



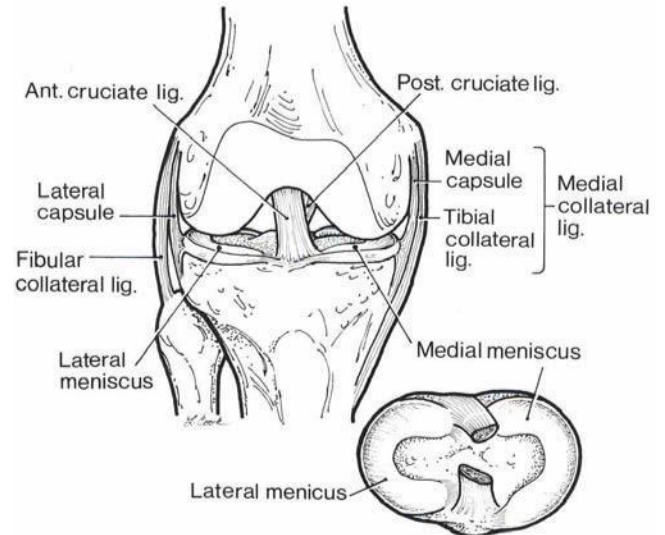
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ANTERIOR CRUCIATE LIGAMENT INJURY

WHAT IS THE ANTERIOR CRUCIATE LIGAMENT?

The anterior cruciate ligament (ACL) is one of four major ligaments that stabilize the knee joint. A ligament is a tough band of fibrous tissue, similar to a rope, which connects the bones together at a joint. There are two ligaments on the sides of the knee (collateral ligaments) that give stability to sideways motions: the medial collateral ligament (MCL) on the inner side and the lateral collateral ligament (LCL) on the outer side of the knee. Two ligaments cross each other (therefore, called cruciate) in the center of the knee joint: The crossed ligament toward the front (anterior) is the ACL and the one toward the back of the knee (posterior) is the posterior cruciate ligament (PCL). The ACL prevents the lower bone (tibia) from sliding forward too much and stabilizes the knee to allow cutting, twisting and jumping sports. The PCL stops the tibia from moving backwards.



HOW CAN THE ACL TEAR?

The most common mechanism that tears the ACL is the combination of a sudden stopping motion on the leg while quickly twisting on the knee. This can happen in a sport such as basketball, for example, when a player lands on the leg when coming down from a rebound or is running down the court and makes an abrupt stop to pivot. In football, soccer, or lacrosse, the cleats on the shoes do not allow the foot to slip when excess force is applied. In skiing, the ACL is commonly injured when the skier sits back while falling. The modern ski boot is stiff, high, and is tilted forward. The boot thus holds the tibia forward and the weight of the body quickly shifts backwards too much force is suddenly applied to the knee. The excess force causes the ACL to pop.

A contact injury, such as when the player is clipped in football, forces the knee into an abnormal position. This may tear the ACL, MCL and other structures.

WHAT ARE THE SIGNS THAT AN ACL IS TORN?

When the ACL tears, the person feels the knee go out of joint and often hears or feels a “pop”. If he or she tries to stand on the leg, the knee may feel unstable and give out. The knee usually swells a great deal immediately (within two hours). Over the next several hours, pain becomes more severe and it becomes difficult to walk.

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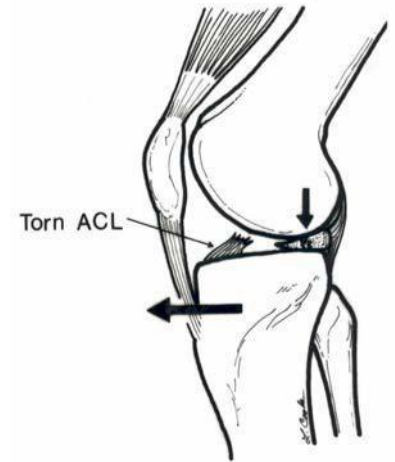


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WHAT OTHER KNEE STRUCTURES CAN BE INJURED WHEN THE ACL TEARS?

The meniscus is a crescent shaped cartilage that acts as a shock absorber between the femur and tibia. Each knee has two menisci: medial (inner) and lateral (outer). The menisci are attached to the tibia. When the tibia suddenly moves forward and the ACL tears, the meniscus can become compressed between the femur and tibia tearing the meniscus. The abnormal motion of the joint can also bruise the bones. There is a second type of cartilage in the knee joint called articular cartilage. This is a smooth, white glistening surface that covers the ends of the bones. The articular cartilage provides lubrication and as a result, there is very little friction when the joint moves. This joint cartilage can get damaged when the ACL tears and the joint is compressed in an abnormal way. If this articular cartilage is injured, the joint no longer moves smoothly. Stiffness, pain, swelling and grinding can occur. Eventually, arthritis can develop. The MCL and other ligaments in the joint can also be disrupted when the ACL tears. This is more common if an external blow to the knee caused the injury (such as if the knee was clipped while playing football) or when skiing.



WHAT IS THE INITIAL TREATMENT FOR A TORN ACL?

The initial treatment of the injured joint is to apply ice and gentle compression to control swelling. A knee splint and crutches are used. The knee should be evaluated by a doctor to see which ligaments are torn and to be sure other structures such as tendons, arteries, nerves, etc. have not been injured. X-rays are taken to rule out a fracture. Sometimes an MRI is needed, but usually the diagnosis can be made by physical examination.

HOW WILL THE KNEE FUNCTION IF THE ACL IS TORN?

If no structure other than the ACL is injured, the knee usually regains its range of motion and is painless after six or eight weeks. The knee will typically feel completely normal. However, it can be a “trick knee”. If a knee does not have an ACL it can give way or be unstable when the person pivots or changes direction. The athlete can usually run straight ahead without a problem but when he or she makes a quick turning motion such as when pivoting, the knee tends to give way and collapse. This abnormal motion can damage the menisci or articular cartilage and cause further knee problems.

If a person does not do sports and is relatively inactive, the knee can feel quite normal even if the ACL is torn. Thus, many patients especially over the age of thirty may not need to have the ACL reconstructed, especially if they do not participate in sports that require quick changes in direction. In young, athletic patients, however, the knee will tend to reinjure frequently and give way during activities in which the person quickly changes direction. Therefore, it is usually best to reconstruct the torn ACL.

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WHEN SHOULD SURGERY BE PERFORMED FOR A TORN ACL?

It is best to wait for the pain and swelling to subside and to allow associated injuries to heal before performing surgery for the ACL. If surgery is done soon after injury, rehabilitation is difficult; the knee may get stiff and have permanent loss of motion. The athlete will usually get back to sports much more quickly if the knee is allowed to recover from initial injury and to regain its full painless range of motion (usually at least six weeks) before performing surgery.

If surgery is delayed until the joint has full painless range of motion, then an accelerated rehabilitation program can be used after surgery. With accelerated rehabilitation, continuous passive range of motion (CPM) is used for the first week following surgery. The knee heals much more quickly and better joint function results.

The best treatment following acute ACL injury is to usually protect the joint and apply ice and use crutches for several weeks. As the swelling and pain subside, and the patient can put weight on the leg; then the immobilizer and crutches are discontinued. The emphasis is on regaining knee motion. Resistive exercises to build up strength should not be done during this time to prevent damaging the knee cap and causing chondromalacia patella.

If the knee also has an injured medial collateral ligament (MCL), it is best to allow the MCL to heal completely (usually six to eight weeks) before reconstructing the ACL. Then an arthroscopic procedure can be performed to reconstruct the ACL. The torn MCL usually does not need to be repaired surgically.

