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Anterior Cruciate Ligament Reconstruction Rehabilitation Protocol

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The following document is an evidence-based rehabilitation protocol for knee arthroscopy with ACL reconstruction. The protocol is both chronologically and criterion based for advancement through four post-operative phases:

- Phase 1 : Maximum protection
- Phase 2 : Progressive stretching and early strengthening
- Phase 3 : Advanced strengthening and plyometrics
- Phase 4 : Return to sports functional program

If a meniscus repair is performed in conjunction with ACL reconstruction, **follow meniscus repair protocol**.

Graft choice:

Allograft

-Fastest rate of progression

-Graft of choice in low demand/older patients

Hamstring Autograft

-Graft of choice for high impact and agility sports

-Preferred over BTB if open growth plates present

Bone-Patellar Tendon-Bone Autograft (BTB)

-Risk of anterior knee pain during early phases of rehabilitation

-Graft of choice in high impact and contact sports

	Weightbearing* **	**Crutches or assistive device**	**Brace**	**ROM Limitations/Goals**
Allograft	WBAT	Wean over 1-2 weeks with progression to FWB	0-90° seated, 0-30° when ambulating, gradually unlocked 10° as quad function improves	0°-90° knee flexion at 2 weeks, 120° at 4 weeks, full at 6 weeks
Hamstring Autograft	WBAT	Wean over 1-2 weeks with progression to FWB	0-30°, gradually open 10-20° as quad function improves	0°-90° knee flexion at 2 weeks, 120° at 4 weeks, full at 6 weeks
BTB Autograft	WBAT	Wean over 1-2 weeks with progression to FWB	Unlocked 0-30°, gradually open 10-20° as quad function improves	0°-90° knee flexion at 2 weeks, 0°-120° at 4 weeks, full at 6 weeks

*****If meniscus repair performed, weight bearing limited to toe touch weight bearing (max 20-25 lbs) for the first 4 weeks post-operatively and follow meniscus repair protocol*****

Pre-Operative Physical Therapy Visits

Pre-Operative Physical Therapy Visits

- Emphasis on reducing swelling and inflammation
- Restore terminal extension
- Emphasis on full active and passive range of motion (0^o-120^o)
- Educate on quadriceps function – quad sets, straight leg raises, prone terminal knee extension
- Normalize gait mechanics
  - Priority becomes protection if concurrent meniscus tear or articular cartilage defect
- Prepare patient for initial post-operative phase
- Consider pre-operative strength testing on uninvolved LE for baseline numbers
  - Force plate vs. isokinetic testing vs. dynamometer – pick appropriate for patient

Post-Operative Precautions

- Educate on any post-operative precautions
  - Dependent on procedure planned (i.e. meniscus repair)

Weight Bearing Restrictions

- Instruct on post-operative WB restriction (dependent on procedure performed)
  - **Weight bearing as tolerated**
  - **Toe touch weight bearing** for meniscus repair 4-6 weeks to limit stress on repaired meniscus

Crutches/Assistive Device

- Instruct on proper use of crutches/assistive device
  - Weaning to occur as tolerated within 1-2 weeks of surgery
    - Consider pain, swelling and gait quality
  - If meniscus repair, weaning to occur after 4-6 weeks post-operative, increasing weight bearing 25% every 3-4 days until full weight bearing and normalized gait pattern

ROM Limitations

- Instruct on post-operative ROM limitations

Initial Post-Operative Exercises

- Instruct on initial post-operative exercises to be performed 3 times per day
  - Include ankle pumps, quad sets, straight leg raise, assisted heel slides and heel prop

Modalities

- Instruct on cryotherapy post-operative with Game Ready (worker's comp) or IceMan unit
- Instruct on elevation above heart to reduce post-operative swelling
- Instruct on compression with ace wrap in immediate post-operative period

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Phase 1 – Maximum Protection

Post-Operative Weeks 0-6

Goals for Phase 1

- Minimize pain and inflammation
- Swelling within 1.0 cm of contralateral
- Protect ACL graft
- Emphasis on quad function
- Restore terminal extension (0°)
- Scar tissue mobility
- Prevent quadriceps inhibition
- Initiate knee PROM and AROM within limitations
- Restore normalized gait pattern

Criteria for progression to Phase 2

- Minimal pain with Phase 1 exercises
- Full knee extension
- Knee ROM ≥ 90°
- Perform straight leg raise without lag sign
- Normal neuromuscular firing patterns of knee musculature
- Normalized gait pattern with proper lower extremity biomechanics OR ability to unilateral WB without pain

Post-Operative Physical Therapy

- 1st visit to occur within 3 days of surgery
  - Review initial post-operative exercises
  - Perform first dressing change

Weight bearing

- Weight bearing as tolerated

Brace (0-6 weeks post operatively)

- Hamstring allograft : 0-90°, gradually unlocked as quad function improves (10° each week)
- Hamstring autograft : 0-30° , gradually unlocked as quad function improves (ex: 10-20° each week)
- BTB autograft : 0-30° , gradually unlocked as quad function improves (ex: 10-20° each week)

