

MACI CARTILAGE REPAIR OF THE KNEECAP OR TROCHLEA

Physical Therapy Protocol

PATIENT

SURGEON

Andrew L. Merritt, MD

DATE OF SURGERY

PT START DATE

For the patient

MACI replaces damaged cartilage on your kneecap, or the groove it runs in (the trochlea), with a patch grown from your own cartilage cells. **You can put weight on your leg right away, as long as the brace is locked straight:** with the knee straight, the kneecap barely presses on the repair. Bending while sitting or lying down is not limited.

PROTOCOL AT A GLANCE

WEIGHT BEARING	As tolerated from day 1, brace locked straight. Crutches for comfort for about 2 to 3 weeks
BRACE	Locked straight for standing, walking, and sleep for 6 weeks . Then opened gradually; off by about 8 to 10 weeks
MOTION GOALS	No limit without weight on the leg. 90° by 2–3 weeks , 105° by weeks 3–4, 120° by week 6. Never weight on a bent knee
PHYSICAL THERAPY	Starts 5 to 7 days after surgery, 2 times a week at first
KEY PRECAUTIONS	No kneeling or squatting early. No leg-extension machine until week 14. 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	Walking in a locked brace; off crutches by weeks 2–3; 90° by weeks 2–3
2	Weeks 6–12	2× a week	Brace opened, off by weeks 8–10; bike, step-ups, strength in a safe range
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.
- **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.
- **Patellofemoral loading.** Under axial (closed-chain) load, contact pressure peaks at 45–90°, so loaded flexion is limited early. In open-chain extension it is highest near full extension, so open-chain work uses the 90–40° arc first and the full arc only from month 5. Unloaded motion is unrestricted from day 1.
- **Brace.** Locked at 0° for all weight bearing and for sleep for 6 weeks; off only for seated or supine exercises and hygiene. Opened gradually from week 6; off by weeks 8–10. Crutches for comfort for about 2–3 weeks.
- **Motion.** Active and active-assisted. CPM optional if provided.
- **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

Protection and Early Activation

Weeks 0–6

For the patient: what to expect

You can put weight on your leg, with crutches for comfort for 2 to 3 weeks, but **your brace must be locked straight whenever you are standing, walking, or sleeping**. Bending starts on day 1, out of the brace, sitting or lying down, with no limit. **Goals: 90° by 2 to 3 weeks, 105° by 3 to 4 weeks, 120° by 6 weeks.** Ice and elevate after every session.

WEIGHT BEARING	As tolerated with the brace locked at 0°; crutches weaned by about weeks 2–3. Never bear weight without the brace locked
BRACE	Locked at 0° for all weight bearing and for sleep through week 6. Off for seated or supine exercises and hygiene
MOTION	Unloaded motion unrestricted from day 1. Goals 90° by weeks 2–3, 105° by weeks 3–4, 120° by week 6. Full extension (0°)

Goals

- Protect the graft from patellofemoral load
- Flexion goals on schedule
- SLR without extensor lag by week 3
- Swelling and pain controlled
- Safe gait in the locked brace

Move on when

- ☐ 120° passive flexion by week 6
- ☐ Full passive extension maintained
- ☐ SLR without extensor lag
- ☐ Safe gait in the locked brace, off crutches
- ☐ Pain and swelling decreasing

Exercises

Exercise	How
Quad sets · SLR	Quad sets 3 × 15 every waking hour (VMO first); straight-leg raises in 4 planes, 3 × 10 each
Heel slides · ankle pumps	Supine active-assisted flexion toward the goals, 3 × 15; ankle pumps hourly
Patellar mobilization	Superior and inferior glides, gentle, 2 × 10 each, 2× a day. No lateral loading; medial glide only per surgeon preference
Weight shifts · calf raises	Brace locked: side-to-side shifts from weeks 2–3; bilateral standing calf raises from week 2, 3 × 15
Hip · leg press · bands	Clamshells, supine hip abduction, 3 × 15. From week 4: isometric leg press 0–10°, minimal load; light-band extension, 90–40° arc; 3 × 15
Pool	Once the incision is healed (about week 4): walking, gentle motion, heel raises

Precautions

- Brace locked at 0° for all weight bearing and sleep for 6 weeks: non-negotiable
- Never stand or walk on a bent knee; no kneeling, squatting, or low sitting
- No resisted straightening before week 4; then light bands only. No leg-extension machine until week 14
- No aggressive patellar compression; the graft surface is fragile

Why: Patellofemoral pressure peaks at 45–90° under load. In weeks 0–6 the scaffold is held only by fibrin glue. The locked brace allows weight bearing while keeping the joint at its lowest pressure (0°).