There may be instances when immediate surgery is indicated following injury. Examples are knee dislocation when multiple ligaments are torn. Tears of the outer knee ligaments (lateral collateral ligament) often do require surgical repair. Individual decisions need to be made on whether or not to reconstruct the ACL soon after injury in these instances where immediate surgery may be required.

DO ALL ACL TEARS NEED SURGERY?

No — some knees function almost normally despite having a torn ACL. Good knee function is more common in patients who are over thirty years old who are relatively inactive in sports. Patients who are less than twenty-five years old, regardless of activity level, tend to have problems with instability and frequent episodes of giving way. Therefore, surgical reconstruction of a torn ACL is usually recommended for patients who are less than age twenty-five years. However, surgery should be delayed until after the acute injury has subsided (usually at least six weeks following injury).

TREATMENT OPTIONS FOR TORN ACL

I. NON-OPERATIVE

Some patients can function well even if the ACL is torn. However, it may be necessary to modify activities and avoid high-risk sports (such as basketball, soccer and football). The key to prevent the knee that has a torn ACL from giving out is to avoid quick pivoting motions. Wearing a knee brace can help reinjury. The main effect of a knee brace is to be a constant reminder to be careful.

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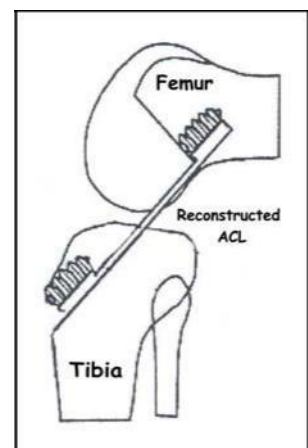
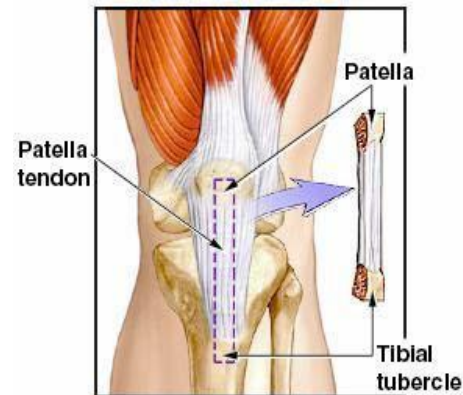
However, a brace will not completely stabilize a knee that has a torn ACL. Exercises that restore the muscle strength, power, coordination, and endurance will also improve knee function and help stabilize the knee. However, a fully rehabilitated knee that has a torn ACL can still give way if a quick change in direction is unexpected.

II. LIMITED ARTHROSCOPIC SURGERY

Many knees in which the ACL is torn have additional injuries such as torn menisci or fragments of articular cartilage that are knocked loose (creating a loose body and a defect in the articular cartilage). These associated injuries can cause symptoms of pain, swelling, and locking (in addition to symptoms of giving way due to a torn ACL). Arthroscopic surgery to remove torn menisci or to remove loose bodies can improve pain and eliminate locking. However, it would usually not eliminate symptoms of instability, i.e. giving way. Thus, correcting can improve the knee symptoms but not restore stability to the knee.

III. ACL RECONSTRUCTION

Surgical reconstruction of a torn ACL involves replacing the torn ACL with a tendon (called a graft) from another part of the knee and putting it into a position to take the place of the torn ACL. The most commonly used graft is taken from the middle third of the patellar tendon (the tendon connecting the knee cap to the tibial bone). Hamstring tendon grafts taken from the inner thigh to the back of the knee are also used. Occasionally, tendon grafts are taken from cadavers (referred to as allograft). For most of these procedures, the operation is done arthroscopically instead of making big incisions. The knee is examined arthroscopically and associated injuries such as torn menisci, loose bodies, etc. are treated. If the middle third of the patellar tendon is used, a small incision is made on the inner side of the leg just below the knee to take the graft (this results in numbness on the front of the knee). While viewing the inside of the joint through the arthroscope, guides are used to create bone tunnels in the exact positions to allow proper placement of the graft. The graft is then pulled into the bony tunnels. Absorbable screws are placed in the tunnels to wedge the bone graft against the wall of the tunnel to give immediate stability and allow healing of the bone graft. Thus, the bone plug on one end of the graft is secured to the tunnel in the femur and the bone plug on the other end of the graft is secured to the tunnel in the tibia. The piece of patellar tendon graft between the two bone plugs becomes the new ACL.



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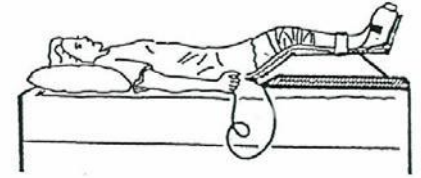
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Postoperatively, an accelerated rehabilitation program allows the quickest return of function. This necessitates using a continuous passive motion (CPM) machine for approximately 10 hours a day for the first week following surgery. The patient can get up whenever he or she wishes for short periods of time using crutches and a knee immobilizer.



The CPM can be rented and it is a small device that sits on the bed and very slowly moves the knee continuously. The knee actually has less pain and regains its function much more quickly if CPM is used continuously. If the knee is taken out of the CPM for periods of time, it becomes stiff and more painful. Therefore, it is best to devote the first week following surgery to continuous use of the CPM at home. One week after surgery, the sutures are removed and the patient can walk bearing full weight on the leg. A knee immobilizer and/or crutches are used for the first week or two until the leg regains enough strength to allow unaided walking.

WHEN CAN I EXPECT TO RETURN TO SPORTS FOLLOWING SURGERY?

Within two or three weeks after surgery, the patient is usually walking on level surfaces without a brace or crutches. At about five or six weeks, he or she can usually go up and down stairs without support. For the next several months, exercises are done to regain motion in the knee. When the knee has full range of motion (usually at six to eight weeks), muscle-strengthening exercises are done. At six months, the patient is usually running and at nine months, participating in sports.

WHEN CAN I EXPECT TO RETURN TO ACTIVITIES AFTER SURGERY?

Most people can get back to desk work or sedentary activity one or two weeks after surgery. If the right knee has been operated, it may be four to six weeks before the knee is strong enough to hit the brakes to drive safely. For heavy work, it may take 3 to six months before the leg is strong enough to allow working.

<u>WORK</u>	<u>RETURN</u>	<u>SPORTS</u>	<u>RETURN</u>
Sedentary/Desk	1 to 2 weeks	Normal walking/stairs	1 to 2 months
General Office	2 to 3 weeks	Light individual sports	3 to 4 months
Light	6 to 8 weeks	Running and jumping	6 months
Medium	3 months	Contact/high performance	9 months
Heavy	4 to 5 months		

WHAT ARE THE RISKS AND BENEFITS OF ACL TREATMENT?

NON-OPERATIVE

RISKS

- Repetitive injuries may cause further permanent damage and eventually lead to arthritis.
- Inability to participate in sports that require pivoting.

BENEFITS

- Some people manage well without surgery.

OPERATIVE

RISKS

<u>Complications</u>	<u>%</u>
Permanent numbness in the front of the knee near the incision	100
Other nerve injury	0.5
Patella-femoral pain (kneecap)	5
Flexion contracture (stiffness/reduced motion of the knee)	10
Reinjury (knee becomes unstable again)	5 to 10
Swelling	10
Superficial infection	1
Deep infection	0.5
Deep vein thrombosis (blood clots)	0.5
Delay in regaining motion	5
Vascular (damage to blood vessels)	0.01
Death	0.0

BENEFITS

- Return to sports with a stable knee



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ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION SURGERY

Here are guidelines that will help you in preparing for surgery to reconstruct your torn anterior cruciate ligament.

