

PHYSICAL THERAPY PROTOCOL

ACL Reconstruction Rehabilitation

Anterior Cruciate Ligament Reconstruction — Isolated or with Concomitant Meniscus Repair

FOR THE PHYSICAL THERAPIST

Overview and Goals

This protocol follows a criterion-based, milestone-driven approach consistent with current best-practice guidelines.^{1,2,3} Progression between phases is determined by achievement of functional benchmarks, not time alone. Time ranges are provided as typical windows — patients who meet criteria early may advance; those who do not should remain in the current phase regardless of elapsed time.

The overarching goals of rehabilitation are: restoration of full, symmetrical range of motion; recovery of quadriceps and hamstring strength; neuromuscular re-education; and a safe, criteria-based return to sport. Throughout all phases, management of pain and effusion is a shared priority that gates progression.

MENISCUS REPAIR — READ BEFORE STARTING

If a concomitant meniscus repair was performed, refer to the **Meniscus Repair Modifications** section below before initiating rehabilitation. Weight bearing, ROM, and exercise progressions differ based on tear type and repair pattern. If unsure of the tear type, contact Dr. Roth's office before initiating rehabilitation.

Rehabilitation Phases

PHASE	WEIGHT BEARING	BRACE	ROM GOALS	EXERCISES	CRITERIA TO ADVANCE
PHASE 1 Weeks 0–6 <i>Early recovery</i>	Autograft: - WBAT immediately.¹ Allograft: 50% PWB for 2–4 weeks, then WBAT (slower graft incorporation). - Crutches as needed for comfort and gait quality; wean as quad control allows.	- Locked at 0° extension until adequate quadriceps control. - Unlock when patient can perform SLR without extension lag. - Worn day and night; may remove for exercises and hygiene.	Goal by end of Phase 1: - Full passive extension (0°) - Flexion ≥ 115°¹ - Symmetrical extension to contralateral side	Swelling / pain control: - Cryotherapy, elevation, NMES to quadriceps⁴ ROM: - Heel slides, wall slides, prone hangs, towel-roll passive extension, patellar mobilization, tibiofemoral mobs into extension Strengthening: - Quad sets with knee support - SLR (all 4 planes) — begin once extension lag resolved - Hamstring sets / digs - Hip abduction, adduction, extension - Ankle pumps, plantarflexion / dorsiflexion, eversion / inversion - OKC knee extension 90°–40° only (terminal arc quads)^{1,5} - CKC: heel raises, leg press (minimal resistance), weight shifting BFR training: - Initiate weeks 1–6 — see BFR section below^{18,22,24} Conditioning: - Gait training toward normalized pattern - Stationary bike (week 2 when flexion	- Full passive knee extension - Flexion ≥ 115° - Effusion ≤ 1+ - Quad LSI ≥ 60% - Normalized gait without crutches - SLR without extension lag

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PHASE	WEIGHT BEARING	BRACE	ROM GOALS	EXERCISES	CRITERIA TO ADVANCE
				allows)	
PHASE 2 Weeks 7–9 <i>Intermediate strengthening</i>	- Full weight bearing. - No assistive device.	- Discontinue brace when quad control adequate. - Functional brace for sport activities at physician discretion (not routinely recommended by current guidelines).⁴	Full symmetrical, pain-free ROM	Neuromuscular re-education: - Single-leg balance, perturbation training, foam-surface balance Strengthening progression: - Leg press progressing resistance, progress to single leg - Step-ups, step-downs, lateral step-ups - Mini-squats progressing to full squat to 90° - Terminal knee extension against resistance - Hamstring curls (PREs) - Single-leg squat (begin when strength allows) Aerobic conditioning: - Stationary bike (progressive resistance), elliptical, pool BFR: - Continue weeks 7–12^{20,21} Core: - Core and trunk stabilization	- Full symmetrical ROM - Quad LSI ≥ 70% - No effusion - Single-leg balance ≥ 20 sec - Normal stair gait pattern
PHASE 3 Weeks 10–16 <i>Progressive loading & running initiation</i>	Full weight bearing.	None.	Full, pain-free ROM maintained throughout	Running initiation (when Quad LSI ≥ 80%): - Treadmill walk/run intervals → treadmill running¹ - Track: run straights, walk turns → full track → road Progressive overload strengthening: - Single-leg press, single-leg squat progression - Lateral step-downs, sustained squat side-stepping - Eccentric hamstring loading (Nordic curls) Hip strengthening: - Glute bridges, clamshells, side-lying abduction Landing mechanics: - Double-leg jump/land with technique emphasis — valgus control, soft landing - Jogging on trampoline → treadmill - Stair climber, outdoor walking on uneven surfaces	- Quad LSI ≥ 80% - Hamstring LSI ≥ 80% - No pain or effusion with running - Safe double-leg landing mechanics
PHASE 4 Months 4–6 <i>Agility & plyometrics</i>	Full weight bearing.	None.	Full, pain-free ROM maintained	Plyometrics progression: - Gravity-eliminated shuttle (double leg → single leg) - Box jumps, broad jumps, lateral bounds - Single-leg hopping in multiple planes Agility: - Ladder drills, carioca, sport-cord lateral drills, deceleration training Sprinting: - Progressive straight-line sprinting → curved running Sport-specific:	- Quad LSI ≥ 85% - Hop test battery LSI ≥ 85%^{1,13} - Safe single-leg landing mechanics - No pain or effusion

