KNEE ANTERIOR CRUCIATE LIGAMENT (ACL) RECONSTRUCTION
POST-OPERATIVE GUIDELINES

The following anterior cruciate ligament (ACL) reconstruction guidelines were developed by the HSS Rehabilitation. Progression is both criteria-based and patient specific. Phases and time frames are designed to give the clinician a general sense of progression. Progression through the phases may vary in individuals with concomitant injuries/procedures such as graft choice, donor site, chondral injury, meniscal injury, and ligament injury.

Specific modifications related to each graft type will be addressed in each phase.

FOLLOW SURGEON MODIFICATIONS AS PRESCRIBED.
KNEE ACL RECONSTRUCTION POST-OPERATIVE GUIDELINES

Pre-Operative Phase

PRECAUTIONS
- Avoid pain with ROM and strengthening exercises
- Modify or minimize activities that increase pain and/or swelling
- Use appropriate assistive device as needed

ASSESSMENT
- Lower Extremity Functional Scale (LEFS)
- International Knee Documentation Committee (IKDC)
- Single Assessment Numeric Evaluation (SANE)
- Anterior Cruciate Ligament Return to Sport after Injury (ACL RSI)
- Numeric pain rating scale (NPRS)
- Edema/effusion
- Girth measurement of thigh and joint line
- Lower extremity (LE) active range of motion (AROM) and passive range of motion (PROM)
- LE flexibility
- Quality of quadriceps contraction
- LE handheld dynamometry
- Functional assessment
  - Gait, sit to stand, single limb stance (SLS), if appropriate

TREATMENT RECOMMENDATIONS
- Patient education
  - Pre-operative care
    - Edema/effusion reduction (including elasticized wrap/tubing)
    - Activity modification
  - Basic home exercise program (HEP)
  - Post-operative plan of care
    - Gait training with expected post-operative assistive device
    - Education on weight bearing, edema control, what to expect day of surgery
- LE flexibility exercises (e.g., supine calf and hamstring stretches)
- Range of motion
  - Knee flexion active assisted range of motion (AAROM)
  - Passive knee extension with towel roll under heel
• Core strengthening
• LE strengthening exercises
  o Ankle pumps, quadriceps sets, gluteal sets
  o Straight leg raises (SLR) in multiple planes, advance ankle weight as appropriate)
• Balance/proprrioceptive training
• Stationary bicycle: initially focus on ROM and progress to cardiovascular conditioning/leg strength

GOALS FOR PRE-OPERATIVE PHASE
• Able to verbalize/demonstrate post-operative plan of care
• Minimal to no swelling
• Knee PROM: full extension to 120° degrees flexion
• Active quadriceps contraction with superior patella glide
• Demonstrates normal gait
• Able to ascend stairs

EMPHASIZE
• Familiarization with post-operative plan of care
• Control swelling
• Knee ROM with focus on extension unless mechanically blocked
• Quadriceps contraction
KNEE ACL RECONSTRUCTION POST-OPERATIVE GUIDELINES
Acute Care (Ambulatory Surgery): Day of Surgery

PRECAUTIONS
- Avoid excessive loading (standing, walking), prolonged sitting
- Avoid weight bearing without brace and crutches
  - Adhere to instructed weight bearing progression, avoid advancing weight bearing (WB) too quickly which may prolong recovery
  - Avoid painful activities, including walking and exercising
- Avoid putting heat on knee
- Do not place a pillow under the operated knee

ASSESSMENT
- NPRS
- Mental status: Alert and Oriented x3
- Wound status
- Edema/effusion
- Post-anesthesia sensory motor screening
- PROM/AAROM of knee
- Functional status including ability to manage brace

TREATMENT RECOMMENDATIONS
- Patient education:
  - Edema management
  - Activity modification
  - Brace management
    - Sleeping- keep brace on and locked in extension and elevated until surgeon directs otherwise
    - Day time usage as per surgeon recommendation
  - Initiate and emphasize importance of HEP
- Transfer training
- Gait training per weight bearing status
- Range of motion
  - Seated knee AAROM flexion
  - Passive knee extension with towel roll under heel
- Quadriceps sets, gluteal sets, ankle pumps
- SLR with brace locked in extension, if able
CRITERIA FOR DISCHARGE
- Independent brace management
- Independent with transfers
- Independent ambulation with appropriate assistive device on level surfaces and stairs
- Independent with HEP