PREOPERATIVE INSTRUCTIONS

WITHIN A FEW WEEKS BEFORE SURGERY:

Your doctor will see you in the office. He will do a preoperative history and physical examination and complete the necessary paperwork. He will write preoperative hospital orders and schedule an appointment with the pre-operative test center. You will have an opportunity to speak with anesthesia and physical therapy. It is recommended that you utilize a stationary cycle to maintain your knee range of motion and improve the overall function of the knee prior to surgery.

SEVERAL DAYS PRIOR TO SURGERY:

Wash the knee several times a day to get it as clean as you can. This decreases the risk of infection. **Be careful not to get any scratches, cuts, sunburn, poison ivy, etc.** The skin has to be in very good shape to prevent problems. You do not need to shave.

THE DAY BEFORE SURGERY:

Please be in touch with your doctor's office to confirm the exact time that you should report to the hospital for surgery. **You can have nothing to eat or drink after midnight on the day before surgery.** It is very important to have a completely empty stomach prior to surgery for anesthesia safety reasons. If you have to take medication, you can do so with a sip of water early in the morning prior to surgery (but later tell the anesthesiologist you have done so).

DAY OF SURGERY:

Surgery is performed in the Advanced Health Sciences Pavilion at Cedar Sinai Medical Center Campus on the 5th floor. 127 S. San Vicente Blvd. Los Angeles, CA 90048

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SURGERY:

The operation to replace the torn **anterior cruciate ligament** will be done arthroscopically. A small incision will be made on the inner side of the knee to take the graft from the middle of the patellar tendon together with a small piece of bone from the bottom of the kneecap to the upper part of the leg bone (mid-third patellar tendon graft, bone-tendon-bone). The incision leaves a small area of numbness on the outer side of the upper leg. Most of this numbness clears but it takes a year or two and is not usually bothersome. In certain circumstances, the graft is a hamstring tendon or a donor graft from a cadaver (allograft).

AFTER SURGERY:

- After four days, try to have the CPM at least 90 degrees of flexion.
- **The most important aspect is to get the knee out straight.**
- You will be able to **adjust the speed**: at night have the machine move as slowly as possible and you will be able to sleep better.
- During the day, you can speed up the machine and also gain more flexion.

You will be given a **prescription** for pain medication to take home with you. In addition to this medication, you should take one aspirin a day to help prevent blood clots (phlebitis) for 10 days. The pain medication has a tendency to make you constipated.

The **dressing** should not be changed or removed until you follow-up with Dr. Lerebours. You **can shower** on the second day following surgery, but be careful standing in the shower so that you **do not fall**. Cover your dressing with a plastic garbage bag or purchase a premade cast cover from CVS or your local pharmacy. It is better to have a small stool to be able to sit on. Do not submerge the knee under water in a bath, hot tub or swimming pool.

If you develop calf pain or excessive swelling in the leg, call your doctor.

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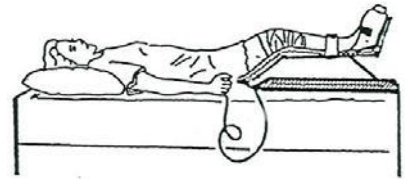
ACL Reconstruction Rehabilitation Guidelines

PHASE 1: 0-2 weeks after surgery

This handout is to use as a guideline for your **rehabilitation after anterior cruciate reconstruction**. You may vary in your ability to do these exercises and to progress from one phase to the other. Please call the doctor if you are having a problem with your knee or if you need clarification of these instructions.

GOALS

1. Protect the reconstruction – avoid falling
2. Ensure wound healing
3. Attain and maintain full knee extension
4. Gain knee flexion (knee bending) to 90 degrees
5. Decrease knee and leg swelling
6. Promote quadriceps muscle strength
7. Avoid blood pooling in the leg veins



When a meniscus repair is done along with the ACL reconstruction, limit knee flexion to 90 °.

Do not place a pillow under the knee for comfort. This can lead to knee stiffness.

BRACE/CRUTCHES

Your knee brace is set to allow your knee to bend and straighten from 0 to 90 degrees. Use it when walking. In some cases, you may be sent home with the brace locked at 0 degrees (fully straight). After you arrive home, and the anesthetic nerve block has worn off, re-set the brace to allow 0 to 90 degrees of motion.

For patients with a patellar tendon autograft (from your own knee), put as much weight on your operated leg as possible when walking. You should use the crutches in the beginning, but can discontinue the crutches when you have confidence in the knee to support you. In some cases, crutches and restricted weight bearing may be necessary for longer periods. The doctor or physical therapist will give special instructions in these cases.

In cases where hamstring autograft or allograft is used, you will be advised to put partial weight (50%) on your leg with crutches and brace for the first 6 weeks after surgery.

In cases where a meniscus repair is done along with the ACL reconstruction, the brace should be locked fully straight when walking for the first 6 weeks after surgery.

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WOUND CARE

Remove your bandage on the second morning after surgery but leave the small pieces of white tape (steri strips) across the incision. You can wrap an elastic bandage (ace) around the knee at other times to control swelling. You may now shower and get your incision wet, but **do not** soak the incision in a bathtub or Jacuzzi until the stitches have been removed.

ASPIRIN / ELASTIC STOCKINGS

Take an aspirin 325mg each morning, and do at least 10 ankle pump exercises each hour to help prevent phlebitis (blood clots in the veins) until your first post-operative visit.

FREE/MACHINE WEIGHTS (Upper Body/Trunk Only)

We suggest that you do not use any lower extremity free or machine weights. If you are doing free or machine weights for the upper body and trunk, we suggest a very light resistance of 3 sets of 15-20 repetitions. Do not place yourself in a compromising position with your recently operated knee.

EXERCISE PROGRAM

Perform exercises without brace. See "Knee Exercises" handout for illustrations.

Days per Week: 7 Times per Day: 3-4

Quadriceps setting	1-2 sets of 15-20 reps
Heel prop	5 minutes
Heel slides with towel assist	1 set of 5 to 15 minutes
Sitting heel slides	1 to 2 sets of 15 to 20 reps
Straight leg raises	1-2 sets of 15-20 reps
Patellar mobilization	1 set for 1 to 3 minutes
Hip abduction	3 sets of 10 reps
Ankle pumps	1 set of 2 to 3 minutes
Prone hang	5 minutes

START PHYSICAL THERAPY

- You can start formal physical therapy after your first post-op visit.
- We ask that your PT follow our written protocol.
- If your PT has questions, please ask them to call us to discuss them.

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PHASE 2: 2 – 6 weeks after surgery

GOALS

1. Protect the reconstruction, avoid falling
2. Ensure wound healing
3. Maintain full knee extension (straighten knee fully)
4. Begin quadriceps muscle strengthening
5. Attain knee flexion of 120 degrees or more
6. Decrease knee and leg swelling
7. Normal gait without crutches

CRYOCUFF

Use the cryocuff or ice bags to decrease swelling for 20 minutes three times a day after each exercise session.

BRACE/CRUTCHES

In cases where the patellar tendon autograft is used, you can begin placing all of your weight on the operated leg when you walk unless otherwise instructed by your surgeon. Discontinue using your crutches when you are comfortable doing so. Continue using your brace when walking outside of the home. Within one or two weeks, you can usually discontinue use of the crutches if you have good control of the leg and are sure that you will not fall or get injured. Concentrate walking normally, in a heel-strike to toe-off pattern, without a limp. Occasionally (every one or two hours) practice standing on your operated leg, with your knee fully straight, for 10 to 20 seconds.

In cases where hamstring autograft or allograft is used, you will be advised to put partial weight (50%) on your leg with crutches and brace for the first 6 weeks after surgery.

In cases where a meniscus repair is done along with the ACL reconstruction, the brace should be locked fully straight when walking for the first 6 weeks after surgery.

