

ACL INJURY PREVENTION

Neuromuscular Training Program

PATIENT

PHYSICIAN

Andrew L. Merritt, MD

DATE OF REFERRAL

PT START DATE

For the patient

This program trains the hip, core, and leg muscles that keep the knee safe during sport. **Most ACL tears happen without contact.** They happen because of how the body moves when landing, cutting, or slowing down, and we can teach your body to move better. Programs like this one **reduce ACL injury risk by 50% or more.** The focus is hip strength, landing technique, and step-by-step neuromuscular training. The program moves ahead **as your form and strength improve, not just by the calendar.** When you finish, the **FIFA 11+ warm-up** becomes your permanent routine before practices and games. **After ACL surgery,** you may start in late rehab once Dr. Merritt and your therapist clear you.

PROTOCOL AT A GLANCE

GOAL	Stronger hips, core, and hamstrings, and safer landing and cutting, to lower the risk of an ACL tear
ACTIVITY	Full weight bearing, no restrictions. No brace needed
PHYSICAL THERAPY	2× a week for weeks 1–10, then 1–2× a week plus a home program
KEY PRECAUTIONS	No knee collapsing inward in squats, lunges, or landings. Muscle soreness is normal; sharp pain is not
PROGRESSION	Next phase when your form and strength goals are met. No jumping until Phase 2; no hard jumping until landings are consistently correct
MAINTENANCE	Then the FIFA 11+ warm-up, 20 min, 3× a week, for as long as you play

Recovery Timeline

Phase	When	PT visits	Focus
1	Weeks 1–4	2× a week	Hip and glute strength, squat and landing technique, single-leg balance, core stability
2	Weeks 5–10	2× a week	Landing mechanics, single-leg squats, Nordic hamstring curls, lateral movement and early agility, strength testing
3	Weeks 11–16+	1–2× a week + home program	Plyometrics, sport-specific agility and cutting, testing; FIFA 11+ as an ongoing habit; return to full sport when criteria are met

Questions about your prevention program? Call our office or bring them to your next appointment. We are always glad to coordinate with your therapist.

For the Therapist

Check the surgeon notes first. They override anything else in this protocol. Questions or setbacks: call (425) 656-5060.

Surgeon notes and special instructions

General principles

- **Not a protection protocol.** Full weight bearing throughout, with no activity restrictions. This is a strengthening and movement-training program.
- **Criterion-based progression.** Time ranges are targets, not guarantees. Advance on movement quality and strength milestones, not the calendar alone.
- **Landing mechanics are a trainable skill.** Use external-focus cues (“land quietly,” “land like a cat”) rather than internal cues (“bend your knees”) for better motor learning and automaticity.
- **Hip strengthening is foundational.** The gluteus medius controls the knee valgus moment during landing. Every phase emphasizes hip abductor and external rotator strength.
- **Nordic hamstring curls are a cornerstone.** Eccentric hamstring strength is the primary dynamic restraint to anterior tibial translation. Introduce progressively from Phase 2.
- **FIFA 11+ as the warm-up model.** Athletes adopt FIFA 11+ as their standard pre-practice and pre-game warm-up (20 min, at least 3× a week). It replaces the standard warm-up; it is not additional training.
- **Soreness vs pain.** Delayed-onset muscle soreness is expected when starting hip work (weeks 1–2) and Nordic curls (weeks 5–6). Reduce resistance if pain (not soreness) occurs; reduce volume if soreness lasts beyond 48–72 hours. Patellar tendinopathy: keep squats, lunges, and jumps in a pain-free range and do not push through anterior knee pain.
- **BFR** (blood flow restriction training) is approved for lower-extremity strengthening when available, particularly hip and quad strengthening in Phase 1.
- **Train both legs.** Training is bilateral throughout. After ACL reconstruction, monitor symmetry: the other (non-operated) knee carries an elevated injury risk and should be trained equally.
- **After ACL reconstruction.** Athletes may start this program during late rehab (typically months 3–6), alongside the post-operative protocol, once cleared by Dr. Merritt and the treating therapist. Entry criterion: quad strength LSI $\geq 70\%$. Post-ACLR strength gates apply at the end of Phase 2 ($\geq 80\%$ LSI) and Phase 3 ($\geq 90\%$ LSI). The post-operative return-to-sport criteria still govern return to competition.

