



ORTHOPEDIC
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Return-to-Sport ACL with Hamstring Tendon Autograft or Allograft Techniques Reconstruction Protocol

- Healing time for the autograft hamstring (tendon-to-bone) is approximately 8-12 weeks
 - *** No resistive Hamstring strengthening until weeks 6-8 to allow for graft site healing**
- Revascularization of graft occurs at 8-12 weeks post-op- Rodeo et al. JBJS 1993
- Allograft: Initial rehabilitation protocol should follow the same criteria and goals, however, progression to activities such as running, jumping (plyometrics), and cutting may be delayed depending on how the patient presents with recovery and healing.
 - Delayed as much as 4-6 months, depending on the fixation on the soft tissue in the bone tunnels and individual patient healing time.
- *** Not a good candidate for an accelerated Rehabilitation Protocol or early running, jumping, cutting, etc. (2° to slower soft tissue->bone healing)**
- Be aware of patellofemoral type pain, if it does arise, treat it like Patellofemoral Pain Syndrome with modalities, taping techniques, myofascial release techniques, NMES for quad strength regeneration
 - 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
 - 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**, classified as an extender of the hip, look at the alignment of the muscle fibers, just as much a hip abductor and external rotator. 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: connected fascially and interact for true functional movement
 - **Example: SLR=** Strain on multiple tissues, not just the hamstring
 - 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:
 - Patient is WBAT in full locked extension brace with bilateral crutches
- Exercises:
 - Ankle Pumps to ↓ swelling/edema

- Ankle resistance band open chain exercises- all 4 directions
 - Patellar mobilization in all directions
 - Quadriceps isometric setting, with VMO self biofeedback
 - Straight Leg Raises (flexion, abduction, adduction)
 - 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 for increasing knee flexion
 - Gentle overpressure into full extension (PT passively or patient actively)
 - Weight Bearing: weight shifts in full extension brace
- NMES:
 - Can and should be used, if contraction deficit is present, during active muscle exercises
 - CP with full Extension, could also use Kinesiotape (basket weave technique) or dry needling technique, to control swelling/edema
 - Home Exercises Program- See attached HEP for Immediately Post-op Phase

Early Post-Operative Phase: (approx. Weeks 2-3)

Criteria for entering this phase is:

- 1- Quadriceps control with a proper quad set and SLR
- 2- Full passive knee extension
- 3- Knee A + PROM of 0°-90°
- 4- Good patellar mobility
- 5- Minimal joint effusion
- 6- 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
 - Continue Quad Sets
 - SLR in all 4 directions- progression with 1# weight in flexion, abduction, adduction only- (***Proximal loading**)
 - OKC –Knee Extension 90° to 40°
 - Overpressure into Full Knee Extension, Prone Knee Hangs if lacking full extension
 - PROM 0° to 110°-120°
 - Weight Shifts- Medial/Lateral & Diagonal Patterns, Balance Weight Shifting- progressing with balance board, BOSU®
 - 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:
 - Patellar Mobilization (If flexion is limited), Scar Mobs, (If skin is healed)
- Continue to control swelling: Ice, elevation if needed

Intermediate Post-Operative Phase: (approx. Weeks 4-6)

Criteria for entering this phase:

- 1- P & AROM knee flexion to $\geq 110^\circ$
- 2- Quadriceps strength $\geq 60\%$ of 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 at least 75% of the 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**)
 - Knee concentric & eccentric $90^\circ \leftrightarrow 40^\circ$ (no weights) at 4 weeks, isometrics can be begun at 5-6 weeks post-op
 - Front step downs
 - Toe calf raises
 - Progress lateral stepping exercise
 - Lateral step-downs exercise
 - Forward and Lateral Lunge
 - Wall Slides 0° - 30°
 - 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**
 - Patient can begin Pool exercises if available: forward & backward walk/run (***begin forward at week 6**), hip and leg exercises
 - 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
 - Progress bike to minimum of 10 minutes for increasing endurance
 - Core stabilization/strengthening- Bridging (Progress with ball squeeze \rightarrow unstable surface)
- Manual Treatments:
 - Continue patellar and scar mobilization if needed
 - Tibiofemoral mobilization with rotation for ROM if joint mobility is limited.