SWELLING

Continue using the elastic stockings (TED) for the lower leg and wrapping the knee with an elastic bandage (ACE) to control swelling

EXERCISE PROGRAM

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Stationary Bicycle

Days per week: 5-7

Times per day: 1-2

Utilize a stationary bicycle to move the knee joint and increase knee flexion. If you cannot pedal all the way around, then keep the foot of your operated leg on the pedal, and pedal back and forth until your knee will bend far enough to allow a full cycle. Most people are able to achieve a full cycle revolution backwards first, followed by forward. You may ride the cycle with no resistance for up to 10-15 minutes, 1 to 2 times a day. Set the seat height so that when you are sitting on the bicycle seat, your knee is fully extended with the heel resting on the pedal in the fully bottom position. You should then actually ride the bicycle with your forefoot resting on the pedal.

Water Workout (optional)

Days per week: 3

Times per day: 1

Aqua-jogger exercise or Flutter kick swimming

20-30 minutes

RANGE OF MOTION AND STRENGTHENING EXERCISES (brace off)

Days per Week: 5-7

Times per Day: 1-2

Quadriceps setting	1-2 sets of 15-20 reps
Heel prop	5 minutes
Prone hang	5 minutes
Heel slides with towel assist	1 set of 5 to 15 minutes
Straight leg raises	1-2 sets of 15-20 reps
Standing hamstring curl	3 sets of 10 reps
Standing toe-raises	3 sets of 10 reps
Hip abduction	3 sets of 10 reps
1/3 knee bends	3 sets of 15 reps
Wall slides	3 sets of 15 reps

OPTIONAL ADDITIONAL EXERCISES

If you did not have a meniscus repair, you can start the Leg Press and Hamstring Curl machine during this phase under supervision of a physical therapist if you have achieved the following goals:

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1. Full passive knee extension
2. Full extension while quadriceps setting
3. Flexion of 125 degrees
4. Minimal swelling

PHASE 3: 6-12 weeks after surgery

GOALS

1. Protect the reconstruction; avoid falling
2. Maintain full knee extension
3. Attain full knee flexion
4. Walk with a normal heel-toe gait with no limp
5. Muscle strength and conditioning improvements

BRACE

The brace is discontinued after you see your surgeon at your 6-week post-operative office visit. Concentrate on walking with a heel-toe gait without a limp. In some cases, use of the brace will continue if the knee requires a longer period of protection.

CRYOCUFF/ICE

Continue to use the cryocuff for 20 minutes after each workout

EXERCISE PROGRAM

Range of Motion and Strengthening Exercises

Days per week: 3

Times per day: 1

Quadriceps setting	1-2 sets of 15-20 reps
Heel prop	5 minutes
Prone hang	5 minutes
Heel slides with towel assist	1 set of 5 to 15 minutes
Straight leg raises	3 sets of 10 reps
Standing hamstring curl	3 sets of 10 reps
Standing toe-raises- single leg	3 sets of 10 reps

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Hip abduction	3 sets of 10 reps
Squat to chair	3 sets 15 reps
Wall slides	3 sets of 15 reps
Single leg strengthening progression	see timeline

Stretching Exercises

Days per week: 5-7

Times per day: 1-2

Hamstring stretch	3-5 reps holding 15 to 30 seconds
Quadriceps stretch	3-5 reps holding 15 to 30 seconds
Calf Stretch	3-5 reps holding 15 to 30 seconds

Optional Additional Weight Training

Days per week: 2-3

Times per day: 1

3 sets of 20 repetitions

The following exercises may be added to your exercise program about 6 weeks after surgery:

Seated Leg Press	Roman Chair
Hamstring Curl	Calf Raise Machine
HIP Abductor/Adductor Machine	Hip Flexor Machine

Cardiovascular Conditioning

Days per week: 1-2 Times per day: 1 Duration: 20-30 minutes The following can be performed for conditioning: stationary bicycle, walking, rowing, elliptical trainer, and water workout

Single-Leg Strengthening Progression

At this time, it is important to begin the development of single-leg strength. Begin to follow the "Progression for Single Leg Strengthening" included in this packet.



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Phase 3 Exercise Program Summary:

Frequency: 3 times a week 3 sets of 10-15 repetitions

- Leg Press
- Hamstring Curl
- Wall Slides
- Roman Chair
- Chair Squat
- Hip Flexor machine
- Single leg strengthening progression
- Hamstring, Calf and Quadriceps stretching
- Calf Raises or Calf Raise machine
- Hip Abductor/Adductor machine
- Quadriceps setting 20 repetitions, 3 times a day with heel prop

If you do not have access to gym equipment, the following exercises from Phase 2 can be substituted using ankle weights (Start with one pound and add one pound a week until 5 pounds): Straight leg raise, Side lying abduction, and Standing hamstring curl

Precautions When Exercising

- Avoid pain at the patellar tendon site
- Avoid pain and/or crepitus at the patella
- Build up resistance and repetitions gradually
- Perform exercises slowly avoiding quick direction change and impact loading
- Exercise frequency should be 2 to 3 times a week for strength building
- Be consistent and regular with the exercise schedule

Principles of Strength Training

- Warm-up prior to exercising by stationary cycling or other means
- You are “warmed –up” when you have started sweating
- Gently stretch all muscle groups next
- Do exercises involving multiple muscle groups first and individual muscle groups last
- Do aerobic workouts **after** strength workouts
- Cool-down by stretching after finishing exercise



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DO NOT do any of the following exercises:

1. Knee extension weight lifting machine
2. Running
3. Jumping
4. Pivoting or cutting
5. Lunges
6. Stairmaster
7. Step exercises with impact

PHASE 4: 12-16 weeks after surgery

GOALS

1. Regain full muscle strength.
2. Work on cardiovascular conditioning.
3. Sports-specific training.

EXERCISE PROGRAM

Muscle Strengthening Exercises

You should continue muscle-strengthening exercises from Phase 2 and 3 on a three times a week basis. At this time, you can decrease the number of repetitions per set from 15 to 10. This will allow you to work with more resistance. Remember to do all exercises slowly, with good form. You may begin to hold dumbbells when doing the chair squat, single-leg 1/3 knee bends and single- leg wall slides. Weights can be increased when you can do a particular weight easily, for 3 sets of 10 repetitions, for 3 consecutive workouts. At all times, be cautious of pain or crunching at the kneecap or patellar tendon while exercising. You may use resistance machines at your gym, but do not use the knee extension machine and do not do lunging or high impact drills.

Cardiovascular Conditioning

You can use the elliptical trainer, stationary bicycle, rowing machine or swimming workouts to build cardiovascular fitness. Three to five times per week for 20 to 30 minutes is sufficient for improvement in this area. Please note that excessive long duration cardiovascular exercise can retard or delay muscular strength development when strength improvement and gains in muscle size are the programs' primary goal.

At this time, light running on a soft level surface with a sports brace can begin if your surgeon advises. You need to have full range of motion, good strength and no swelling to run safely. If you run, 3 times per week for 10 minutes is advisable for the first 2 weeks. If there is no pain or swelling, you can increase your running time by 1 minute per session for a maximum of 30 minutes. Walking and hiking on gentle trails can also be used for conditioning activity.

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Jump and Plyometric training

With the approval of the doctor and physical therapist, you can begin the Jump and Plyometric Training Progression that is included in this packet.

