

# **ACL Reconstruction and Rehabilitation Protocol**

**FRANK A. PETRIGLIANO, MD**

**Associate Professor of Orthopaedic Surgery**

**Chief - USC Epstein Family Center for Sports Medicine**

Keck Medicine  
of **USC**



# ACL REHABILITATION PROTOCOL

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# ACL REHABILITATION PROTOCOL

## INTRODUCTION

THE ANTERIOR CRUCIATE LIGAMENT (ACL) IS A MAIN STABILIZING LIGAMENT OF THE KNEE. IT PREVENTS ABNORMAL TRANSLATION AND ROTATION OF THE TIBIA WITH RESPECT TO THE FEMUR. THE ACL IS COMMONLY TORN DURING ATHLETICS IN SPORTS INVOLVING CUTTING OR PIVOTING (E.G. BASKETBALL, SOCCER), BUT ALSO CAN BE TORN IN ANY EVENT THAT CAUSES AN UNDUE ROTATIONAL FORCE TO THE KNEE (TWISTING INJURY, COLLISION SPORTS, FALLS, SKIING).



FIGURE 1. NORMAL KNEE ANATOMY. THE ACL IS A MAIN STABILIZING LIGAMENT OF THE KNEE THAT CONNECTS THE TIBIA BONE TO THE FEMUR BONE.

MANY PATIENTS WHO SUFFER AN ACL TEAR RECALL THE EXACT MOMENT THAT THE ACL TEAR HAPPENED BECAUSE THEY FELT A 'POP' IN THE KNEE AND WERE UNABLE TO CONTINUE THEIR ATHLETIC EVENT. THE KNEE JOINT COMMONLY SWELLS AND IS DIFFICULT TO WALK ON AFTER INJURY. A PATIENT WITH AN INJURED ACL USUALLY IS COMPELLED TO VISIT THEIR DOCTOR OR EMERGENCY ROOM. AN UNTREATED ACL INJURY COMMONLY RESULTS IN A KNEE THAT FEELS UNSTABLE AND GIVES WAY, ESPECIALLY WITH SPORTS BUT SOMETIMES WITH DAILY ACTIVITIES AS WELL.

## DIAGNOSIS OF ACL TEAR

AN ACL TEAR CAN BE RELIABLY DIAGNOSED BY A SKILLED ORTHOPAEDIC PHYSICIAN WITH HISTORY AND PHYSICAL EXAM. TWO TESTS ARE USED DURING THE PHYSICAL EXAM TO DIAGNOSE A TORN ACL. THE FIRST IS THE LACHMAN EXAM; DURING THIS TEST THE EXAMINER PULLS FORWARD ON THE TIBIA WHILE STABILIZING THE FEMUR AND ABNORMAL TRANSLATION IS FELT. THE SECOND IS THE PIVOT SHIFT; DURING THIS TEST, THE EXAMINER INTERNALLY ROTATES THE TIBIA WHILE FLEXING THE KNEE TO DEMONSTRATE THE ROTATIONAL INSTABILITY OF THE KNEE WITH A DEFICIENT ACL.

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WHEN AN ACL INJURY IS SUSPECTED, IMAGING IS ORDERED. X-RAYS ARE TAKEN TO RULE OUT FRACTURE OR MALALIGNMENT OF THE KNEE. AN MRI IS ORDERED TO CONFIRM THE ACL TEAR BUT ALSO TO EVALUATE THE OTHER LIGAMENTS IN THE KNEE, CARTILAGE, AND MENISCUS.

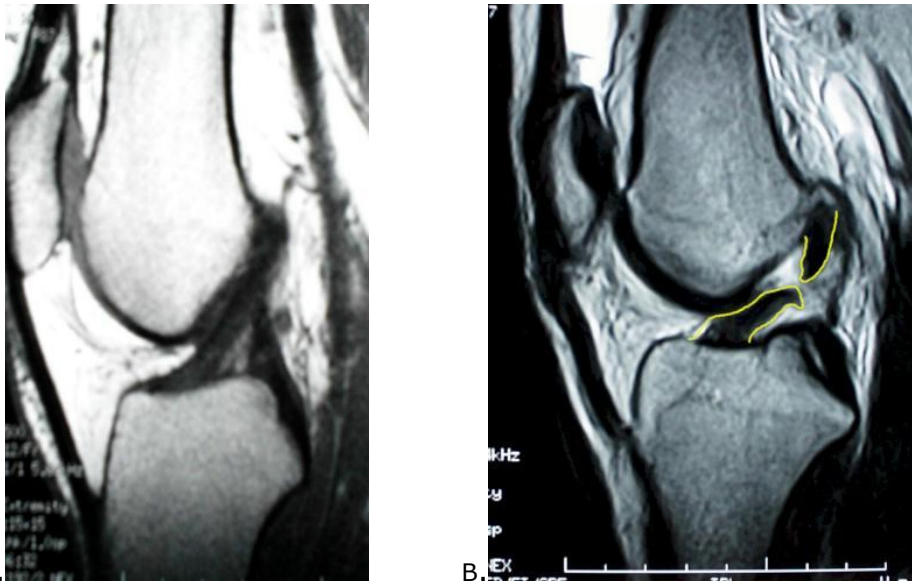


FIGURE 2. NORMAL ACL ON MRI (A) AND TORN ACL ON MRI (B).

PROPER DIAGNOSIS AND MANAGEMENT OF THE INJURIES ASSOCIATED WITH ACL TEARS (E.G. MENISCUS, CARTILAGE) ARE CRITICALLY IMPORTANT FOR THE LONG-TERM HEALTH OF THE KNEE. MRI SCAN CAN REVEAL THE FOLLOWING INJURIES ASSOCIATED WITH AN ACL TEAR:

**MENISCUS:** THE MEDIAL AND LATERAL MENISCI ARE FIBROCARTILAGE CUSHIONS BETWEEN THE TIBIA AND FEMUR THAT ACT AS SHOCK ABSORBERS AND DISTRIBUTE STRESSES PLACED ON THE KNEE JOINT. THE MENISCUS CAN TEAR DURING THE TRAUMA THAT CAUSED THE ACL TEAR AS WELL. TREATMENT OF MENISCUS TEARS (REPAIR VS. PARTIAL MENISCECTOMY) IS BASED ON THE SIZE, LOCATION, AND CONFIGURATION OF THE MENISCAL TEAR. DEPENDING ON THESE FACTORS THE MENISCUS TEAR IS COMMONLY REPAIRED OR EXCISED AT THE TIME OF ACL RECONSTRUCTION.

