

ANTERIOR-CRUCIATE LIGAMENT RECONSTRUCTION PROTOCOL

Early Post-Op Restrictions:

Patellar Tendon Graft: Follow protocol as outlined below.

Quad Tendon Graft: Follow protocol as outlined below

Hamstring graft: No resisted hamstring for 8 weeks

Meniscus repair: Knee ROM 0-90 for first 4 weeks. **Please refer to MD order for repair type and WBing status for the first 6 weeks**

For root repair or radial tear: NWB for 4 to 6 weeks (**see MD referral**), brace locked in extension when not in therapy

For bucket handle, ramp lesion, or partial tear repair: WBAT (**see MD referral for any additional precautions**)

Expectations for return to sport should be no sooner than 9 months post-operatively. These expectations will be based on an individual basis, though it is expected no sooner than 9 months for best long term outcomes.

PREOPERATIVE REHABILITATION (3-5 WEEKS)

Rehabilitation Goals	Full knee extension range of motion Minimize/eliminate swelling Maximize muscular control around knee (no knee extension lag with straight leg raise) If above goals are met, patient will have better chance to return to prior level of function and normal knee function
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Intervention	Passive knee extension exercise Passive knee flexion as tolerated Perturbation/proprioception training to restore neuromuscular control Aggressive quadriceps strengthening (quad set, SLR without lag, squats (tolerated ROM), lunges, step ups)
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PHASE I: IMMEDIATE POST-OP (0-2 WEEKS AFTER SURGERY)

Frequency: 2-3 days/week

1st Physical Therapy session should be scheduled 2 days or next available date after surgery

Rehabilitation Goals	Protect the reconstructed graft Manage inflammation: Ice, Compression, Elevation (20 minutes every hour with knee in extension) Restore patellar mobility Restore full passive knee extension to 0 degrees Gradually increase flexion ROM (0-90+ degrees) Re-establish quadricep control and normalized ambulation Restore independent, normalized ambulation with good swing phase Administer initial KOS-ADLS
Weight Bearing Status	Extension brace - locked into full extension for ambulation and sleeping, can be unlocked for sitting Axillary crutches- WBAT with 2 crutches

Intervention	<p>Range of Motion:</p> <ul style="list-style-type: none"> - Heel slides - Wall slides - Stationary bike with no resistance - Low Load Long duration stretches for extension as needed (supine heel prop or bag hangs) <p>Patellar Mobility:</p> <ul style="list-style-type: none"> - medial/lateral/superior/inferior patellar mobilizations at 0-30 degrees flexion performed by PT and patient at home <p>Quad Activation:</p> <ul style="list-style-type: none"> - Quad sets (50-100 reps per day) - Prone TKEs - Standing TKEs - LAQ (90-45 degrees) no resistance (refer to MD protocol) - Seated submaximal multi-angle isometrics at 90 and 60 degrees (against resistance) - Step Ups <p>Hip Strength:</p> <ul style="list-style-type: none"> - SLR 4 way <p>Functional Training:</p> <ul style="list-style-type: none"> - Pre-gait standing weight shifts - Mini squats (0-60 degrees) <p>Modalities:</p> <ul style="list-style-type: none"> - NMES to quads with BFR if tolerated and incision is fully healed - NMES guidelines: 10-20s on, 50s off, x15 min total, 2 sec ramp, recommend 60 degrees isometric at edge of table
Criteria to Progress	<p>Range of Motion: Knee full extension, 110 degrees flexion</p> <p>SLR 2x10 without quad lag to DC extension brace</p> <p>Good Patellar Mobility</p>

PHASE II: EARLY PHASE POST-OP (2-4 WEEKS AFTER SURGERY)

Frequency: 2-3 days/week

<p>Rehabilitation Goals</p>	<p>Protect the reconstructed graft</p> <p>No anterior knee pain during or after exercise</p> <p>Restore full range of motion at the knee (limit hyperextension past 5 degrees)</p> <p>Restore normal gait mechanics</p> <p>Restore reciprocal stair climbing</p> <p>DC brace with good quad control</p> <p>KOS-ADLS >65%</p> <p>Quad strength >60% of uninvolved side</p>
<p>Weight Bearing</p>	<p>Full weight bearing</p> <p>Wean from assistive device</p> <p>If still in brace, unlock to 80% of flexion ROM for ambulation</p> <p>Avoid plant and pivot movements with surgical limb</p>
<p>Intervention</p> <p>-include exercises from previous phases as needed</p>	<p>Range of Motion:</p> <ul style="list-style-type: none"> - Heel slides - Stationary Bike - Prone and seated leg hangs and/or bag hangs - Patella mobilizations, both in extension and into flexion - Scar mobilization <p>Quad activation:</p> <ul style="list-style-type: none"> - Quad sets - Prone TKE - Standing TKE - LAQ (90-45 degrees) no resistance (refer to MD protocol) - Seated multi-angle isometrics against resistance <p>Functional training:</p> <ul style="list-style-type: none"> - Step ups/Stair climber - Gait training - Sit to stand - Squats - Hip Hinging <p>Hip strengthening:</p> <ul style="list-style-type: none"> - 4-way SLR - Bridges - Standing calf raise - Leg press/total gym squat <p>Core strengthening:</p> <ul style="list-style-type: none"> - Planks, side planks <p>Stability:</p> <ul style="list-style-type: none"> - DL and SL stable surface, focused (no distractions)