Progressive Resistance Exercise (PRE) Principle

- To build muscle strength and size, the amount of resistance used must be gradually increased.
- The exercises should be specific to the target muscles
- The amount of resistance should be measurable and gradually increased over a longer period of time
- To avoid excess overload and injury, the weight or resistance must be gradually increased in increments of 5 to 10 %
- Resistance can be increased gradually every 10 to 14 days when following a regular and consistent program
- Adequate rest and muscle recovery between workout is necessary to maximize the benefit of the exercise
- If the PRE principle is followed too strictly, the weights potentially will go higher and higher.
- At a certain point, the joints and muscles will become overloaded and injury will occur.
- This eventuality can be avoided by refraining from using excessive weight during strength training.

Basic Knee Strengthening Program

Days per week: 2-3 Times per day: 1 3 sets of 10-15 repetitions

- Emphasis is to build muscle strength using BOTH legs
- Progress according to the PRE principle

Basic Program Exercises (See illustrations at the back of the handout)

- Leg Press
- Hamstring Curl
- Wall Slides (hold dumbbells for resistance)
- Roman Chair (strengthens hamstrings)
- Chair Squat (hold dumbbells for resistance)
- Calf Raises or calf raise machine
- Hip Abductor/Adductor machine
- Hip flexor machine
- Single leg strengthening progression

PRECAUTIONS

The following exercises can cause injury to the knee and are usually not recommended at this time:

- Leg extension machine (quadriceps extensions)

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- Stairmaster or stair climber machines
- Lunges
- Squats past 90 degrees of knee flexion
- High Impact and plyometric exercises

PHASE 5: 16-24 weeks after surgery

Cardiovascular Conditioning

Continue with the program outlined in phase 4

Muscle Strengthening Exercises

Continue with the program outlined in phase 4

Speed and Agility Training

Refer to Speed and Agility Progression

Jump and Plyometric Training

Refer to Jump and Plyometric Progression

Sports-Specific Training

To reach your ultimate goal of returning to sports participation, you must follow an orderly sequence of drills that are designed to re-train the muscle-to-joint coordination that is necessary to provide the proper control of your knee. The following time-table illustrates an ideal progression sequence:

Activity	Weeks post-surgery
Running slowly	12-16
Golf	16-20
Roller blading	18
Tennis	20-24
Return to sports practice	24-32
Full return to sports	32-36

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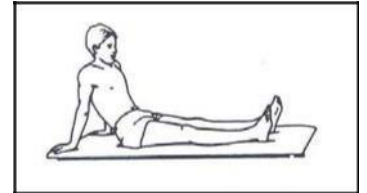
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Returning to Sports

You should discuss the timing of return to sports activities and brace use with your surgeon.

Knee Exercises for ACL Reconstruction

Quadriceps setting to maintain muscle tone in the thigh muscles and (extend) straighten the knee. Lie on your back or sit with the knee extended fully straight as in the figure. Tighten (contract) and hold the front thigh muscle (quadriceps) making the knee flat and straight. If done correctly, the kneecap will slide slightly upward toward the thigh muscle. The tightening action of the quadriceps muscles should make your knee straighten and be pushed flat against the bed or floor. Hold 5 seconds for each contraction. Do 20 repetitions three times a day. **Also try to do any time your knee is out of CPM.**



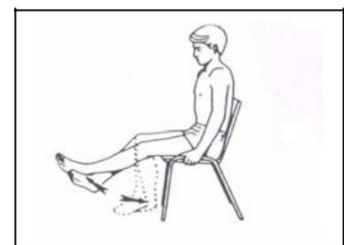
Patellar Mobilization to prevent scar tissue from binding the kneecap. With the knee fully straightened, grasp the edges of your kneecap between your thumb and index finger. Move the kneecap side to side and up and down.



Heel Slides to gain knee flexion. While sitting or lying on your back, actively slide your heel backward to bend the knee. Keep bending the knee until you feel a stretch in the front of the knee. Hold this bent position for five seconds and then slowly relieve the stretch and straighten the knee. While the knee is straight, you may repeat the quadriceps setting exercise. Continue this exercise until you can fully bend your knee equal to the un-operated side. Also, as you start to gain flexion, you can assist your efforts to gain flexion by assisting the heel slide with a towel. For patients who have had a meniscus repair along with the ACL reconstruction, limit knee flexion to 90°. See illustration. Repeat 20 times, three times a day.



Sitting Heel Slides to regain the bend (flexion of the knee). When sitting in a chair, slide the heel backward as if trying to get the foot underneath the chair (figure 5). Hold 5 seconds and slowly relieve the stretch by sliding the foot



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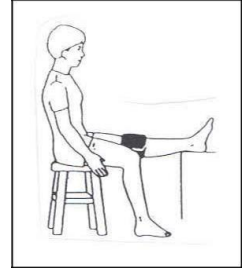


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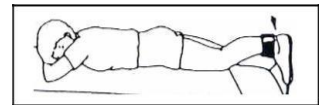
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forward. You can help with the opposite foot if necessary. For patients who have had a meniscus repair along with the ACL reconstruction, limit knee flexion to 90°. See illustration. Repeat 20 times, three times a day.

Heel Prop to straighten (extend) the knee. Lie on your back with a rolled up towel under your heel or sit in a chair with the heel on a stool as shown. Let the knee relax into extension (straight). If the knee will not straighten fully, you can place a weight (2 to 5 pounds) on the thigh, just above the kneecap. Try to hold this position for 5 minutes, three times a day. While maintaining this extended position, practice quadriceps setting.



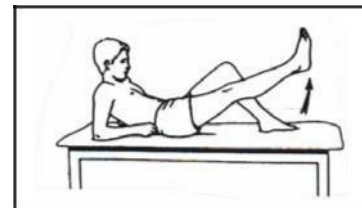
Prone Hang to straighten (extend) the knee. Lie face down across your bed so that the kneecap is just off the edge of the mattress. Let your leg drop down toward the floor so that your knee straightens fully. If the knee will not fully extend, then attach a weight around the ankle to help pull the leg down. Use an amount of weight as described above for the heel prop exercise. Try to hold this position for 5 minutes, three times a day.



Straight Leg Lift

The quality of the muscle contraction in this exercise is what counts the most, not just the ability to lift the leg!

1. Tighten the quadriceps (quadriceps setting) as much as you can, push the back of the knee against the floor.
2. Tighten this muscle harder!
3. Lift your heel 4 to 6 inches off the floor
4. Tighten the quadriceps harder again.
5. Lower your leg and heel back to the floor. Keep the quadriceps as tight as possible.
6. Tighten this muscle harder again.
7. Relax and repeat



If the knee bends when you attempt to lift the limb off of the bed, do not do this exercise. Keep trying to do the quadriceps setting exercise until you can lift the limb without letting the knee bend.

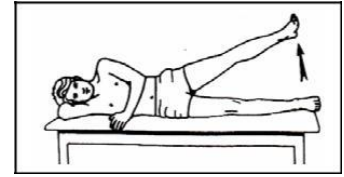


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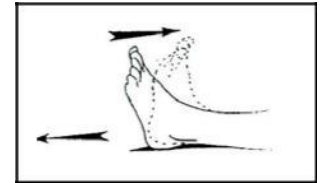
Hip Abduction

Lie on your unoperated side. Keep the knees fully extended. Raise the operated limb upward to a 45-degree angle as illustrated. Hold one second, then lower slowly.



Ankle Pumps to stimulate circulation in the leg.

Move your foot in an up and down motion 30- 40 times a minute.



1/3 Knee Bends

Stand facing a table or desk with the feet about 1 foot apart. Lean forward at the hips and bend the knees as if starting to sit down. Lower the hips about 5 or 6 inches, pause 1 to 2 seconds and return to the full upright position.



