



BRIGHAM AND WOMEN'S HOSPITAL

Department of Rehabilitation Services Physical Therapy

Anterior Cruciate Ligament Reconstruction: Post-Operative Protocol

The intent of this protocol is to provide the clinician with a guideline of the post-operative rehabilitation course of a patient that has undergone an Anterior Cruciate Ligament (ACL) Reconstruction. It is in no means intended to be a substitute for one's clinical decision making regarding the progression of a patient's post-operative course based on their physical exam/findings, individual progress, and/or the presence of post-operative complications. If a clinician requires assistance in the progression of a post-operative patient they should consult with the referring Surgeon.

These time frames are just examples and can be adjusted based on the given procedure:

Progression to the next phase based on Clinical Criteria and/or Time Frames as Appropriate.

This protocol has been adopted from Adams et al (2012) which has been published in Journal of Orthopedics and Sports Physical Therapy¹; and, the Delaware Physical Therapy Clinic Guidelines from: Manal TJ, Hoffman SA, Sturgill L. Rehabilitation practice guidelines for Anterior cruciate ligament reconstruction.²

The Department of Rehabilitation Services at Brigham & Women's Hospital has modified and accepted these protocols as our standard protocol for the management of patients s/p ACL Reconstruction.

The goal of ACL reconstruction surgery is to restore and maximize the stability of the knee and prevent recurrent injuries or degenerative changes to the knee. ACL reconstruction surgery is not a repair or a salvage procedure.^{1,2,3} The entire ligament is reconstructed from either autografts from the patellar tendon or the hamstring, or an allograft, in order to recreate the ligament.^{1,2} This procedure is done arthroscopically.

Graft Types:

The most commonly used grafts include bone – patellar tendon – bone (BTB) autograft, hamstring autograft and ACL Allografts. Some patients may undergo concomitant meniscal repairs or chondral defect repairs. A few factors should be considered while rehabilitating patients with different graft types.¹

- Patients with bone – patellar tendon – bone autograft may have increased incidence of anterior knee pain, especially with kneeling. Patellar taping and pain relieving modalities maybe used to relieve patellar pain or tenderness.

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- Patients with a hamstring autograft should not be performing resisted hamstring activities for 12 weeks
- Patients with an allograft may have slightly increased risk of graft failure, especially if they engage in high level activities too soon after surgery. However, there is no evidence that delaying return to sport will decrease the likelihood of graft failure. Therefore, all patients should be advanced to the next phase of rehabilitation based upon meeting the criteria of the previous phases.
- Patients with concomitant meniscal reconstruction, weight bearing at angles greater than 45° of knee flexion should be avoided for 4 weeks with no restriction in weight bearing in full extension. For weeks 4-8, weight bearing should be limited to 90 degrees of knee flexion. After week 8, regular ACL reconstruction guidelines may be followed.

PHASE 1 – POST OPERATIVE PHASE (0-2 Weeks)

Goals:

- Control pain and swelling
- Protect healing tissue
- Restore range of motion (ROM), emphasize full extension
- Quadriceps control
- Patient education
- Flexion to 90 degrees

Precautions:

- Weight bearing as tolerated
- Brace locked in extension with ambulation and sleeping
- Brace unlocked 0-90° when non-weight bearing

Knee Orthotic/ Brace:

Post-operatively, typically patients are placed in a locked hinged knee brace. The post-op hinged knee brace may be used or weaned off per surgeon recommendations and based upon quadriceps control.³

Typically, during the 1st week, the brace is kept locked in full extension for ambulation and sleeping

By week 2, if the patient demonstrates good quadriceps control, progress to unlocking the brace during ambulation.

There is strong evidence showing no significant difference in joint laxity, isokinetic torque, ROM, and function (including the Tegner scale and Lysholm scale) at any time point with post-operative bracing versus no post-operative bracing.³

The post-op hinged knee brace may be used or weaned off per surgeon recommendations and based upon quadriceps control.

