

MACI CARTILAGE REPAIR (LARGE LESION)

Physical Therapy Protocol

PATIENT

SURGEON

Andrew L. Merritt, MD

DATE OF SURGERY

PT START DATE

For the patient

MACI replaces damaged cartilage on your thigh bone with a patch grown from your own cartilage cells. Because your area is **large (5 cm² or more)**, more surface has to attach before it can take load, so you stay on crutches longer. The patch matures over 12 to 18 months. **Patience in the first six months protects a repair built to last decades.** You move on when your knee meets the goals, not just when the weeks pass.

PROTOCOL AT A GLANCE

WEIGHT BEARING	Toe-touch (about 10–15 lb, for balance) on crutches from the day of surgery for 6 weeks , then as tolerated. Off crutches by about 10 to 12 weeks
BRACE	Hinged, unlocked for walking from day 1. Not needed for sleep. Stops once you are off crutches
MOTION GOALS	90° by 2 weeks (don't force it), 105° by weeks 3–4, 120° by weeks 5–6. 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 week 6. No anti-inflammatory medicines for 6 weeks , including gels
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; 90° by 2 weeks; quad activation
2	Weeks 6–12	2× a week	Weight as tolerated; off crutches by weeks 10–12; bike, pool, early 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.
- **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.
- **Tibiofemoral loading.** The graft is on the weight-bearing condyle: toe-touch from day 0 through week 6, as tolerated from week 6. Toe-touch = about 10–15 lb, for balance. No standing weight shifts or calf raises before week 6 (seated calf raises instead). Avoid extended standing through Phase 2.
- **Large lesion ($\geq 5 \text{ cm}^2$).** More immature graft is exposed to compression, so full weight bearing is delayed to weeks 10–12. An unloading brace may be prescribed case by case.
- **Brace.** Hinged, unlocked for walking from day 1; not needed for sleep. Keep it for walking until off crutches.
- **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.
- **Motion.** Active and active-assisted; do not force past the target. 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

MACI + meniscal repair

- If the meniscal repair's weight-bearing rules are stricter, they take precedence. Follow Dr. Merritt's instructions for weight-bearing milestones.

PHASE

1

Protection

Weeks 0–6

For the patient: what to expect

The new cartilage needs time to attach. **Toe-touch only from the day of surgery:** your foot rests on the floor for balance (about 10 to 15 pounds) and your crutches carry your weight **for 6 weeks**. Your brace is unlocked for walking and not needed for sleep. **Aim for 90° of bend by 2 weeks, but don't force it.** Avoid standing for long periods.

WEIGHT BEARING	Toe-touch (about 10–15 lb) on 2 crutches until week 6; no partial weight. Avoid extended standing
BRACE	Hinged, unlocked for walking from day 1. Off for sleep, seated or supine exercises, and hygiene
MOTION	Passive flexion 90° by week 2, 105° by weeks 3–4, 120° by weeks 5–6; don't force past it. Full extension (0°). CPM optional within limits

Goals

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

Move on when

- ☐ 90° by week 2; 120° by week 6
- ☐ Full passive extension maintained
- ☐ SLR without extensor lag
- ☐ Weight-bearing limits followed
- ☐ 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 week 6); 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

- Toe-touch to week 6; no standing weight shifts or standing calf raises
- No loaded knee flexion past 45°; avoid extended standing
- 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: compression and shear risk delamination or failed integration. Toe-touch lets the fibrin glue fixation stabilize before real loading.

PHASE

2

Transition

Weeks 6–12

For the patient: what to expect

You can now put weight through your leg. Because your area is large, full weight comes a little later: **most people are off crutches by 10 to 12 weeks**, and the brace stops once you are. Bending is no longer limited, but avoid bending past 90° with weight on the leg until month 5. If your knee swells after exercise, you did too much: back off and ice.

WEIGHT BEARING	As tolerated from week 6: 2 crutches → 1 by week 8 → none by weeks 10–12
BRACE	Hinged, for walking until off crutches (about weeks 10–12). An unloading brace may be prescribed case by case
MOTION	125–135° by week 10, full by week 12. Loaded flexion ≤60° 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° first)
- 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	Recumbent bike from weeks 6–8, low resistance, 15–20 min; upright at weeks 10–12. Shallow pool: walking, heel raises, gentle squats
Weight shifts · calf raises	Standing, from week 6; calf raises bilateral to single-leg, 3 × 15
Open-chain knee extension	90–40° arc; resistance from week 8, add 1 lb a week; 3 × 15
Mini squats · leg press	Mini squats 0–45° from week 8 as weight improves, 3 × 15; leg press 0–60°, 3 × 12. Both to 0–90° by week 12
Step-ups	2–4-inch step from week 10, 3 × 10; 4–6-inch by weeks 10–12
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

- Full weight is delayed to weeks 10–12 for a large lesion; don't rush crutch weaning
- Loaded flexion ≤60° 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
- More swelling after a session means reduce the load

PHASE

3

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

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**, 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
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	Day 0 to week 6
Weight as tolerated · standing exercises	From week 6
Off crutches · brace stops	Weeks 10–12
Bike and pool therapy	Weeks 6–8
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 and surgeon review	12-month visit