KNEE ARTICULAR CARTILAGE MACI TIBIOFEMORAL POST-OPERATIVE GUIDELINE

The following Knee Articular Cartilage Matrix-induced Autologous Chondrocyte Implantation (MACI) Guideline was developed by HSS Rehabilitation. Progressions in this guideline are both criteria-based and can be modified for individual patient needs. Phases and time frames are designed to give the clinician a general sense of progression. The rehabilitation program following a MACI procedure emphasizes early, controlled motion to prevent knee stiffness and to avoid disuse atrophy of the musculature. The program should be a balance of managing prior deficits, tissue healing and appropriate interventions to maximize flexibility, strength, and pain-free performance of functional activities. This model should not replace clinical judgment.

These types of patients may have additional alignment issues that may have caused their initial cartilage breakdown. Please be aware if concomitant surgical procedures have been performed. Defer to the surgeon for additional direction.

Monitor edema throughout the rehabilitation process. If persistent edema occurs, monitor load volume and consult with the referring surgeon.

FOLLOW SURGEON MODIFICATIONS AND BRACE GUIDELINES AS PRESCRIBED

KNEE ARTICULAR CARTILAGE MACI TIBIOFEMORAL POST-OPERATIVE GUIDELINE

Post-operative Phase 1: Weeks 0-2

PRECAUTIONS

- Range of motion (ROM)
  - 0-90˚ as tolerated or as per surgeon guidelines
  - **Do not force ROM**
- Adhere to weight bearing restrictions
  - 20% body weight foot flat weight bearing (FFWB) with bilateral axillary crutches or as per SURGEON guidelines
- Brace guidelines
  - Ambulation with brace locked in extension and bilateral axillary crutches
  - **Sleep with brace locked in extension for 2 weeks (or as per surgeon guidelines)**
- Avoid pillow under knee to prevent knee flexion contracture

ASSESSMENT

- Lower Extremity Functional Scale (LEFS) - Validated for ages 18+ years
- Pediatric International Knee Documentation Committee Subjective Knee Evaluation Form (Pedi-IKDC) validated for ages 10 -18 years
- Numeric pain rating scale (NPRS)
- Inspection of incision
- Edema (girth and description)
- Patellar mobility
- Lower extremity (LE) passive ROM (PROM)
- LE flexibility
- Quality of quadriceps contraction
- Gait assessment

TREATMENT RECOMMENDATIONS

- Patient and family/caregiver education
- Immediate ROM after surgery
  - Active assisted ROM pain-free: seated knee flexion off table
  - **Do not force ROM**
- Emphasize full knee extension immediately
  - Heel prop multiple times per day
  - LE stretching (hamstring/gastrocnemius/soleus)
- Soft tissue mobilization, if applicable

    - Quadriceps, hamstring, gastrocnemius/soleus
    - Mobilization to superior patellar pouch and infra-patellar soft tissue structures to provide proper patellar mobility
- Patellar mobilization as indicated (all planes)
- Strengthening
    - Quadriceps re-education with neuromuscular electric stimulation (NMES) (If not tolerated by youth patient consider biofeedback)
    - Straight leg raise (SLR) all planes- emphasize no extensor lag
        - Brace locked in extension if pain and/or extensor lag
    - Ankle progressive resistive exercises (PRE)
    - Short crank bike (once sufficient ROM attained: 85-90˚)
- Consider blood flow restriction (BFR) program with FDA approved device and qualified therapist if patient cleared by surgeon
- Edema control (cryotherapy)

CRITERIA FOR ADVANCEMENT

- Maintain knee ROM: 0°-90°
- Control post-operative pain/edema
- SLR flexion without extensor lag

EMPHASIZE

- Adherence to post-op restrictions and home exercise program
- Ambulation with brace locked in extension and 20% FFWB
- Improving quadriceps activation
- ROM 0°-90°
- Pain/effusion control

KNEE ARTICULAR CARTILAGE MACI TIBIOFEMORAL POST-OPERATIVE GUIDELINE

Post-operative Phase 2: Weeks 2-6

PRECAUTIONS

- Progress ROM as tolerated: **do not force motion**
- Adhere to weight bearing restrictions or as per surgeon guidelines
    - Weeks 2-4: partial weight bearing (PWB) up to 50% body weight
    - Weeks 4-6: 75% weight bearing (WB) with crutches
- Brace guidelines: locked in extension x 6 weeks with ambulation
- Avoid pillow under knee to prevent knee flexion contracture