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Treatment (Week 1)

- Patellar mobilization
- Normalize gait pattern; use Neuro-muscular electric stimulation (NMES) if quadriceps not firing or if the patient tests less than 2 on manual muscle testing (MMT)
- Quadricep Strengthening : quadriceps sets, long arc quads (90-45 degrees), supine heel slides on wall 30- 50 reps/ day, Straight Leg Raise (SLR) 3 x 10 reps, 3 times/ day
- *exercises should be trialed in clinic prior to sending patient home with them and sets and repetitions may be altered based on patient performance

Criteria for Progressing to Next level

- Knee active/ passive ROM: 0-90
- Active quadriceps contraction with superior patellar glide

EARLY POST-OPERATIVE PHASE (Week 2):

Goals:

- Increase knee flexion
- Improve quadriceps control in SLR and ambulation
- Wean off hinged knee brace for all activities
- Normalize gait pattern, decrease to least assistive device

Treatment (Week 2):

- Portal/ Incision mobilization as needed (if skin is healed)
- Stair master/elliptical/stationary bicycle
- Progress quadriceps strengthening to weight-bearing exercises: wall squats/ slides, step-up exercise, in pain free range.
- Prone knee hangs (if lacking full extension)
- Patellar mobilization in flexion (if flexion is limited)
- Gait training: heel-toe pattern, knee flexion during swing phase, terminal knee extension on heel strike
- Progress to functional bracing as swelling permits and if indicated.

A functional knee brace is designed to compensate for a torn knee ligament and to allow for movements including sport specific activities. A functional brace is commercially available in a variety of forms and is usually a form of a hinged knee brace. There is no clinically significant difference in prevention of post-operative injury, decreased pain, altered knee range of motion, or improved knee stability with post-operative ACL repair bracing to limit range of motion or protect against varus or valgus forces.^{1,2} A discussion with the surgeon and the patient must be made prior to fitting a patient with a functional brace for sports specific activities.

Criteria for progression to the next phase:

- Knee flexion greater than 100 degrees
- Progress to walking without crutches with full knee extension
- Use of stationary bicycle/stair master without difficulty

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- SLR without knee extension lag
- Reciprocal stair climbing
- Knee Outcome Survey activities of daily living (KOS-ADL) greater than 65%

INTERMEDIATE POST-OPERATIVE PHASE (WEEK 3- WEEK 5):

Goals:

- Normalize knee flexion
- Improve quadriceps strength

Treatment (Week 3-5):

- Tibio-femoral mobilizations with rotation for ROM if joint mobility is limited
- Progress bike and stair master duration (10-minute minimum)
- Begin balance and proprioception activities including:
 - Squats on BOSU
 - Single leg squat on total gym (TG)/leg press starting at 90 degrees knee flexion
 - Hamstring curls on medicine ball
- At this stage, you may initiate perturbation and balance training as below:

Perturbation Training Protocol⁴

Session 1: Rocker board: bilateral stance antero-posterior and medial-lateral.

- Roller board/Platform: antero-posterior slides.
- Perform with the operated leg on roller board first.
- Progress to standing with un-involved leg on roller board and operated leg on platform.
- Roller board: bilateral stance, antero-posterior perturbations to roller board.

Session 2: Rocker board: unilateral stance, antero-posterior and medial-lateral.

- Roller board/platform: antero-posterior and medial-lateral slides.
- Progress to operated leg on platform and non operated leg on the roller board as tolerated.
- Roller board: unilateral stance, atnerio-posterior perturbations.

Session 3: Rocker board: session 2 plus diagonals.

- Roller board/platform: session 2 plus rotation
- Progress to operated leg on platform and non operated leg on the roller board as tolerated.
- Roller board: session 2 plus medial/lateral perturbations.

Session 4: Rocker board: session 3

- Roller board/platform: session 3
- Progress to operated leg on platform and non operated leg on the roller board as tolerated.
- Roller board: session 3 plus rotation.

