

MACI KNEECAP CARTILAGE REPAIR WITH TIBIAL TUBERCLE 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 kneecap or its groove (the trochlea), plus a tibial tubercle osteotomy (TTO): a bone cut that moved the kneecap tendon's attachment to take stress off the repair. **The bone cut sets the first six weeks: toe-touch only** until an X-ray shows healing, brace locked straight, and bending on a schedule. The cartilage keeps maturing for 12 to 18 months.

PROTOCOL AT A GLANCE

WEIGHT BEARING	Toe-touch (about 10–15 lb, for balance) on 2 crutches for 6 weeks , until the X-ray. Off crutches by about 8 to 10 weeks
BRACE	Locked straight for walking and sleep through week 6 . Opened in weeks 7–8. Stops after you are off crutches
MOTION GOALS	Never past the limit: 45° by day 5, 60° by week 1, 75° by week 3 , then up to 90° until the 6-week X-ray
PHYSICAL THERAPY	Starts 5 to 7 days after surgery, 2 times a week at first
KEY PRECAUTIONS	No standing exercises while toe-touch. Bike from week 3, rocking within the limit. 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; brace locked; bending step by step up to 90°; quad activation
2	Weeks 6–12	2× a week	Weight after the X-ray; off crutches by weeks 8–10; brace opened, then off
3	Months 3–6	1–2× a week + home program	Deeper squats; 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.
- **The TTO drives Phase 1.** Toe-touch until the 6-week X-ray confirms tubercle healing; flexion at or below 90° until then; bike rocking only within the limit. Toe-touch = about 10–15 lb, for balance.
- **Why this differs from TTO alone.** The bone cut sets the 90° cap and the bike rules, as after an isolated TTO. The cartilage adds the slower 45°/60°/75° steps and the brace locked straight at night, because kneecap contact pressure rises as the knee bends.
- **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.
- **After the X-ray,** the MACI kneecap precautions apply: loaded flexion $\leq 45^\circ$ at first, no deep squats or step-downs until month 5. Open-chain extension uses the 90–40° arc first (lowest patellofemoral stress for open-chain work); full arc from month 5.
- **Brace.** Locked at 0° for weight bearing and sleep through week 6; opened weeks 7–8; stops after off crutches.
- **Motion.** Active and active-assisted on the schedule. CPM optional if provided, within the limits.
- **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.
- **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 MPFL reconstruction or lateral retinacular lengthening

- **MPFL:** no change; avoiding aggressive lateral patellar stress is already part of the progression.
- **Lateral retinacular lengthening:** no change; gentle medial patellar mobilization per surgeon preference, avoiding excessive compression of the graft.

PHASE

1

Dual Protection: TTO and MACI

Weeks 0–6

For the patient: what to expect

Two repairs are healing at once. **Toe-touch only for 6 weeks:** your foot rests on the floor for balance (about 10 to 15 pounds) and your crutches carry your weight. The brace stays **locked straight** when you are up and while you sleep. **Bending: no more than 45° by day 5, 60° by week 1, 75° by week 3, and 90° until your 6-week X-ray.**

WEIGHT BEARING	Toe-touch (about 10–15 lb) on 2 crutches until the 6-week X-ray
BRACE	Locked at 0° for weight bearing and sleep through week 6; off for exercises and hygiene
MOTION	Passive flexion 45° day 5, 60° week 1, 75° week 3, then up to 90° until the X-ray. Never exceed it. Full extension (0°). CPM optional within limits

Goals

- Protect the tubercle until the X-ray
- Flexion on schedule
- SLR without extensor lag by week 4
- Swelling and pain controlled
- Patellar and scar mobility

Move on when

- ☐ Toe-touch kept for 6 weeks
- ☐ 90° passive flexion by week 6
- ☐ 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 · scar mobilization	Superior and inferior glides, gentle, 2 × 10, 2× a day; medial per surgeon preference; no lateral stress or graft compression. Scar work at the TTO incision once closed
Hip · isometric leg press	Clamshells, supine abduction, prone hip extension 3 × 15. Isometric leg press, minimal load, 0–10° only, from week 4, 3 × 15
Bike · pool	Bike from week 3: rocking or partial revolutions within the bending limit only. Deep-water walking once healed (weeks 4–5), with surgeon approval; upper body and core

Precautions

- Absolute toe-touch for 6 weeks; no bridges or standing exercises of any kind
- Brace locked at 0° for weight bearing and sleep through week 6: non-negotiable
- Never exceed the flexion schedule or the 90° cap; deep flexion stresses the tubercle fixation
- No loaded knee flexion; gentle patellar mobilization only

Why: The TTO heals like a fracture: load or excess flexion before union risks hardware failure or displacement. The MACI scaffold is also at its most fragile.

PHASE

2

Progressive Weight Bearing

Weeks 6–12

For the patient: what to expect

Once the X-ray shows the bone cut is healing, you start putting weight through your leg. **Most people are off crutches by 8 to 10 weeks.** The brace is opened in weeks 7 to 8 and stops once you are off crutches. You can bend past 90° now, but not with weight on the leg until month 5. Full turns on the bike, shallow-water work, and gentle strengthening start.

