

MACI (Matrix-Induced Autologous Chondrocyte Implantation)



Physical Therapy Protocol · Graft-Maturation-Paced, Lesion Location-Specific

Based on the Verice! MACI Rehabilitation Manual, the Ohio State University Wexner Medical Center Autologous Chondrocyte Implantation Clinical Practice Guideline (2023), and the JOSPT clinical rehabilitation guidelines for tibiofemoral MACI (Edwards et al., 2014).

AT A GLANCE

TIMELINE	12-15 months to full return to sport; three broad blocks - protect/mobilize (0-3 months), build strength (3-6 months), return to activity (6 months onward) - progressed by criteria, not calendar alone
WEIGHT BEARING	Tibiofemoral lesions: $\leq 20\%$ BW initially, advancing $\sim 10\text{-}15\%$ BW per week to full WB by weeks 7-9. Patellofemoral single lesions: immediate full WB in a brace locked in extension; brace opened weeks 5-6 and discharged by week 8
KEY MILESTONES	CPM from days 1-10 post-op; full passive extension immediately; flexion $0\text{-}90^\circ$ by weeks 2-3, $0\text{-}125^\circ$ by week 6, full ROM weeks 8-10; assistive device discharge $\sim$ weeks 7-10
RETURN TO ACTIVITY	Low-impact recreation (cycling, golf, swimming) ~ 6 months; walk-jog progression 6-9 months once isokinetic symmetry $\geq 80\%$; full sport 12-15 months with $\geq 90\%$ strength and hop-test LSI

KEY PRECAUTIONS

- Protect the graft: no WB beyond the prescribed percentage for tibiofemoral lesions, no ambulation without crutches/brace as prescribed, and no resisted knee extension through the lesion-engaging arc in early phases.
- Monitor pain and swelling at every visit; sharp pain, locking, catching, or a new effusion warrants immediate surgeon contact. Use the stroke-test traffic-light system - effusion $\geq 2+$ halts impact progression.
- Patellofemoral lesions: brace locked in extension for ambulation through week 4-5; limit loaded knee flexion angles and use protected-arc ($90^\circ\text{-}45^\circ$) OKC/CKC work per the operative note.
- High compression, shear, and rotational loads are avoided until 12-18 months; concomitant procedures (TTO, meniscal allograft, osteotomy) slow the WB and ROM timeline.

PHASED REHABILITATION

PHASE 1 - PROTECTION & EARLY MOTION		Weeks 0-6
GOALS	- Protect the implant while achieving full passive extension and flexion to 125° by week 6 - Establish quadriceps activation (SLR without lag) and control effusion - Advance WB per lesion location without symptom flare	
INTERVENTIONS	- CPM initiated within days 1-10 per surgeon order (start 0-45°, at least 1 hour daily per Vericel; advance toward maximum comfortable range); discontinue by week 6 - Tibiofemoral: ≤20% BW weeks 0-1, 30-50% BW weeks 2-3, 60-80% BW weeks 4-5; patellofemoral: full WB with brace locked in extension, opened weeks 5-6 - High-volume motion: 300+ flexion repetitions/day (heel slides, wall slides) plus 60 min/day low-load extension stretching - Quad/hamstring/gluteal isometrics, 4-way SLR, prone TKE, patellar mobilization, ankle pumps - NMES to quadriceps in long sitting (10-20 s on / 50 s off × 15 min); BFR training 2×/week after suture removal if cleared - Recumbent cycling from ~week 3, upright cycling weeks 5-6; hydrotherapy/deep-water walking once incision is healed - SAQ/LAQ through protected 90°-45° arc only (tibiofemoral) beginning weeks 2-3	
CRITERIA TO ADVANCE	- Pain-free full passive extension and active flexion ≥125° 3×10 SLR without extension lag; strong quad set with superior patellar glide - Pain-free gait at the prescribed WB level; effusion controlled (≤2+)	

PHASE 2 - FULL WEIGHT BEARING & MOTION RESTORATION		Weeks 7-12
GOALS	- Full unassisted WB with normalized gait (tibiofemoral by weeks 7-10); brace discharged (patellofemoral by week 8) - Full active ROM by weeks 8-10 - Initiate balance/proprioception and early CKC loading	
INTERVENTIONS	- Gait training to full WB; discharge crutches when full active extension, 2×10 SLR without lag, effusion ≤1+, and no gait deviation - Mini squats 0-45° (weeks 8-10), heel taps 2-4 inches and step-ups 6-8 inches (weeks 10-12) - Resisted OKC quad strengthening through protected 90°-45° arc (weeks 10-12) - Multi-angle isometrics; standing hip strengthening; trunk stability (planks, TrA work) - Balance and proprioception progression, double- to single-leg, stable to unstable surfaces - Upright cycling and rowing ergometer for conditioning; NMES continued seated at 60° flexion	
CRITERIA TO ADVANCE	- Full pain-free active ROM symmetrical to the opposite side - Pain-free ambulation and upright cycling without reactive effusion - Independent of assistive device and brace	