	<p>Aerobic Conditioning</p> <ul style="list-style-type: none"> - Cycling on stationary bike (Week 3) - Treadmill walking with normalized gait pattern (Week 3) - Swimming, gentle flutter kick only (Week 3) - Pool walking, when incision is fully healed <p>Modalities:</p> <ul style="list-style-type: none"> - NMES: russian stim for quad activation with BFR for hypertrophy - BFR: with stationary bike (unilateral or bilateral), BFR with any exercise with 30:15:15:15 rep scheme where possible
Criteria to Progress	<p>Overall the knee should be “Quiet” meaning the following:</p> <p>Full extension range of motion, 110 deg flexion</p> <p>Minimal effusion (Modified Stroke Test $\leq 2+$)</p> <p>No joint line and anterior knee pain</p> <p>Normal gait pattern without crutches</p> <p>Normal functional activities: Squat, stairs</p>

PHASE III: MID PHASE POST-OP (4-6 WEEKS AFTER SURGERY)

Frequency: 2-3 days/week

Rehabilitation Goals	<p>Protect the reconstructed graft (graft is weakest from 6-20 weeks)</p> <p>Continue with graded lower extremity strength and neuromuscular control programs emphasizing quads, glutes, hamstrings, etc.</p> <p>Emphasize eccentric quad control and force absorption in preparation for eventual running</p>
Intervention	<p>Range of Motion:</p> <ul style="list-style-type: none"> - Tibiofemoral mobilization with rotation if flexion is limited - Stationary bike <p>Quad:</p> <ul style="list-style-type: none"> - Full LAQ as tolerated (refer to MD protocol) <p>Strengthening:</p> <ul style="list-style-type: none"> - Hamstring curls as tolerated (unless HS autograft, see first page of protocol) - Introduce hip hinge/deadlift with kettlebell or trapbar - Split squats <p>-include exercises from previous phases as needed</p>

	<ul style="list-style-type: none"> - 4-way SLR (add resistance) - Bridges (progressions) - Calf raises (progressions) - Side step/monster walk - Leg Press (Eccentric and/or SL) - Core strengthening: planks, side planks, bird dogs, modified copenhagens <p>Balance/Proprioception:</p> <ul style="list-style-type: none"> - DL, SL, stable and unstable surface, focused (no distractions) <p>Functional training:</p> <ul style="list-style-type: none"> - Squats (bilateral and unilateral) - Stairs <p>Modalities</p> <ul style="list-style-type: none"> - BFR with any exercise with 30:15:15:15 rep scheme, bilateral or unilateral cuff use encouraged
Criteria to Progress	<p>Normal AROM or flexion within 10 degrees of contralateral side</p> <p>Quad strength $\geq 60\%$ contralateral leg with isokinetic testing, or with relative 1RM testing on leg press</p> <p>Minimal effusion (Modified Stroke Test $\leq 1+$)</p> <p>No patellofemoral pain or complaints</p> <p>Normal Gait pattern and squat pattern, no shifting away from surgical side</p>

PHASE IV: MID PHASE POST-OP (6-12 WEEKS AFTER SURGERY)

Frequency: 2 days/week and supplement 1 day of home exercise program (supplied by PT)