PHASE

1

Foundation: Hip, Core, and Movement Quality

Weeks 1–4

For the patient: what to expect

For the first 4 weeks, the focus is building the hip, core, and leg strength that protects your knee. You'll learn proper squat and landing technique. **No jumping yet:** this phase builds the foundation. Expect muscle soreness, especially in the glutes and hamstrings. That is normal as these muscles become more active. **Sharp pain is not normal;** tell your therapist so the exercise can be eased back.

WEIGHT BEARING	Full, no restrictions
BRACE	None required

Goals

- Baseline hip abductor and external rotator strength (gluteus medius $\geq$ grade 4/5 MMT)
- Hamstrings and quad activated and strengthened in preparation for eccentric loading
- Core stability for trunk control during dynamic movement
- Single-leg balance and proprioceptive awareness on a firm surface
- Gross movement faults (knee valgus, trunk lean) corrected on double-leg squat and lunge

Move on when

- ☐ Gluteus medius $\geq$ grade 4/5 on manual muscle testing, both sides
- ☐ Pain-free double-leg squat to 90° with neutral knee alignment
- ☐ Single-leg stance 30 sec without trunk deviation, firm surface
- ☐ Side plank 30 sec without hip drop

Exercises

Exercise	How
Side-lying hip abduction	3 × 15, slow tempo, 2-sec hold at the top
Clamshells with band	3 × 15, full external rotation
Monster walks with band	Forward, backward, and lateral. 3 × 12 each direction
Single-leg glute bridges	3 × 12 each leg, 2-sec hold at the top
Double-leg squats	3 × 12–15. Knee over the second toe, no valgus
Reverse lunges	3 × 10 each leg, controlled tempo
Dead bugs	3 × 10 each side
Side planks	3 × 30–45 sec each side
Double-leg bridges (hamstring isometric)	3 × 12, 2-sec hold
Single-leg stance, firm surface	3 × 30 sec each leg

Precautions

- No knee valgus during squats or lunges. If valgus persists despite cueing, regress the load or range and reinforce hip abductor activation before progressing. Valgus under load is the problem this program is designed to correct
- Delayed-onset soreness in the gluteus medius and TFL is expected for the first 1–2 weeks and is not a sign of injury. Reduce resistance if pain (not soreness) occurs
- After ACL reconstruction: may begin during late rehab, alongside the post-operative protocol, once cleared by Dr. Merritt and the treating therapist. Entry criterion: quad strength LSI $\geq 70\%$
- Patellar tendinopathy: modify lunges and squats to a pain-free range. Do not push through anterior knee pain

Why: The hip abductors, particularly the gluteus medius, are the primary controllers of knee valgus during landing and single-leg stance. Weakness allows hip adduction and femoral internal rotation, increasing the knee valgus moment that loads the ACL. Phase 1 corrects this upstream deficit before dynamic loading is introduced.

PHASE

2

Landing Mechanics and Neuromuscular Control

Weeks 5–10

For the patient: what to expect

This phase is about **how you move**: teaching your muscles to control your knee during landing and cutting. You'll learn to “stick” landings quietly, with your knees lined up over your toes. You'll also start the **Nordic hamstring curl**, one of the most important exercises for ACL protection. Expect sore hamstrings when you start it. This phase takes 6 weeks because retraining how you move takes a lot of repetition.