**ARTICULAR CARTILAGE:** CARTILAGE IS THE SMOOTH GLIDING SURFACE THAT COATS THE END OF THE FEMUR BONE AND TIBIA BONE. DAMAGE TO ARTICULAR CARTILAGE IS CALLED CHONDROMALACIA. THE CHRONIC LOSS OF CARTILAGE IS CALLED ARTHRITIS. CARTILAGE DAMAGE CAN OCCUR DURING ACUTE ACL TEARS OR AS A RESULT OF CHRONIC INSTABILITY DUE TO A CHRONIC ACL TEAR.

**MCL:** THE MEDIAL COLLATERAL LIGAMENT PROVIDES STABILITY TO THE INSIDE ASPECT OF THE KNEE. THIS LIGAMENT IS COMMONLY INJURED DURING AN ACL TEAR AS WELL. MOST ACL INJURIES (GRADE 1 AND 2 INJURIES) ASSOCIATED WITH ACL TEARS DO NOT REQUIRE FURTHER SURGICAL TREATMENT AT THE TIME OF ACL RECONSTRUCTION. HIGHER GRADE INJURIES MAY REQUIRE SURGICAL REPAIR.

**ACL/PCL/LCL or ACL/PCL/MCL:** IF THE POSTERIOR CRUCIATE LIGAMENT AND MEDIAL/LATERAL COLLATERAL LIGAMENT IS TORN IN CONJUNCTION WITH THE ACL TEAR, THIS

## ACL REHABILITATION PROTOCOL

INDICATES A HIGHER ENERGY INJURY. THESE INJURIES ARE TERMED MULTI-LIGAMENT KNEE INJURY AND REQUIRE RECONSTRUCTION OF ALL INJURED LIGAMENTS.

ONCE THE CONSTELLATION OF INJURIES TO THE KNEE IS DETERMINED BY PHYSICAL EXAM, X-RAY, AND MRI, A PLAN OF TREATMENT IS DETERMINED. A COMPLETELY TORN ACL WILL NEVER HEAL BACK TO IT PRE-INJURY "NORMAL" STATE EVEN AFTER CONSERVATIVE TREATMENT SUCH AS REHABILITATION. THE INTRA-ARTICULAR NATURE OF THE LIGAMENT BATHES THE ENDS OF THE INJURED ACL IN JOINT FLUID, PREVENTING PRIMARY HEALING FROM OCCURRING. FOR THIS REASON, THE ACL IS COMMONLY TREATED SURGICALLY WITH AN ACL RECONSTRUCTION.

### **TREATMENT OF ACL TEARS**

AN ACL RECONSTRUCTION SURGERY IS USUALLY RECOMMENDED IN THE FOLLOWING SITUATIONS:

- 1) ATHLETES WHO SUSTAIN ACL TEARS ALMOST ALWAYS REQUIRE RECONSTRUCTION OF THE ACL TO RETURN TO PRIOR LEVEL OF COMPETITION.
- 2) SYMPTOMS OF PERSISTENT KNEE INSTABILITY AND A FEELING OF GIVING WAY IN THE ACL DEFICIENT KNEE DESPITE REHABILITATION.
- 3) INJURY TO ASSOCIATED STRUCTURES IN THE KNEE (CARTILAGE AND MENISCUS) IN THE SETTING OF ACL INJURY IS BEST TREATED SURGICALLY IN MOST CASES.

AN ACUTELY INJURED KNEE WITH AN ACL TEAR IS ALMOST UNIVERSALLY TREATED INITIALLY WITH A COURSE OF PHYSICAL THERAPY TO RESTORE KNEE RANGE OF MOTION, DECREASE SWELLING, AND INCREASE STRENGTH. RESTORATION OF MOTION AND NORMAL WALKING AFTER AN ACL INJURY USUALLY TAKES 2-4 WEEKS. ONCE THIS PERIOD OF REHABILITATION IS COMPLETE, THE KNEE IS READY FOR RECONSTRUCTION. RESTORATION OF MOTION AND ELIMINATION OF MOST SWELLING IS IMPORTANT PRIOR TO SURGERY TO MINIMIZE THE RISK OF POSTOPERATIVE STIFFNESS.

### **ACL RECONSTRUCTION SURGERY**

MOST TEARS TO THE ACL ARE COMPLETE RUPTURES OF THE LIGAMENT AT ITS MIDPOINT. THE INTRA-ARTICULAR LIQUID ENVIRONMENT OF THE KNEE IS A POOR ENVIRONMENT FOR LIGAMENT HEALING AND THEREFORE TEARS OF THE ACL DO NOT HEAL ON THEIR OWN. SIMILARLY SUTURING THE ENDS OF THE LIGAMENT TOGETHER HAS NOT RESULTED IN SUCCESSFUL RESULTS DUE THE SAME POOR HEALING RESPONSE OF THE ACL.

SURGERY TO "FIX" THE ACL IS THEREFORE A RECONSTRUCTION (LIGAMENT REPLACEMENT) RATHER THAN A REPAIR. A RECONSTRUCTION OF THE LIGAMENT INVOLVES PLACING A NEW GRAFT ACROSS THE ANATOMIC SITE OF THE NORMAL ACL WHICH RUNS FROM THE TIBIA TO THE FEMUR. A SMALL TUNNEL IS DRILLED IN EACH BONE AND A NEW LIGAMENT (THE 'GRAFT') IS BROUGHT INTO THE TUNNEL AND IS FIXED WITH SCREWS IN THE ANATOMIC POSITION OF THE ACL. THE OPERATION IS PERFORMED THROUGH SMALL INCISIONS WITH THE AID OF AN ARTHROSCOPE (CAMERA WITHIN THE KNEE).

THE TYPE OF GRAFT USED IS SPECIFIC FOR EACH PATIENT AND DEPENDS BOTH ON SURGEON PREFERENCE, PATIENT PREFERENCE, AGE, AND ANATOMIC FACTORS. GRAFT TYPES ARE DESCRIBED AS AUTOGRAFT IF THEY COME FROM THE PATIENT'S OWN KNEE OR ALLOGRAFT IF THEY COME FROM CADAVER TISSUE.

# ACL REHABILITATION PROTOCOL

## **ACL GRAFT OPTIONS:**

- 1) **BONE-PATELLAR TENDON-BONE AUTOGRAFT (BTB):** THIS GRAFT COMES FROM THE ANTERIOR (FRONT PORTION) OF THE KNEE. A STRIP OF PATELLAR TENDON ALONG WITH TWO SMALL PIECES OF BONE (BONE BLOCKS) IS HARVESTED THROUGH A SMALL INCISION. THESE BONE BLOCKS ARE SECURED INTO BONE TUNNELS AT THE ANATOMIC LOCATION WHERE THE ACL ORIGINATES ON THE FEMUR (THE 'ORIGIN') AND THE ANATOMIC LOCATION WHERE THE ACL ENDS AT THE TIBIA (THE 'INSERTION'). BTB AUTOGRAFT HAS AN ESTABLISHED TRACK RECORD IN YOUNG ATHLETES. ADVANTAGES INCLUDED BONE TO BONE HEALING OF THE GRAFT, SECURE FIXATION AND LOW RE-RUPTURE RATES. DISADVANTAGES INCLUDE TEMPORARY OR RARELY PERMANENT PAIN AT THE SITE OF HARVEST AND INCREASED PAIN IN THE EARLY POSTOPERATIVE COURSE.



