.
- Bone-patellar tendon-bone graft (BPTB).
- Quadriceps tendon with or without tendon bone graft (QT).
- Semitendinosus and gracilis tendon grafts (ST/G).
- Allografts.
- Synthetic grafts.

The BPTB is well preferred by the majority of surgeons (the gold standard). The ST/G and the QT are less preferred, and allografts are indicated for patients who are not involved in competitive sports and need to quickly return to work and activities of daily living. Usually the graft is placed in anatomical and isometric position and is fixed with interference screws or other systems of fixation.

**REHABILITATION**

Postoperative rehabilitation programs that follow reconstruction of the ACL ligament can be “accelerated” by:

- Early initiation of movement, weight bearing, and closed kinetic chain exercise.
- Slow initiation of open kinetic chain exercise.

During postoperative rehabilitation, balance should be maintained between the protection of the graft during maturation process (ligamentation), preserving full range of motion, and dynamic stability as well as functioning of the knee joint.

The criteria for when patients can return to sports after surgical treatment are based upon clinical findings and laboratory results. Returning to sports is usually allowed when:

1. There is full range of motion of the knee joint.
2. There is no knee joint instability or effusion.
3. The comparative degree of functional tests is at least 95 percent.
4. Knee joint proprioception is restored.
5. The comparative degree of power and force of the quadriceps and the hamstrings in K-T1000 evaluation is at least 85-90 percent.

Finally, return to sports may be as early as five months or as long as nine months to a year.