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Roller Board



BOSU Rocker board

Criteria to progress to next Phase:

- Knee flexion ROM to within 10 degrees of uninvolved side
- Quadriceps strength greater than 60% of uninvolved side

Stationary bike may be used for warm up at the patient's preferred resistance level. Continuous biking of 10 minutes is recommended for a warm up hereafter for all phases.

LATE POST-OPERATIVE PHASE - I (WEEK 6-8):

Goals:

- Improve quadriceps and hamstrings strength
- Attain full knee AROM
- Normalize gait pattern

Treatment (Week 6-8):

- Progress exercises in intensity and duration with appropriate mechanics.

Include exercises such as single leg step downs with appropriate mechanics and quad control

- By week 7-8, begin running progression: on treadmill or track with functional brace (if all milestones are met; may vary with physician)
- Progress perturbation training as below:
 - **Session 5:** same as 4, with /rollerboard with throwing ball on wall
 - **Session 6:** same as 4, with ball against wall or floor with throwing ball on wall/floor
 - **Session 7:** same as 4, with ball thrown by another person
 - **Session 8-10:** same as 7, but with sport specific activities

Transfer to fitness facility if all milestones are met and if the patient's goals do not involve return to high level impact activities.

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Criteria for progression to the next phase:

- Quadriceps strength greater than 80% of uninvolved side
- Normal gait pattern
- Full knee ROM (compared to uninvolved side)
- Knee effusion of trace or less

Phase IV – RETURN TO ACTIVITY PHASE (WEEK 9-12):**Goals:**

- Keep improving quadriceps strength
- Perform hop testing by week 12
- Transition to fitness facility

Treatment (Week 9-12):

- Return to sports-specific activities
- Initiate a return to running program if strength and hop test are 85% of uninvolved side
- Agility exercises
- Functional testing (At week 12): single, cross-over hop, triple and timed hop tests.⁶
- If hop test results in patient performing 85% of the uninvolved side, add exercises such as single leg hop and lateral single leg hop. See description of these tests below
- During this phase you may progress perturbation training to sport specific perturbation.
- If hamstring allograft was used, you may begin resisted training for hamstrings at this time.

Running progressions should be initiated on a treadmill with a walk run program after ensuring that the patient has at least 80% of strength and scores at least 85% with functional testing. Refer to BWH return to running program for details.

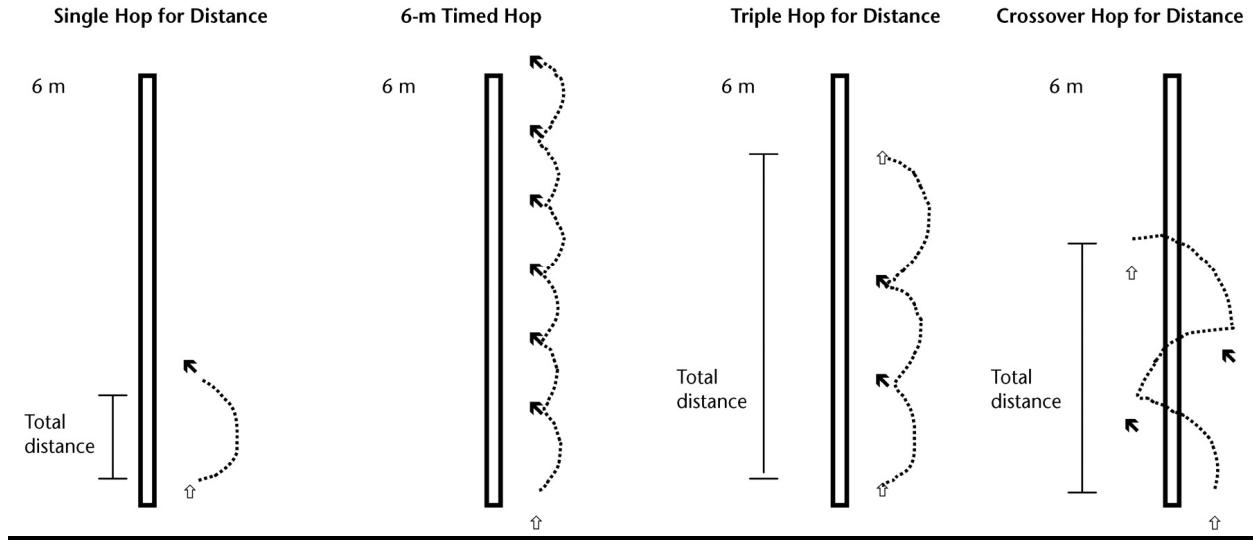
Based upon the sport or the activity that the patient wishes to return to, training should be individualized. The therapist may begin biasing the training based upon the patient's sport as early as week 9, depending quadriceps control.