FIGURE 3. BONE PATELLA TENDON BONE AUTOGRAFT (BTB)

- 2) **HAMSTRING AUTOGRAFT:** THE HAMSTRING TENDONS THAT COURSE ALONG THE MEDIAL (INNER) ASPECT OF THE KNEE CAN ALSO BE USED AS A GRAFT. THESE TWO TENDONS ARE CALLED THE GRACILIS AND SEMITENDINOSUS; THE TENDONS ARE FOLDED OVER THEMSELVES TO CREATE A QUADRUPLED HAMSTRING GRAFT. NO BONE IS HARVESTED WITH THE HAMSTRING TENDONS AND THEREFORE, THERE IS LESS IMMEDIATE POSTOPERATIVE PAIN. TRADITIONALLY, THE DOWNSIDE OF HAMSTRING ACL RECONSTRUCTION IS THAT THE FIXATION OF THESE GRAFTS WAS NOT AS PREDICTABLE AS THE BTB GRAFT, LEADING TO A HIGHER RE-RUPTURE RATE. NEWER FIXATION DEVICES HAVE LARGELY ELIMINATED THIS PROBLEM AND RANDOMIZED CONTROLLED TRIALS HAVE SHOWN RELATIVE EQUIVALENCY BETWEEN THE BTB GRAFT AND THE HAMSTRING GRAFT. THERE MAY BE A SLIGHT LOSS OF HAMSTRING STRENGTH WITH THIS GRAFT LONG-TERM.



FIGURE 4. QUADRUPLED HAMSTRING AUTOGRAFT

- 3) **ALLOGRAFT:** ALLOGRAFT ACL RECONSTRUCTION IS PERFORMED WITH TISSUE HARVESTED FROM FROM ORGAN DONORS. THERE ARE MANY DIFFERENT SOURCES OF DONOR TENDONS AND LIGAMENTS THAT CAN BE USED FOR ACL RECONSTRUCTION. ALLOGRAFT HAMSTRING, BTB, ACHILLES TENDON, AND TIBIALIS ANTERIOR ARE ALL COMMON SOURCES OF ALLOGRAFT TISSUE USED IN ACL RECONSTRUCTION. ADVANTAGES OF AN ALLOGRAFT ACL RECONSTRUCTION IS THAT NO TISSUE IS HARVESTED FROM THE

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PATIENT'S KNEE AND THEREFORE THERE IS NO "DONOR SITE MORBIDITY."

DISADVANTAGES INCLUDE A THEORETICAL RISK OF DISEASE TRANSMISSION, INFECTION, OR REJECTION; THIS RISK IS EXCEEDINGLY SMALL DUE TO RIGID DONOR SCREENING AND TESTING AS WELL AS IRRADIATION/CLEANING OF THE GRAFTS PRIOR TO IMPLANTATION. ANOTHER DISADVANTAGE IS THE POSSIBILITY OF RE-RUPTURE IN THE MOST HIGH DEMAND, YOUNG ATHLETES. ALLOGRAFTS ARE VERY COMMONLY USED IN REVISION ACL RECONSTRUCTION AND IN CASES THAT REQUIRE THE RECONSTRUCTION OF MORE THAN ONE LIGAMENT.

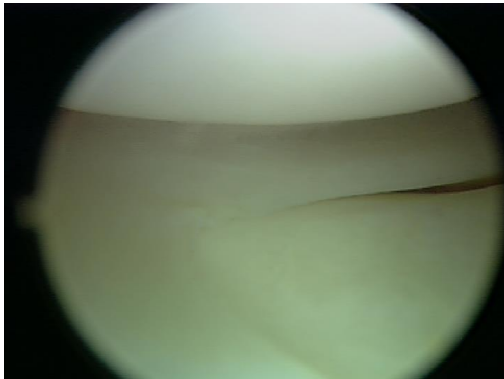


FIGURE 5. ACHILLES TENDON ALLOGRAFT

### TECHNICAL CONSIDERATIONS IN ACL RECONSTRUCTION

PERFORMING A TECHNICALLY SOUND ACL RECONSTRUCTION THAT RECREATES THE NORMAL ANATOMY OF THE NATIVE ACL WITH A SECURELY FIXED GRAFT IS PROBABLY MUCH MORE IMPORTANT THAN THE TYPE OF GRAFT USED. ACL SURGEONS HAVE BECOME INCREASINGLY INTERESTED IN THE EXACT LOCATION OF THE ACL ON THE TIBIA AND FEMUR (THE FOOTPRINT OF THE ACL). AT USC WE FOCUS ON PERFORMING AN "ANATOMIC" SINGLE BUNDLE RECONSTRUCTION, PLACING THE NEW ACL GRAFT PRECISELY WHERE IT BELONGS ON BOTH THE TIBIA AND FEMUR BY INDEPENDENTLY DRILLING EACH TUNNEL IN THE ANATOMIC FOOTPRINT OF THE NATIVE ACL.

FIGURE 6. ARTHROSCOPIC PICTURES OF AN ACL RECONSTRUCTION.

