

Christopher Betz, DO - Orthopedic Surgery & Sports Medicine

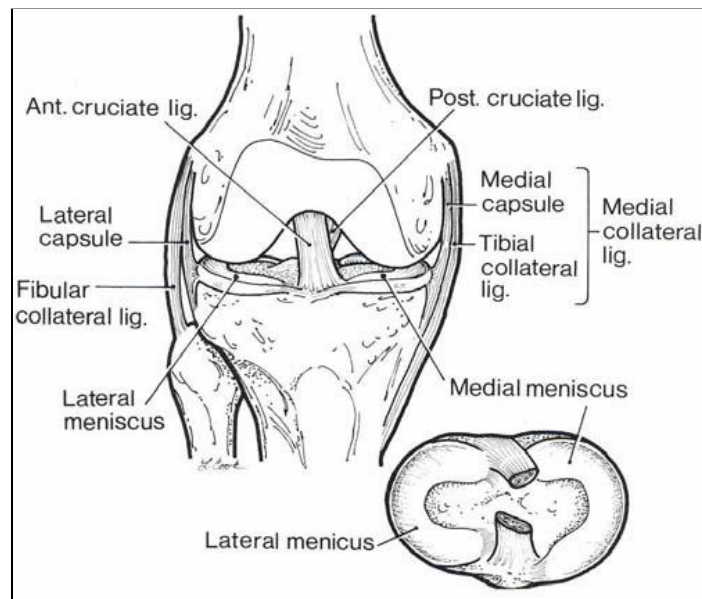
Starling Physicians

289 Western Blvd, Glastonbury, CT 06033

(860) 832-4666

ANTERIOR CRUCIATE LIGAMENT (ACL) RECONSTRUCTION

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. The ACL prevents the lower bone (the tibia) from sliding forward too much and stabilizes the knee joint to allow cutting, twisting and jumping activity.



The most common mechanism that tears the ACL is the combination of a sudden stopping motion of the leg while quickly twisting the knee. This can happen in sports such as basketball and soccer when a player lands on the leg when coming down from a rebound, or is running down the field and makes an abrupt stop to pivot. In skiing, the ACL is commonly injured when a skier slides back while falling. These excess forces cause the ACL to pop.

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

It is also possible to injure other structures inside your knee when the ACL is torn. The meniscus is a crescent shaped shock absorber between the femur and tibia, and each knee has one on the inside (medial) and outside (lateral) of the knee joint. When the tibia suddenly moves forward the meniscus can also be torn. Similarly the articular cartilage (the smooth liner of the joint) can also be injured. If this articular cartilage is injured the joint no longer moves smoothly. Stiffness, pain, swelling and grinding can occur. Eventually arthritis can develop.

Finally, it is also possible to injure the other ligaments of the knee, which can cause pain or instability with activity. Tears of the outer ligament (the lateral collateral ligament, or LCL) often do require surgical repair, while tears of the inner ligament (the medial collateral ligament, or MCL) often heal completely over six to eight weeks and usually do not require surgery.

If no other structure than the ACL is injured the knee usually regains its range of motion and is painless after six to eight weeks. The knee will typically feel completely normal, but may 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. It is usually possible to run straight ahead without any problems, but when the athlete makes a quick turning motion the knee tends to give way and collapse. This abnormal motion can damage other structures in the knee.

If a person does not engage in 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 30 may not need to have the ACL reconstructed, especially if they do not participate in sports that require quick changes in direction. In younger athletic patients or those older patients that still participate in sports at a high level, however, the knee will tend to re-injure frequently and give way during activities in which the person quickly changes direction. Therefore in these groups it is best to reconstruct the torn ACL.

In those in whom ACL reconstruction is not undertaken it may be necessary to modify activities and avoid high-risk sports such as basketball, football, and soccer. Wearing a knee brace may help prevent further injury but 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.

