



Orthopedic Associates of Hartford Pre-Operative ACL Repair Protocol

Pre-Operative Phases: (2 phases approx. 5-7 weeks of at least 10-15 sessions)

General Goals for both phases 1 and 2 are:

- Diminish inflammation, swelling, and pain
- Restore normal ROM, especially knee extension
- Restore voluntary muscle activation, especially quadriceps
- Improve Neuromuscular control including perturbation training
- Restore normal walking gait pattern

Phase One: Initial Phase-

- **Goal:**

- o Patients to fill out an the International Knee Documentation Committee Subjective Form (IKDC) or the Knee Injury and Osteoarthritis Outcome Score Form (KOOS)- age appropriate version, and the Knee Outcome Survey Activities of Daily Living Scale (KOS-ADL), and Lower Extremity Functional Scale (LEFS)
- o Resolve edema and/or ROM deficits-
 - As soon as this is accomplished patient can begin phase two.

Phase Two: Progressive Phase-

- **Goal:**

- o To restore adequate muscle strength and neuromuscular responses

- **Exercises:**

- o Warm-up on stationary bicycle, or treadmill- at least 10 minutes
- o Single-leg Squat- Maintaining knee-over-toe position- 8 reps, up to 3 sets
 - (ROM 0°- 45° to start)
- o Step-up- Maintaining knee-over-toe position- 10 repetitions, up to 2 sets
 - Starting with 4 inch/ 10cm step
- o Squats on BOSU®- Maintaining knee alignment and core stability- 20 repetitions, one to 2 sets
- o Single-Limb Leg Press- 90° of knee flexion- 6 repetitions, up to 3 sets
- o Single-Limb Knee Extension- 90° of knee flexion 6 repetitions, up to 6 sets, starting with number of tolerated sets
- o Squats- Squat slowly down to 90° of knee flexion, stop, lift quickly up again- 8 repetitions, up to 3 sets
- o Leg Curl- Lift quickly up, stop, and slowly lower down into full extension- 8 repetitions, up 3 sets
- o Bridges with Hamstring Curl (DL->progress to SL)- leg(s) on ball, Lift lower back and pelvis up, roll the ball towards you then away, and repeat. 6 repetitions up to 3 sets
- o Single-Leg Hop- hop forward and stop with controlled landing up to 15 repetitions (Alternating LE's, with 30 second rests between repetitions)
- o Sideways Single-Leg Hop- hop side-to-side quickly 3 times then stop. Perform 5 repetitions. (Alternating LE's, with 30 second rests between repetitions)- Focus on soft landing and proper knee position
- o Perturbation Training
- o * **Patients should follow +2 principle of if the patient can perform an additional 2 repetitions of an exercise, with good form, they can progress the load the next session**

- **Patient Education:**

- o Post-op Rehabilitation Program (end of Pre-Op Rehabilitation sessions)

Orthopedic Associates of Hartford

Return-to-Sport after ACL Reconstruction Protocol

* This protocol is a time and 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 is specific for each individual.

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

Physical Therapy Interventions: Perform/increase number and duration of exercises as tolerated

- **Gait Training:**
 - Patient is WBAT in full locked extension brace with bilateral crutches, patient is provided instruction, demonstration and given verbal and tactile cues as appropriate to ensure the crutches are safe and are of the correct height for the shoulder and hand grips
- **Exercises:**
 - Ankle Pumps to ↓ swelling/edema
 - Ankle resistance band open chain exercises- all 4 directions
 - Patellar mobilization in all directions
 - Quadriceps and Gluteal Isometric Setting
 - Hamstring Stretches- hamstring re-lengthening- **Gentle if H/S graft used**
 - Straight Leg Raises (flexion, abduction, adduction)
 - Gastrocnemius Stretching + Manual Release for re-lengthening + Knee /
 - Active and Passive Knee Flexion exercises to tolerance, **not pushed**- (to 90° by days 5-7)
 - Wall Heel 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° (no weight)
 - **NMES:** Russian E-stim 2,500Hz with other appropriate settings):
 - Can and should be used, especially if contraction deficit is present, during active muscle exercises to enhance muscle contraction
 - CP with full Extension, +/- Kinesiology Tape (basket-weave technique), dry needling technique, (control swelling/edema)
 - **Home Exercises Program**- See 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
- 3- Knee A + PROM of 0°-90°, with 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 semi-recumbent cycle or NUSTEP without difficulty
- Perform a SLR with no extension lag
- Reciprocal stair climbing
- KOS-ADL Score of >65%