WEIGHT BEARING

Full. Progress from two-leg to single-leg loading

BRACE

None required. Functional bracing at the athlete's or coach's discretion only

Goals

- Proper double-leg landing (knee flexion $\geq 60^\circ$, neutral knee alignment, soft landing), consistently
- Single-leg squats with a controlled, valgus-neutral knee position
- Nordic hamstring curls progressed from assisted to unassisted
- Single-leg plyometric preparation (box drops, hop landings)
- Dynamic hip stability on an unstable surface in single-leg stance
- After ACL reconstruction: LSI $\geq 80\%$ on knee extensor and flexor testing before Phase 3

Move on when

- ☐ Correct landing on double-leg box drops (knee flexion $\geq 60^\circ$, no valgus, soft landing) for 3 consecutive sets
- ☐ Single-leg squat: 8 reps each leg without valgus or trunk deviation
- ☐ Nordic hamstring curl: 8 unassisted reps with a 3-sec eccentric descent
- ☐ Single-leg stance on foam: 30 sec without loss of balance, both sides
- ☐ After ACL reconstruction: LSI $\geq 80\%$ on isokinetic or handheld dynamometer testing

Exercises

Exercise	How
Phase 1 hip strengthening	Maintenance, 2 sets; reduce volume to allow progression loading
Single-leg squats	3 × 8–10 each leg, with mirror or video feedback for valgus correction
Lateral band walks	Feet hip-width, resisted. 3 × 15 steps each direction
Nordic hamstring curls	Weeks 5–6: 3 × 5, assisted (band or slow eccentric). Weeks 7–8: 3 × 6–8, partly unassisted. Weeks 9–10: 3 × 8–10, unassisted, 3-sec eccentric descent
Box drops (20 cm), stick landing	Double-leg. 3 × 6–8. Cue “land quiet”; knee flexion $\geq 60^\circ$, knees over toes, no valgus
Lateral bounds	Two-leg deceleration. 3 × 6 each side, controlled landing
Single-leg stance, foam or unstable surface	3 × 30–45 sec each leg
Perturbation training	Single-leg stance with arm perturbations from the therapist. 3 × 30 sec each leg
Cone stepping, forward and backward	3 × 30 sec; hip, knee, and ankle at 90°
Cone stepping, lateral	3 × 30 sec, controlled deceleration

Precautions

- No Phase 3 plyometrics until landing mechanics are consistently correct. Higher-intensity plyometrics with a persistent valgus landing pattern reinforce the injury mechanism instead of preventing it
- Nordic curls cause significant soreness in weeks 5–6 as a new eccentric stimulus. Begin conservatively (3 × 5, assisted). Soreness beyond 48–72 hours warrants a volume reduction; do not rush the progression
- Video feedback or a mirror is strongly recommended for single-leg squats and box drops; external visual feedback corrects movement patterns better than verbal cueing alone
- After ACL reconstruction: athletes who do not yet meet the 80% LSI gate stay in Phase 2 and continue targeted quad and hamstring strengthening in their post-operative protocol before advancing

Why: Landing mechanics are a trainable motor skill governed by neuroplasticity. Feedback during early repetitions is critical because the nervous system automates whatever pattern is repeated most. Progressing to reactive plyometrics before a safe pattern is established locks in the high-risk movement under load.

PHASE

3

Performance and Return to Sport

Weeks 11–16+

For the patient: what to expect

This is the performance phase: jumping, landing, cutting, and sport-specific movements. The focus shifts from learning to reacting, so your muscles control your knee automatically. You'll progress from two-leg jumps to single-leg and multi-direction drills. When you finish, the **FIFA 11+ becomes your permanent warm-up, 3 times a week**, to keep what you've gained. Athletes who stop the warm-up lose most of the protection within one season.