WEIGHT BEARING	After X-ray clearance: as tolerated, 2 crutches → 1 → none by about weeks 8–10
BRACE	Opened in weeks 7–8; stop after off crutches
MOTION	The 90° cap lifts after the X-ray; full by weeks 12–14. Loaded flexion ≤45° in weeks 6–10, to 90° by weeks 12–14

Goals

- Off crutches by weeks 8–10
- Flexion from 90° toward full by weeks 12–14
- Quad strength 50–60% of the other leg
- Closed-chain work outside the loaded 45–90° arc
- Bike and pool by weeks 6–8

Move on when

- ☐ Near-normal gait without crutches
- ☐ Full motion (0–130°+)
- ☐ Mini squat (0–45°) × 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	Full revolutions once the cap has lifted and motion allows (about 100–110°): recumbent, low resistance, 15–20 min; upright at weeks 10–12. Shallow pool from weeks 6–8
Open-chain knee extension	90–40° arc, no resistance, after the X-ray; 3 × 15
Mini squats · leg press	Mini squats 0–45°, 3 × 15; leg press 0–60°, 3 × 12. Both to 0–90° by week 12
Step-ups	2–4-inch step, 3 × 10; 4–6-inch by weeks 10–12
Hip · balance · calves	Standing band abduction and adduction 3 × 12; single-leg balance 3 × 30 sec, then unstable; calf raises bilateral to single-leg 3 × 15
Weeks 10–12 additions	Stair machine by week 12 (low resistance, short); elliptical once walking pain-free

Precautions

- Weight follows pain and X-ray confirmation of tubercle healing (more imaging if unclear)
- Loaded flexion ≤45° in weeks 6–10; no step-downs, deep squats, or lunges past 90° through month 5
- Open-chain extension only 90–40°, no resistance; no resisted leg extension machine in Phase 2
- No running, jumping, or impact; more swelling or joint-line pain means regress

Why: The tubercle unites by weeks 6–8 and keeps consolidating. The graft is in the proliferation stage, so the patellofemoral limits still apply; open-chain work stays unresisted in the 90–40° arc.

PHASE

3

Strengthening

Months 3–6

For the patient: what to expect

This phase builds strength for daily life: deeper squats, more resistance, and low-impact fitness. Deep bending under load (past 90°) is allowed after month 5. By the end of this phase your quad should be 75 to 80% as strong as your other leg. **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 functional 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	Squat depth to 90° by month 4; progress leg press range and load. Full depth for both after month 5
Step-ups · step-downs	Step-ups 6–8-inch, 3 × 10; eccentric step-downs from months 4–5
Lunges · single-leg squat	Forward and reverse lunges, progressing depth and load (past 90°, including lateral, after month 5); single-leg squat 3 × 10
Open-chain knee extension	90–40° arc with low resistance (the tubercle is healed). Full arc from month 5: no resistance first, add 1 lb every 2 weeks from about week 20
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; treadmill walking, adding distance and incline

Maintenance program (weeks 16–20): home exercises 3× a week (squats, step-ups, single-leg balance, calf raises, hip abduction and extension) and cardio 3× a week, 30–45 min. Formal PT may drop to 2× a month.

Precautions

- No running until months 9–12 and quad strength criteria are met; no jumping or impact until Phase 4
- Loaded deep flexion only after month 5; full-arc open-chain extension only from month 5, adding 1 lb every 2 weeks
- Patellofemoral pain above 3/10 with loading means regress

Why: Remodeling (months 3–6) lays down organized type II collagen; progressive loading aligns it. Full-arc open-chain extension is added from month 5. The TTO is consolidated and no longer limits exercise.

PHASE

4

Return to Activity

Months 6–18

For the patient: what to expect

Running starts with walk–jog intervals at **9 to 12 months**. High-impact and cutting sports need **at least 12 months**; clearance is based on strength and hop testing, not time alone. Dr. Merritt checks the cartilage and the TTO screws at 12 months.

RUNNING	Walk–jog intervals at months 9–12; continuous running over the next 6–8 weeks
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 and TTO hardware review at 12 months)

Exercises

Exercise	How
Running program	Walk–jog intervals from months 9–12 on flat ground, no hills at first; continuous over 6–8 weeks. Same for every lesion size
Plyometrics	Month 12+: bilateral jump and land, then single-leg hops
Agility · cutting	Cutting and deceleration drills from months 12–15; then sport-specific training
Hop testing	Single hop, triple hop, crossover hop, timed 6-meter hop
Maintenance	Quad and hip strength work, long term

Precautions

- High-impact or cutting sport: 12 months minimum; no jumping or plyometrics before 12 months
- Running at months 9–12 for everyone, regardless of lesion size
- Maturation continues for up to 3 years; avoid unnecessary high-load impact training after return
- TTO hardware review at 12 months (removal if symptomatic); recurrent anterior knee pain warrants an MRI

Why: Cartilage maturation drives the return-to-sport timeline; the TTO is remodeled well before then.

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
TTO hardware	Radiographic and clinical review at 12 months
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 reflect both graft maturation and TTO healing; clinical judgment and testing take precedence over time alone.

Clinical Timeline Summary

Milestone	When
Toe-touch (about 10–15 lb)	Day of surgery to the 6-week X-ray
Flexion limits	45° day 5, 60° week 1, 75° week 3, 90° until the X-ray
Bike, rocking within the limit	From week 3; full revolutions after the X-ray
Brace locked (walking and sleep)	Weeks 0–6; opened weeks 7–8; stops after off crutches
Off crutches	Weeks 8–10
Open-chain extension 90–40°	After the X-ray; resistance in Phase 3
Loaded deep flexion · full-arc extension	Month 5+
Home maintenance program	Weeks 16–20
Running (walk-jog) · plyometrics	Months 9–12 · month 12+
TTO hardware review	12-month visit
Cutting, pivoting, impact sport	Months 12–18, after criteria and clearance