PHASE 3 - STRENGTH & FUNCTION		Months 3-6
GOALS	- Restore functional CKC strength and endurance; return to work per job demands - Quadriceps symmetry approaching 80% on isometric testing (test at 4-4.5 months at 90°)	
INTERVENTIONS	- Progressive CKC loading: leg press, terminal knee extension, lunges, single-leg sit-to-stand through protected ROM, bridging, single-leg calf raises - Resisted OKC quad work advanced through full ROM from weeks 12-14 - Continue NMES until quadriceps symmetry $\geq 80\%$ - Elliptical; outdoor cycling and rowing ergometry months 5-6; increase cycling distance - Stair and gradient negotiation training; 3x10 single-leg heel raises on a 6-inch step with neutral alignment	
CRITERIA TO ADVANCE	- Negotiates stairs and mild gradients without pain or reactive effusion - Isometric quadriceps symmetry $\geq 80\%$ - Work capacity appropriate to occupational demands	

PHASE 4 - IMPACT PREPARATION		Months 6-9
GOALS	- Meet criteria to initiate walk-jog and light plyometrics - Tolerate low-impact recreation (cycling, golf, swimming, elliptical) without symptom flare	
INTERVENTIONS	- Isokinetic testing at 6 and 9 months (60°/s and 300°/s) - Walk-jog progression once criteria met: full symmetrical pain-free ROM, isokinetic symmetry $\geq 80\%$, effusion $\leq 1+$, normalized gait mechanics, pain-free hopping in place - Jump progression: partial-BW double-leg (shuttle/leg press) advancing to full-BW double-leg, then single-leg - Single-leg eccentric strengthening; advanced OKC loading 3+ mile walks and uneven-surface tolerance work without reactive symptoms	
CRITERIA TO ADVANCE	- Quad/hamstring isokinetic symmetry $\geq 80\%$ at both speeds - Tolerates walk-jog and low-impact recreation without reactive pain or effusion $\geq 1+$ - Effusion stable with progressive loading (green-light on stroke test)	

PHASE 5 - RETURN TO SPORT		Months 9-15
GOALS	- Progress agility, plyometrics, and sport-specific training to unrestricted participation - Achieve $\geq 90\%$ limb symmetry across strength and hop testing	
INTERVENTIONS	- Step-hold to single-leg hop progression; multi-plane agility and plyometrics - Sport-specific drills progressing from controlled to reactive; running volume progression - Isokinetic testing at 12 months and at discharge - Contact/collision sport progression 10-12+ months (single defects earlier; multiple defects and heavy labor 9-12+ months per Vericel framework)	
CRITERIA TO ADVANCE	- Isokinetic quad/hamstring symmetry $\geq 90\%$ at 60°/s and 300°/s; hop-test LSI $\geq 90\%$ on all tests - No reactive effusion with sport-specific activity; sound landing/agility mechanics - Physician clearance; full return to sport expected 12-15 months post-op	

GUIDING PRINCIPLES

This protocol follows criterion-based progression over rigid time-based advancement; phased rehabilitation balancing tissue healing with controlled stress application; objective milestones (ROM, strength LSI, functional testing) to guide phase transitions; individualization based on surgical findings, tissue quality, and patient factors; and ongoing surgeon–therapist communication throughout recovery.

REFERENCES

1. Vericel Corporation. MACI Rehabilitation Manual. <https://www.maci.com/pdf/MACI-Rehabilitation-Manual.pdf>
2. Ohio State University Wexner Medical Center Sports Medicine. Autologous Chondrocyte Implantation (ACI) Clinical Practice Guideline (2023). https://medicine.osu.edu/-/media/files/medicine/departments/sports-medicine/medical-professionals/knee-ankle-and-foot/autologous-chondrocyte-implantation_2023.pdf
3. Edwards PK, Ackland T, Ebert JR. Clinical Rehabilitation Guidelines for Matrix-Induced Autologous Chondrocyte Implantation on the Tibiofemoral Joint. *J Orthop Sports Phys Ther.* 2014;44(2):102-119.

For clinical use by licensed physical therapists treating patients of Robert Pettit, MD. This document is a rehabilitation guideline, not a substitute for clinical judgment. Progression must be individualized based on intraoperative findings, tissue quality, and patient response. Scan the QR code for the current version of this protocol.