PHASE	WEIGHT BEARING	BRACE	ROM GOALS	EXERCISES	CRITERIA TO ADVANCE
				• Sport-specific drills (non-contact at physician clearance) • Continue progressive resistance training — maximize strength symmetry	
PHASE 5 Months 6–9+ <i>Return to sport</i>	• Full weight bearing.	• None.	• Full, pain-free ROM	• Sport-specific training and conditioning at progressive intensity • Full cutting, pivoting, lateral maneuvers • Return to practice/training (non-contact → contact) • ACL-RSI psychological readiness assessment^{14,15,16} • Home maintenance strength program established	<i>See Return-to-Sport Criteria section below.</i> • Minimum 9 months from surgery.^{6,7}

Meniscus Repair Modifications

If a concomitant meniscus repair was performed, the following modifications apply based on tear type.^{8,9,11,12} Contact Dr. Roth's office if tear type is uncertain.

Stable Tear Patterns — Longitudinal / Bucket-Handle / Ramp Lesion

- **Weight bearing:** 50% partial weight bearing (PWB) with crutches for the first 2 weeks, then progress to WBAT. A modest step-down from isolated ACLR to protect the early repair.^{9,10}
- **ROM:** 0°–115° by end of Phase 1 — same as isolated ACLR.
- **Loaded flexion:** Avoid closed-chain exercises with knee flexion >90° for the first 6 weeks. Passive ROM beyond 90° is acceptable.
- **Return to activity:** Minimum 4 months. Persistent joint-line tenderness or effusion may indicate delayed healing — do not progress through criteria until resolved.⁸

Complex Tear Patterns — Radial / Root / Complex Tear

- **Weight bearing:** Touch-down weight bearing (TDWB) for 6 weeks. These tears disrupt meniscal hoop-stress mechanics — early loading can displace the repair.^{11,12}
- **ROM:** Limit to 0°–90° for the first 6 weeks. Progress gradually to full ROM between weeks 8–12.
- **Loaded flexion:** No closed-chain exercises with knee flexion >90° for the first 12 weeks.
- **OKC exercises:** Delay until weeks 8–12.
- **Running:** Typically delayed to ≥16 weeks; criterion-based as above once WB restrictions are lifted.
- **Return to activity:** Minimum 4–6 months from surgery; overall RTS timeline ≥9 months still applies.⁹

Blood Flow Restriction (BFR) Training

BFR training is recommended as a standard component of ACL rehabilitation in Phases 1–3 (weeks 1–12).^{18,20,21,22,24} It allows meaningful quadriceps hypertrophy and strength gains at low loads when pain, effusion, and surgical precautions prevent high-load training. A 2024 meta-analysis of 13 RCTs demonstrated BFR superior to general rehabilitation for muscle strength (MD 12.96), Lysholm score, and IKDC score.²⁰ A 2026 network meta-analysis ranked BFR highly for IKDC, Lysholm, and ROM outcomes across 22 RCTs.²¹

PARAMETER	RECOMMENDATION	NOTES
Cuff placement	Proximal thigh	As proximal as possible on the operative limb
Cuff pressure	60–80% of arterial occlusion pressure (AOP)	Higher pressure (80% AOP) produces greater quad torque and muscle thickness. ¹⁹ Individualize based on limb occlusion pressure measurement.
Load	20–30% of 1-repetition maximum (1RM)	Low load is essential — BFR paired with high-load exercise is not effective. ⁹
Sets / reps	4 sets: 30–15–15–15 repetitions	Standard protocol from NHS RCT. ²² 30-second rest between sets with cuff inflated.
Exercises	Leg press, knee extension, heel raises, straight-leg raises	Seated knee extension (90°–40°) acceptable early; progress to leg press and functional exercises
Frequency	2–3 sessions per week	Can be performed on non-PT days as a home program if equipment available
Duration	Weeks 1–12 (Phases 1–3)	Transition to conventional progressive overload as strength allows ²⁴

BFR CONTRAINDICATIONS

Avoid BFR in patients with known or suspected thromboembolic disease, peripheral vasculopathy, or sickle cell trait/disease. Rare cases of rhabdomyolysis have been reported — monitor for unusual muscle soreness or dark urine, especially in early sessions.¹⁸

Return-to-Sport Criteria

Return-to-sport readiness after ACLR is multifactorial. No single test — including isokinetic strength or limb symmetry — is sufficient on its own to clear an athlete; clearance requires a battery spanning strength, hop performance, movement quality, and psychological readiness, together with adequate time and the absence of pain and effusion.^{7,25,28} Return to sport requires a minimum of 9 months from the date of surgery, with all of the following criteria met, including a minimum of 2 functional tests.^{6,7} For contact sports, 12 months is recommended regardless of graft type or criteria achievement, given the higher re-injury risk with earlier return.¹⁷