Physical Therapy Interventions:

- **Gait Training:** WBAT, with a goal of discontinuing use of crutches by day 8-14 post-op- continue locked brace until voluntary quad control is demonstrated, ***May be subject to change by MD**
- **Exercises: (continue/progress all exercises from previous phase)**
 - o Continue NMES with quadriceps exercises, if needed
 - ~ 4 weeks: Quadriceps isometrics multiple angles (90°, 70°, 50°)
 - o SLR in all 4 planes- Hip Abd performed with ~10°-15° of Hip Extension, possible progression- 1# weight (***Proximal loading above knee joint**)
 - o ~ 4 weeks: OKC –Knee Extension 90° to 40°, with or without NMES
 - o 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 to 40°
 - o Overpressure into Full Knee Extension, Prone Knee Hangs if it is lacking
 - o Hamstring Curls (* Only for B-T-B Graft)- ~8 weeks for H/S Graft
 - o PROM 0° to 110°-120°
 - o Weight Shifts- Medial/Lateral & Diagonal Patterns, Balance Weight Shifting- balance board, BOSU
 - o Forward & Lateral Mini Lunges (30°-40° of flexion)- **if patient has good quadriceps control**
 - o Step-Ups (pain free range)- Front & Lateral- *** Low Step initially**
 - o Lateral Step Over: Cones, Hurdles- ***Instruct to raise knee to level of hip**
 - o DL Leg Press- ***Sub-Maximal**
 - o Stationary cycle (if ROM permits)/ rocking on LE cycle (**not forced**)
- **Manual Treatments:**
 - o Patellar Mobilization (If flexion is limited), Scar Mobs, (If skin is healed)
 - o 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 to >60% of non-injured leg (dynamometry)
- 3- Minimal to no effusion
- 4- No joint line or patellofemoral pain
- 5- Mild laxity on clinical examination, or +1 mm or less with the KT-2000 test
 - 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)

Physical Therapy Interventions:

- **Gait Training:** Unlocked brace, discontinued use if sufficient quad strength is present. Retrain with normal walking gait pattern
- **Exercises: (Continue/progress all from previous phases as tol./as needed)**

- OKC Knee extensions: 90°-40°
- Front & Lateral step down exercise
- Heel Raises (raising up onto toes)
- Progress lateral stepping exercise
- Mini Squats with forward trunk tilt (to decrease ACL strain + recruit H/S)- in Patient's ROM and Tolerance, not lower than 40°-50° of knee flexion
- Perturbation Training – DL-> progress to →SL Balance when appropriate- Can also use uneven surfaces and external perturbations to progress (DL & SL)- Tilt Board (stabilized to level position initially), BOSU®, Airex®- progress with ball toss & catch/reaching (UE & LE), external tapping on hips and trunk on any surface- ***With knee slightly flexed**
- Eccentric Exercises: (for H/S & Quad)- Decline Squat, DL+SL Squat, etc.
- Pool Exercises if available: forward & backward walk/run (***forward at week ≥6**), hip & leg exercises- **slow speeds of mvmt. (Graft protection)**
- Begin testing/training for proprioception on the Biodex® Stability System (or other system)- ***if available**, or: BESS Test, Functional Reach Test, Tandem Walking tests- **See attached sheets**
- Progress Stationary Cycle and Walking- min of 10 minutes, increasing 10min/wk (walk)
- Core Stabilization/Strengthening- Bridging (Progress with Band: Abd→ unstable surface→ hamstring curl w/ball), SL Bridge (knee /, Valslide®)
- **Manual Treatments:**
 - Continue patellar and scar mobilization if needed
 - Tibiofemoral mobilization with rotation for ROM if needed

