

MACI CARTILAGE REPAIR WITH HIGH TIBIAL OSTEOTOMY

Physical Therapy Protocol

PATIENT

SURGEON

Andrew L. Merritt, MD

DATE OF SURGERY

PT START DATE

For the patient

You had MACI cartilage repair on your thigh bone and a high tibial osteotomy (HTO): a bone cut in the shin bone that realigns your leg to take pressure off the new cartilage. Both must heal together. **You are toe-touch only until your 6-week X-ray**; then weight is added in steps. The cartilage keeps maturing for 12 to 18 months.

PROTOCOL AT A GLANCE

WEIGHT BEARING	Toe-touch (about 10–15 lb, for balance) until the 6-week X-ray , then in steps: 25%, 50%, 75%, full. Off crutches by about 10 to 12 weeks
BRACE	Hinged and unlocked from day 1, also for sleep: 0–90° week 1, 0–105° week 2, then fully open. Stops after you are off crutches
MOTION GOALS	90° by week 1 , 105° by week 2, 115° by week 3, 125° by week 4. Keep the knee fully straight
PHYSICAL THERAPY	Starts 5 to 7 days after surgery, 2 times a week at first
KEY PRECAUTIONS	No standing exercises until after the X-ray. No hamstring curls for 6 weeks. No anti-inflammatory medicines for 6 weeks
RUNNING · SPORT	Walk-jog at 9 to 12 months . Cutting and impact sport no sooner than 12 months

Recovery Timeline

Phase	When	PT visits	Focus
1	Weeks 0–6	2× a week	Toe-touch until the X-ray; bending to 125° by week 4; quad activation
2	Weeks 6–12	2× a week	Weight in steps after the X-ray; off crutches by weeks 10–12; bike, pool, strength
3	Months 3–6	1–2× a week + home program	Strength; loaded deep bending after month 5; symmetry testing at month 6
4	Months 6–18	As needed	Walk-jog at months 9–12; hop testing; impact sport at 12–18 months

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

- **Criterion- and time-based.** Advance when the phase goals are met and the minimum time has passed; Dr. Merritt's judgment overrides the timeline. Reactive effusion after a session means the load was too high.
- **Two tissues heal at once.** The graft integrates over 12–18 months; the HTO unites in 6–12 weeks. The bone cut sets weight bearing, gated by the 6-week X-ray; toe-touch for 6 weeks protects the cartilage, whichever way the bone was cut. Toe-touch = about 10–15 lb, for balance. No standing weight shifts or calf raises until week 7.
- **Graft biology.** Four stages: implantation (weeks 0–6), proliferation (weeks 6–12), remodeling (weeks 12–26), maturation (months 6–18). Full compressive stiffness takes 12–18 months.
- **Brace.** Hinged, unlocked from day 1 (walking and sleep): 0–90° week 1, 0–105° week 2, then open. When weight starts: unlocked if the SLR has no lag, otherwise locked for walking until it has none. Keep until off crutches.
- **Accelerated motion.** Faster than after MACI alone, to prevent arthrofibrosis: don't force past the target, but don't fall behind. CPM optional within the limits. **Hamstrings:** no curls or resisted knee flexion for 6 weeks.
- **Open-chain sequence.** Active extension in the 90–40° arc without resistance in Phase 1 (avoids the 0–40° zone of peak condylar contact); resistance in that arc from week 8; full 0–90° arc in Phase 3.
- **No anti-inflammatory medicines for 6 weeks**, including topical: no ibuprofen, naproxen, meloxicam, celecoxib, or diclofenac (Voltaren). They can slow cartilage and bone healing. The 81 mg aspirin is part of the plan. **No smoking or nicotine** for at least 3 months after surgery.
- **NMES** at PT visits only (no home unit). **Ice or cold compression** 20 min on, 20 min off after each session, leg elevated.

Procedures done at the same time

With meniscal repair or ACL reconstruction

- Meniscal repair: its weight-bearing rules take precedence if stricter.
- ACL reconstruction: ACL bracing rules in Phase 1, but toe-touch until the 6-week X-ray; MACI timeline and arc limits unchanged.

PHASE

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Protection

Weeks 0–6

For the patient: what to expect

Toe-touch only until your 6-week X-ray: your foot rests on the floor for balance (about 10 to 15 pounds) and your crutches carry your weight. Your brace is hinged and unlocked, and you sleep in it. Bending moves quickly to prevent stiffness: **90° by week 1, 105° by week 2, 115° by week 3, 125° by week 4.** Don't force past each goal, but don't fall behind.