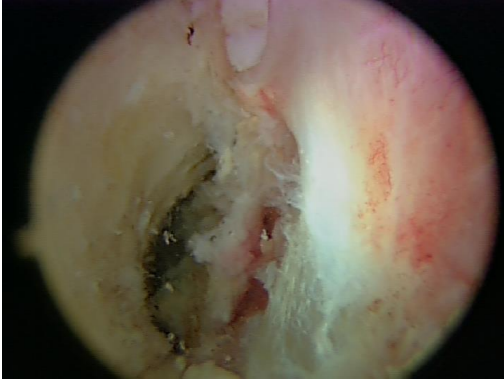


A. NORMAL MENISCUS AND CARTILAGE

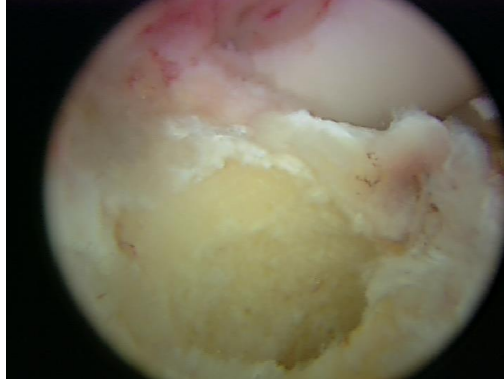


B. ACL STUMP

# ACL REHABILITATION PROTOCOL



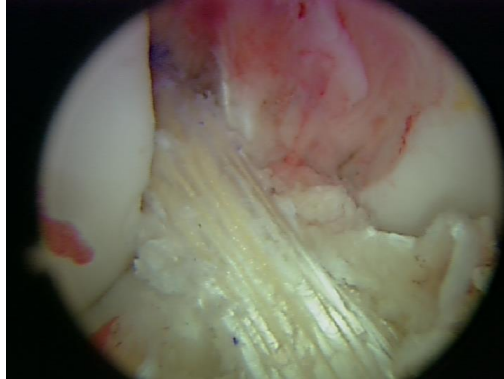
C. REMOVAL OF ACL STUMP (NOTCHPLASTY)



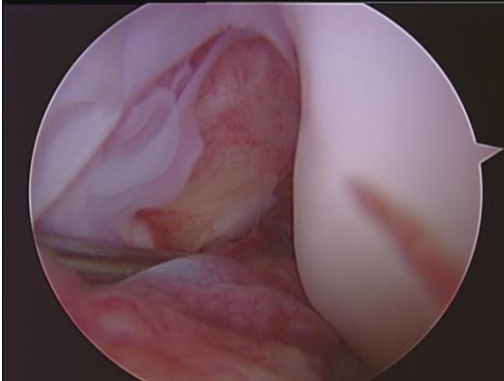
D. TIBIAL TUNNEL IN ACL FOOTPRINT



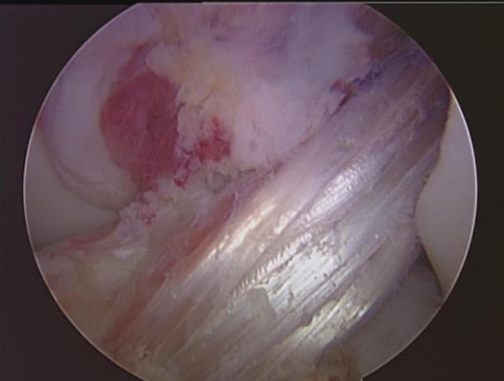
E. FEMORAL TUNNEL



F. COMPLETED ACL RECONSTRUCTION (BTB)



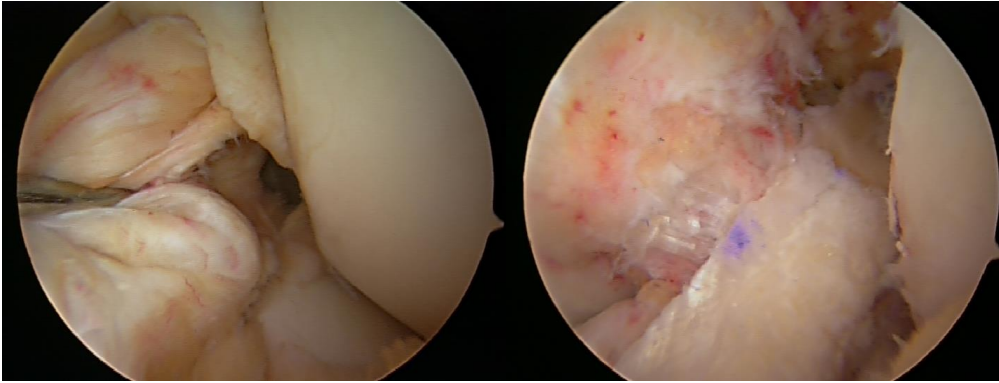
G. ACL TEAR RECONSTRUCTION



H. HAMSTRING AUTOGRAFT



## ACL REHABILITATION PROTOCOL



I. ACL TEAR

J. ACHILLES ALLOGRAFT RECONSTRUCTION

### EFFECTIVENESS OF ACL RECONSTRUCTION

IN THE HANDS OF AN EXPERIENCED SURGEON, ARTHROSCOPIC ACL RECONSTRUCTION IS VERY EFFECTIVE AT ELIMINATING INSTABILITY IN THE KNEE AND RETURNING PATIENTS BACK TO HIGH DEMAND SPORTS WITHOUT PAIN. THE POSITIVE EFFECT OF THE ACL RECONSTRUCTION IS PERMANENT. GREATER THAN 90% OF PATIENTS ARE USUALLY SATISFIED WITH THEIR SURGERY AND RETURN BACK TO SPORT. THE PROGNOSIS OF THE KNEE AFTER ACL RECONSTRUCTION LONG TERM DEPENDS MORE ON THE CONCOMITANT INJURIES TO MENISCUS AND CARTILAGE. OVER THE COURSE OF DECADES, ESPECIALLY IN KNEES WITH SEVERE CARTILAGE OR MENISCUS INJURY, ARTHRITIS CAN STILL DEVELOP DESPITE ACL SURGERY.

### RISKS OF ACL RECONSTRUCTION

THEORETICAL RISKS OF AN ACL RECONSTRUCTION INCLUDE THE FOLLOWING. THE SURGEON AND HIS OR HER TEAM WILL DO EVERYTHING POSSIBLE TO MINIMIZE THESE RISKS:

- INFECTION
- DAMAGE TO NERVES OR ARTERIES
- STIFFNESS
- PAIN OR WEAKNESS AT GRAFT DONOR SITE
- SCAR AND PERI-INCISIONAL NUMBNESS
- REJECTION/INFECTION/DISEASE TRANSMISSION FROM ALLOGRAFT (EXCEEDINGLY LOW RISK)
- FAILURE OR RE-RUPTURE OF THE RECONSTRUCTED LIGAMENT (5%)
- FAILURE TO RETURN TO PREVIOUS LEVEL OF SPORT
- REOPERATION
- ANESTHESIA RISK

### WHAT TO EXPECT

ACL RECONSTRUCTION IS PERFORMED AS OUTPATIENT SURGERY. SURGERY TAKES 1.5 TO 2 HOURS TO COMPLETE. GENERAL AND/OR REGIONAL ANESTHESIA IS REQUIRED. AFTER THE SURGERY STERILE BANDAGES ARE APPLIED AS WELL AS A HINGED KNEE BRACE AND A COLD-THERAPY DEVICE (CRYO-CUFF). THE PATIENT CAN LEAVE THE SAME DAY ON CRUTCHES TO LIMIT WEIGHT BEARING ON THE LEG.

