



Return-to-Sport ACL with Patellar Tendon Autograft Reconstruction Protocol

- Osseous healing of the bone-to-bone tunnel occurs at approximately 8 weeks Post-Op
- Graft revascularization 80%-90% at 6-8 weeks post-op- Clancy et al. JBJS 1981
- Flexion angles for exercises would be most comfortable to the patient between 45° and 60°
- Be aware of any forces that affect the patellar tendon. If patellofemoral type pain does arise, treat like Patellofemoral Pain Syndrome with modalities, taping techniques, myofascial release techniques, NMES for quad strength regeneration
 - o Also evaluated the entire kinetic chain, look for dysfunctional patterns along the chain, especially in the hip, ankles, SI, and Lumbar spine
 - Kinetic Chain Ripple Effect- everything is connected
 - o Functional movement is through all 3 planes, and there is a mobility and stability component at each joint and with each muscle for proper movement
 - **Example:** Gluteus Maximus, is classified as an extender of the hip, however, if you look at the alignment of the muscle fibers, it is just as much a hip abductor and external rotator. Which means it acts as a prime mover and a stabilizer at the same time. Moving in one, while stabilizing in the other two, depending on the position of the joint and the movement the athlete is performing
 - All muscles/movements have to be train for both strength and stability
 - You need to look at soft tissue: they are all connected fascially and interact for true functional movement
 - **Example:** SLR= Strain on multiple tissues, not just the hamstring
 - o ITB, ipsilateral lumbar fascia, Achilles tendon, contralateral lumbar fascia, and plantar fascia in descending percentages

* This protocol is a criterion-based protocol, with a goal of maximizing healing and strength recovery, while minimizing risk of re-injury, so the athlete can return, as quickly and safely as possible, to athletic activities at the pace that each individual progresses.

Immediately Post-Operative Phase: (Week 1, approx. days 1-7 post-operatively)

Goals of this phase are:

- Restore full passive knee extension, and gradually ↑ knee flexion to 90°
- Diminish joint swelling and pain
- Restore patellar mobility
- Re-establish quadriceps control- active quadriceps contraction with superior patellar glide
- Improve ambulation to FWB/ ↓ assistive device use

Treatments: Perform/increase number and duration of exercises as tolerated

- Gait Training:
 - o Patient is WBAT in full locked extension brace with bilateral crutches
- Exercises:
 - o Ankle Pumps to ↓ swelling/edema
 - o Ankle resistance band open chain exercises- all 4 directions
 - o Patellar mobilization in all directions
 - o Quadriceps isometric setting, with VMO self biofeedback
 - o Gluts sets
 - o Hamstring stretches for hamstring re-lengthening
 - o Straight Leg Raises (all 4 directions)

- Gastrocnemius/heel cord stretching for re-lengthening
- Active and Passive knee flexion exercises to tolerance, not pushed- (to 90° by days 5-7)
- Wall slides (supine with foot on wall/window) for increasing knee flexion, or seated AAROM
- Gentle overpressure into full extension (PT or pt. actively)
- Weight Bearing: weight shifts in full extension brace
- Standing Hamstring concentric & eccentric- 90°↔40°
- NMES:
 - Can and should be used, if contraction deficit is present, during active muscle exercises
- CP with full Extension, could also use Kinesio Tape (basket weave technique) or dry needling technique, to control swelling/edema
- Patient Education: What to expect, Goals of the phases, contraindicated movements/activities, etc.-
- **Continued throughout all phases of the protocol**
- Home Exercises Program- See attached HEP for Immediately Post-op Phase

Early Post-Operative Phase:

Criteria for entering this phase is:

- 1- Quadriceps voluntary initiation with quad set and SLR
- 2- Full passive knee extension, Knee A + PROM of 0°-90°
- 3- Good patellar mobility
- 4- Minimal joint effusion
- 5- Independent ambulation

Goals of this phase are:

- To maintain full passive and active knee extension
- To gradually increase knee flexion to 110°-120°
- To diminish swelling and pain
- Increase muscular training
- Restore proprioception
- Maintain patellar mobility
- Use a recumbent cycle without difficulty
- Perform a SLR with no extension lag
- Reciprocal stair climbing
- KOS-ADL Score of >65%

Treatment:

- Gait Training: WBAT, with a goal of discontinuing use of crutches by day 10-14 post-op- continue brace until voluntary quad control is demonstrated, ***May be subject to change by MD**
- Exercises: (**continue/progress all exercises from previous phase**)
 - Continue NMES with quadriceps exercises, if needed, & Quad Sets
 - SLR in all SLR in all 4 directions- progression with 1# weight/week (***Proximal loading**)
 - PROM 0° to 110°-120°, OKC –Knee Extension 90° to 40° eccentric
 - Mini Squats 0°-30° DL (BW only) Progress to unstable surface such as tilt board (Med./Lat. & Ant./Post.) or foam with 3-5 second holds ***Forward trunk tilt- recruit H/S & unload ACL**, Wall Squats/Sits to 45°-60°
 - Overpressure into Full Knee Extension, Prone Knee Hangs if lacking full extension
 - Hamstring Curls
 - Weight Shifts- Medial/Lateral & Diagonal Patterns, Balance Weight Shifting- progressing with balance board, BOSU
 - Forward & Lateral Mini Lunges (30°-40° of flexion)- **if patient has good quadriceps control**
 - Step-Ups in pain free range- Front & Lateral
 - Lateral Step Over: Cones, Hurdles- ***Instruct to raise knee to level of hip**
 - DL Leg Press- Sub Maximal
 - Stationary Bicycle (if ROM permits)

- Manual Treatments:
 - o Patellar Mobilization (if limited), Scar Mobs (when skin is healed), TFM/MFR to any tight tissues in the hip, back, and lower extremity
- Continue to control swelling: Ice, elevation if needed

Intermediate Post-Operative Phase:

Criteria for entering this phase:

- 1- P & AROM knee flexion to $\geq 110^\circ$
- 2- Quadriceps & Hamstring strength $\geq 60\%$ of the non-injured leg (Dynamometry)
- 3- Minimal to no effusion
- 4- No joint line or patellofemoral pain
- 5- Mild laxity on clinical examine, or +1 or less with the KT-2000 test (*if available)
 - a. Week 4 & 6: KT-2000 test at 20 & 30 lbs anterior and posterior

Goals of this phase are:

- Quadriceps strength to $\geq 75\%$ of the non-injured leg, H/S $\geq 75\%$ non-injured leg
- Restore knee ROM to 0° - 125° , or knee ROM to within 10° - 15° of non-injured leg
- Improve lower extremity strength
- Enhance proprioception, balance, and neuromuscular control
- Improve muscular endurance
- Restore limb confidence and function
- KOS-ADL score or $>75\%$
- Get an Post-Op score for IKDC or KOOS (age appropriate version)

Treatments:

- Gait Training: Unlocked brace, discontinued use if sufficient quad strength is present. Retrain with normal walking gait pattern
- Exercises: (**Continue/progress all exercises from previous phases as tolerance/as needed**)
 - o Knee concentric and eccentric $90^\circ \leftarrow \rightarrow 40^\circ$
 - o Front & Lateral step down exercises
 - o Standing heel raises (raising up onto toes)
 - o Progress lateral stepping exercise
 - o Squats with forward tilt to decrease ACL strain
 - o Perturbation training - DL \rightarrow SL Balance- Tilt Board (stabilized to level position), BOSU®, Airex®- progress with ball toss & catch/reaching (UE & LE), external tapping on hips and trunk- ***With knee slightly flexed**
 - o Pool exercises if available: forward & backward walk/run (***forward at week ≥ 6**), hip & leg exercises- at slow speeds of mvmt. (Graft protection)
 - o Begin testing/training for proprioception on the Biodex® Stability System (or other system)- ***if available, or:** Balance Error Scoring System Test, Functional Reach Test, Tandem Walking tests- See attached sheets
 - o Progress bike and walking- min of 10 minutes, increasing 10min/wk (walk)
 - o Stair-stepper machine for minimum of 10 minutes to increase endurance- ***if available**
 - o Core stabilization/strengthening- Bridging (Progress with ball squeeze \rightarrow unstable surface \rightarrow hamstring curl with physioball)
- Manual Treatments:
 - o Continue patellar and scar mobilization if needed
 - o Tibiofemoral mobilization with rotation for ROM if joint mobility is limited

Late Post-Operative Phase:

Criteria for entering this phase:

- 1- Active knee ROM 0° - $\geq 125^\circ$

- 2- Quadriceps Strength & Girth $\geq 75\%$ of non-injured leg (dynamometry & tape measure), Hamstring Strength $\geq 75\%$ of non-injured leg (dynamometry)

Goals for this phase:

- Restore full knee ROM
- Continue to improve lower extremity strength, balance, proprioception, neuromuscular control, muscular endurance
- Knee effusion to trace or less
- Quadriceps strength to $>80\%$, Hamstring Strength $>80\%$ of the non-injured leg
- Normal gait pattern
- Minimal laxity on clinical exam, or 2mm or less on the KT-2000 test
- Get a baseline FMS[®] and Y-Balance[™] score at ≥ 8 weeks post-op- when appropriate- Begin with the SFMA (no pain with the assessment) will determine readiness for FMS[®] and Y-Balance[™] Test
- Patient is tested with the Landing Error Scoring System (LESS): **See Attached Sheets: - Test at Patient's individual max vertical jump height, not standard measure on the LESS- may be too high or too low for accurate individual jump assessment score, no sooner than 10 weeks post-op**
 - o Excellent Score is ≤ 4
 - o Good Score is >4 and ≤ 5
 - o Moderate Score is >5 and ≤ 6
 - o Poor Score is >6
- Perform hop testing at no sooner than 10 weeks post-op: See Attached Sheets
 - o 2 practice trials on each leg, then 2 timed or measured trials on each leg; measure and average to compare injured to non-injured legs
 - o 1- Single-leg hop for distance
 - o 2- Triple hop for distance
 - o 3- Single-Leg Crossover triple hop
 - o 4- 6-Metered timed hop

Treatment:

- Exercises: (**Continue/progress all exercises from previous phases as tolerance/as needed**)
 - o Progress exercises in intensity and duration
 - o Perturbation training continues
 - o Dynamic/Plyometric Leg Press (Begin at ≥ 10 Weeks- To learn technique and control ground reaction forces, "land softly on toes with knees slightly flexed" for dissipation of force and to avoid hyperextension)
 - o Progress lateral stepping and lateral step-down exercises with resistance bands on the distal femur creating a medial pull (bilateral with stepping, SL with lateral step-down)
 - o Advance core stabilization exercises
 - o Isokinetic exercises at (90° - 40°) ($120^\circ/s$ - $240^\circ/s$)
 - o Begin training on Athletic Dynamic Stretching Program- **See Sheets**

Advanced Activity Phase:

Criteria for entering this Phase:

- 1- Full knee AROM, with No pain or effusion
- 2- Quadriceps Strength & Girth $>80\%$ of the non-injured leg, knee flexor-extensor ratio of 70% to 75%, Hamstring Strength $>80\%$ of the non-injured leg
- 3- No laxity/instability on clinical exam, or KT-2000 test of 2mm or less compared to the non-injured side
- 4- Hop Tests (80% of non-injured leg), LSI-Limb Symmetry Index of $\geq 80\%$
- 5- IKDC (use for concomitant injuries)- score of 80% or higher, or the KOOS (use with ACL alone) score of ≥ 80
- 6- Score of \geq "Good " on the LESS to be able to begin Plyometric Training Protocol

Goals for this phase:

- Normalize lower extremity strength

- Increase muscle power and endurance
- Maintain/Gain Hamstring & Quadriceps Strength and Girth of 80% or greater
- Hop Tests to > 90% of the non-injured leg
- Continue to improve neuromuscular control
- Begin selected skill drills
- KOS-sports score of > 70%
- FMS® (goal of $\geq 14/21$ points with no 0/3, 1/3, or asymmetries) and Y-Balance™ score (goal statistically symmetrical to non-injured leg)
- Subjective Knee score (Cincinnati Knee Rating System) of 80 points or higher

Treatments:

- Exercises: (**Continue/progress all exercises from previous phases as tol./need.**)
- o Agility exercises- side shuffling, cariocas, zigzags
- o Advanced core & hip stabilization exercises
- o Begin walk→run protocol, toward the end of phase, when patient is able to perform a controlled single leg squat (injured leg) to 60° of knee flexion- **see attached sheets**
- o Begin Plyometric Training Protocol- when appropriate according to LESS, Hop Tests, and no increase in patient's symptoms- **See attached sheets**
- o Isokinetic exercises (180°/s), if available
- o CKC exercises may be progressed to 75°-90° of flexion
- o Eccentric exercises for all lower extremity muscles
- o Continue Athletic Dynamic Stretching Program- **See Sheets**

Functional Assessments:

- FMS® and Y-Balance Assessment™ **at beginning and end of this phase**
- Repeat the 4 Hop Tests from the previous Phase **at beginning and end of phase**

Core Testing:

- Segmental Multifidus Test
- Trunk Curl Up Test
- Double-Leg Lowering Test
- Side Bridge Test
- Prone Bridge Test
- Supine Single-Leg Bridge Test
- Extensor Endurance Test

Return to Activity Phase:

Criteria for entering this Phase:

- 1- Full ROM
- 2- A score of $\geq 14/21$ on the FMS® Assessment Screen, with **No** 0/3= pain on any of the 7 fundamental movement patterns
- 3- **No statistical asymmetries** and on the Y-Balance Assessment™
- 4- Hop Tests (90% or higher compared to non-injured leg)
- 5- Limb Symmetry Index (LSI) of 90% or greater on hop tests
- 6- IKDC Score $\geq 85\%$, or the KOOS score of ≥ 85
- 7- KOS-Sports Score 90% or greater
- 8- Cincinnati Knee Rating System score of 290 points or higher
- 9- No change in knee laxity (clinical exam or ≤ 2 mm on KT 2000 test)
- 10- Isokinetic testing: (if available)
 - i. Quadriceps (80% or greater) compared to non-injured leg
 - ii. Hamstring (100%-110%) compared to non-injured leg
 - iii. Hamstring-Quadriceps Ratio (70% or greater)

Goals of this Phase:

- Achieve maximal strength and endurance
- Normalize neuromuscular control
- Progress to skill training
- Gradually return to sport specific training

Treatments:

Exercises:

- Continue strengthening exercises
- Continue/Advance core training exercises
- Continue Neuromuscular control exercises
- Begin Sport Specific Dynamic Stretching program- **See Sheets**
- Continue plyometric exercises
- Progress running program
- Begin agility and skill training exercises:
 - o Continue cariocas, zigzags, side-shuffling
 - o Begin sudden start and stops, figure-8's, 45° and 90° cutting drills, box jumps (progressing & varying heights up to 20cm)

Functional Assessment:

- FMS® and Y-Balance Assessment™ **at the end of this phase**
- Repeat the 4 Hop Tests from the previous Phase, Plus Hop to Stop Test at the end of this phase

Functional Testing: for progression to sport-specific training- (No sooner than 24-36 Weeks) -*Can be perform over multiple days- See Attached Sheets

Strength and Power Testing:

- Single-Leg Squat Test/ Single-Leg Squat Test
- Vertical Jump Test
- Figure-8 Hop Test
- Up-Down Test
- Hexagon Test (DL), Modified Hexagon Hop Test (SL)

Speed, Agility, and Quickness Testing:

- T-Test, or Modified Agility T-Test (MAT)
- Three-Cone Drill Test
- Slalom Test
- Backward Movement Agility Test
- Zigzag Run Test
- Lower Extremity Functional Test (LEFT)

Core Testing:

- Segmental Multifidus Test
- Trunk Curl Up Test
- Double-Leg Lowering Test
- Side Bridge Test
- Prone Bridge Test
- Supine Single-Leg Bridge Test
- Extensor Endurance Test

Function and Balance Testing:

- FMS® Assessment Screen
- Y-Balance Assessment™
- Vail Sport Test™

***Return-to-Sport Protocol- See Specific Sport Return-to-Sport Protocols**

Criteria for Return-to-Sport Specific Protocols:

- A score of $\geq 16/21$ on the FMS[®] Assessment Screen, with no pain or asymmetries, especially with Inline-lunge, and 2 or greater on all 7 fundamental movement patterns
- Y-Balance Test[™]- No asymmetries and passing score when compared to peers with data analysis through the Move2Perform software= a composite score as close to 100 as possible
- Limb Symmetry Index (LSI) of $\geq 95\%$ on hop tests
- LEFT Score: ≤ 117 seconds (females), ≥ 105 seconds (males)
- Vail Sport Test[™]: $\geq 46/54$ points
- Isokinetic testing: (if available)
 - o Quadriceps (90% or greater) compared to non-injured leg
 - o Hamstring (100%-110%) compared to non-injured leg
 - o Hamstring-Quadriceps Ratio (80% or greater)
- IKDC score of $\geq 85\%$, or KOOS score of ≥ 90
- Knee Outcome Survey-Sports Activities Scale (KOS-SAS): $\geq 95\%$
- Cincinnati Knee Rating System: Score ≥ 350
- SL Hop tests $\geq 100\%$ compared to non-injured leg
- No discomfort or swelling, and passing/statistically equal to normative values (if available) with above Functional Tests

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