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ACL RECONSTRUCTION REHABILITATION PROTOCOL

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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 has 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.

Control Pain and Swelling

Crushed ice or a cryocuff, along with nonsteroidal anti-inflammatory (NSAID) medications such as ibuprofen, Advil, Motrin, Aleve, 2 tablets twice a day can be used to help control pain and swelling. The nonsteroidal anti-inflammatory (NSAID) medications are continued for 7 - 10 days following the acute injury.

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:

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 its own weight until maximum extension is achieved.

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.** Heel prop using a rolled towel.

Figure 1. Heel prop using a rolled towel.

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.

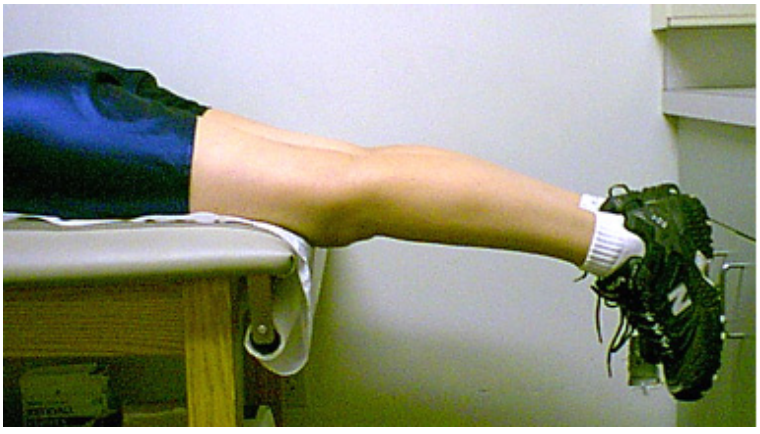

Figure 2. Prone Hang. Note that the knee is off the edge of the table.

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

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

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.

Heel slides are used to gain final degrees of flexion:
- 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.

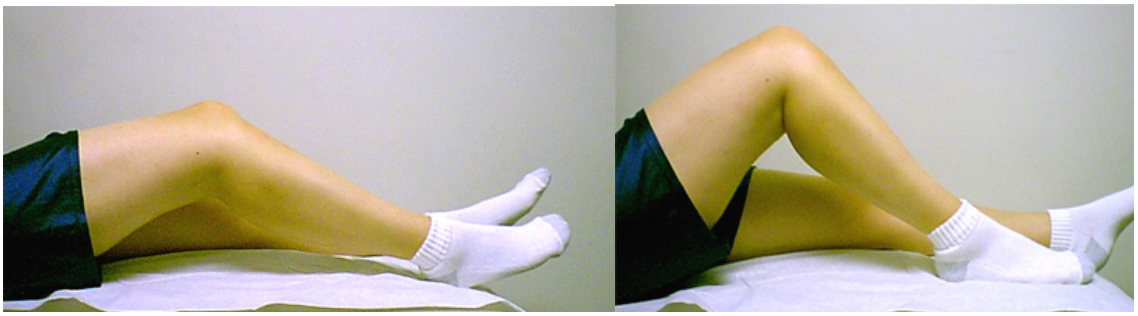

Figure 4. Heel slide – leg is pulled toward the buttocks.

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

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:

- 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. Stationary Bicycle helps to increase strength.

Figure 6. Stationary Bicycle helps to increase strength.

- Swimming, **in calm water,** is also another exercise that can be done during this phase to develop muscle strength and maintain your range of motion.
- 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).

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

UNDERSTANDING SURGERY

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

Before Surgery

Prior to beginning the operation and at the conclusion of the operation, a solution containing a long-acting local anesthetic *Marcaine* will be injected into your knee. This solution will block the pain nerve fibers and local pain receptors in your knee. Recent studies have shown that this is a safe and effective way to control pain after knee surgery. In many cases the injection will last 12 or more hours after surgery and significantly reduce the amount of pain medication that you will have to take.

During Surgery

At the time of surgery, a *plastic drainage tube* which 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

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.

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. You may get up to use the bathroom and eat, but otherwise you should rest with your leg elevated. 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.

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.

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

Caring for your knee

The first night and day after the surgery you can expect the elastic stocking and 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 elastic stocking 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 with a clean elastic dressing.
- Do not use tape to keep the gauze in place as this may cause skin blisters. The wrap will keep the gauze in place.

You are allowed to put as much weight on the leg as you can tolerate, except if a cartilage or meniscus in your knee was repaired, or if this is the second ACL reconstruction in the same knee. If that were the case, you should apply partial weight to the leg.

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.

You may shower, but you must keep your incisions dry for the first 7-10 days. This can be achieved by placing an AquaShield or waterproof plastic bag over your leg.

It is important to keep the incisions dry for the first 7-10 days.

- A follow-up visit should be scheduled 10-14 days following the operation by contacting my office.
- 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 sleeping for the first 4 weeks.

If you had a cartilage or meniscal repair

If you had a cartilage or meniscal repair you should not put weight on your leg and use the crutches for the first 2 weeks. The brace should still be removed to allow for you to work on range of motion without weight bearing. After the first 2 weeks, if you can get your leg completely straight, you can put weight on the leg with the brace locked in full extension. Between 4 and 6 weeks, you should wean from the brace and weight bear as tolerated

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Early Range of Motion and Extension

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 3.