## ACL REHABILITATION PROTOCOL

PAIN MEDICATIONS (PERCOCET) AND AN ANTI-INFLAMMATORY (NAPROSYN) ARE PROVIDED. PROLONGED SITTING/STANDING/WALKING ARE AVOIDED FOR THE FIRST 7 DAYS. PATIENTS WITH DESK JOBS CAN RETURN TO WORK AFTER ABOUT 1 WEEK. TO SHOWER, THE LEG IS COVERED WITH A PLASTIC BAG UNTIL THE WOUNDS ARE HEALED (7-10 DAYS). CRUTCHES AND THE BRACE ARE USED FOR 3-4 WEEKS DEPENDING ON THE TYPE OF GRAFT AND CONCOMITANT INJURIES TO THE KNEE. GENTLE RANGE OF MOTION AND STRENGTHENING EXERCISES BEGIN IMMEDIATELY AND FORMAL PHYSICAL THERAPY STARTS 3-5 DAYS AFTER SURGERY.

# ACL REHABILITATION PROTOCOL

## ACL Reconstruction Rehabilitation Protocol

One of the most common complications following ACL reconstruction is loss of motion, especially loss of extension. Loss of knee extension has been shown to result in a limp, quadriceps muscle weakness, and anterior knee pain. Studies have demonstrated that the timing of ACL surgery may have a significant influence on the development of postoperative knee stiffness.

**THE HIGHEST INCIDENCE OF KNEE STIFFNESS OCCURS IF ACL SURGERY IS PERFORMED WHEN THE KNEE IS SWOLLEN, PAINFUL, AND HAS A LIMITED RANGE OF MOTION.**

The risk of developing a stiff knee after surgery can be significantly reduced if the surgery is delayed until the acute inflammatory phase has passed, the swelling has subsided, a normal or near normal range of motion (especially extension) has been obtained, and a normal gait pattern has been reestablished.

### Preoperative Rehabilitation Phase

Prepare for surgery using the information within this section.

#### Goals:

- \* **Control pain and swelling**
- \* **Restore normal range of motion**
- \* **Develop muscle strength sufficient for normal gait and ADL**
- \* **Mentally prepare the patient for surgery**

Before proceeding with surgery the acutely injured knee should be in a quiescent state with *little or no swelling*, have a full range of motion, and the patient should have a normal or near normal gait pattern.

*More important than a predetermined time before performing surgery is the condition of the knee at the time of surgery.* Use the following guidelines to prepare the knee for surgery:

#### Immobilize the knee

Following the acute injury you should use a knee immobilizer and crutches until you regain good muscular control of the leg. Extended use of the knee immobilizer should be limited to avoid quadriceps atrophy. You are encouraged to bear as much weight on the leg as is comfortable except in the case of multi-ligament knee injury.

#### Control Pain and Swelling

Crushed ice, Cryocuff or a Game Ready compression device, along with nonsteroidal anti-inflammatory medications such as Advil, Nuprin, Motrin, Ibuprofen, Aleve (2 tablets twice a day) are used to help control pain and swelling. The nonsteroidal anti-inflammatory medications are continued for 7 - 10 days following the acute injury.

## ACL REHABILITATION PROTOCOL

### Restore normal range of motion

*You should attempt to achieve full range of motion as quickly as possible.* Quadriceps isometrics exercises, straight leg raises, and range of motion exercises should be started immediately.

Full extension is obtained by doing the following exercises:

1) Passive knee extension.

- Sit in a chair and place your heel on the edge of a stool or chair.
- Relax the thigh muscles.
- Let the knee sag under it's own weight until maximum extension is achieved.

2) Heel Props:

- Place the heel on a rolled towel making sure the heel is propped high enough to lift the thigh off the table.
- Allow the leg to relax into extension.
- 3 - 4 times a day for 10 - 15 minutes at a time. See Figure 1:



Figure 1. Heel prop using a rolled towel.

3) Prone hang exercise.

- Lie face down on a table with the legs hanging off the edge of the table.
- Allow the legs to sag into full extension.

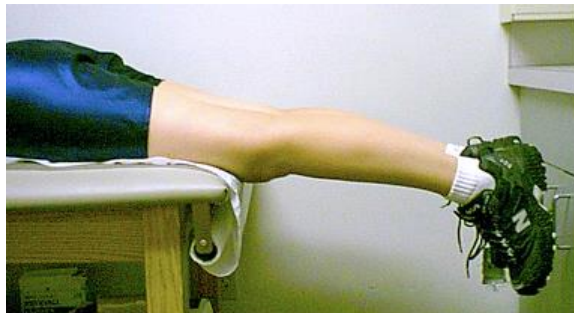


Figure 2. Prone Hang. Note the knee is off the edge of the table.

## ACL REHABILITATION PROTOCOL

Bending (Flexion) is obtained by doing the following exercises:

1) Passive knee bend

- Sit on the edge of a table and let the knee bend under the influence of gravity.

2) Wall slides are used to further increase bending.

- Lie on the back with the involved foot on the wall and allow the foot to slide down the wall by bending the knee. Use other leg to apply pressure downward.



Figure 3. Wall Slide: Allow the knee to gently slide down

3) Heel slides are used to gain final degrees of flexion (see Figure 4).

- Pull the heel toward the buttocks, flexing the knee. Hold for 5 seconds.
- Straighten the leg by sliding the heel downward and hold for 5 seconds.



Figure 4. Heel slide – leg is pulled toward the buttocks

- In later stages of rehabilitation, do heel slides by grasping the leg with both hands and pulling the heel toward the buttocks.

## ACL REHABILITATION PROTOCOL



Figure 5. Heel slides in later stages of rehabilitation

### **Develop muscle strength**

Once 100 degrees of flexion (bending) has been achieved you may begin to work on muscular strength:

1) Stationary Bicycle. Use a stationary bicycle two times a day for 10 - 20 minutes to help increase muscular strength, endurance, and maintain range of motion. See Figure 6:



Figure 6. Stationary Bicycle helps to increase strength

2) Swimming is also another exercise that can be done during this phase to develop muscle strength and maintain your range of motion.

3) Low impact exercise machines such as an elliptical cross-trainer, leg press machine, leg curl machine, and treadmill can also be used. This program should continue until you have achieved a full range of motion and good muscular control of the leg (you should be able to walk without a limp).

## ACL REHABILITATION PROTOCOL

### **Mentally prepare**

- Understand what to realistically expect of the surgery
- Make arrangements with a physical therapist for post-operative rehabilitation
- Make arrangements with your place of employment.
- Make arrangements with family and/or friends to help during the post-operative rehabilitation
- Read and understand the rehabilitation phases after surgery.