WEIGHT BEARING	Full. High-impact and sport-specific loading
BRACE	None required; athlete preference only

Goals

- Two-leg plyometrics progressed to single-leg jumping and landing
- Correct landing at plyometric intensity without active feedback
- Sport-specific cutting, pivoting, and deceleration integrated
- LSI $\geq 90\%$ on strength testing (after ACL reconstruction) or a sport-functional baseline (primary prevention)
- Sport-specific return-to-competition testing passed
- FIFA 11+ established as the standard warm-up and ongoing maintenance program

Move on when

- ☐ Single-leg hop testing $\geq 90\%$ LSI (triple hop, crossover hop, 6-meter timed hop)
- ☐ Drop vertical jump: no gross knee valgus on video at full intensity
- ☐ Reactive cutting drill at full speed with no instability
- ☐ After ACL reconstruction: isokinetic knee extensor and flexor strength $\geq 90\%$ LSI at $60^\circ/\text{sec}$
- ☐ Psychological readiness: feels confident and ready to return to competition

Exercises

Exercise	How
Countermovement jump	Double-leg. 3 × 8–10, soft, controlled landing
Box jump (30–40 cm)	Double-leg. 3 × 6–8, immediate stick landing
Lateral bounds	Two-leg to single-leg. 3 × 5–6 each direction, deceleration emphasis
Single-leg hop for distance	Stick landing. 3 × 5 each leg
Single-leg lateral hop	3 × 5 each leg, controlled landing
Drop vertical jump (30 cm)	3 × 5–6, with video analysis of landing mechanics; knee valgus eliminated or minimal
Reactive cutting drills	T-drill, 5-10-5 shuttle, figure-8, at progressive intensity
Pivoting and change of direction	45° and 90° cuts, both directions
Nordic hamstring curl	Maintenance, 2 × 8–10; continue through the season
Single-leg pistol squat (or box variation)	3 × 5–8 each leg
FIFA 11+	Full warm-up 3× a week, 20 min: running warm-up, then strength, balance, and plyometrics, then speed drills

Precautions

- Plyometrics follow a staged model: two-leg to single-leg, and controlled to reactive, before sport-specific drills. Skipping stages risks injury during a prevention program
- After ACL reconstruction: no clearance for full competition until LSI $\geq 90\%$ **and** sport-specific testing is passed, along with the post-operative return-to-sport criteria (including at least 9 months from surgery). Time alone (even 12 months) is not enough; re-injury rates stay elevated when LSI is $< 90\%$ at return
- Reinforce FIFA 11+ compliance at program completion; athletes who stop a structured warm-up lose most of the protective benefit within one season
- Patellar tendinopathy: modify high-intensity plyometrics (lower jump height and ground contact forces); do not push through anterior knee pain

Why: Single-leg reactive movements place the highest demand on dynamic valgus control. By this phase the neuromuscular system should automate the correct pattern without conscious cueing. If valgus reappears under reactive loading, return to Phase 2 landing drills before continuing. The goal is not completion; it is durable pattern change.

Return to Competition and Maintenance

All criteria must be met before return to full competition.

Measure	Target
Single-leg hop battery	≥90% LSI (triple hop, crossover hop, 6-meter timed hop)
Drop vertical jump	No gross knee valgus on video review at full jump intensity
Reactive cutting	Full speed, no instability
Strength (after ACL reconstruction)	Isokinetic knee extensor and flexor strength ≥90% LSI at 60°/sec, plus the post-operative return-to-sport criteria (at least 9 months from surgery)
Strength (primary prevention)	Sport-functional baseline
Psychological readiness	Feels confident and ready to return to competition
Maintenance	FIFA 11+ as the warm-up, 20 min, 3× a week; Nordic hamstring curls 2 × 8–10 through the season

Functional testing

- Hop testing: single hop, triple hop, crossover hop, 6-meter timed hop
- Drop vertical jump (30 cm) with video analysis
- Strength: isokinetic dynamometry at 60°/sec (after ACL reconstruction); handheld dynamometry acceptable in Phase 2
- Reactive cutting drills (T-drill, 5-10-5 shuttle, figure-8) at full speed

If valgus reappears under reactive loading, return to Phase 2 landing drills before continuing. Athletes who stop a structured warm-up lose most of the protective benefit within one season.