Late Post-Operative Phase: (approx. 7-11 Weeks)

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)

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 $\geq 90\%$ 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 SFMA Assessment at 8 weeks post-op

Treatment:

- Exercises: **(Continue/progress all exercises from previous phases as tolerance/as needed)**
 - Progress exercises in intensity and duration
 - Light isotonic hamstring exercises begun 6-8 weeks post-op
 - Perturbation training continues
 - 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**, Progress to 45° - 60°
 - Dynamic/Plyometric Leg Press (Begin at 8 Weeks or later- To learn technique and control ground reaction forces, "land softly on toes with knees slightly flexed" for dissipation of force and to avoid hyperextension)
 - 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)
 - Advance core stabilization exercises- SL, Bosu[®], Airex[®], external perturbation, Dynamic/rhythmic stabilization exercises, combination of UE and LE with unstable surface and external perturbations, etc.
 - Isokinetic exercises at (90° - 40°) ($120^{\circ}/s$ - $240^{\circ}/s$), if available
 - Walking program- 10 minutes minimum, increasing by 10 minutes per week

Advanced Activity Phase: (approx. 12-16 Weeks)

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%
- 3- No laxity/instability on clinical exam, or KT-2000 test of 2mm or less compared to the non-injured side
- 4- IKDC (use for concomitant injuries)- score of 80% or higher, or the KOOS (use with ACL alone) score of ≥ 80
- 5- Score of "Good " on the LESS to be able to begin Plyometric Training Protocol

Goals for this phase:

- Normalize lower extremity strength, and increase muscle power and endurance
- Maintain/Gain Quadriceps Strength and Girth of 80% or greater
- Continue to improve neuromuscular control
- KOS-sports score of $> 70\%$
- Patient is tested with the Landing Error Scoring System (LESS): **See Attached Sheets:**
 - Excellent Score is ≤ 4
 - Good Score is >4 and ≤ 5
 - Moderate Score is >5 and ≤ 6
 - Poor Score is >6
- Get a baseline FMS and Y-Balance Assessment score at 12 weeks Post-op
- FMS (goal of $\geq 14/21$ points) and Y-Balance score (statistically symmetrical to non-injured leg & within 80% of peers through software program)

- Perform hop testing at **12-14** weeks post-op: **See Attached Sheets**
 - 2 practice trials, 2 timed/measured trials; average injured to non-injured
 - 1- Single-leg hop for distance
 - 2- Triple hop for distance
 - 3- Single-Leg Crossover triple hop
 - 4- 6-Metered timed hop

Treatments:

- Exercises: (**Continue/progress all exercises from previous phases as tol./need.**)
 - Advanced core & hip stabilization exercises
 - Begin Plyometric Training Protocol at 12-14 weeks * **If LSI \geq 90% of uninjured leg, with hop tests-** May be delayed longer if allograft reconstruction- patient healing and graft fixation dependant
 - Isokinetic exercises (180°/s), if available
 - CKC exercises may be progressed to 75°-90° of flexion
 - Eccentric exercises for all lower extremity muscles

Functional Assessments:

- FMS and Y-Balance Assessments **at 12 and 16 weeks Post-Op**
- 4 Hop Tests **at 12 and 16 weeks Post-Op**

Core Testing: - **At 12 Weeks Post-op, re-assess any deficits at week 16 Post-op**

- 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: (Approx. 16-24 Weeks)

Criteria for entering this Phase:

- 1- Full ROM
- 2- A score of $\geq 14/21$ on the FMS Assessment Screen
- 3- No statistical asymmetries and 90% of standards of peers 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 (85%-100%) compared to non-injured leg
 - iii. Hamstring-Quadriceps Ratio (70% or greater)

Goals for 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
- Continue plyometric exercises
- Begin walk→run protocol- See attached sheets with progression
- Begin agility and skill training exercises:
 - Agility exercises- side shuffling, cariocas, zigzags- *** If cleared by MD**
 - Begin sudden start and stops, figure-8's, 45° and 90° cutting drills, box jumps (progressing & varying heights up to 20cm)- *** If cleared by MD**

Functional Assessment:

- Repeat 4 previous hop test and add Hop-to-Stop test- **at 22-24 weeks Post-Op**
- FMS and Y-Balance Assessments **at 22-24 Weeks Post-Op**

Functional Testing: for progression to sport-specific training- (at 24-36 Weeks) -*Can be perform over multiple days- See Attached Sheets

Strength and Power Testing:

- Repeat all 5 previous Hop tests
- 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
- Three-Cone Drill Test
- Slalom Test
- Backward Movement Agility Test
- Zigzag Run Test

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 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
- Y-Balance Test- No asymmetries and statistically equal (100%) to peers with data analysis through the software
- Limb Symmetry Index (LSI) Of $\geq 95\%$ on hop tests
- Isokinetic testing: (if available)

- Quadriceps (90% or greater) compared to non-injured leg
 - Hamstring (100%-110%) compared to non-injured leg
 - 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