Late Post-Operative Phase:

Criteria for entering this phase:

- 1- Active knee ROM 0°- ≥125°
- 2- Quadriceps Strength & Girth ≥75% of non-injured leg (dynamometry & tape measure), Hamstring Strength ≥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- can proceed to other tests)
- 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**
 - Excellent Score is </= 4
 - Good Score is >4 and </=5
 - Moderate Score is >5 and </=6
 - Poor Score is >6
- Perform hop testing at no sooner than 10 weeks post-op: See Attached Sheets
 - 2 practice trials on each leg, then 2 timed or measured trials an each leg; measure and average to compare injured to non-injured legs
 - 1- Single-leg hop for distance
 - 2- Triple hop for distance
 - 3- Single-Leg Crossover triple hop
 - 4- 6-Metered timed hop

Physical Therapy Interventions:

- **Exercises: (Continue/progress all exercises from previous phases as tolerance/as needed)**
 - o Progress exercises in intensity & duration, Advance core stab. exercises
 - o Continue Perturbation Training- Internal & External Cues
 - o Dynamic/Plyometric Leg Press (Begin no sooner than 8 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 Begin walk→run protocol, toward the end of phase, when patient is able to perform a controlled single leg squat (injured and non-injured legs) to 60° of knee flexion- **see attached protocol**
 - o Continue Eccentric Training: (See sheet)

Early Activity Phase:

Criteria for entering this Phase:

- 1- Full knee AROM
- 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 (Dynamometer)
- 3- No pain or effusion
- 4- No laxity/instability on clinical exam, or KT-2000 test of 2mm or less compared to the non-injured side
- 5- Hop Tests (80% of non-injured leg)
- 6- IKDC (use for concomitant injuries)- score of 80% or higher, or the KOOS (use with ACL alone) score of ≥80

Goals for this phase:

- Normalize lower extremity strength (<15% difference Left to Right)
- Increase muscle power and endurance, & begin selected skill drills
- Maintain/Gain Hamstring & Quadriceps Strength and Girth of 80% or greater
- Hop Tests to > 85% of the non-injured leg
- Continue to improve neuromuscular control
- KOS-sports score of > 70%
- A score of ≥14/21 on the FMS® Assessment Screen, with No 0/3= pain on any of the 7 fundamental movement patterns
- No statistical asymmetries and on the Y-Balance Assessment™
- Subjective Knee score (Cincinnati Knee Rating System) of 80 points of higher

Physical Therapy Interventions:

- **Exercises: (Continue/progress exercises from previous phases as tol./need.)**
 - o Agility exercises- side shuffling, cariocas, zigzags- **when appropriate and cleared by MD**
 - o Advanced Core & Hip Stab. exercises: Resisted Clam, Quadruped Reach w/Resistance, Lateral Squat Stepping, Side+ Prone Planks w/LE Lift, etc.
 - o Continue/Progress Walk-to-Run Protocol
 - o Begin Plyometric Training Protocol- when appropriate- landing screening, Hop Tests, and no increase in pt’s symptoms- **See attached sheets**
 - o CKC exercises may be progressed to 75°-90° of flexion
 - o Continue Eccentric exercises: For all LE muscles-ex. Step-Down exercises

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 or this Phase:

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

Physical Therapy Interventions:

- Exercises:

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

Functional Assessment:

- Repeat 4 previous hop tests, plus Hop-to-Stop test- at the end of this phase
- FMS® and Y-Balance Assessment™ **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

*** Use Real Time and SLO-MO video for Scoring and Movement Analysis**

Strength and Power Testing:

- Single-Leg Squat Test/ Alternate Single-Leg Squat Test- **(Not needed if Vail Sport Test™ is used)- See Function and Balance Testing**
- Vertical Jump Test
- Figure-8 Hop Test
- Step Down 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 Test[™]
- 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 a composite score as close to 100 as possible (minimum of $\geq 95\%$)
- 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 $\geq 95\%$ 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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