## ACL REHABILITATION PROTOCOL

### Understanding Surgery

This section provides an understanding of the pre and post-operative phases of surgery.

### Key terms: Pain control, Drainage tube, Cryocuff, Knee Immobilizer

#### Before Surgery

You will be prescribed antibiotic cleanser to clean the skin around the knee. You will be fitted for a knee brace and provided an ice machine. Please bring these with you the day of surgery.

#### During Surgery

At the time of surgery you *may* have a *plastic drainage tube* that is connected to a vacuum container may be placed in the subcutaneous tissues around your knee and into the knee joint to prevent blood from collecting.

#### After Surgery

Prior to leaving the operating room a *Cryocuff*, *Gameready*, or *PolarCare* cooling device and a *knee brace* will be applied to your knee.

- The *Cryocuff™* or *Gameready™* will provide cold and compression, reducing pain and swelling. This unit should be used continuously for the first 3 - 4 days after your surgery. After this time period the *Cryocuff™* can be used as needed for comfort. The *Cryocuff* will remain cold for approximately 30-45 minutes, and we suggest about 1 hour between sessions.
- The postoperative knee brace helps to maintain extension and is to be worn at all times while walking and during sleeping, otherwise it can be removed.
- After surgery, your leg will be wrapped in an ACE wrap. You can unwrap the bandage to change the dressings as needed.
- If there are drainage tubes, they will be removed before you leave the hospital.

After the anesthesia has worn off, your vital signs are stable and your pain is under control you will be discharged from the hospital or surgical center.

You will not be allowed to drive a car. Therefore prior to your discharge, you must arrange for transportation.



## ACL REHABILITATION PROTOCOL

### Postoperative Days 1 – 7

Follow the guidelines within this section for the first seven days after your surgery

**IT IS EXTREMELY IMPORTANT THAT YOU WORK ON EXTENSION IMMEDIATELY.**

#### Goals:

- \* **Control pain and swelling**
- \* **Care for the knee and dressing**
- \* **Early range of motion exercises**
- \* **Achieve and maintain full passive extension**
- \* **Prevent shutdown of the quadriceps muscles**
- \* **Gait training**

#### Control Pain and Swelling

Control Swelling. Following discharge from the hospital you should go home elevate your leg and keep the knee iced using the Cryocuff™ or Gameready™. You may get up to use the bathroom and eat, but otherwise you should rest with your leg elevated. The ice water in the Cryocuff™ will remain cold for approximately 45 - 60 minutes. Once the feeling of cold has worn off, the water in the cuff should be re-chilled. The ice water in the Cryocuff container will last approximately 2 - 3 hours.

**DO NOT SIT FOR LONG PERIODS OF TIME WITH YOUR FOOT IN A DEPENDENT POSITION (LOWER THAN THE REST OF YOUR BODY), AS THIS WILL CAUSE INCREASED SWELLING IN YOUR KNEE AND LEG. WHEN SITTING FOR ANY SIGNIFICANT PERIOD OF TIME, ELEVATE YOUR LEG AND FOOT.**

2) Control Pain. You will be sent home with a prescription for a strong narcotic medication such as Percocet or Vicodin. You should take this for severe pain, as directed on the prescription bottle label.

3) You may also be given a special anti-inflammatory such as Naprosyn or Celebrex. Take this as directed for the first 10 days.

4) As your pain and swelling decrease you can start to move around more and spend more time up on your crutches.

## ACL REHABILITATION PROTOCOL

### Caring for your knee

1) The first night and day after the surgery you can expect the bandages to get bloody. This is normal! We want the blood to drain out of the knee on to the dressings rather than build-up in your knee and cause swelling and pain.

If the dressings become extremely bloody or wet you should change them as needed.

Use the following directions for changing the dressing:

- The Ace bandage should be removed first followed by the cotton wrap and 4 inch x 4 inch gauze bandages.
- A clean, dry, 4 inch x 4 inch gauze bandage should be applied over the incisions and held in place a clean elastic dressing.
- Do not use tape to keep the gauze in place as this may cause skin blisters. The Ace bandage will keep the gauze in place.

2) You are allowed to put partial weight on the leg for the first two weeks after surgery. Thereafter, you can put as much weight on the leg as is comfortable.

3) You can start using a stationary bike. Cycling is an excellent conditioning and building exercise for the quadriceps. Start with the seat fairly high and use a short diameter pedal if available so that the knee doesn't bend too much. At this early stage, you should just "spin" without any resistance. Use your good leg to turn the pedal.

4) You may shower 48 hours after surgery, however you must place a plastic bag over the brace while showering or you have the option to take off the brace to shower. Whatever you decide to do please use CAUTION!! Be careful not to slip, twist, or fall. A stool placed in the shower so you can sit is a great idea so you can stabilize your knee. Do not soak in a bathtub, hot tub, or pool until the doctor tells you it is O.K. to do so. Once you are done showering pat the wound dry.

5) The sutures are not absorbable and need to be removed.

6) A follow-up visit should be scheduled 2 weeks following the operation by contacting Dr. Petrigliano's office at (323) 442-5822

7) You may remove the knee brace while doing exercises or if you are in a safe, protected environment. However, the knee immobilizer should be worn while walking or sleeping for the first 2 to 4 weeks depending on the type of surgery and your progress.

## ACL REHABILITATION PROTOCOL

### Early Range of Motion and Extension

1) Passive extension of the knee by using a rolled towel. Note the towel must be high enough to raise the calf and thigh off the table. See Figure 1 on page 4.

- Remove the knee immobilizer from your knee every 2 - 3 hours while awake
- Position the heel on a pillow or rolled blanket with the knee unsupported
- Passively let the knee sag into full extension for 10 - 15 minutes. Relax your muscles, and gravity will cause the knee to sag into full extension.

This exercise can also be done by sitting in a chair and supporting the heel on the edge of a stool, table or another chair and letting the unsupported knee sag into full extension.