FUNCTIONAL TESTING:

Patient should be asked to practice, twice on each leg prior to measuring. The patient then performs 2 trials of the hop test sequence on each leg. Measured trials are averaged and compared to the opposite side

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Picture from: Reid A, Birmingham TB, Stratford PW, Alcock GK, & Giffin JR. Hop testing provides a reliable and valid outcome measure during rehabilitation after anterior cruciate ligament reconstruction. *Phys ther*, 2007; 87(3), 337-349.

Criteria for progression to the next phase:

- Knee Outcome Scale (KOS) -sports questionnaire greater than 70%
- Hop tests greater than 85% of uninvolved side
- Quadriceps strength 85% of uninvolved side.

If a patient is not involved in moderate or high impact activities or sport, he may be discharged from PT between weeks 12 to 16. However sport specific training may extend up beyond week 16

DISCHARGE CRITERIA:

- Full pain-free ROM
- No joint effusion
- Non-antalgic gait
- Good knee stability
- Strength of quadriceps 80-85% of uninvolved side
- ham/quad ratio > 70%

RETURN TO SPORT PHASE: WEEK 12- 16 :

Goals:

- Maintaining gains in strength (greater than or equal to 90% to 100%)
- Hop test 90% or greater
- KOS- sports 90% or greater

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Recommend changes in rehabilitation as needed. It is recommended that the patient should be able to perform all activities without increase in swelling or effusion in the operated knee or increase in pain. Patient engaging in high level contact sport or team sports may require a hop test scores of $\geq 95\%$ prior to return to sports.²

Treatment:

Sport specific training may include and is not limited to:

- Bilateral and unilateral hopping/ jumping
- Single leg activities
- Sprinting and explosive activities
- Agility training/ Change in direction training including lateral and reverse changes in directions

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APPENDIX:

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Phase	Number of Weeks Post-Op	Milestones	Treatment
Preoperative Goals	—	<ul style="list-style-type: none"> • Full knee extension range of motion (ROM) • Absent or minimal knee effusion • No extension lag with straight leg raise (SLR) 	
Immediate Postoperative	Week 1	<ul style="list-style-type: none"> • Knee active/passive ROM, 0-90 degrees • Active quadriceps contraction with superior patellar glide 	<ul style="list-style-type: none"> • Wall slides, patellar mobilization, gait training, NMES, bike for ROM • Home Exercise Program (HEP)- supine wall slides, self-patellar mobilization 30 – 50 times per day, quadriceps set, long-arc quadriceps (90- 45 degrees), straight leg raise (SLR) 3 x 10 repetitions (3 times per day)
Early Postoperative Phase	Week 2	<ul style="list-style-type: none"> • Knee flexion greater than 100 degrees • Walking without crutches • Use of cycle/stair climber without difficulty • Walking with full extension • Reciprocal stair climbing • SLR without a knee extension lag • Knee Outcome Survey activities of daily living (KOS-ADL) greater than 65% 	<ul style="list-style-type: none"> • Step-ups in pain-free range • Portal/incision mobilization as needed (if skin is healed) • StairMaster, wall squats/sits • Progress to functional brace as swelling permits • Prone hangs if lacking full extension • Patellar mobilization in flexion (if flexion is limited)
Intermediate Postoperative Phase	Weeks 3 - 5	<ul style="list-style-type: none"> • Knee flexion ROM to within 10 degrees of uninvolved side • Quadriceps strength greater than 60% of uninvolved side 	<ul style="list-style-type: none"> • Tibiofemoral mobilizations with rotation for ROM if joint mobility is limited • Progress bike and StairMaster duration (10-minute minimum) • Begin balance and proprioception activities • Begin perturbation training.
Late Postoperative Phase	Week 6-8	<ul style="list-style-type: none"> • Quadriceps strength greater than 80% of uninvolved side • Normal gait pattern • Full knee ROM (compared to uninvolved side) • Knee effusion of trace of less 	<ul style="list-style-type: none"> • Progress exercises in intensity and duration • Initiate jogging / walk-run progression on treadmill with functional brace at the end of this phase (if all milestones are met; may vary with physician) • Transfer to fitness facility (if all milestones are met)
Return to Activity	Week 9-12	<ul style="list-style-type: none"> • Maintaining or gaining 	<ul style="list-style-type: none"> • Return to running program