ROM

- 0-2 weeks : 0-90° , emphasis on extension
- 2-6 weeks : 0-120° , emphasis on extension
- 6+ weeks : full ROM

Stretching

- Emphasis on terminal knee extension (avoid hyperextension)
  - Heel prop for extension, calf stretch, prone hang
  - Avoid hamstring stretching if hamstring autograft used

Manual Therapy

- Patellar mobilizations – all directions
- Tibiofemoral mobilizations to promote knee flexion
  - Avoid anterior tibiofemoral glides to reduce stress on graft
- Scar mobilization, soft tissue mobilization, lymph edema massage as needed

NMES

- Quadriceps re-education
  - Consider home unit if insurance allows

AAROM

- Stationary bike
  - Relatively high seat height, low resistance level
  - Rocking for range of motion
- Heel slides, seated slides on floor, supine slides at wall

AROM

- Knee AROM to tolerance within limitations
  - If hamstring autograft, no active knee flexion for 6 weeks

Phase 1 – Maximum Protection Phase (continued)

Strengthening

- Ankle pumps, calf sets
- Quadriceps sets, prone terminal knee extension
- Open kinetic chain hip strength including straight leg raises – all planes with goal of no lag sign
  - Avoid adduction if grade 2-3 MCL sprain present
  - Brace to be worn if lag sign present
- Progress to closed kinetic chain as able (demonstrates strong quadriceps contraction, minimal swelling, able to bear at least 50% weight)
  - Standing TKE, Leg press, Mini squats/weight shifts, Forward step up program (8" stair goal), Double leg bridging
- Hamstring isometrics with progression to AAROM and AROM, as able
  - Avoid AAROM and AROM if hamstring autograft used
- Blood flow restriction training
  - May initiate once incisions are completely healed and edema is less than 1.0 cm
  - Ideally performed 2-3 times per week utilizing 3-5 exercises
- Core stabilization exercises

Proprioception

- Bilateral leg on stable surface, advancing difficulty as tolerated

Gait Re-Training

- Normalize gait pattern
  - Utilize Alter-G treadmill or underwater treadmill if available

Cardiovascular

- Upper body ergometer

Aquatics

- Initiate aquatic therapy when surgical incisions have healed
  - Focus on normalizing weight bearing and gait
  - Consider alternating between land and water-based sessions if available

Modalities

- Instruct on cryotherapy use with Game Ready or IceMan – at least three times per day for 20-30 minutes with leg elevated above heart
- NMES unit at home if significant quadriceps lag present
- Compression to be worn during all waking hours
  - May remove to sleep

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Phase 2 –Progressive Stretching & Early Strengthening

Post-Operative Weeks 6-12

Goals for Phase 2

- Minimize pain and inflammation
- Restore full knee ROM
- Progress muscle strength and endurance
- Initiate neuromuscular control exercises
- Perform ADLs with minimal pain or compensation
- Able to descend 8" stair with proper knee control and without pain
- Forward step down or SL squat to specific ROM

Criteria for progression to Phase 3

- Minimal pain with Phase 2 exercises
- Forward step down or SL squat to specific ROM
- Full pain-free knee ROM
- Descend 8" stair with proper knee control/alignment
- Less than a 20% quadriceps strength deficit on 3PQ

Precautions

- No kicking in the pool for 12 weeks
- Avoid twisting and pivoting
- Avoid impact until able to pass functional testing (Y balance & 3PQ/dynamometry)

Brace

- Wear for at risk activity

Stretching

- Continue stretching of all lower musculature, as needed

Manual Therapy

- Patellar mobilizations – all directions
- Motion dominant tibiofemoral mobilizations to restore full ROM
- Scar mobilization, soft tissue mobilization, lymph edema massage as needed

ROM

- Restore full ROM by week 8

Strengthening

- Continue Phase 1 strengthening exercises
- Continue focus on closed kinetic chain quadriceps strength with progression from bilateral to unilateral
  - Leg press, squats, step-up/downs, lateral stepping, multi-directional lunges, etc.
  - Focus on avoidance of knee valgus
- Progress closed kinetic strength hamstring to open kinetic chain as able
- Blood flow restriction training
  - Continue 2-3 times per week utilizing 3-5 exercises
  - Introduce endurance protocol as necessary
- Core stabilization

Proprioception

- SL balance
  - Progress stable to unstable surfaces
  - Add perturbation and dual tasking as able

Cardiovascular

- Stationary bike, elliptical trainer, stair climber
- Retrograde treadmill walking

Aquatics

- Continue phase 1 aquatics, as needed

Modalities

- Utilize cryotherapy and other modalities, as needed

Testing

- Y balance test within 6 cm of uninvolved side
- 3PQ isometric or hand-held dynamometry quadriceps testing (<20% difference)

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Phase 3 – Advanced Strengthening, Proprioception and Plyometric

Post-Operative Weeks 12-24

Goals for Phase 3

- Minimize pain and inflammation
- Maintain full knee ROM
- Improve muscle strength and endurance
- Quad girth within 1-2 cm of contralateral
- Improve neuromuscular control
- Initiate return-to-running progression
- Initiate plyometrics and agility training
- Isokinetic test ≥ to 85% limb symmetry (or force plate/dynamometer)