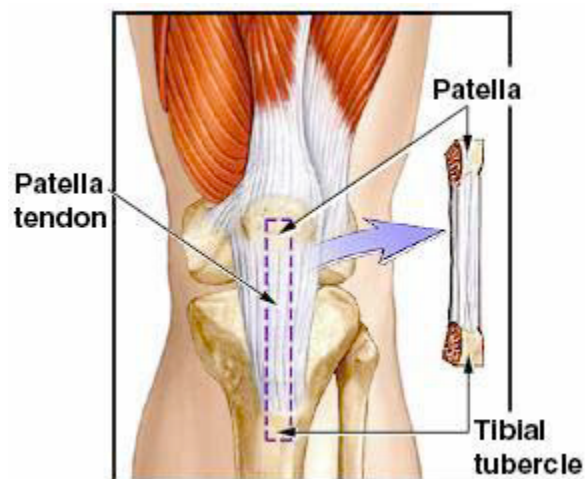
It is best to wait for the pain and swelling from the initial injury to subside and allow other associated injuries to heal prior to performing ACL surgery. If surgery is done too soon after injury, rehabilitation is difficult; the knee may get stiff and have permanent loss of motion. The athlete will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

The best treatment for the initial period after an ACL injury is to 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 the crutches can be discontinued. The emphasis is then on regaining knee motion. Exercises designed to build up knee strength should not be done at this point in order to avoid damaging the cartilage under the kneecap (patella). There may be some examples when immediate surgery is indicated following injury, such as in a knee dislocation when multiple ligaments are torn. Your doctor will discuss this with you should you fall into one of these categories.

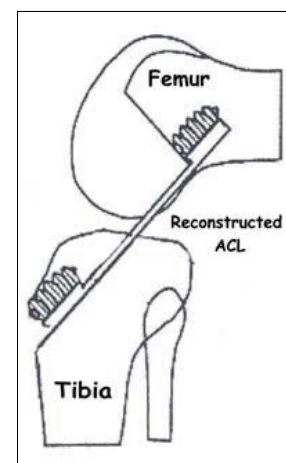
ACL RECONSTRUCTION SURGERY

Surgical reconstruction of a torn ACL involves replacing the torn ACL with a tendon (called a graft) from another part of the knee or a cadaver donor, and putting it into a position to take the place of the torn ACL. Examples of commonly employed grafts include the middle third of the patellar tendon (the tendon connecting the kneecap to the tibial bone), hamstring tendons, and Achilles tendons. In the case of patellar tendon and hamstring grafts, they may be obtained either from your own tissue or a cadaver donor (called allograft). In the case of Achilles tendon, the grafts are always obtained from a cadaver donor.

For most of these procedures the operation is done arthroscopically instead of making big incisions. Associated injuries such as torn meniscus, loose bodies, etc. are addressed at the same time. If patellar tendon graft is used, a small incision is made on the inner side of the leg just below the knee cap to take the graft (this results in a small area of numbness on the front of the knee). If a hamstring tendon graft is used a small incision is made on the inside of the leg below the knee joint. Guides are used to place the graft in the proper position of your knee. The graft is then pulled into bony tunnels and secured in place with screws.



Postoperatively, an accelerated rehabilitation program allows the quickest return of function. A knee brace and crutches are used for the first 2-6 weeks after surgery, depending on the choice of graft. The amount of weight you are allowed put on your leg will depend on the choice of graft as well. Numerous studies have been done to try to prove superiority of one graft choice over another, and as it currently stands no choice offers clear benefits over all the others in all situations. Your surgeon will discuss with you the pros and cons of the various graft options.



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The risks of ACL reconstruction include but are not limited to:

- Permanent numbness in the front of the knee 100%
- Other nerve injuries 0.5%
- Patellofemoral pain (kneecap) 5%
- Stiffness or reduced motion of the knee 10%
- Re-injury 5-10%
- Superficial infection 1%
- Deep infection 0.5%
- Blood clots 2-3%
- Delay in regaining motion 5%

How soon will I return to work?