EMPHASIZE
- Independent transfers
- Gait training with appropriate assistive device
- Edema/effusion reduction (including elasticized wrap/tubing)
- PROM/AAROM (focus on extension)
- Quadriiceps contraction
- Appropriate balance of activity and rest
KNEE ANTERIOR CRUCIATE LIGAMENT (ACL) RECONSTRUCTION
POST-OPERATIVE GUIDELINES
Post-Operative Phase 1: Weeks 0-2

PRECAUTIONS
- Avoid prolonged sitting, standing, and walking
- Avoid progressing beyond prescribed weight bearing
  - Avoid advancing weight bearing (WB) too quickly which may prolong recovery
  - Avoid painful activities including walking and exercising
- Avoid putting heat on knee
- Do not place pillow under operated knee
- Avoid active knee extension 40° → 0°

ASSESSMENT
- LEFS
- IKDC
- SANE
- ACL RSI
- NPRS
- Wound status
- Edema/effusion
- Girth measurement of thigh and joint line
- Neurovascular assessment
- Patellar mobility
- Quality of quadriceps contraction
- LE PROM and AROM
- LE flexibility, where appropriate
- Hip and ankle strength, where appropriate
- SLR in supine
- Functional assessment: gait, SLS, when appropriate

TREATMENT RECOMMENDATIONS
- Gait training with progressive WB with brace locked at 0° as per physician instructions
- Patellar mobilization
- Initiate flexibility exercises
• Range of motion
  o Passive knee extension with towel under heel
  o AAROM knee flexion/extension to tolerance
  o Avoid active knee extension 40-0
• Stationary bicycle for ROM
  o Short (90mm) crank ergometry (requires knee flexion > 85°)
  o Standard crank for ROM and/or cycle (requires 115° knee flexion)
• Quadriceps re-education: quadriceps sets with towel under knee with neuromuscular electric stimulation (NMES) or biofeedback
• SLR flexion with brace locked at 0°
• SLR abduction, adduction, extension
• Calf strengthening unilateral elastic band → bilateral calf raises
• Leg press bilaterally in knee 80°- 5° arc if knee flexion ROM > 90°
• Proprioception board/balance system (bilateral WB)
• Edema/effusion reduction (including elasticized wrap/tubing), cryotherapy (no submersion), compression device, elevation, gentle edema mobilization avoiding incision
• Progressive home exercise program
• Upper body ergometry (UBE) for cardiovascular conditioning

CRITERIA FOR ADVANCEMENT
  ▪ Ability to SLR without quadriceps lag or pain
  ▪ Knee ROM 0°-90°
  ▪ Minimal pain and edema/effusion

EMPHASIZE
• Patellar mobility
• Full PROM knee extension
• Improving quadriceps contraction
• Edema/effusion reduction (including elasticized wrap/tubing)
• Compliance with HEP and precautions
KNEE ANTERIOR CRUCIATE LIGAMENT (ACL) RECONSTRUCTION
POST-OPERATIVE GUIDELINES
Post-Operative Phase 2: Weeks 3-6

PRECAUTIONS

- Do not place pillow under operated knee
- Avoid pain during and after exercises, standing, walking and other activities
- Monitor response to load, frequency, intensity, and duration to avoid reactive effusion
- Avoid premature discharge of assistive device - should be used until gait is normalized
- Avoid advancing weight bearing too quickly which may prolong recovery
- Avoid active knee extension 40° → 0°
- Avoid heat application
- Avoid prolonged standing/walking
- Avoid ascending/descending stairs reciprocally until adequate quadriceps control & lower extremity alignment

ASSESSMENT

- LEFS
- IKDC
- SANE
- ACL RSI
- NPRS
- Wound status
- Edema/effusion
- Girth measurement of thigh and joint line
- Neurovascular assessment
- Patellar mobility
- LE flexibility, where appropriate
- LE AROM and PROM
- Quality of quadriceps contraction
- Hip and ankle strength, where appropriate
- SLR in supine
- Functional assessment: gait, single leg stance, when appropriate
- 6-week HSS Return to Sport Testing
TREATMENT RECOMMENDATIONS