WEIGHT BEARING	Toe-touch (about 10–15 lb) on 2 crutches until the 6-week X-ray; no partial weight. Avoid extended standing
BRACE	Hinged, unlocked, for walking and sleep: 0–90° week 1, 0–105° week 2, then fully open. Off for seated or supine exercises and hygiene
MOTION	Passive flexion 90° week 1, 105° week 2, 115° week 3, 125° week 4, 125°+ week 6. Full extension (0°). CPM optional within limits

Goals

- Protect the graft and the bone cut
- Full passive extension (0°)
- Flexion on schedule
- SLR without lag by weeks 3–4
- Swelling and pain controlled

Move on when

- ☐ Toe-touch kept until the X-ray
- ☐ 125° by week 4
- ☐ Full passive extension maintained
- ☐ SLR without extensor lag
- ☐ Pain and swelling decreasing

Exercises

Exercise	How
Quad sets · SLR	Quad sets 3 × 15 every waking hour (VMO first); straight-leg raises, flexion first then all planes, 3 × 10 each. NMES at PT
Heel slides · ankle pumps	Active-assisted flexion within the schedule, 3 × 15; ankle pumps hourly
Patellar mobilization	Gentle glides in all 4 directions, 2 × 10 each, 2× a day. Avoid compressing the graft
Open-chain knee extension	Active, 90–40° arc, no resistance, 3 × 15 from week 1
Seated calf raises · hip	Seated calf raises 3 × 15 (standing waits until after the X-ray); clamshells, supine abduction, prone hip extension 3 × 15
Leg press · pool	Isometric leg press, minimal load, 0–10° only, from week 4, 3 × 15. Deep-water walking once the incision is healed (weeks 4–5); upper body and core as tolerated

Precautions

- Strict toe-touch until the 6-week X-ray; no standing weight shifts or standing calf raises; avoid extended standing
- No hamstring curls or resisted knee flexion through week 6; no loaded knee flexion past 45°
- No loaded open-chain extension in the 0–40° arc; no running, jumping, or impact
- Stop and call us for sharp joint pain or excessive swelling

Why: Weeks 0–6 are the scaffold's most fragile stage. Strict toe-touch until the X-ray lets the fibrin glue fixation stabilize and protects the bone cut before loading increases.

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Transition

Weeks 6–12

For the patient: what to expect

If the 6-week X-ray shows the bone cut is healing, weight is added in steps: about a quarter at 6 weeks, half at 8, three-quarters at 9 to 10, full at 10 to 12. **Most people are off crutches by 10 to 12 weeks; the brace stops after that.** If the bone needs more time, you stay toe-touch longer.

WEIGHT BEARING	After X-ray clearance: 25% week 6, 50% week 8, 75% weeks 9–10, full weeks 10–12. Otherwise toe-touch until Dr. Merritt advances it. Standing work stays within the current step
BRACE	Fully open; unlocked for walking if the SLR has no lag, otherwise locked until it has none. Stop after off crutches
MOTION	Full by week 12. Loaded flexion $\leq 60^\circ$ in weeks 6–10, to 90° by week 12

Goals

- Off crutches by weeks 10–12
- Full motion by week 12
- Quad strength 50–60% of the other leg
- Closed-chain strength in a safe arc ($0-60^\circ$ first)
- Bike and pool by weeks 6–8

Move on when

- ☐ Near-normal gait without crutches
- ☐ Full motion ($0-130^\circ$ +)
- ☐ Mini squat ($0-45^\circ$) $\times 15$ pain-free
- ☐ Bike 20–30 min pain-free
- ☐ Quad within 30%, hamstring within 20%, balance within 30% of the other leg

Exercises

Exercise	How
Bike · pool	After the X-ray: recumbent bike, low resistance, 15–20 min (upright at weeks 10–12); shallow pool walking, heel raises, gentle squats
Weight shifts · calf raises	Standing, from week 7, within the weight step; single-leg calf raises at full weight
Open-chain knee extension	$90-40^\circ$ arc; resistance from week 8, add 1 lb a week; 3×15
Mini squats · leg press	Mini squats $0-45^\circ$ from week 8, 3×15 ; leg press $0-60^\circ$, 3×12 . Both to $0-90^\circ$ by week 12
Step-ups	2–4-inch step at full weight, 3×10 ; then 4–6-inch
Hip · balance	Standing band abduction and adduction, 3×12 ; single-leg balance 3×30 sec once off crutches, then unstable and dynamic
Weeks 10–12 additions	Treadmill walking on level ground once off crutches; stair machine by week 12 (low resistance, short); elliptical once walking without crutches

Precautions

- No added weight until the 6-week X-ray confirms healing of the bone cut
- Weight steps follow pain, swelling, and quad control; don't rush crutch weaning
- Loaded flexion $\leq 60^\circ$ in weeks 6–10; to 90° after week 10 only without reactive effusion
- No deep squats, lunges past 90° , or step-downs until Phase 3; no running, jumping, or impact

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Strengthening

Months 3–6

For the patient: what to expect

This phase builds strength for daily life. Squats and lunges go deeper and resistance goes up, and by weeks 16–20 you'll have a home program to keep doing on your own. Deep bending under load is allowed after month 5. **No running yet:** that starts at 9 to 12 months.