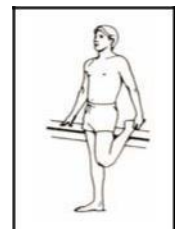
Wall Slides

Stand upright with your back and buttocks touching a wall. Place the feet about 12 inches apart and about 8 inches from the wall. Slowly lower your hips by bending the knees and slide down the wall until the knees are flexed about 45 degrees (illustration). Pause five seconds and then slowly slide back up to the upright starting position. Do 3 sets of 10 to 15 repetitions.



Hamstring Stretch

Perform this stretch in the position illustrated at the right. Bend slowly forward at the hips, keeping the knee fully extended until you feel gentle stretch in the back of your thigh and knee. Hold the stretch for 15 to 20 seconds and repeat 3 to 5 times.



Quadriceps Stretch

This stretch is performed in the position illustrated at the right. Lean gently Backward as if bringing you heel toward the buttock. When a stretch is felt in the front of the thigh and knee, hold 15 to 20 seconds for 3 to 5 repetitions.



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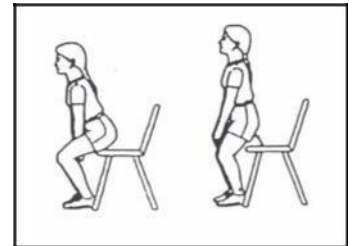
Calf/Achilles Stretch

In the position illustrated, keep the heel flat on the floor and the knee fully extended. Lean forward at the hips with the arms supporting your weight. When you feel a gentle stretch in the back of your calf and knee, hold for 15 to 20 seconds, 3 to 5 repetitions.



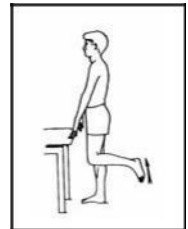
Squat to Chair

In the chair squat exercise, you lower your buttocks toward the chair until your buttocks touch the chair. Do not sit or rest at the chair, but instead immediately and slowly return to the standing and starting position. Remember to keep your head over your feet and bend at the waist as you descend. After the first week, you may hold dumbbells while performing this exercise. Start with 3 to 5 pounds each hand. You may add 2 to 3 pounds per week until you reach 10 pounds in each hand.



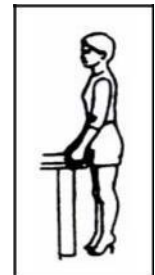
Standing Hamstring Curl

Stand facing the wall, using the wall for balance and support. While standing on the unoperated limb, bend the knee of the operated side and raise the heel toward the buttock. Hold this flexed position for one second. Slowly lower the foot back to the floor. Keep the thighs aligned as illustrated.



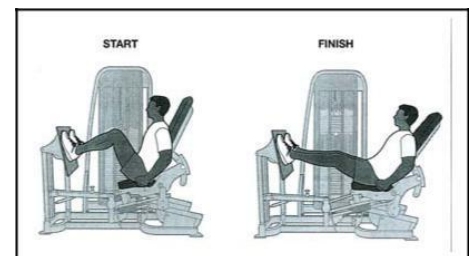
Standing Toe Raises

Stand facing a wall, hands on the wall for support and balance. Keep the knees extended fully. Tighten the quadriceps to hold the knee fully straight. Raise up on 'tip-toes' while maintaining the knees in full extension. Hold for one second, then lower slowly to the starting position.



Seated Leg Press

Use an amount of weight that feels easy enough to perform 20 repetitions as the starting weight for this exercise. Use this weight for the first week before raising the weight. The weight may be increased by about 5 pounds every 7 to 10 days thereafter, as long as you can perform 20 repetitions per set for 3 sets. In this exercise, avoid letting the knees **snap** or drop suddenly into extension when reaching the fully straightened position. Avoid starting the exercise with the knees excessively bent. Do not bend the knee so far that your calves and



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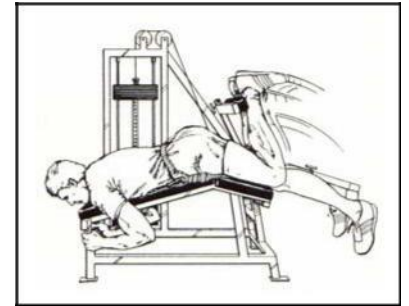
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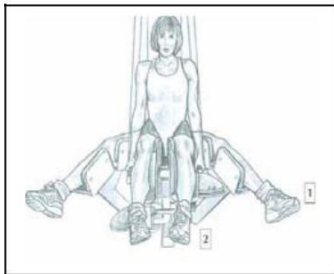
back of thighs touch. Adjust the seat position to limit the excursion of the machine.

Resisted Hamstring Curls

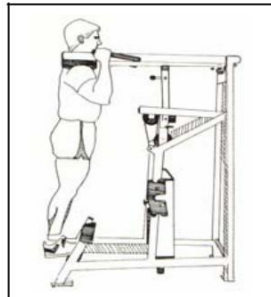
If you have access to a hamstring curl machine (illustration), you may start using it. As with the leg press, start with a reasonable weight and use that weight for the first week. You may increase the weight by 3 to 5 pounds every 10 days as long as you can perform 3 sets of 20 repetitions slowly, with good form. If you do not have access to a hamstring machine, continue doing the standing hamstring curl adding an ankle weight for resistance. Start with 3 to 5 pounds and add 1 pound per week until you build to 10 pounds for 3 sets of 15 repetitions.



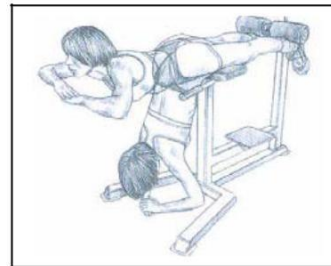
Additional Weight Training



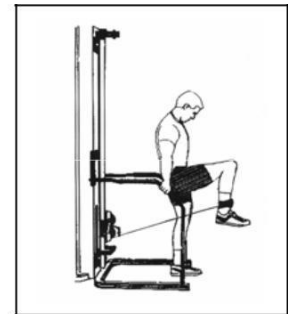
Hip Abductor/Adductor Machine



Calf Raise Machine



Roman Chair

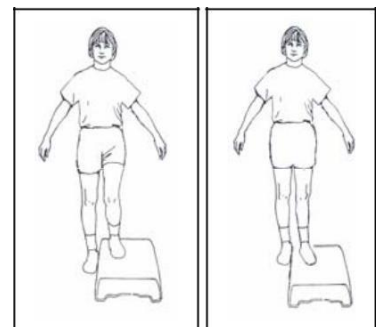


Hip Flexor Pulls

Single Leg Strengthening

Step Up- Down Exercise

Place the foot of the operated limb on the stool. Maintain balance, if necessary, by holding onto the wall or chair (illustration). Standing **sideways** to the step, slowly step up onto the stool and slowly straighten the knee using the quadriceps muscles. Slowly lower the opposite foot to touch the floor. Do not land on the floor, just touch gently and repeat the step up



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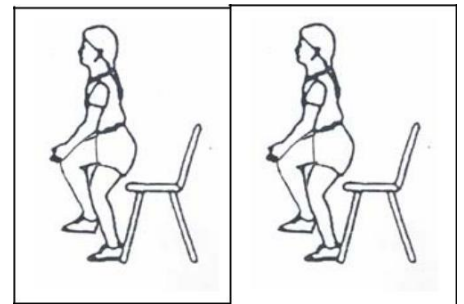
Single Leg Wall Slide Exercise

Stand on the single leg with your back and buttocks touching a wall. Place the foot about 6 inches from the wall. Slowly lower your body by bending the knee and slide down the wall until the knee is flexed about 45 degree (illustration). Pause five seconds and then slowly slide back up to the upright starting position. Keep the hips level and be sure you are using your knee muscles to perform the exercise.