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Phase		<p>quadriceps strength (greater than 80% of uninolved side)</p> <ul style="list-style-type: none"> • Hop tests greater than 85% of uninolved side at 12 weeks • KOS-sports questionnaire greater than 70% 	<p>is initiated</p> <ul style="list-style-type: none"> • Early Sports-specific activities • Agility exercises • Functional testing (week 12)- Single, cross, Triple and Time Hop tests
Return to Sport	<p>Week 12- 16 With possible, 5, 6 Months and 1 Year Postoperative</p>	<ul style="list-style-type: none"> • Sport specific training • Hop test 90% or greater • KOS- sports 90% or greater • Return-to-sport criteria 	<ul style="list-style-type: none"> • Recommend changes in rehabilitation as needed. • Progression may emphasize single-leg activities in gym, explosive types of activities (cutting, jumping, plyometrics, landing training)

REFERENCES:

ACL Reconstruction Protocol:

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1. Adams et al. Current Concepts for Anterior Cruciate Ligament Reconstruction: A Criterion-Based Rehabilitation Progression. *Journal of Orthopaedic and Sports Physical Therapy*. 2012; 7:601-614
2. Delaware Physical Therapy Clinic guidelines from: Manal TJ, Hoffman SA, Sturgill L. Rehabilitation practice guidelines for Anterior cruciate ligament reconstruction. *Current Concepts of Orthopedic Physical Therapy: Independent Study Course*. 2011; 3: 32-34.
3. Kruse, L. M., Gray, B., & Wright, R. W. (2012). Rehabilitation After Anterior Cruciate Ligament ReconstructionA Systematic Review. *The Journal of Bone & Joint Surgery*, 94(19), 1737-1748.
4. Eitzen I, Moksnes H, Snyder-Mackler L, Risberg MA. A progressive 5-week exercise therapy program leads to significant improvement in knee function early after anterior cruciate ligament injury. *J Orthop Sports Phys Ther*. 2010; 40(11): 705-721.
5. Lobb R, Tumilty S, Claydon LS. A review of systematic reviews on anterior cruciate ligament reconstruction rehabilitation. *Phys Ther Sport*. 2012; 13(4):270-8.
6. Reid, A., Birmingham, T. B., Stratford, P. W., Alcock, G. K., & Giffin, J. R. (2007). Hop testing provides a reliable and valid outcome measure during rehabilitation after anterior cruciate ligament reconstruction. *Physical therapy*, 87(3), 337-349.
7. Manal TJ, Hoffman SA, Sturgill L. Rehabilitation practice guidelines for Anterior cruciate ligament reconstruction. *Current Concepts of Orthopedic Physical Therapy: Independent Study Course*. 2011; 3: 32-34.
8. Teyhen DS, Robertson J. Anterior cruciate ligament surgery: optimize return to activity and minimize risk of a second injury. *J Orthop Sports Phys Ther*. 2013; 43(11):793

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