PHASE

2

Progressive Loading

Weeks 6–12

For the patient: what to expect

After 6 weeks your therapist opens the brace a little at a time; **most people are out of it by 8 to 10 weeks.** You'll start mini squats and step-ups in a limited range, plus the bike and pool. **Key rule: no bending past 45° with weight on the leg at first**, working up to 90° by week 12. No running, jumping, or impact.

BRACE	Opened gradually for walking from week 6; off by about weeks 8–10, as quad control allows
MOTION	Full unloaded. Loaded flexion $\leq 45^\circ$ in weeks 6–10, to 90° by weeks 10–12. No deep squats, step-downs, or stair descent past 90° through month 5

Goals

- Out of the brace by weeks 8–10
- Normal gait on level ground and stairs
- Quad strength 50–60% of the other leg
- Closed-chain work outside the loaded $45\text{--}90^\circ$ arc
- Bike without pain by weeks 8–9

Move on when

- ☐ Near-normal gait without brace or crutch
- ☐ Mini squat ($0\text{--}45^\circ$) $\times 15$ pain-free
- ☐ Bike 20 min pain-free
- ☐ Quad within 30%, hamstring within 20%, balance within 30% of the other leg

Exercises

Exercise	How
Bike	Recumbent from weeks 7–8 once active flexion is $\geq 100^\circ$, low resistance, 15–20 min; upright at weeks 9–12
Mini squats · leg press	Mini squats $0\text{--}45^\circ$, 3×15 , load from week 10; leg press $0\text{--}60^\circ$, 3×12 . Both to $0\text{--}90^\circ$ by week 12
Step-ups	2–4-inch step only, 3×10 ; 4–6-inch by weeks 10–12
Open-chain knee extension	$90\text{--}40^\circ$ arc, light bands (from week 4), low resistance from weeks 6–8, 3×15 . No leg-extension machine until week 14; no full arc until month 5
Hip · balance · calves	Standing band abduction and adduction 3×12 ; single-leg balance 3×30 sec, then unstable; calf raises to single-leg 3×15
Pool	Shallow-water walking, heel raises, gentle squats at a buoyancy-assisted depth
Weeks 10–12 additions	Stair machine by week 12 (low resistance, short); elliptical once walking pain-free

Precautions

- Loaded flexion $\leq 45^\circ$ in weeks 6–10; to 90° by week 12. No step-downs, deep squats, or lunges past 90° through month 5
- Open-chain extension only in the $90\text{--}40^\circ$ arc in Phase 2
- No running, jumping, or impact
- Joint-line pain or more swelling after exercise means overload; regress right away

Why: In the proliferation stage (weeks 6–12) the defect fills with primitive repair tissue, not yet organized. Open-chain extension stays in the $90\text{--}40^\circ$ arc, where patellofemoral stress is lowest for open-chain work.

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

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 progressive low resistance. Full arc from month 5: body weight first, add 1 lb every 2 weeks from about week 20
Leg extension machine	From about week 14, only if cleared by Dr. Merritt: 90–40° arc first; full arc after month 5; light resistance only
Hip strengthening	Hip thrust, lateral band walks
Low-impact cardio	Bike with rising resistance 30–40 min; elliptical; rowing ergometer (seated, less knee flexion); swimming

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: In the remodeling stage (weeks 12–26) organized type II collagen matrix is laid down, and progressive loading aligns it. Full-arc open-chain extension is added carefully from month 5.

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** as the cartilage keeps maturing. Cutting, pivoting, and high-impact sports need **at least 12 months** and full strength. Dr. Merritt checks the cartilage with an exam and MRI 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 exam 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

- No high-impact or cutting sport before 12 months, regardless of how the patient feels
- Running at months 9–12 for everyone; lesion size does not change this
- Maturation continues for up to 3 years; avoid unnecessary high-load impact training after return
- Recurrent anterior knee pain with loading warrants an MRI

Why: Returning to high impact before 12 months often leads to graft pain and MRI signs of poor matrix consolidation, so the running timeline is the same for everyone.

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
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. MACI maturation takes years; clinical judgment and objective testing take precedence over the timeline. Please call us with any question about a patient's progress.

Clinical Timeline Summary

Milestone	When
Weight as tolerated, brace locked	From day 1
Off crutches	Weeks 2–3
Brace locked (walking and sleep)	Weeks 0–6; opened from week 6, off by weeks 8–10
Open-chain extension 90–40°	Bands from week 4; low resistance from weeks 6–8; leg-extension machine from about week 14
Bike and pool therapy	Weeks 7–12
Loaded deep flexion · full-arc extension	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