



Goshen Physicians

ORTHOPEDICS & SPORTS MEDICINE

Anterior Cruciate Ligament Reconstruction Protocol

The anterior cruciate ligament, or ACL, is one of the major stabilizing ligaments in the knee joint. Damage to this ligament commonly results in “giving way” or buckling of the knee and a progressive loss of function. Surgical reconstruction of the ACL is usually required in order to restore normal function.

When the ACL is reconstructed using a patellar tendon autograft, the middle one third of the patellar tendon is harvested along with a “plug” of bone from the tibia and patella. The resultant bone-tendon-bone graft is placed such that one bone plug is inserted in the femoral tunnel and one in the tibial tunnel. Both bone plugs are usually secured with a screw in each tunnel. Patients with patellar tendon grafts will usually have more anterior knee pain due to the trauma to the extensor mechanism. Therefore, aggressive resisted knee extension exercises are usually delayed for the first 6 – 8 weeks.

When the ACL is reconstructed using a hamstring autograft, a strip of the semitendinosus and gracilis tendons is harvested. The tendons are doubled over such that the resultant graft consists of 4 strands. Patients with hamstring grafts will usually have more posterior knee pain where the graft was harvested. Therefore, aggressive resisted knee flexion exercises (e.g. hamstring curls) are usually delayed for the first 4 – 6 weeks.

Post-Op Protocol

0 - 4 Days

- **Full passive extension immediately post-op.**
- ROM 0-90 degrees.
- Ambulate WBAT with 2 crutches unless otherwise instructed by the physician.
- Begin SLR's , quad sets, ankle pumps, and heel props to regain extension in the hospital -if possible
- Use ice and elevation to decrease pain and swelling (4-5x/day).

5 Days - 2 Weeks

- Emphasize full passive extension/hyperextension equal to uninjured knee unless $\geq 5^\circ$ of hyperextension- heel props, prone hang.
 - ROM 0-110 degrees until sutures removed, then flexion to tolerance.
 - Progress to FWB as soon as patient achieves adequate quad control (e.g. able to ambulate without flexed-knee gait and no increase in effusion).
1. Gait training with assistive device (as appropriate).
 2. Electrical stimulation to facilitate volitional quad control (11).
 3. Biofeedback for quad strengthening exercises (e.g. knee extension isometrics, SLR's, etc.).
 4. Patella mobilization. Instruct patient in self-mobilization technique with emphasis on superior glide and scar tissue massage as incision heals.
 5. Multi-angle isometrics for quads ($\geq 60^\circ$ knee flexion) and hamstrings.
 6. AA/AROM exercises to increase flexion (e.g. knee flexed over table edge with support of opposite leg, wall slides, etc.).
 7. Leg press (ROM as tolerated) and calf exercises on leg press machine.
 8. Supine SLR's with weight of leg only. Add weight as tolerated only if full knee extension is maintained.
 9. SLR's for hip adduction, abduction, and extension with added weights as tolerated.
 10. Hamstring curls with added weights as tolerated. Hold until after 6 weeks if hamstring autograft was used.
 11. Partial squats (ROM as tolerated but not to exceed 90° knee flexion).
 12. Anterior lunge weight shifting with crutches as needed.
 13. Calf raises.
 14. Hamstring and calf stretching, but avoid aggressive hamstring stretching if hamstring autograft has been used.