2) Active-assisted extension is performed by using the opposite leg and your quadriceps muscles to straighten the knee from the 90 degree position to 0 degrees. Hyperextension should be avoided during this exercise. See Figure 7:

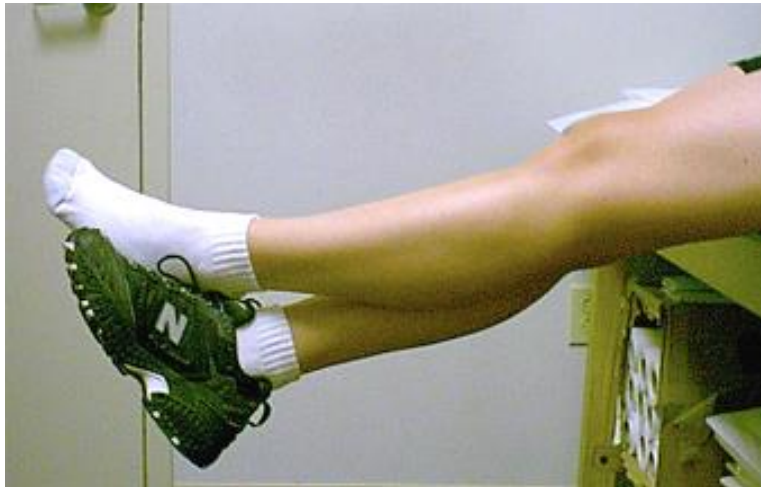


Figure 7. Use the non-injured leg to straighten the knee

3) Passive flexion (bending) of the knee to 90 degrees. (See Figure 8 below)

- Sit on the edge of a bed or table and letting gravity gently bend the knee.
- The opposite leg is used to support and control the amount of bending.
- This exercise should be performed 4 to 6 times a day for 10 minutes. It is important to achieve at least 90 degrees of passive flexion by 5 - 7 days after surgery.

## ACL REHABILITATION PROTOCOL



Figure 8. Passive Flexion allowing gravity to bend the knee to 90 degrees

### Exercising Quadriceps

1) You should start quadriceps isometric contractions with the knee in the fully extended position as soon as possible.

- Do 3 sets of 10 repetitions 3 times a day.
- Each contraction should be held for a count of 6 sec.

This exercise helps to prevent shut down of the quadriceps muscle and decreases swelling by squeezing fluid out of the knee joint.

2) Begin straight leg raises (SLR) with the knee immobilizer on 8 sets of 10 repetitions 3 times a day. Start by doing these exercises while lying down.

- This exercise is performed by first performing a quadriceps contraction with the leg in full extension. The quadriceps contraction "locks" the knee and prevents excessive stress from being applied to the healing ACL graft.
- The leg is then kept straight and lifted to about 45-60 degrees and held for a count of six.
- The leg is then slowly lowered back on the bed. Relax the muscles.

### REMEMBER TO RELAX THE MUSCLES EACH TIME THE LEG TOUCHES DOWN

This exercise can be performed out of the brace when the leg can be held straight without sagging (quad lag). Once you have gained strength, straight leg exercises can be performed while seated. See Figure 9:



Figure 9. Straight leg raises – lying (left) and seated (right)

## ACL REHABILITATION PROTOCOL

### Exercising Hamstrings

1) **For patients who have had ACL reconstruction using the hamstring tendons** it is important to avoid excessive stretching of the hamstring muscles during the first 6 weeks after surgery.

- The hamstring muscles need about 6 weeks to heal, and excessive hamstring stretching during this period can result in a "pulled" hamstring muscle and increased pain.
- Unintentional hamstring stretching commonly occurs when attempting to lean forward and put on your socks and shoes, or when leaning forward to pick an object off the floor.
- To avoid re-injuring the hamstring muscles, bend your knee during the activities below, thus relaxing the hamstring muscles.

2) The hamstring muscles are exercised by pulling your heel back producing a hamstring contraction. See Figure 4:

- This exercise should be performed only if your own patellar tendon graft was used to reconstruct the ACL.
- If a hamstring tendon graft from your knee was used to reconstruct the ACL, this exercise should be avoided for the first 4 - 6 weeks, as previously mentioned.

### Postoperative Days 8 – 10

Use the guidelines within this section for days 8-10 after your surgery

#### Goals:

- \*Physical therapy
- \*Maintain full extension
- \*Returning to work

- 1) Schedule an office follow-up.
- 2) As the steri-strips get wet, they will peel off. Do not pull at them for the first 2 weeks.
- 3) After 4 weeks, you may apply vitamin E oil or another emollient to the incisions, as this will improve their appearance.
- 4) The appearance of your incision can be improved further if you keep direct sunlight off of it for one year. When exposed to the sun the incisions can be covered with a bandage, sunscreen with SPF of 30 to 50, or zinc oxide paste.

## ACL REHABILITATION PROTOCOL

### **Physical Therapy and Full Extension**

- 1) Outpatient physical therapy should be initiated during the first few days after surgery.
- 2) Continue doing the quadriceps isometrics, SLR, active flexion, and active-assisted extension exercises.

**REMEMBER THAT IT IS EXTREMELY IMPORTANT TO CONTINUE TO REMOVE YOUR LEG FROM THE KNEE IMMOBILIZER 4 TO 6 TIMES A DAY FOR 10 - 15 MINUTES AT A TIME TO MAINTAIN FULL EXTENSION**

## ACL REHABILITATION PROTOCOL

### Returning to Work or School

- 1) As far as returning to work or school, you can return to work when your pain medication requirements decrease, and you can safely walk with your crutches. Typically this is between 3 - 10 days after surgery.
- 2) Patients who have jobs where light duty is not permitted; policemen, firemen, construction workers, laborers, will be out of work for a minimum of 6 - 12 weeks.

### Postoperative Week 2

Use the guidelines in this section during the second week after your surgery

#### Goals:

- \* **Maintain full extension**
- \* **Achieve 100 – 120 degrees of flexion**
- \* **Develop enough muscular control to wean off knee brace**
- \* **Control swelling in the knee**

**MAINTAINING FULL EXTENSION AND DEVELOPING MUSCULAR CONTROL ARE IMPORTANT**

### Maintain Full Extension

- 1) Continue with full passive extension (straightening), gravity assisted and active flexion, active-assisted extension, quadriceps isometrics, and straight leg raises.
- 2) Work toward 90-100 degrees of flexion (bending)

### Develop Muscular Control

- 1) Start Partial Squats.
  - Place feet at shoulder width in a slightly externally rotated position.
  - Use a table for stability, and gently lower the buttocks backward and downward.
  - Hold for 6 seconds and repeat.
  - Do 3 sets of 10 repetitions each day.



Figure 10. Partial squat using Table for stabilization

## ACL REHABILITATION PROTOCOL

### 2) Start Toe Raises.

- Using a table for stabilization, gently raise the heel off the floor and balance on the ball of the feet.
- Hold for 6 seconds and ease slowly back down.
- Do 3 sets of 10 repetitions each day.



Figure 11. Toe Raise

3) Continue to use the knee brace for walking even if you have good muscle control of the leg. This will protect your graft.

4) Wean from crutches when you can put full weight on the leg and walk with a normal heel-toe gait and no limp.

5) You can continue using a stationary bike. Cycling is an excellent conditioning and building exercise for the quadriceps. See Figure 6 on page 6.