Criteria for progression to Phase 4

- Minimal pain with Phase 3 exercises
- Isokinetic test ≥ 85% limb symmetry
- No apprehension with basic plyometric and agility activity
- Initiated return-to-running progression with proper lower extremity biomechanics and without pain
- Reports confidence in lower extremity with sport specific activities

Stretching

- Continue stretching of all lower extremity musculature, as needed

Manual Therapy

- As needed to maintain range of motion and flexibility

Strengthening

- Continue Phase 2 strengthening exercises
- Introduce isokinetic knee extension (full arc, pain and crepitus free)
- Single leg exercise progressions (step-ups/downs, lunges, squats & RDLs)
    - Progress to multi-directional stepping patterns
    - Progress stable to unstable surfaces
    - Add perturbations
- Progressive hip and hamstring strengthening
    - Multi-directional band walks and stability training
    - Introduce eccentric hamstring strength training
- Core Stabilization
    - Focus on rotational patterns

Neuromuscular Control

- Incorporate unstable surfaces and dynamic movement patterns with functional strengthening progression
- Incorporate dual tasking and sport-specific progressions

Advanced Gait Re-Training & Agility

- Initiate return-to-running progression (12-14 weeks)
    - Utilize Alter-G treadmill or underwater treadmill, if available
    - 14+ weeks: sagittal plane jogging, sub-maximal ladder drills
    - 16+ weeks: advance to multi-directional running, sub-maximal pivoting and cutting

Plyometrics

- Initiate and gradually progress return hoping activities
    - Sagittal → Frontal → Rotational
    - Double leg → Single leg
    - Ascending → Descending → Repetitive box jumps/hops

Aquatics

- Advanced gait re-training
- Plyometric drills

Athletic Republic

- Consider ACL Bridge as early as 12 weeks post-operatively

Work Conditioning

- Consider at 12 weeks if physically demanding occupation

Modalities

- Utilize cryotherapy, thermotherapy, and electrical modalities as needed

Phase 4 – Return to Sports Functional Program

Post-Operative Weeks 24+

Goals for Phase 4

- Minimize pain and inflammation
- Restore muscle strength and endurance
- Restore neuromuscular control
- Safe and effective return to previous level of function for sport or activity
- Forward step down or SL squat to 60°

Criteria for Return-to-Sport and Activity

- Full, pain free knee ROM
- Normal lateral step-down test without compensation
- Successful completion of return-to-sport testing
- Lower Extremity Functional Scale score ≥ 80/80 (athletes) and 75/80 (sedentary)
- Reports confidence in lower extremity with sport specific activities (ACL-RSI)

Independent Gym Based Program (HEP)

- Stretching as needed
- Single leg strength stabilization, and power development with emphasis on dynamic knee control
- Continue incorporation of core integrated exercises with functional strengthening progression

Agility & Plyometrics

- Advanced agility and plyometric drills
  - Progress towards full speed with sudden changes in direction
  - Incorporate dual tasking and sport-specific progressions
  - Continue focus on proper lower extremity biomechanics

Sport-Specific Training

- Initiate sport-specific training programs
  - Interval sport programs for running, cycling, swimming, skating, throwing, golfing, etc.
  - Olympic/power weight-lifting exercises
- Transition to Athletic Republic program if competitive or recreational athlete with specific goals for return-to-sport
- Progress return-to-running program
  - Progress distances, speed intervals, surfaces, hill training, and sprint work if appropriate

Activity-Specific Training

- Transition to work re-conditioning program if physical laborer or if specific occupational demands

Modalities

- Utilize cryotherapy and other modalities as needed

Brace

- Custom fit functional brace to be utilized for contact or potential contact sports or activities for ~1 year post-op

Return to Sport Testing (6-12 months post-op per MD)

- Balance: Y-balance testing within 4 cm of uninvolved side
- Strength: Knee isokinetic test ≥ 90-95% of the uninvolved side, lateral step-down test without compensation
- Hop testing: ≥ 90-95% limb symmetry
- Agility: Full speed sport-specific drills without pain or compensation
- ACL-RSI to determine readiness to return-to-play

References

1. Cavanaugh JT, Powers M. ACL rehabilitation progression: where are we now? *Curr Rev Muskuloskelet Med.* 2017;10:289-296.
2. Filbay SR, Grindem H. Evidence-based recommendations for the management of anterior cruciate ligament (ACL) rupture. *Best Practice & Research Clinical Rheumatology.* 2019;33:33-47.
3. Wright RW, Haas AK, Anderson J, et al. Anterior cruciate ligament reconstruction rehabilitation: MOON guidelines. *Sports Health.* 2015;7(3):239-243.
4. Bousquet BA, O'Brien L, Singleton S, Beggs M. Post-operative criterion-based rehabilitation of ACL repairs: a clinical commentary. *The International Journal of Sports Physical Therapy.* 2018;13(2):293-305.

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