Single Leg Squat Exercise

In the single leg squat exercise, you stand on the single leg and then lower your buttocks toward the chair. Slowly return to the standing and starting position. Remember to keep your head over your feet and bend at the waist as you descend. You do not have to squat all the way to the chair, instead, try to stay in a comfortable range of motion where there is no knee pain. As you gain strength, try to do the exercise without holding on to anything.



Progression for Single Leg Strengthening

These instructions estimate a time period of 10 to 12 weeks for you to progress through the whole program. This time line will vary for different people and knees. Your ability to progress through this program may be limited by the presence of other knee problems. It is recommended that you follow this program as written, step-by-step. The progress of your strengthening will be evaluated by the physical therapist using these particular drills and the timeline in the progression.

Step Up-Down Exercise

Start with a step of 3 inches in height. Start with 3 sets of 5 repetitions

Add one repetition per set, per workout, until you can do 3 sets of 10 about 2 weeks If pain free, progress to a step of 6 inches in height

Repeat progression starting with 3 sets of 5 repetitions

Add one repetition per set until you can do 3 sets of 10 (about 2 weeks)

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If pain free, progress to a step of 9 inches in height (the height of a standard stair) Repeat process of progression from 3 sets of 5, to 3sets of 10 (about 2 weeks)

At this point, you can begin to add the single leg wall slide exercise. The strength workouts should be practiced 3 times a week (every other day)

Single Leg Wall Slide

Start with 3 sets of 5 repetitions

Add one repetition per set, per workout, until you can do 3 sets of 10 (about 2 weeks minimum)

At his point, you can begin to add the single leg squat exercise. The strength workouts should continue every other day at the most, with more time between workouts if the knee gets sore after a session.

Single Leg Squat

Start with 3 sets of 5 repetitions

Add one repetition per set, per workout, until you can do 3 sets of 10 (about 2 weeks minimum).

After working up to the point where you can do 3 sets of ten of all three drills, you can hold dumbbells to add resistance. Start with 3 pounds in each hand and add 1 to 2 pounds a week until you reach 10 pounds in each hand. As you get stronger and gain better control of your leg muscles, try not to hold onto anything for balance. When you return to sports or recreational activities, you can decrease the strength workouts to 2 times a week and do 1 set of 10 of each of the three drills only, as a maintenance workout.

Speed and Agility Progression

Goals

1. Safely recondition the knee for the demands of sports activity
2. Provide a logical sequence of progressive drills for pre-sports conditioning
3. Provide objective criteria for safe return to sports

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Phases of Training

Straight ahead running phase

Direction change running phase

Unrestricted direction change and impact phase

Prerequisites

Full Range of Motion

Strength at least 80 % of uninjured limb

Thigh girth within ½ inch of unaffected limb

No tenderness at the graft harvest site

Symmetrical quadriceps and hamstring flexibility

Perform and pass functional tests

Obtain clearance from your doctor or physical therapist

Functional Tests

Before starting the running sequence, you must be able to:

1. Hop forward on both legs at least 2 feet
2. Hop to either side at least 1 foot
3. Hop up and down on both feet 10 times
4. Jog with no limp for 100 yards

Warm-up, Stretch and Ice

Be sure that you warm-up and stretch before and after workouts. Generally, you should do some walking, cycling or elliptical so that you break a sweat before starting the running program. You can then stretch before beginning the running drills. Ice your knee for 20 minutes following workouts and stretch all muscle groups as you are cooling down.

Recommended Frequency 2-3 times per week

Criteria to Progress

Do not progress to the next step in the phase until the present step is pain free, and you can perform with proper technique and without difficulty (muscle soreness or fatigue). Add only one new step in the progression per workout.

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I. Straight Ahead Running (16-20 weeks)

1. Run $\frac{1}{2}$ speed 100 yards, 10 repetitions
2. Run $\frac{3}{4}$ speed 100 yards, 10 reps
3. Run $\frac{1}{2}$ speed 100 yards, 3 reps; $\frac{3}{4}$ speed 100 yards, 3 reps; full-speed 50 yards, 4 reps
4. Continue $\frac{1}{2}$ and $\frac{3}{4}$ speed 100-yard runs, for 3 reps each and add one 50-yard run each workout until you can do (10) 50-yard full speed runs.

II. Basic Change of Direction Running (20-24 weeks)

Intensity: Progress drills from walking \rightarrow $\frac{1}{2}$ speed \rightarrow $\frac{3}{4}$ speed \rightarrow full speed

Continue current workout from above (Step 4): Run $\frac{1}{2}$ and $\frac{3}{4}$ speed 100 yd runs for 3 reps each.
Run full speed 50-yard run for 5 reps

Progressively add each step below:

5. Zig-Zag run, round corners, 50 yards, 5 reps
6. Backward run 25 yards to gradual stop, then forward run 25 yards to gradual stop, 5 reps
7. Circle run 20 feet or greater diameter circle, 3 reps to left and 3 reps to right
8. Figure '8' run 20 feet or greater length, 5 reps
9. Carioca 50 yards, 5 reps left, 5 reps right

III. Advanced Speed and Agility Running (24 weeks onward)

Intensity: Progress drill from walking \rightarrow $\frac{1}{2}$ speed \rightarrow $\frac{3}{4}$ speed \rightarrow full speed

Continue current workout above and progress with below:

10. Run forward to plant-and-cut off of the unoperated limb, $\frac{1}{2}$ speed, 5 reps
11. Run forward to plant-and-cut off of the operated limb, $\frac{1}{2}$ speed, 5 reps
12. Zig-Zag drill with alternate limb plant-and-cut, 6 reps
13. Box drill 20 yards square, 6 reps, alternate sides
14. Shuttle run 50 yards with direction change every 10 yards, 5 reps
15. Agility run, 5 reps, alternate starting sides

Suggested Final Workout Summary:

1. 100-yard run $\frac{1}{2}$ speed, $\frac{3}{4}$ speed and full speed each distance 2 reps each
2. Zig-Zag run, 6 reps
3. Forward/backward run, 6 reps
4. Circle run, 6 reps
5. Figure '8' runs, 6 reps
6. Carioca, 6 reps each way
7. Shuttle run 50 yards with direction change every 10 yards, 6 reps

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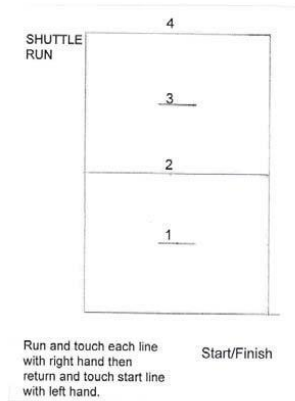
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- 8. Box drill 20 yards square, 6 reps, alternate starting side
- 9. Agility run, 6 reps, alternate starting side

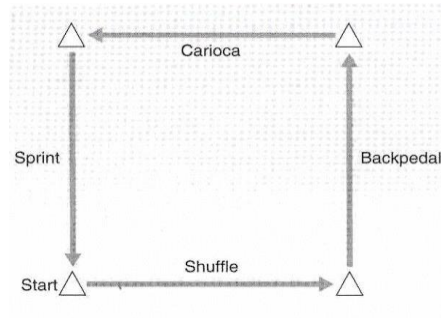
IV: Begin Sports Practice

Agility Drills

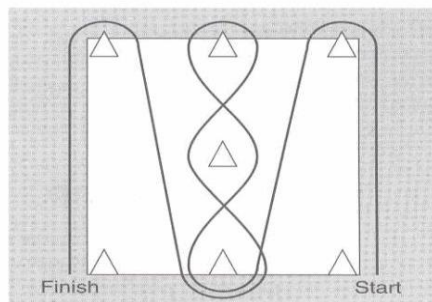
Shuttle Run



Box Drill



Agility Drill





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Jump and Plyometric Training Progression

Goals

1. Safely condition the knee and lower limb for the demands of jumping and landing during sports activity
2. Provide a logical sequence of progressive drills for pre-sports conditioning
3. Provide objective criteria for safe progression from training to sports participation

Phases of Training

Double-leg training

Double-leg complex training

Single-leg training

Recommended Frequency 2 times per week

Sequencing

Begin each training session with a warm-up routine. Perform the jumping drills listed in the appropriate phase of your rehab. Be sure to limit your total contacts (or jumps) to the suggested amount listed for each training session to prevent injury. Progress within the phase as you master each exercise, performing each jump with proper technique and without pain.