- The seat position is set so when the pedal is at the bottom, the ball of the foot is in contact with the pedal and there is a slight bend at the knee.
- No or low resistance used. Maintain good posture throughout the exercise.
- As your ability to pedal the bike with the operative leg improves, you may start to increase the resistance (around 5-6 weeks).
- Your objective is to slowly increase the time spent on the bike starting first at 5 minutes and eventually working up to 20 minutes a session.
- The resistance of the bike should be increased such that by the time you complete your work-out your muscles should "burn".

**THE BIKE IS ONE OF THE SAFEST MACHINES YOU CAN USE TO REHABILITATE YOUR KNEE, AND THERE IS NO LIMITATION ON HOW MUCH YOU USE IT.**



## ACL REHABILITATION PROTOCOL

### Control Pain and Swelling

1) At this point you should begin reducing the amount of narcotic pain medication you take. You will be instructed on how to do this during your follow-up appointment.

2) Once you have finished the anti-inflammatory that was given to you, you can take an over-the-counter anti-inflammatory medication, provided you have no history of stomach ulcer. The cheapest and simplest medication to take is Advil, Motrin, Nuprin or Aleve, 2 tablets twice a day. This medication will help to prevent scar tissue from forming in the knee, and also help to prevent blood clots from forming in your legs.

### When can you drive a car?

**REMEMBER, IT IS ILLEGAL TO TAKE PRESCRIPTION PAIN MEDICATIONS AND OPERATE A MOTOR VEHICLE!**

- First, you must not be taking any prescription pain medications.
- Patients who have had surgery on the left knee, and who have an automatic transmission may drive when they can comfortably get the leg in and out of the car.
- During driving the knee brace can be unlocked.
- Patients who have had surgery on the left knee and have standard transmissions, should not drive until they have good muscular control of the leg. This usually takes 3-4 weeks.
- Patients who had surgery on the right knee should not drive until they have good muscular control of the leg. This usually takes 4-6 weeks.

# ACL REHABILITATION PROTOCOL

## Postoperative Weeks 3 – 4

### Goals:

- \* Full range of motion
- \* Strength through exercise

- 1) Expected range of motion is from full extension to 100 – 120 degrees of flexion. Add wall slides (see Figure 3) and hand assisted heel drags to increase your range of motion.
- 2) Continue quadriceps isometrics and straight leg raises (see Figure 9).
- 3) Continue partial squats and toe raises (see Figure 10 and Figure 11).
- 4) If you belong to a health club or gym you may start to work on the following machines:
  - Stationary bike. Seat position regular height to high to avoid too much bending or straightening of the knee. Increase resistance as tolerated. Try to work up to 15-20 minutes a day.
  - Elliptical cross-trainer 15 - 20 minutes a day.
  - Inclined leg-press machine for the quadriceps muscles. 70 - 0 degree range. See Figure 12:

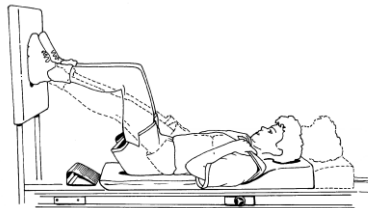


Figure 12. Leg press using 90-0 degree range

- Seated leg curls machine for the hamstring muscles. **Note** this exercise should be delayed until the postoperative week 8-10 if your ACL was reconstructed with a hamstring tendon graft.
- Upper body exercise machines.
- Swimming: pool walking, flutter kick (from the hip), water bicycle, water jogging. No diving, or whip kicks.

## ACL REHABILITATION PROTOCOL

### Postoperative Weeks 4 – 6

#### Goals:

- \* **125 degrees of flexion pushing toward full flexion**
- \* **Continued strength building**

- 1) Your expected range of motion should be full extension to 125 degrees. Start to push for full flexion. Walls slides added if your flexion range of motion is less than desired.
- 2) Continue quad sets, straight leg raises, partial squats, toe raises, stationary bike, elliptical machine, leg presses, and leg curls.
- 3) Tilt board or balance board exercises. This helps with your balance and proprioception (ability to sense your joint in space)

### Postoperative Weeks 6 – 12

By week 6, your range of motion should be full extension to at least 135 degrees of flexion.

#### Goals:

- \* **135 degree of flexion**
- \* **Continued strength**
- \* **Introduce treadmill**

- 1) Continue quad sets, straight leg raises, partial squats, toe raises, stationary bike, elliptical machine, leg presses, and leg curls.
- 2) Hamstring reconstruction patients can start leg curls in a sitting position. If you develop hamstring pain then decrease the amount of weight that you are lifting, otherwise you can increase the weight as tolerated.

**IT IS IMPORTANT TO AVOID USE OF A LEG CURL MACHINE THAT REQUIRES YOU TO LIE ON YOUR STOMACH. THIS MACHINE PUTS TOO MUCH STRAIN ON THE HEALING HAMSTRING MUSCLES, AND CAN RESULT IN YOU "PULLING" THE HAMSTRING MUSCLE.**

- 3) Continue tilt board and balance board for balance training.
- 4) Continue swimming program.
- 5) Start treadmill walking (flat only).
- 6) You may begin outdoor bike riding on flat roads.

**NO MOUNTAIN BIKING OR HILL CLIMBING!**

## ACL REHABILITATION PROTOCOL

### Postoperative Weeks 12 – 20

#### Goals:

- \* Continued strength
- \* Introduce jogging and light running
- \* Introduce agility drills
- \* Determine need for ACL functional brace

- 1) Continue all of week 6 -12 strengthening exercises.
- 2) Start straight, forward and straight, backward jogging and light running program.
- 3) Start functional running program after jogging program is completed.
- 4) Optional fitting for ACL functional brace.
- 5) Start agility drills, zig-zags and cross over drills.

### 24 Weeks Postoperative (6 months)

This is the **EARLIEST** you should plan on returning to full sports. Most patients require **8-12 MONTHS** to return to full activity.

#### Goals:

- \* Return to sports

To return to sports you should have:

- Quadriceps strength at least 80% of the normal leg
- Hamstring strength at least 80% of the normal leg
- Full motion
- No swelling
- Good stability
- Ability to complete a running program

### Medication Regimen

1. Percocet – 5/325 mg. A prescription will be given for this. Take 1 to 2 tablets every 4 to 6 hours as needed for pain. Stop using the Percocet as soon as you can. Please fill the prescription immediately and store the medication in a child-proof, safe, locked location.
2. Naprosyn – 500 mg. A prescription will be given for this. Take 1 tablet twice a day for 10 days. Take this with food, and if you have any symptoms of heartburn stop the medication.
3. Enteric Coated Aspirin – 81 mg. You may be given a prescription for this. Take 1 tablet each day for 14 days to prevent blood clots.