WEIGHT BEARING	Full, unrestricted
MOTION	Full. Loaded deep flexion (past 90°) only after month 5

Goals

- Quad strength ≥ 75 –80% of the other leg
- Full motion; loaded deep flexion after month 5
- Low-impact conditioning established
- Neuromuscular control in single-leg tasks
- Home maintenance program by weeks 16–20

Move on when

- ☐ Quad strength ≥ 80 % of the other leg
- ☐ Squat to 90° under load without pain
- ☐ 8-inch step-down, symmetric and pain-free
- ☐ 30+ min low-impact cardio without pain or swelling
- ☐ Balance within 75–80% of the other leg

Exercises

Exercise	How
Squats · leg press	Squats 0–60°, to 90° by month 4; leg press 0–60° to 0–90°. Full depth after month 5
Step-ups · step-downs	Step-ups 6–8-inch, 3 × 10; eccentric step-downs from months 4–5
Lunges	Forward and reverse, progressing depth and load; past 90° (including lateral) after month 5
Single-leg squat	3 × 10; progress depth
Open-chain knee extension	0–90° arc, low resistance; add 1 lb a week from about week 20; progressive full-arc loading after month 5. Watch for anterior knee pain or effusion
Hip strengthening	Hip thrust, lateral band walks, single-leg bridge
Low-impact cardio	Bike with rising resistance 30–40 min; elliptical or ski machine; swimming (freestyle, backstroke); treadmill walking, adding distance, cadence, and incline

Maintenance program (weeks 16–20): squats, step-ups, hip strengthening, cycling, and stretching, 3–4× a week, continued independently.

Precautions

- No running until months 9–12 and quad strength criteria are met, regardless of lesion size
- No plyometrics before month 12; no aggressive pivoting or cutting before months 12–18
- Persistent swelling after loading means progression is too fast

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Return to Activity

Months 6–18

For the patient: what to expect

Running starts with walk–jog intervals at **9 to 12 months**, once you meet the strength goals. Jumping and cutting sports come **after 12 months**. To return to full sport you need to pass hop testing, have near-equal strength in both legs, and be cleared by Dr. Merritt.

RUNNING	Walk–jog intervals at months 9–12, once criteria are met
IMPACT · CUTTING	Plyometrics from month 12; agility and cutting drills from months 12–15

Goals

- Quad strength $\geq 90\%$ of the other leg
- Hop tests $\geq 90\%$ LSI
- Return to full recreational or sport activity

Move on when

- ☐ Quad strength $\geq 90\%$ (isokinetic or functional)
- ☐ Hop tests $\geq 90\%$ LSI
- ☐ Running 20 min continuous without pain
- ☐ Clearance from Dr. Merritt (MRI recommended at 12 months)

Exercises

Exercise	How
Maintenance program	3–4× a week, progressive resistance; whole-leg strength and flexibility
Running program	Walk–jog intervals from months 9–12 on flat ground, no hills at first. Same for every lesion size
Plyometrics	Month 12+: bilateral jump and land, then single-leg hops
Agility · cutting	Balance and agility drills; cutting and deceleration from months 12–15; then sport-specific training
Hop testing	Single hop, triple hop, crossover hop, timed 6-meter hop

Precautions

- High-impact or cutting sport: 12 months minimum, no exceptions regardless of how the patient feels
- Walk–jog intervals first; no continuous running before building a base
- Plyometrics only after month 12 and with sound bilateral landing mechanics
- Persistent pain, swelling, or giving way needs evaluation by Dr. Merritt before advancing

Return to Activity

All criteria met, with clearance from Dr. Merritt, before high-impact, cutting, or pivoting sport.

Criterion	Required
Quadriceps · hamstring strength	≥90% LSI
Single-leg hop tests	≥90% LSI (single, triple, crossover, timed)
Motion	Full and pain-free, equal to the other knee, including loaded deep flexion
Effusion	None after functional activity
HTO hardware	Reviewed by Dr. Merritt; removal per surgeon preference
Running	Months 9–12, once criteria are met
High-impact or cutting sport	12 months minimum
MRI	Recommended at 12 months, before return to sport
Clearance	Formal clearance from Dr. Merritt

Testing: isokinetic or functional strength testing; hop battery (single, triple, crossover, timed 6-meter); MRI and clinical review at 12 months. Timelines follow MACI graft maturation; clinical judgment and objective testing guide each step.

Clinical Timeline Summary

Milestone	When
Toe-touch (about 10–15 lb)	Day of surgery to the 6-week X-ray
Weight steps	25% week 6, 50% week 8, 75% weeks 9–10, full weeks 10–12
Standing exercises · bike · pool	After the X-ray (weeks 6–8)
Brace hinge	0–90° week 1, 0–105° week 2, then fully open
Off crutches · brace stops	Weeks 10–12
Hamstring curls	After week 6
Open-chain extension	90–40° in Phase 1; resistance from week 8; 0–90° in Phase 3
Loaded deep flexion (past 90°)	Month 5+
Home maintenance program	Weeks 16–20
Running (walk–jog) · plyometrics	Months 9–12 · month 12+
Cutting, pivoting, impact sport	Months 12–18, after criteria and clearance
MRI, surgeon and hardware review	12-month visit