- Sedentary 1-2 weeks
- General office 2-3 weeks
- Light physical 6-8 weeks
- Medium 3 months
- Heavy 4 months

How soon will I return to sports?

- Normal walking/stairs 1-2 months
- Light individual sports 3-4 months
- Running/jumping 6 months
- Contact/high performance 9 months

Postoperative Instructions

You will wake up in the operating room with a brace and ice pack in place. You will also have white compression stockings on both legs. These are to help prevent blood clots and should be worn for the first two weeks following surgery.

Depending on your surgery, you may have a continuous passive motion (CPM) machine, which is designed to help your knee move and regain your full motion. You should plan on using this at least 10 hours per day. The machine should be set to -50 of extension and 30-400 of flexion. It is set to pause for five seconds in extension.

- After 4-5 days try to have the CPM machine to 900 of flexion
- The most important aspect is to have your knee out straight
- You can adjust the speed. Many patients find it easier to sleep with the machine at slower speeds, and have faster speeds when up during the day.

You will be sent home with a prescription for pain medication. In addition to the pain medication you should take one adult strength aspirin every day for 14 days, in order to help prevent blood clots. The pain medication can make you constipated. If this is the case, take an over the counter stool softener such as Colace while taking the pain medication.

You will be sent home from the recovery room after a few hours. You will need someone else to drive you home.

Activities and advice for in the hospital and while at home:

1. Please call with any concerns: (860) 832-4666
2. Apply ice to the knee, as it will be quite helpful. After two days, you can change the dressing to a smaller one to allow the cold to better get to the knee. Be sure to leave the little pieces of tape (steri-strips) in place.
3. After two days it is okay to shower and get the wound wet, but do not soak the wound as you would in a bath tub or hot tub.
4. After knee surgery there is a variable amount of pain and swelling. This will dissipate after several days. Continue to take the pain medication you were prescribed as needed. Remember it is called pain control, not pain elimination. If you notice calf pain or excessive swelling in the lower leg, call your doctor.
5. It is important to look out of signs of infection following joint replacement surgery. These can include: fever (temperature > 101.50), chills, nausea, vomiting, diarrhea, redness around your incision, or yellow or green drainage from your incision. Should any of these be present, please contact your doctor's office immediately.
6. You should start your physical therapy approximately 5 days after your surgery.
7. You will have an office visit scheduled approximately 10-14 days after your surgery.

ACL RECONSTRUCTION - REHABILITATION PROTOCOL

Phase I: Immediate Post-op Phase (0 to 2 weeks after surgery)

Goals:

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

Activities:

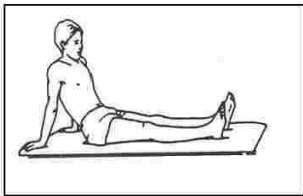
1. Continuous passive motion (CPM). This should be used at least 10 hours per day. You may use it anywhere that is comfortable. Use it at night while sleeping. It is very important that you straighten your knee completely. After 5 to 7 days of using the machine, if you have achieved greater than 100 degrees of flexion you can stop using the CPM machine.
2. Brace/crutches/weight bearing: your knee brace is set to allow you to bend and straighten your knee. Use it when walking or out of bed, but it may be removed for range of motion exercises. In cases where a meniscus repair surgery was done as part of your surgery you will need to keep the brace locked in extension (fully straight) when walking for 6 weeks after surgery.
3. Post operatively you will be on crutches for 5 weeks and use the knee brace for 4 weeks. Beginning postoperative day 0, you will remain in the knee brace, locked in extension for 2 weeks. You will only come out of the brace for range of motion exercises. At the 2 week mark the knee brace hinge will be unlocked, allowing for knee bending. At the 4 week mark the brace may be discontinued, provided satisfactory quadriceps and hamstring strength have returned. At the end of week 5 the crutches may be discontinued.
 - a. If you had a patellar tendon autograft (your own tendon), you can put as much weight on your leg as you feel like. You should use the crutches in the beginning, but can stop using them when you feel as though your knee can support you. You will still need to wear your brace for the first six weeks after surgery. There may be some circumstances where restricted weight bearing will be necessary. Your doctor and therapist will discuss this with you if this is the case.
 - b. If you had a hamstring autograft or allograft, you will be allowed to put 50% weight on your leg with crutches and a brace for the first six weeks after surgery.
 - c. If you had a patellar tendon allograft (cadaver tendon) you will be allowed to put 50% weight on your leg with crutches and a brace for the first six weeks after surgery.
4. Your nurse or therapist will demonstrate the proper form for walking with crutches:
 - a. Put the crutches forward about one step's length
 - b. Put the injured leg forward in line with the crutch tips
 - c. Touch the foot of the injured leg to the floor and put as much weight down as is comfortable (brace on and locked)
 - d. While bearing weight on the injured leg, take a step through with the uninjured leg.
5. Elastic stockings: wear an elastic stocking below the knee until your first postoperative visit. Do at least 10 ankle pump exercises each hour to help prevent blood clots. Take one adult aspirin daily for the first two weeks.
6. It is okay to remove your bandage on the second morning after surgery but leave the small pieces of white tape (steri-strips) across the incision (if present). You can wrap an elastic bandage (ACE wrap) around the