Rehabilitation Goals	<p>Emphasize strength in various planes of motion for the lower extremity</p> <p>Continue with exercises noted from previous phases, including quad strength and motor control</p> <p>Administer initial KOS-SPORTS, TSK-11, ACL-RSI</p>
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<p>Intervention</p> <p>-include exercises from previous phases as needed</p>	<p>Mobility:</p> <ul style="list-style-type: none"> - Restore lower extremity muscle lengths <p>Strengthening:</p> <ul style="list-style-type: none"> - HS curls and deadlifts - 4-way SLR with resistance - Bridges (DL to SL progressions) - Calf raise (DL to SL progressions) - Side step/monster walk - Leg Press (Eccentric and/or SL) - Quad strengthening (OKC/CKC) (refer to MD script for OKC guidelines) <ul style="list-style-type: none"> - Leg extensions to tolerance - Wall sits - Squats - RFESS - Lunge progressions in multiple planes - Core strengthening: Planks, side planks, Bird Dogs, modified copenhagen's <p>Cardiovascular/Endurance Training:</p> <ul style="list-style-type: none"> - Treadmill walking (working up to 10-15 minutes at fast pace) - Cycling with resistance - Rowing <p>Stability:</p> <ul style="list-style-type: none"> - DL and SL, stable and unstable, some distraction (rebounder, body blade) <p>Functional training:</p> <ul style="list-style-type: none"> - DL hop, SL hop, jump landings, box drops <p>Modalities</p> <ul style="list-style-type: none"> - BFR with any exercise with 30:15:15:15 rep scheme, bilateral or unilateral cuff use encouraged
<p>Criteria to Progress</p>	<p>Minimal to no effusion (Modified Stroke Test ≤ trace)</p> <p>Normal ROM</p> <p>Strength ≥75% contralateral leg for quad and hamstring</p> <p>Fast walking 10-15 min without pain or increased effusion</p> <p>Functional Testing for Return to Running:</p> <p>Single Leg Squat Test >85-90% LSI, minimum of 10 repetitions each leg</p> <p>No Effusion</p> <p>ROM ≥ 95% (must have full active knee extension)</p> <p>10-15 minutes fast treadmill walking with normalized mechanics and no patellofemoral Sx</p>

	<p>Ability to single leg squat with proper mechanics</p> <p>≥ 70% quad/HS strength</p>
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PHASE V: LATE PHASE POST-OP (3-4 MONTHS AFTER SURGERY)

Frequency: 1-2 days/week and supplement 1 day of home exercise program (supplied by PT)

Rehabilitation Goals	<p>Normalize strength, enhance muscular power and endurance of the lower extremity</p> <p>1 RM on leg press >80% of uninvolved side</p> <p>Improve neuromuscular control of the lower extremity</p> <p>Emphasize functional strength and in various planes of motion</p> <p>Initiate running progression</p>
Interventions -include exercises from previous phases as needed	<p>Progress exercises from previous phases as appropriate</p> <p>Exercises should be between 60%(novice lifter) and 80%(experienced lifters) of 1-RM</p> <p>Athletes should be aiming for 2-3 training sessions per week</p> <p>Training volume should be between 2-4 sets per exercises</p> <p>Functional:</p> <ul style="list-style-type: none"> - Bilateral and unilateral squats - Lunge and hinge patterned movements <p>Strength:</p> <ul style="list-style-type: none"> - Hamstring curls and deadlifts - Bridges (progressions)/Hip thrusts - Calf raise (progressions) - Side step/monster walk - Leg Press (Eccentric and/or SL) - Quad strengthening (OKC, CKC) - Core strengthening: Planks, side planks, Bird Dogs <p>Power:</p> <ul style="list-style-type: none"> - Plyometric progressions Double -->Single leg <p>Running Progressions (in clinic or at home)</p>
Criteria to Progress	<p>KOS-Sports ≥80%</p> <p>Normal running technique/form</p> <p>Asymptomatic knee with running</p>

	<p>Perform 10 consecutive single leg squats with good form, while holding >75% weight the athlete is able to perform on uninjured leg</p> <p>>85% LSI on 1-RM leg press</p>
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PHASE VI: LATE PHASE POST-OP (4-6 MONTHS AFTER SURGERY)

Frequency: 1-2 day/week and supplement 2-3 day of home exercise program (supplied by PT)

Rehabilitation Goals	<p>Development of lower extremity muscular strength, power and endurance preparing for eventual return to functional and sport specific activities</p> <p>No compensations or side to side differences with high velocity multiplane testing</p> <p>Continued aerobic conditioning and core strength as needed for athletes</p>
Interventions	<p>Functional:</p> <ul style="list-style-type: none"> - Bilateral and unilateral squats - Lunge and hinge patterned movements <p>Strength:</p> <ul style="list-style-type: none"> - Hamstring curls and deadlifts - Leg Press (Eccentric and/or SL) - Quad strengthening (OKC/CKC) - Core strengthening: Planks, side planks, Bird Dogs - Hip thrusts - Hip strengthening with focus on preventing hip adduction with landing <p>Power:</p> <ul style="list-style-type: none"> - Plyometric progressions Double -->Single leg <p>Running Progressions (in clinic or at home)</p> <p>Agility:</p> <ul style="list-style-type: none"> - Ladder drills (single plane) - T-drills - Reaction Training
Criteria to Progress	<p>Side Plank Abduction Test >85-90% LSI, minimum 30 second hold</p> <p>Y-Excursion limb symmetry (90% or better)</p> <p>>80% LSI on 1-RM hamstring curl and leg extension</p> <p>>80% LSI on peak torque testing with isokinetic device or crane scale in clinic</p>