- Patient education
  - Regarding monitoring of response to increase in activity level and weight bearing
  - May unlock brace when patient able to perform SLR without extension lag and demonstration of knee stability in single leg stance position with unlocked knee
- Gait training WBAT- may still have brace locked at 0° and crutches (see appendix 2)
- Continue previous exercises with the following additions and modifications
- Progress knee flexion PROM/AAROM as tolerated
- Hip-gluteal progressive resistive exercises
  - May introduce Romanian Dead Lift (RDL) toward end of phase
- Hamstring strengthening (unless hamstring autograft)
- SLR progressive resisted exercises (PRE) in all planes
  - With brace locked at 0° in supine until no extension lag demonstrated
  - Brace may be removed in other planes
- Terminal knee extension in weight bearing
- Calf strengthening: progression from bilateral to unilateral calf raises
- Leg press progression bilaterally → unilateral eccentric 2 up/1 down → unilateral
- Functional strengthening
  - Mini squats progressing to 0°- 60°, initiating movement with hips
  - Forward step-up progression starting with 2”-4” and then progress
- Consider blood flow restriction (BFR) program with FDA approved device if patient cleared by surgeon and qualified therapist available
- Proprioception board/balance system
  - Progression from bilateral to unilateral weight bearing
  - Once single leg stance achieved with good alignment and control, progress from stable to unstable surfaces
- Edema/effusion reduction (including elasticized wrap/tubing), cryotherapy (no submersion), compression device, elevation, gentle edema mobilization avoiding incision
- Progressive home exercise program
- Stationary bicycle - progress to cardiovascular and power development for LE, transitioning off of UBE

CRITERIA FOR ADVANCEMENT

- Non-antalgic gait and discharged brace
- Minimal edema/effusion
- Good patellar mobility
- Knee ROM 0°-130°
- SLS FWB without pain
- Ascend 6” stairs with good control without pain
EMPHASIZE

- Normalizing gait pattern
- Patellar mobility
- Knee ROM
- Quadriceps contraction
- Activity level to match response and ability
KNEE ACL RECONSTRUCTION POST-OPERATIVE GUIDELINES
Post-Operative Phase 3: Weeks 7-12

PRECAUTIONS

- Avoid pain during and after exercises, standing, walking and other activities
- Monitor response to load, frequency, intensity and duration to avoid reactive effusion
- Avoid active knee extension $40^\circ \rightarrow 0^\circ$ until post-op week 12

ASSESSMENT

- LEFS
- IKDC
- SANE
- ACL RSI
- NPRS
- Edema/effusion
- Girth measurement of thigh and joint line
- Neurovascular assessment
- Scar mobility
- Patellar mobility
- LE flexibility, where appropriate
- LE AROM and PROM
- LE strength: quadriceps isometrics testing with dynamometer (handheld or other) at $60^\circ$ at 12 weeks
- Functional assessment: squat, single leg stance, step ups/downs, balance testing

TREATMENT RECOMMENDATIONS

- Patient education regarding monitoring of response to increase in activity level
- Continue patellar mobilization, if needed
- Flexibility exercises and foam rolling as indicated
- Continue to work on ROM, if needed
- Core and UE strengthening
- Advance foundational hip-gluteal PRE
- Advance hamstring and calf strengthening
- Quadriceps strengthening
  - Isometric knee extension $60^\circ$
  - Open chain knee extension progression
    - At week 12 initiate PRE in limited arc $90^\circ-40^\circ$
• Functional strengthening
  o Progress squats to 0°- 90°, initiating movement with hips
  o Continue forward step-up progression
  o Initiate step-down progression starting with 2”- 4” and then progress
  o Lateral and crossover step-ups
  o Lunges
  o Add weight to functional strengthening exercises when appropriate

• Advance BFR program to include weight bearing strengthening
• Advance proprioception training to include perturbations
• Edema/effusion reduction/prevention (including elasticized wrap/tubing), cryotherapy, compression device, elevation, edema mobilization
• Progressive home exercise program
• Can begin elliptical when able to perform 6” step-up with good form

CRITERIA FOR ADVANCEMENT
• No edema/effusion
• Full symmetrical knee ROM
• Single leg bridge holding for 30 seconds with level hips and effort felt in gluteals
• Symmetrical squat to parallel
• Ability to perform 8” step-down with good control and alignment without pain
• Balance testing and quadriceps isometrics 70% of contralateral lower extremity

EMPHASIZE
• Proper functional movement patterns with strengthening
KNEE ACL RECONSTRUCTION POST-OPERATIVE GUIDELINES
Post-Operative Phase 4: Weeks 13-26