knee at other times to control swelling. You may shower and get your incision wet (unless there is any drainage from your incisions). Do not soak the incision in a bathtub or hot tub until the stitches have been removed.

Exercises

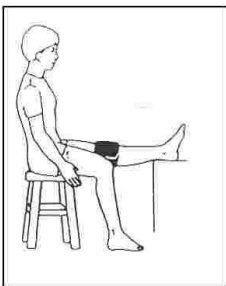
Program: 7 days per week, 3 to 4 times per day

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



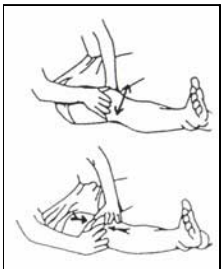
Quadriceps setting

Lie or sit with knee fully straight. Tighten and hold the front thigh muscle making the knee flat and straight (this should make your knee flatten against the bed or floor). Hold 5 seconds for each contraction.



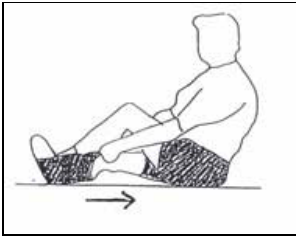
Heel prop

Lie on your back with a rolled up towel under your heel, or sit in a chair with the heel on a stool. Let the knee relax into extension (straight). If the knee will not straighten fully, you can place a small weight (2-5 lbs) on the thigh just above the kneecap. Try to hold for 5 minutes. Try to practice quadriceps setting in this position.



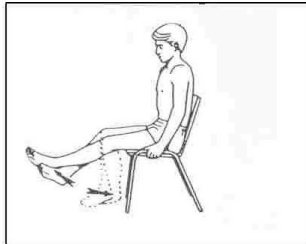
Patellar mobilization

With the knee fully extended, grasp the edges of your kneecap between your thumb and index finger. Move the kneecap side to side and up and down.



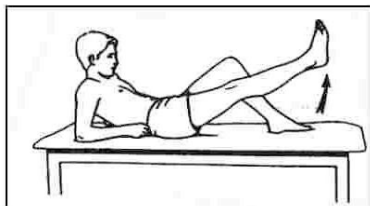
Heel slides with towel assist

While sitting or lying on your back, actively slide your heel backward to bend the knee. Hold this bent position for five seconds then slowly relieve the stretch and straighten the knee. While the knee is straight, you may repeat the quadriceps setting exercise. You can assist by using a towel to pull your heel back.