- 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.

Active-assisted extension is performed by using the *opposite* leg and your quadriceps muscles to support and straighten the injured 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

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.

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

Exercising Quadriceps

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.

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.

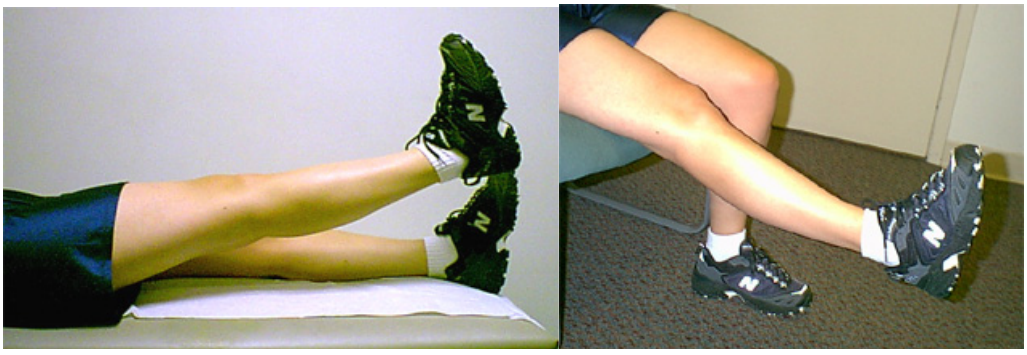

Figure 9. Straight leg raises – lying (left) and seated (right)

Exercising Quadriceps

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.

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

Schedule your office follow-up for 10-14 days postop.

As the steri-strips get wet, they will peel off. Do not pull at them for the first 2 weeks.

After 3 weeks, you may apply vitamin E oil or another emollient to the incisions, as this will improve their appearance.

The appearance of your incision can be improved further if you keep it out of direct sunlight for one year. Incisions can be covered with a bandage, sunscreen with SPF of 30 to 50.

Physical Therapy and Full Extension

Outpatient physical therapy will be modified during the first postoperative office visit.
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.

Returning to Work

If you have a desk type job, you can return to work when your pain medication requirements decrease and you can safely walk with your crutches. Typically, this is between 5 - 10 days after surgery.

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 immobilizer
- Control swelling in the knee

Maintaining full extension and developing muscular control are important

Maintain Full Extension

Continue with full passive extension (straightening), gravity assisted and active flexion, active-assisted extension, quadriceps isometrics, and straight leg raises.

Work toward 90-100 degrees of flexion (bending).

Develop Muscular Control

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. See Figure 10.
- Do 3 sets of 10 repetitions each day.

Figure 10. Partial squat using Table for stabilization

Start Toe Raises.

- Using a table for stabilization, gently raise the heel off the floor and balance on the ball of the feet. See Figure 11.
- Hold for 6 seconds and ease slowly back down.
- Do 3 sets of 10 repetitions each day.

Figure 11. Toe Raise

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

Wean from crutches when you can put full weight on the leg and walk with a normal heal-toe gait and no limp.
You can continue using a stationary bike. Cycling is an excellent conditioning and building exercise for the quadriceps. See Figure 6 on page 5.

- 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.

Control Pain and Swelling

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.

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 ibuprofen, Advil, Motrin, 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.

POSTOPERATIVE WEEK 3 - 4

Goals:

- Full range of motion
- Strength through exercise

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.

Continue quadriceps isometrics and straight leg raises (see Figure 9).

Continue partial squats and toe raises (see Figure 10 and Figure 11).

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.

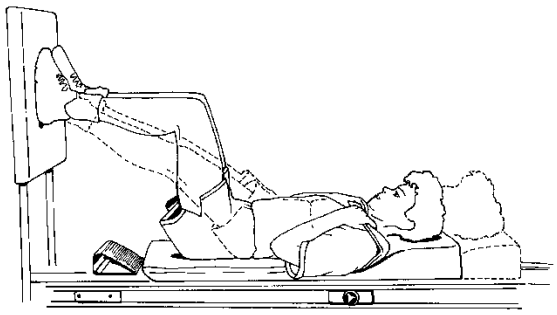

Figure 12. Leg press using 90-0 degree range

- 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.

POSTOPERATIVE WEEK 4 - 6

Goals:

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

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.

Continue quad sets, straight leg raises, partial squats, toe raises, stationary bike, elliptical machine, leg presses, and leg curls.

Tilt board or balance board exercises. This helps with your balance and proprioception (ability to sense your joint in space)

POSTOPERATIVE WEEK 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

Continue quad sets, straight leg raises, partial squats, toe raises, stationary bike, elliptical machine, leg presses, and leg curls.

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.

Continue tilt board and balance board for balance training.

Continue swimming program.

Start treadmill (flat only).

You may begin outdoor bike riding on flat roads.

No mountain biking or hill climbing!

POSTOPERATIVE WEEK 12 – 20

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

Continue all of week 6 -12 strengthening exercises.

Start straight, forward and straight, backward jogging and light running program.

Start functional running program after jogging program is completed.

Optional fitting for ACL functional brace.

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.

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