PRECAUTIONS
- Avoid pain with exercises and functional training
- Initiate return to running/sport only when cleared by physician
- Monitor response to load, frequency, intensity, and duration to avoid reactive effusion

ASSESSMENT
- LEFS
- IKDC
- SANE
- ACL RSI
- NPRS
- Edema/effusion
- Girth measurement of thigh and joint line
- Neurovascular assessment
- Scar mobility
- Patellar mobility
- LE flexibility, where appropriate
- LE PROM and AROM
- LE strength: quadriceps isometrics or isokinetic testing
- Functional assessment: squat, single leg stance, step ups/downs, balance testing, hop testing
- 12-week HSS Return to Sport Testing
- 6-month HSS Return to Sport Testing

TREATMENT RECOMMENDATIONS
- Patient education regarding monitoring of response to increase in activity level
- Flexibility exercises and foam rolling as indicated
- Total body strength and conditioning
- Advance foundational hip-gluteal, hamstring and calf progressive resistive exercises
- Open chain knee extension progression (if cleared by Surgeon)
  - At week 12 initiate PRE in limited arc 90° - 40°
  - Progress to 90° - 30°
  - Progress to 90° - 0° by end of phase
- Functional strengthening
  - Progress to single leg squats
  - Forward step-up and step-down progression
  - Progress lateral and crossover step ups
  - Progress lunges
- Initiate running progression (see appendix 3)
- Initiate plyometric progression (see appendix 4)
- Supplementing use of BFR for higher level strengthening
- Progress proprioception training
- Incorporate agility and controlled sports-specific movements
  - Starting with planned agility and progress to reactionary movements
  - Emphasize uncompensated movement strategies with acceleration and deceleration
  - Begin with linear movements, progress to lateral and then rotational
- Preventative cryotherapy and/or compression therapy, if needed
- Progressive home exercise program

**CRITERIA FOR ADVANCEMENT**
- No edema/effusion
- Quantitative assessments ≥ 85% of contralateral lower extremity
  - Note that uninvolved side may be deconditioned; use pre-injury baseline or normative data for comparison if available
  - Isometric quadriceps testing
  - Hop testing
  - Quadriceps girth measurement
- Proper functional movement patterns
- Completion of 12 week and 6-month HSS Return to Sport Testing

**EMPHASIZE**
- Return to normal functional activities
KNEE ACL RECONSTRUCTION POST-OPERATIVE GUIDELINES
Post-Operative Phase 5: Weeks 27 - Discharge

PRECAUTIONS
- Note importance of gradual return to participation with load and volume monitoring under guidance of physical therapist, surgeon, athletic trainer, and coach
- Avoid premature or too rapid full return to sport

ASSESSMENT
- LEFS
- IKDC
- SANE
- ACL RSI
- NPRS
- Edema/effusion
- Girth measurement of thigh and joint line
- Neurovascular assessment
- Scar mobility
- LE flexibility, where appropriate
- LE AROM and PROM
- LE strength: quadriceps isometrics or isokinetic testing
- Functional assessment: squat, single leg stance, step ups/downs, balance testing, hop testing
- 9-month (and 12 month if needed) HSS Return to Sport Testing

TREATMENT RECOMMENDATIONS
- Gradually increase volume and load to mimic load necessary for return to activity
- Progress movement patterns specific to patient’s desired sport or activity
- Progression of agility work
- Increase cardiovascular load to match that of desired activity
- Collaborate with certified athletic trainer (ATC), performance coach/strength and conditioning coach, skills coach, and/or personal trainer to monitor load and volume as return to participation
- Consult with referring surgeon on timing return to sport including any recommended limitations

CRITERIA FOR DISCHARGE
- Quantitative assessments ≥ 90% of contralateral lower extremity
- Movement patterns, functional strength, flexibility, motion, endurance, power, deceleration, and accuracy to meet demands of sport
EMPHASIZE

• Return to participation
  o Begin with non-contact play and progress to contact play
  o Progress minutes with team in controlled practice setting before advancing to game situations

• Collaboration with Sports Performance experts
  o Encourage continued strength and conditioning maintenance
ACLR with Hamstring Autograft

- Weight Bearing (note that status may change per surgeon’s preference)
  - Weeks 0-4 partial weight bearing (PWB)
  - Weeks 5-6 weight bearing as tolerated (WBAT)