ASSESSMENT

- LEFS
- Pedi-IKDC (if applicable)
- NPRS
- Inspection of incision
- Edema (girth and description)
- Patellar mobility
- LE PROM
- LE flexibility
- Quality of quadriceps contraction
- Gait assessment

TREATMENT RECOMMENDATIONS

- Patient and family/caregiver education
- Range of motion
    - Gradual increase to full ROM (Follow surgeon protocol. If no specific ROMs use below ranges as a guideline)
        - Week 3: 0˚-105˚
        - Week 4: 0˚-115˚/120˚
        - Week 6: 0˚-130˚- full
    - Continue exercises from phase 1
    - Step knee flexion stretch
    - Heel slides against wall
    - Maintain passive knee extension
- Patellar mobilizations as needed
- Continue with LE stretching program from Phase 1

- Strengthening
    - Continue with NMES as needed for quadriceps activation (or biofeedback for youth patient if NMES not tolerated)
    - Progress to upright stationary bike (when 110-115˚ knee flexion obtained)
    - Multi-angle quadriceps isometrics (avoid lesion)
    - Weight shift exercises with upper extremity support
        - Bilateral leg balance/proprioceptive activities
    - Standing bilateral heel raises
    - Initiate core stabilization/kinetic linking program
    - Progress multiplanar gluteal/core/hip strengthening (continue Phase 1 exercises)
        - SLR (all planes) with goal to be able to perform without brace or extensor lag
        - Clamshells (with adequate flexion ROM)
        - Bridges with resistance band abduction (with adequate knee flexion ROM)
    - Leg press (light weight bilaterally, monitor arc of motion) – after week 4
    - Hydrotherapy when incisions are healed- week 4-6 for gait, proximal strengthening, functional movements, balance and edema control
- Cryotherapy and elevation of LE to prevent edema

CRITERIA FOR ADVANCEMENT

- 75% WB with crutches and brace locked in extension
- Steady progression toward full ROM
- Normal patella mobility (all planes)
- Minimal edema
- Pain controlled

EMPHASIZE

- Emphasize pain free ROM
- Control edema
- Activity modification that is age appropriate including consideration of Physical Education class

KNEE ARTICULAR CARTILAGE MACI TIBIOFEMORAL POST-OPERATIVE GUIDELINES

Post-operative Phase 3: Weeks 7-12

PRECAUTIONS

- Progress ROM to within functional limits (WFL)
- Progress to WBAT with crutches
    - Unlock brace with adequate quadriceps control
    - Wean from crutches with non-antalgic gait pattern
- Monitor edema and soreness with weight bearing and therapeutic exercise

ASSESSMENT

- LEFS
- Pedi-IKDC (if applicable)
- NPRS
- Edema (girth and description)
- Scar mobility
- Patellar mobility
- LE PROM
- LE flexibility
- Quality of quadriceps contraction
- Gait assessment

TREATMENT RECOMMENDATIONS

- Patient and family/caregiver education
- Range of motion
    - Gradual increase of ROM to WFL
        - Continue ROM exercises from Phase 2
        - Prone knee flexion stretch
        - Supine or kneeling hip flexor stretch
    - Maintain full passive knee extension
    - Continue LE stretching program
    - Continue patellar mobilization as needed
    - Initiate foam rolling program
- Brace
    - Unlock brace with adequate quadriceps control
    - Discharge brace per surgeon direction
    - Wean from crutches with non-antalgic gait pattern