Domain	Criterion
Quadriceps strength	Isokinetic LSI $\geq$ 90% at 60°/s (concentric). Necessary, but not sufficient in isolation — interpret within the full battery. ^{1,7,25}
Hamstring strength	Isokinetic LSI $\geq$ 90%. Hamstring-to-quadriceps ratio assessed — independently associated with reinjury risk. ^{1,7,27}
Hop test battery	LSI $\geq$ 90% on all four tests: single hop, triple hop, crossover hop, side hop ^{1,13}
Single-leg squat	Controlled, pain-free, symmetrical depth comparable to contralateral side ⁷
Pain and effusion	No pain. No effusion (trace or less). ¹
Psychological readiness	ACL-RSI score $\geq$ 65 (validated tool for fear of re-injury, confidence, and emotional readiness) ^{14,15,16}

Domain	Criterion
Time from surgery	≥ 9 months (all sports). ≥ 12 months for contact/collision sports. ^{6,7,17}

ISOKINETIC TESTING — NECESSARY BUT NOT SUFFICIENT

Isokinetic testing — concentric quadriceps and hamstring at 60°/s — is the most frequently used way to assess limb symmetry, and an LSI ≥ 90% is the most commonly cited threshold.^{1,13} It is not, however, a validated standalone predictor of return: there is no standardized isokinetic protocol across studies, and limb-symmetry from strength and hop testing has been shown unable to distinguish athletes who returned safely from those who sustained a second ACL injury.^{25,26} LSI also overestimates recovery when the uninvolved limb has deconditioned, so an absolute quadriceps peak torque-to-bodyweight anchor is a useful adjunct. Isokinetic testing belongs **within** the battery: its value is greatest in combination — quadriceps strength paired with a hop-test battery is associated with reduced reinjury, and the hamstring-to-quadriceps ratio is independently predictive.²⁷

WHY PSYCHOLOGICAL READINESS MATTERS

Most patients return to sport after ACLR — approximately 80% return to some level of sport, and up to 97% of elite athletes return to their pre-injury level.^{14,15,17} A 2025 network meta-analysis found the ACL-RSI scale was the strongest predictor of successful return to sport (effect size 1.55, 95% CI 1.24–1.87), outperforming physical tests alone.¹⁴ Patients who returned to sport had significantly higher self-efficacy and lower kinesiophobia despite similar knee-function scores.¹⁵ Because psychological readiness is modifiable, addressing it actively throughout rehabilitation — alongside physical milestones — is one of the highest-yield interventions for closing the gap between physical readiness and successful return.

CONTACT SPORTS — 12 MONTHS PLUS THE FULL BATTERY

For contact or collision sports (football, soccer, basketball, rugby, wrestling, hockey, martial arts), Dr. Roth requires a minimum of 12 months from surgery **and** passage of the complete return-to-sport battery — not time alone, and not any single test. The battery spans isokinetic quadriceps and hamstring strength (LSI ≥ 90% at 60°/s), a hop-test battery (≥ 2 tests, LSI ≥ 90%), movement-quality assessment, and psychological readiness (ACL-RSI), with no pain or effusion.^{7,29} Psychological readiness is the single strongest predictor of successful return — outperforming physical tests alone — and passing a formal RTS battery is associated with roughly half the graft-rupture risk.^{14,30} Reinjury rates are significantly higher with return before 9 months and remain elevated through 12 months in high-demand activities.^{6,17}

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Glossary

1RM — One-repetition maximum; the heaviest weight a person can lift once with proper form.

ACL-RSI — ACL Return to Sport after Injury scale; a validated 12-item questionnaire measuring fear of re-injury, confidence, and emotional readiness for return to sport.

ACLR — Anterior cruciate ligament reconstruction.

AOP — Arterial occlusion pressure; the cuff pressure required to fully occlude arterial flow in a limb, used to set BFR cuff pressure individually.

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BFR — Blood flow restriction training; low-load resistance training performed with a partially occlusive cuff to drive strength gains at lighter weights.

CKC — Closed kinetic chain; exercises in which the distal limb is fixed (e.g., squat, leg press).

IKDC — International Knee Documentation Committee; a validated patient-reported outcome score for knee function.

LSI — Limb Symmetry Index; the operative limb's strength or performance as a percentage of the contralateral limb (operative ÷ contralateral × 100).

NMES — Neuromuscular electrical stimulation; surface electrical stimulation used to augment voluntary muscle contraction.

OKC — Open kinetic chain; exercises in which the distal limb moves freely (e.g., seated knee extension).

ROM — Range of motion.

SLR — Straight leg raise.

TDWB — Touch-down weight bearing; the operative foot may rest on the floor for balance, but no body weight is loaded through it.

WBAT — Weight-bearing as tolerated; the patient loads the operative limb to comfort, typically with crutch support.



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