2 - 6 Weeks

- **Effusion should be ≤ 3 cm (at mid-patella) by 2 weeks.**
 - Continue to emphasize full knee extension and control of effusion.
 - ROM to tolerance (flexion should be $\geq 120^\circ$).
 - **Gait should be normalized by 6 weeks.**
1. Continue with aggressive patellar mobilizations and scar tissue massage.
 2. Stationary bike for ROM. May begin exercise program if effusion is controlled.
 3. Lateral step-ups/downs beginning at 2" and progressing height only if proper technique is maintained - i.e. no hip substitution (1).
 4. Closed kinetic chain (CKC) terminal knee extensions standing with theraband resistance (may begin sooner if patient is FWB).
 5. Retro-ambulation to facilitate quad control and dynamic extension.
 6. Rocker board for static balance with two-leg stance (may begin sooner if patient is FWB).
 7. Hamstring curls on isotonic machine.
 8. Continue with squats (progressing from double-leg to single-leg as tolerated), emphasizing lower ranges (e.g. $60-90^\circ$ of knee flexion) and proper technique (e.g. knees over/behind toes).
 9. Multi-hip machine.

10. Static single-leg balance on floor. Progress to dynamic single-leg balance activities (e.g. upper or lower extremity reaching, 4-way theraband, unstable surfaces, etc.) as lower extremity muscle control allows (3).
11. Sport cord activities (e.g. marching, lateral stepping in squat position, lunging, etc.).
12. Hip hiking.
13. Lunges (e.g. anterior, lateral, etc.) emphasizing proper alignment and mechanics.

6 - 12 Weeks

- **Effusion should be ≤ 1 cm by 6 weeks.**
 - **P/AROM should be equal, bilaterally, by 10 weeks.**
 - Emphasize concepts of frequency, duration and intensity of training.
 - Continue to emphasize supervised balance and endurance training in the clinic.
 - Encourage continuation of lower extremity strengthening at local gym or health club.
1. Progress endurance training (e.g. bike, Elliptical, Versa Climber, etc.). Initiate high RPM (e.g. 100-120) bike sprints as tolerated.
 2. Progress static and dynamic single-leg balance activities to unsteady surfaces (e.g. pillow, half foam roll, BAPS board, etc.) as lower extremity muscle control allows.
 3. Begin knee extensions on isotonic machine (90-40° only) if minimal effusion (i.e. ≤ 1 cm), and no patellofemoral pain and/or patellar tendon pain.
 4. At 8 weeks, begin isokinetics for quad and hamstring strengthening with anti-shear device (ASD) if no increase in effusion and no patellofemoral complaints. Start with high speeds (180-300°/sec) and gradually introduce slower speeds.
 5. Begin mini-tramp marching.

12 - 16 Weeks

- Re-assess patient's independent strengthening program, ensuring proper weight progressions, training intensity, etc.
 - **At 12 weeks (or 16 weeks depending on physician preference), perform isokinetic (180 and 240°/sec. with ASD), KT-1000, functional and subjective rating testing.** If isokinetic equipment is not available, MVIC testing with a hand held dynamometer may be considered, or unilateral leg press testing (one rep max, or maximum reps at body weight for side to side comparisons).
 - **Appointment with M.D.**
1. Progress isotonic knee extension strengthening (90-0°). Continue to monitor patellofemoral joint and patellar tendon.
 2. Fitter and/or slide board.
 3. Mini-tramp jogging.
 4. Advance balance work to include perturbation drills on wobble board, BOSU, half foam roll, etc (9)
 5. Begin developing proficiency with low impact 2 leg jumping – jump squats, jump rope on soft but stable surface (carpet, rubberized floor)

16 - 24 Weeks

- Re-assess patient's independent strengthening program, ensuring proper weight progressions, training intensity, etc.
1. Begin straight ahead jogging (may begin earlier only with MD approval).
 2. May begin progressive functional activities (in brace if required by M.D.) if isokinetic values from 12 week (or 16 week) test are within 15% of opposite side and if M.D. approves.
 3. Advance 2 leg jumping to include broad jumps for distance, tuck jumps, vertical jumps.
 4. Progress into hopping (one leg) once good form and control are demonstrated
 5. Begin working on explosive power as well as eccentric strength for controlled landings – box jumps and hops, one leg vertical jumps, box drop jumps progressing from bilateral to unilateral landing.
 6. Patient should demonstrate 85% symmetry on single-leg hop for distance prior to moving on to next phase.