- Therapeutic Exercise
  - Avoid active knee flexion and isolated loading of hamstrings (e.g., heel slides, leg curls, hamstring strengthening and flexibility exercises) for the first 4-6 weeks

ACLR with Quadriceps Tendon Autograft

- Weight Bearing (note that status may change per surgeon’s preference)
  - Weeks 0-4 PWB
  - Weeks 5-6 WBAT

ACLR with Allograft

- Weight Bearing (note that status may change per surgeon’s preference)
  - Weeks 0-4 PWB
  - Weeks 5-6 WBAT

ACLR with Osteochondral Allograft (all graft types)

- Weight Bearing (note that status may change per surgeon’s preference)
  - Weeks 0-2 PWB
  - Weeks 3-4 WBAT
  - Weeks 5-6 progressive WBAT

ACLR with Meniscal Repair (all graft types)

- Range of Motion
  - ROM without restrictions unless directed by surgeon
  - Generally speaking, do not push flexion

ACLR with Radial or Root Repair

- Weight Bearing (note that status may change per surgeon’s preference)
  - Weeks 0-2 PWB
  - Weeks 3-4 WBAT
  - Weeks 5-6 progressive WBAT
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Appendix 2: Phase 2 – Gait and Assistive Device

Begin ambulation WBAT with brace locked in full extension with assistive device at all times.

- Encourage slow progression of weight bearing to avoid increased symptoms.
- WBAT should consider pain, quadriceps control and edema/effusion both during gait and after.
- Any increase in symptoms should indicate a reduction of WB during gait or standing activities or decrease in overall volume of WB activities.

Beginning in phase 2 of rehab (week 3), patient may be evaluated for ambulation with unlocked brace.

- Brace may be unlocked for gait when full passive and active knee extension is achieved as demonstrated by a SLR without quadriceps lag for 15 repetitions.
- Patient should be able to demonstrate knee stability in single leg stance position with unlocked knee
- Brace should not be unlocked unless patient can demonstrate appropriate heel strike and quadriceps control during gait.
- May consider only partially unlocking brace (e.g., if patient has 95° flexion, consider unlocking brace to 90°).
- If flexion ROM deficits persist, brace may need to be unlocked (e.g., knee flexed while sitting) to facilitate return to full ROM. Also consider decreasing weight bearing/loading

Brace will be discharged at the discretion of the surgeon.

Wean from assistive device with symmetrical gait pattern, full extension, and full WB during stance phase.

- Begin with no assistive device around home with progression complete discharge of assistive device.
KNEE ANTERIOR CRUCIATE LIGAMENT (ACL) RECONSTRUCTION
POST-OPERATIVE GUIDELINES
Appendix 3: Phase 4 – Examples of Running Progression

Example 1
- Week 1
  - Run: 30 seconds
  - Rest/Walk: 30 seconds
  - Reps: 3
- Week 2
  - Run: 1 minute
  - Rest/Walk: 1 minute
  - Reps: 3
- Week 3
  - Run: 2 minutes
  - Rest/Walk: 1 minute
  - Reps: 2
- Week 4
  - Run: 4 minutes
  - Rest/Walk: 2 minutes
  - Reps: 1
- Week 5
  - Run: 4 minutes
  - Rest/Walk: 2 minutes
  - Reps: 2
- Week 6
  - Run: 8 minutes
  - Rest/Walk: n/a
  - Reps: 1

Example 2
1. Retro running 30” on treadmill or Alter-GTM run 30” 80% WB, progressing to 95% WB
2. Treadmill forward running 30”, advancing to 1’ (note: not jogging, not sprinting, but running)
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POST-OPERATIVE GUIDELINES
Appendix 4: Phase 4 – Examples of Plyometrics Progression

Example 1
- Week 1: Onto box
- Week 2: In place and jumping rope
- Week 3: Drop jumps
- Week 4: Broad jumps
- Week 5: Side to side hops
- Week 6: Hop to opposite

Example 2
1. Bilateral plyometrics on leg press
2. Bilateral jumps onto a 6” box
3. Bilateral jumps in a cross pattern, e.g., clockwise (below right) and counterclockwise (below left)
4. Bilateral jumps on/off box 6” / 8” / 12”
5. Unilateral jumps in a cross pattern, e.g., clockwise (below right) and counterclockwise (below left)
6. Unilateral jumps on/off box
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POST-OPERATIVE GUIDELINES

References