PHASE VII: SPORT PREPARATION PHASE POST-OP (6-9 MONTHS AFTER SURGERY)

Frequency: 1-2 days/week or every other week and supplement 2-3 day of home exercise program (supplied by PT)

Expectations for return to sport should be no sooner than 9 months post-operatively. These expectations will be based on an individual basis, though it is expected no sooner than 9 months for best long term outcomes.

<p>Rehabilitation Goals</p>	<p>Prepare the athlete or individual for functional demands of their respective sport in a graded fashion</p> <p>Continue with lower extremity muscular strength, power, and endurance training either in the clinic or with a home program/with personal trainer</p> <p>Continue with lower extremity neuromuscular control training</p> <p>Athletes will begin progression to return to sport during this phase. Athletes will start with non-contact, non-competitive drilling and progress to full return to sports after 9+ months of complete rehab</p>
<p>Interventions</p>	<p>Functional:</p> <ul style="list-style-type: none"> - Bilateral and unilateral squats - Lunge and hinge patterned movements - Stepping exercises <p>Strength:</p> <ul style="list-style-type: none"> - HS curls and deadlifts - Leg Press (Eccentric and/or SL) - Quad - Core strengthening: Planks, side planks, Bird Dogs - Hip thrusts - Hip strengthening with focus on preventing hip adduction with landing <p>Power:</p> <ul style="list-style-type: none"> - Plyometric progressions Double -->Single leg <p>Running Progressions (in clinic or at home)</p> <p>Agility:</p> <ul style="list-style-type: none"> - Cutting and pivoting - Ladder drills - T-drills - Reaction Training

Criteria to Progress	<p>Knee Outcome Survey > 90%</p> <ul style="list-style-type: none"> - Strength: 1RM testing on cybex knee ext, flex, and leg press calculate LSI. Need a minimum of 90% - Drop Jump Test - Fatigue testing: Drop Jump test after performing (1 min jumping jacks, 30 squat jumps, 1 min plank, 30 alt lunge jumps.) - Hop Testing: Single, Triple, Crossover, 6M Hop Tests (>90% LSI) - Using HHD or crane scale, determine peak torque (>90% LSI)
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Appendices:

Return to Running Progression (between 12-16 weeks if cleared)

Level	Treadmill	Track
1	0.1 mile walk : 0.1 mile jog, x 10	Jog straights/walks curves 2 miles
2	0.1 mile walk : 0.2 mile jog, for 2 miles	Jog straights/jog 1 curve every other lap for 2 miles
3	0.1 mile walk : 0.3 mile jog, for 2 miles	Jog straights/jog 1 curve every lap for 2 miles
4	0.1 mile walk : 0.4 mile jog, for 2 miles	Jog 1.75 laps/walk 1 curve for 2 miles
5	Jog full 2 miles	Jog all laps
6	Increase to 2.5 miles	Increase to 2.5 miles
7	Increase to 3 miles	Increase to 3 miles
8	Alternate between run and jog every 0.25 miles	Increase speed on straights/jog curves

Recommend the patient start jumping if they achieve (see attached screening tests): · 10-Rep Max on the Leg Press was $\geq 85\%$

- 10 consecutive Single Leg Squats to 60° without loss of balance or excessive motion outside of the sagittal plane while holding $\geq 85\%$ extra weight (dumbbells, weight vest, etc.)
- No compensation patterns with deceleration during agility drills performed at 100% effort

Recommend the patient begin hopping and cutting if they achieve (see attached screening tests):

- 10-Rep Max on the Leg Press was $\geq 90\%$
- 10 consecutive Single Leg Squats to 60° without loss of balance or excessive motion outside of the sagittal plane while holding $\geq 90\%$ extra weight (dumbbells, weight vest, etc.)
- No display of genu valgum when loading into or landing from jumps, and equal weight distribution when initiating and landing the jumps

Return to Sport Testing Instructions:

1. Single Leg Forward Hop:

Starting at a designated line, the patient will balance on one leg and hop forward as far as possible, landing on the same leg. The patient must maintain their balance. To pass, the involved leg must measure at least 90% of the distance compared to the uninvolved leg.