24 Weeks+

- **Perform isokinetic (60, 180, 300^o/sec, no ASD required), KT-1000, functional and subjective rating testing. Appointment with M.D.**
 - Functional testing may be delayed if patient has complaints of pain or swelling, has deficits >15% documented by isokinetic testing, or A-P displacement is significant.
 - Fit for functional brace (if applicable).
1. Advanced functional hop tests are performed. Consider using a test battery to improve sensitivity. Goal is 90% symmetry prior to return to sport
 - a. Single-leg hop for distance, 6 meter timed hop, triple hop, cross-over hop (7, 9)
 - b. Single-leg hop for distance, side hop, one leg vertical hop (2)
 2. Star Excursion Balance Test or Y Balance test (4)
 - a. Look for no side to side reach distance greater than 4 cm
 - b. Composite reach distance of greater than 90%
 3. Continue to progress functional activities and sport specific drills as tolerated- figure 8s, full speed cutting, modified agility T-test

REFERENCES

1. Ernst GP, Saliba E, Diduch DR, Hurwitz SR, Ball DW. Lower-extremity compensations following anterior cruciate ligament reconstruction. *Physical Therapy*. 2000; 80(3): 251-260.
2. Gustavsson A et al. A test battery for evaluating hop performance in patients who have undergone ACL reconstruction. *Knee Surg Sports Traumatol Arthrosc*. 2006; 14: 778-788.
3. Hewett TE, Paterno MV, Myer GD. Strategies for enhancing proprioception and neuromuscular control of the knee. *Clinical Orthopaedics and Related Research*. 2002; 402: 76-94.

4. Lehr ME, Plisky PJ, Butler RJ, Fink ML, Kiesel KB, Underwood FB. Field-expedient screening and injury risk algorithm categories as predictors of noncontact lower extremity injury. *Scandinavian Journal of Medicine & Science in Sports*. 2013; 23: 225-232.
5. Lobb R, Tumilty S, Claydon LS. A review of systematic reviews on anterior cruciate ligament reconstruction rehabilitation. *Physical Therapy in Sport*. 2012; 13: 270-278.
6. Myer GD, Paterno MV, Ford KR, Quatman CE, Hewett TE. Rehabilitation after anterior cruciate ligament reconstruction: Criteria-based progression through the return-to-sport phase. *J Orthop Sports Phys Ther*. 2006; 36(6): 385-402.
7. Noyes FR, Barber SD, Mangine RE. Abnormal lower limb symmetry determined by functional tests after anterior cruciate ligament rupture. *Am J Sports Med*. 1991; 19: 513-518.
8. Oeffinger DJ, Shapiro R, Nyland J, Pienkowski D, Cabron DNM. Delayed gastrocnemius muscle response to sudden perturbation in rehabilitated patients with anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc*. 2001; 9(1): 19-27.
9. Reid A, Birmingham TB, Stratford PW, Alcock GK, Griffin JR. Hop testing provides a reliable and valid outcome measure during rehabilitation after anterior cruciate ligament reconstruction. *Physical Therapy*. 2007; 87: 337-349.
10. Shiraishi M, Mizuta H, Kubota K, Otsuka Y, Nagamoto N, Takagi K. Stabilometric assessment in the anterior cruciate ligament-reconstructed knee. *Clinical Journal of Sport Medicine*. 1996; 6(1): 32-39.
11. Snyder-Mackler L, Ladin Z, Schepsis AA, Young JC. Electrical stimulation of the thigh muscles after reconstruction of the anterior cruciate ligament. Effects of electrically elicited contraction of the quadriceps femoris and hamstring muscles on gait and on strength of the thigh muscles. *Journal of Bone and Joint Surgery (Am)*. 1991; 73(7): 1025-1036.
12. van Grinsven S, van Cingel REH, Holla CJM, van Loon CJM. Evidence-based rehabilitation following anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc*. 2010; 18: 1128-1144.