Warm-up and Stretch

Generally, you should cycle, jog or use an elliptical trainer, rower or other device for 15 to 20 minutes so that you break a sweat before starting the program. After completing the jumping drills, cool down by stretching for 15 to 20 minutes.

Criteria to progress

Do not progress to the next step in the phase until the present step is pain free, and you can perform with proper technique and without difficulty (muscle soreness or fatigue).

Technical Essentials

Each hop or jump should be performed with concentration on good technique. Perform each jump with a 'stick' landing, i.e. you should land and hold your balance momentarily before proceeding to the next jump. Keep the feet apart and do not let the knees rotate inward when taking off or landing. Soften the impact by landing on the balls of the feet and land with some bend in the knees and hips.

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Precautions

Do not begin jump/plyometric training without clearance from your doctor and physical therapist. Jump training places heavy loads on the kneecap, patellar tendon and knee joint surfaces. Pain at these areas during jumping exercises should be reported to your physical therapist.

Beginning at Phase 3 (12-16 weeks)

Limit 60 foot contacts/session

1. Double Limb (DL) hops on mini-trampoline
2. DL hops on soft surface (carpeted floor, gym floor)
3. DL Jump rope

Suggested Final Workout:

- DL hops on mini-trampoline x 30 repetitions
- DL hops on soft surface x 10 reps
- DL hops with jump rope x 20 reps

Beginning at Phase 4 (16-20 weeks)

Limit 90 foot contacts/session

4. DL forward hop, 6-12" distance
5. DL side-to-side hops, 6-12" distance
6. DL broad jumps, 12-18" distance
7. DL broad jump-to-vertical jump
8. Jump rope, alternating single limb (SL) hops Suggested

Final Workout:

- Warm-up with DL jumps on mini-tramp or jump rope x 30 reps
- DL forward hop x 5 reps
- DL side-to-side hops x 5 reps each side
- DL broad jumps x 5 reps
- DL broad jump-to-vertical x 5 reps
- Jump rope, alternate SL hops x 30 reps

Beginning at Phase 5 (20-24 weeks)

Limit 120 foot contacts/session

9. 90° DL Jump
10. 180° DL Jump
11. DL broad jump-to-vertical with 90°-180° turn
12. Single limb (SL) hops in place on mini-trampoline
13. Jump rope, double/triple SL hops, alternating feet
14. SL forward hop, 6-12" distance
15. SL side-to-side hops, 6-12" distance Suggested

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Final Workout:

- Warm-up with mini-tramp or jump rope with DL Æ SL hops x 30-60 reps
- DL forward hops (x 5 reps) and side-to-side hops (x 5 reps each direction)
- 90° to 180° DL Jumps x 5 reps each
- DL broad jump-to-vertical with 90° to 180° turn x 5 reps each
- SL forward hops (x 5 reps) and side-to-side hops (x 5 reps each direction)

During this phase, drills can be advanced with exercises jumping over cones/hurdles and use of an agility ladder.



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Post Op Phase	WB Status/Brace	ROM	Strength Training and Plyometric	Balance and proprioception	Conditioning and agility	Restrictions and Precautions	Criteria to Progress
Phase 1: 0 to 2 weeks	WBAT with crutches Brace 0-90° when ambulating PWB for HS and Allograft	CPM 7-14 days; 10 hours/day Week 1: 0-100° Week 2: 0-120°	Q Sets, SLR, Ankle Pumps, Active ROM	Weight Shifts Pre-gait training	Stationary Bike	Avoid pivoting and varus/valgus stresses No resisted open-chain knee extension	1. WBAT 2. Full Passive Knee Extension 3. Flexion 90° 4. Good Quad Set producing TKE
Phase 2: 2 to 6 Weeks	FWB; D/C crutches once ambulating safely with good quad control Continue with Brace 0-90° Continue PWB for HS and allograft	Progress to full ROM	Add: Mini Squats Partial Wall-Slide Toes Raises Standing Ham Curl Hip Abduction	Single Leg Standing Balance Master: WB/Squat for symmetry	Aqua Jogger	Avoid pivoting and varus/valgus stresses No resisted open-chain knee extension	1. Demonstrates normal gait without brace 2. Full Passive Ext 3. Flexion > 125° 4. Full SLR, no lag 5. No increased pain at graft site 6. Stable pain rating 7. No new swelling after workouts
Phase 3: 6 to 12 weeks	FWB No Device D/C brace Wean to FWB for HS and allograft	Full ROM Active stretching all muscle groups	Progress to gym equipment (Leg Press, Ham Curl, hip ABD/ADD) Initiate Single Leg Progression Initiate Jump Progression: Double Limb on/off Trampoline (Limit 60 contacts/session)	DL Standing on unstable surface: wobble board, foam; A/P, Lateral Star Drill A/P, Lateral reaches (Lunge) multi-step and load	Elliptical Trainer Swimming	Avoid pivoting and varus/valgus stress No resisted open-chain knee extension Stairmaster/Impact exercise Avoid patellofemoral overload	1. Full ROM 2. Single Leg Step down 6" x 5 reps 3. SLWS 60° x 5 reps 4. SL Squat 60° 5 sec hold x 5 reps 5. Jog 100' no limp 6. DL hop in place with good GR for 30 sec 7. DL hop for distance

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Phase 4 12 to 16 weeks	Sports Brace	Full	Jump Progression <i>Double Limb</i> 1. Directional Hops on flat, even surfaces (A/P, Lat) 2. Broad Jump 3. Broad Jump to Vertical Jump 4. Wall Jumps (Limit 90 contacts/session)	SL standing on unstable surface: wobble board, foam DL Squats on foam/wobble board/BOSU Star Drill Multi-directional reaches	Jogging, flat surface (Track, Treadmill)	Limited straight ahead jogging/running with brace Patellofemoral precautions	1. Girth within 1/2" 2. Single Leg Step down 6" x 10 reps 3. SLWS 60° x 10 reps 4. SL Squat 60° x 10 reps 5. Run 100 yards with normal stride 6. DL hop tests
Phase 5: 16 to 24	Sports Brace	Full	Jump Progression <i>Double Limb</i> 1. 90° to 180° jump 2. Jump up/down from step 3. Series Jumping: Jump from height ↗ controlled land ↗ vertical jump <i>Single Limb</i> Hop in place on/off trampoline Directional hops on flat, even surface (A/P, Lateral) (Limit 120 contacts/session)	Progress SL tasks with perturbations, ball toss Progress Star Drill with increase speed, added weight or resistance, unstable surface	Running Progression: Acceleration and deceleration; change of direction Basic Agility Drills (Progression from walk ↗ 1/2 speed ↗ 3/4 speed) Figure 8 Carioca Shuttle Run Box Drill Ladder Drills	Patellofemoral precautions	1. SL hop for distance 2. 6-m timed hop 3. Triple hop for distance 4. Crossover hop for distance (Score of above tests within 15% of uninjured limb)
Phase 6: 24 Weeks onward	Sports Brace	Full	Progressive jump training		Full speed agility drills and Sports Specific Training		Per speed/agility and jump progressions

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