2. Single Leg Triple Hop

Starting at a designated line, the patient will balance on one leg and hop forward three times consecutively as far as possible, landing on the same leg. The patient must maintain their balance on the last hop. To pass, the involved leg must measure at least 90% of the distance compared to the uninvolved leg.

3. Single Leg Triple Crossover Hop

Starting at a designated line, the patient will balance on one leg and hop medially at a 45° angle as far as possible, immediately hop laterally at a 45° angle, and then immediately hop medially again at a 45° angle, landing on the same leg. The patient must maintain their balance on the last hop. To pass, the involved leg must measure at least 90% of the distance forward compared to the uninvolved leg

4. Timed 6-meter Single Leg Hop:

Starting at a designated line, the patient will balance on one leg and hop as fast as they can consecutively a distance of 6 meters. To pass, the involved leg must hop 6 meters in at least 90% of the time compared to the uninvolved leg. (6 meters = 19.7 feet)

5. Single Leg Medial Hop

Starting at a designated line, the patient will balance on one leg and hop medially as far as possible, landing on the same leg. The patient must maintain their balance. To pass, the involved leg must measure at least 90% of the distance compared to the uninvolved leg.

6. Single Leg Lateral Hop

Starting at a designated line, the patient will balance on one leg and hop laterally as far as possible, landing on the same leg. The patient must maintain their balance. To pass, the involved leg must measure at least 90% of the distance compared to the uninvolved leg.

7. Peak Torque at 60 degrees

The patient will sit at the end of the plinth or in the leg extension machine. With a crane scale anchored to the testing limb at 90 degrees to the tibia. Measure the distance from the inferior pole of the patella to the anchor on the lower portion of the lower limb. The patient is instructed to slowly kick out to a max effort. The isometric quadriceps contraction should be at 60 degrees of knee flexion. The testing therapist will record the max number recorded on the crane scale. That number is then converted to Newtons. Then multiply the length of the limb (in meters) by the force (in Newtons) and divide the patient's weight (in kg). This will give you the peak force in N*m/kg. Normative data should be above 3 N*m/kg and LSI should be >90%.

8. SL Squat Test

The patient sit on a chair or plinth with the test leg bent to 90 degrees, and 10cm from the edge of the chair. With hands folded across the chest, the patient aims to stand up from the sitting position, and sit down as many times as possible. (>22 repetitions per side and >90% LSI for passing grade)

9. Drop Jump Test

The patient starts on a 12" box, hands places on the hip. The patient then drops down off the box to the floor, bending both knees on landing, then immediately performs a max vertical jump. The patient should land on both feet in the same spot they took off from. This can be performed using a video capture app and timer or with timing mats if available. We are looking to calculate time in air as well as overall landing mechanics.

10. Fatigued Drop Jump Test

Prior to performing a second Drop Jump test as above. The patient will perform the following: 1 minute of jumping jacks, 30 BW squats, 1 min plank, and 30 alternating lunge jumps. The patient will not be given a rest break during those 4 exercises and will immediately perform another drop jump test. We are comparing time in air for both trial as well as overall movement quality of the two trials.

11. 10 Yard Pro-Agility Run

The patient will start straddling line A and will turn and sprint five yards to line B. Then the patient will sprint ten yards to line C. Finally, the patient will sprint five yards through line A. The patient must make sure to touch each line with his/her hand. The administrator will measure the time it takes to patient to complete the test. This test will be completed in reverse order (A to C to B to A) to make sure the patient is planting with both the involved and uninvolved foot. (Males \leq 4.5-5.5 seconds; Females \leq 5.5-6.5 seconds) See diagram.

Criteria to pass return to sport testing: All testing items on the involved side must be within 90% of the uninvolved to pass the test. Balance must be held for at least 2 seconds without any extra hops.

ACL SCORECARD

Patient Reported Outcomes	Passing Score	Patient Score
KOOS	>90%	
TSK-11	11-18	
ACL-RSI	>90%	

1RM Strength Testing	Left (lbs.)	Right (lbs.)	LSI (%)
Leg Press			
Cybex Knee Extension			
Cybex Knee Flexion			

SL Hop Testing	Left (cm)	Right (cm)	LSI (%)
Single			
Triple			
Crossover			
6 Meter Hop			
Single Leg Medial Hop			
Single Leg Lateral Hop			

Single Leg Tests	Left	Right	LSI (%)
Peak Torque at 60 degrees			
SL Squat Test (Reps)			

Other Test	Score
Drop Jump Test	
Fatigue Drop Jump Test	
10 Yard Pro Agility Run	