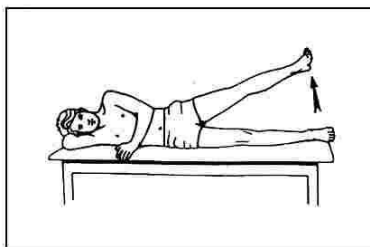
Sitting heel slides

While sitting in a chair or over the edge of the bed, support the operated leg with the uninvolved leg. Lower the operated leg, with the unoperated leg controlling, allowing the knee to bend. Do not go past 60 degrees of bend at the knee. Hold for 5 seconds and slowly relieve the stretch by lifting the foot upward with the uninvolved leg to the straight position.



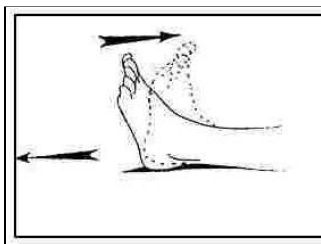
Straight leg lift

Tighten the quadriceps as much as you can. Lift your heel 4-6 inches from the floor. Tighten the quadriceps harder. Lower your leg back to the floor while continuing to tighten the quadriceps. If your knee bends when you attempt to lift do not do this exercise.



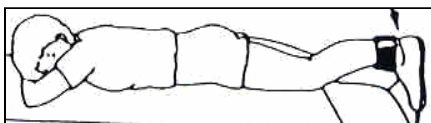
Hip abduction

Lie on your unoperated side. Keep your knees fully extended (straight). Raise the operated limb upward to a 45 degree angle. Hold for one second then lower slowly.



Ankle pumps

Move the ankle up and down to help stimulate circulation in the leg.



Prone hang

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 in the heel prop exercise.

Phase II: Early Rehabilitation Phase (2 to 6 weeks after surgery)

Goals:

1. Maintain full passive knee extension (at least 0-50 of hyperextension)
2. Gradually increase knee flexion
3. Diminish swelling and pain
4. Muscle control and activation
5. Restore proprioceptive and neuromuscular control
6. Normalize patellar mobility
7. Normal gait without crutches (if autograft)

Activities:

1. Continue to use ice to decrease swelling. It should be used for 20 minutes at least three times per day.
2. Brace/crutches: In cases where patellar tendon autograft is used, you can discontinue using your crutches when you are comfortable doing so. Continue using your brace. In cases of hamstring grafts or allograft patellar tendons continue with partial (50%) weight bearing with the crutches and brace. In cases where a meniscus repair surgery was done as part of your surgery you will need to keep the brace locked in extension (fully straight) when walking for 6 weeks after surgery.
3. You may stop wearing the compression stockings and can stop taking the aspirin.
4. You will have a visit with Dr. Betz at 10-14 days after surgery. If your wound is dry, you will likely be able to get the wound wet in a bath or hot tub at this point. Irrespective of whether your right or left leg was operated on, it is unlikely you will be allowed to drive at this point.

Exercises

The following exercises will be demonstrated to you by your physical therapist. He or she will also give you a home exercise program. You should strive to do your home exercise program at least 3 to 4 times per day, every day. The success of your reconstruction depends on your rehab.

- Quadriceps setting
- Heel prop
- Prone hang
- Heel slides with towel assist
- Straight leg raises
- Standing hamstring curl
- Standing toe-raises
- Hip abduction
- 1/3 knee bends
- Wall slides

Optional exercises:

If you did not have a meniscus repair as part of your surgery you may do leg press and hamstring extension exercises on a machine under the supervision of your therapist. You need to have achieved the following, though, in order to do this:

- Full passive knee extension
- Full extension while quadriceps setting
- Flexion of 125 degrees
- Minimal swelling

Phase III: Progressive Strengthening and Neuromuscular Control Phase (6 to 12 weeks after surgery)

Goals:

1. Restore full knee range of motion (0-1250)
2. Improve lower extremity strength
3. Enhance proprioception, balance and neuromuscular control
4. Improve muscular endurance
5. Restore limb confidence and function
6. Protect the reconstruction (avoid falling)

Activities:

1. The brace can be discontinued after you see Dr. Betz at your 6 week visit. Concentrate on walking with a heel to toe gait without a limp. In some cases, use of the brace will continue if your knee requires a longer period of protection.
2. Continue to use ice for 20 minutes after each workout.
3. You are cleared to drive when bearing weight on your operative leg is comfortable and you have good control of the leg. If your left leg was operated on, you should be clear to drive at this point.

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

Exercises:

- *Range of motion/strengthening:*
 - Quadriceps setting
 - Heel prop
 - Prone hang
 - Heel slides with towel assist
 - Straight leg raises
 - Standing hamstring curl
 - Standing toe-raises- single leg
 - Hip abduction
 - Squat to chair
 - Wall slides
 - Single leg strengthening progression
- *Stretching exercises:*
 - 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 exercises:*
 - Seated Leg Press
 - Roman Chair
 - Hamstring Curl

- Calf Raise Machine
- HIP Abductor/Adductor Machine
- Hip Flexor Machine
- *Cardiovascular conditioning can begin at this phase:*
 - Stationary bicycle
 - Walking
 - Rowing
 - Elliptical trainer
 - Water workout

DO NOT perform any of the following exercises:

- Knee extension weight lifting machine
- Lunges
- Running
- Stairmaster
- Jumping
- Step exercises with impact
- Pivoting or cutting

Phase IV: Advanced Activity Phase (12 to 16 weeks after surgery)

Goals:

1. Normalize lower extremity strength
2. Enhance muscular power and endurance
3. Improve neuromuscular control
4. Perform selected sport-specific drills

Criteria to progress to Phase IV:

- AROM 0-1250
- Quad strength 75% contralateral side
- Knee extensor: flexor ratio 70-75%
- No pain or effusion
- Satisfactory clinical exam
- Hop test 80% of contralateral leg

Activities

1. Your activities will increase in this phase of rehab, however it is important to remember that you are not yet fully recovered from your surgery. Progressing too quickly or engaging in sports or other activity prior to being cleared to do so greatly increases the risk of failure of your surgery and compromise of your results.
2. At this time, light running on a soft level surface with a sports brace can begin if Dr. Betz 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.
3. Avoid the following exercises as they place undue stress on your knee:
 - a. Leg extension machine
 - b. Stairmaster or stair climber machines
 - c. Deep knee lunges or squats past 90° of knee flexion
 - d. High impact exercises
4. Avoid pain at the patellar tendon site, as well as crepitus (crunching) at the patella.
5. Build up resistance and repetitions gradually.
6. Perform exercises slowly and avoid quick direction changes.
7. Avoid impact loading.
8. Exercise frequency should be at least 2-3 times per week for strength building.
9. Be consistent and regular with your exercise schedule.

Exercises

- May initiate straight ahead running program
- Light sports okay (golf - pitch and putt)
- Continue strengthening drills
 - Leg press
 - Wall squats
 - Hip abduction and adduction
 - Hip flexion and extension
 - Knee extension 90-40
 - Hamstring curls

- Seated and standing toe calf raises
- Step down
- Lateral step ups and lunges
- Weeks 14-16 may initiate lateral agility drills and backward running.
- It is okay to start jump and plyometric training.

Neuromuscular training:

- Lateral step overs (cones)
- Lateral lunges
- Tilt board drills
- Sports RAC repositioning on tilt board

Phase V: Return to Activity Phase (16 to 22 weeks after surgery)

Goals:

1. Gradual return to full-unrestricted sports
2. Achieve maximal strength and endurance
3. Normalize neuromuscular control
4. Progress skill training

Criteria to enter Phase V:

- Full ROM
- Quadriceps bilateral comparison within 80% or greater
- Hamstring bilateral comparison within 110% or greater
- Quadriceps torque: body weight ratio 55% or greater
- Hamstrings: quadriceps ratio 70% or greater
- Proprioceptive test 100% of contralateral leg
- Functional test 85% or greater of contralateral leg

Exercises:

- Continue strengthening exercises
- Continue neuromuscular control drills
- Continue plyometric drills
- Progress running and agility program
- Progress sport specific training
 - Running/cutting/agility drills
 - Gradual return to sport drills