- Soft tissue mobilization- continue as needed
- Scar mobilization
- Gait Training
    - Emphasize heel toe gait pattern
    - Retro-ambulation for neuromuscular quadriceps control
    - Underwater or anti-gravity treadmill gait training if gait pattern continues to be abnormal
- Strengthening
    - Leg press bilateral → eccentric
    - Resisted terminal knee extension in weight bearing
    - Chair/box squats
        - Band around knees to promote gluteal activation
        - Promote movement through hips and proper form
        - Progressively lower seat height as appropriate for strength gains and pain response
    - Suspension system squats – week 8
        - Emphasizing same principles as box squat
    - Initiate forward step up (FSU)
        - Start with 4 inch (”) step and progress to 8” with adequate quadriceps strength Consider 2” step for short youth patients
        - Emphasize proper movement pattern (no hip drop, no valgus breakdown)
    - Romanian deadlift: double leg → single leg
    - Progressive gluteal/hip strengthening
        - Three-point step
        - Lateral/monster walks
        - Hip abduction isometric at wall
        - Windmills
        - Clamshells in modified side plank
        - Bridge progression
    - Progress balance/proprioception
    - Progress core stabilization/kinetic linking program
    - Initiate forward step down (FSD)
        - Start with 4” step and progress to 6” emphasize eccentric control. Consider 2” step for short youth patients
        - Emphasize proper movement pattern (no hip drop, no valgus breakdown)
- Cardiovascular
    - Progress stationary bike time
    - Progress to elliptical when able to perform FSU 8”

CRITERIA FOR ADVANCEMENT

- ROM WFL
- Ability to ascend 8” step
- Normal gait pattern
- Squat 0°-90° symmetrically
- Single leg stance > 30 seconds

EMPHASIZE

- Minimal edema
- Control volume and load with functional activities
- Emphasis on proper movement strategy/quality of movement
- Age appropriate activity modification including consideration of Physical Education class

KNEE ARTICULAR CARTILAGE MACI TIBIOFEMORAL POST-OPERATIVE GUIDELINES

Post-operative Phase 4: Weeks 12-18

PRECAUTIONS

- Avoid pain with therapeutic and functional activities
- Control post-operative edema

ASSESSMENT

- LEFS
- Pedi-IKDC (if applicable)
- NPRS
- Edema (girth and description)
- LE flexibility
- Strength assessment: isokinetic testing, hand-held dynamometry

TREATMENT RECOMMENDATIONS

- Range of motion: continue if ROM deficits exist
- Strengthening
    - Progress squat program (PRE)
    - Progress eccentric leg press
    - Progress suspension system squats
        - Eccentric double leg squats
        - Single leg squats focusing on control and technique
    - Progress step up and step down progression by increasing height and adding weights (intrinsic load)
    - Advanced proprioception training (perturbations)
    - Continue to progress aquatic program if available
    - Biking/elliptical/climbing machine
    - Continue core/kinetic linking progression

CRITERIA FOR ADVANCEMENT

- 80% quadriceps limb symmetry (dynamometry)
- No pain/inflammation after activity
- Able to descend 8” step with good control, no deviations
- Perform single leg squat (45-60 deg) with good control

EMPHASIZE

- Minimal edema
- Control volume and load with functional activities
- Emphasis on proper movement strategy/quality of movement

KNEE ARTICULAR CARTILAGE MACI TIBIOFEMORAL POST-OPERATIVE GUIDELINES

Post-operative Phase 5 Return to Sport: Weeks 18+

Begin only if returning to sport with surgeon clearance

PRECAUTIONS

- Monitor load and volume
- Monitor pain and edema
- Ensure adequate rest
- Avoid premature or too rapid full return to sport

ASSESSMENT

- LEFS
- Pedi-IKDC (if applicable)
- NPRS
- LE flexibility
- Strength assessment: hand-held dynamometry, isokinetic testing
- Return to sport testing, e.g., hop testing
- Apprehension with sports specific movement

TREATMENT RECOMMENDATIONS

- HSS Return to Sport Assessment
- Running progression- week 20+
    - Initiate running progression with Anti-gravity treadmill or pool running
    - Display good eccentric control with 8” step down prior to initiating running
    - Be cautious of overloading the knee – monitor for edema
    - Progress to interval treadmill running based on no symptom reproduction (pain or edema) after tolerating 95% weight bearing in Alter-G
- Strength maintenance program
    - Bike/elliptical lower resistance
    - Gluteal activation exercises
    - Chair/box squats
    - Leg press
    - Multiplanar hip strengthening
    - Front/side/back lunges
    - Single leg RDL
- LE stretching: include foam rolling

- Plyometric program: double leg → single leg
- Progress strength and flexibility through entire kinetic chain (hips, knees, ankles)
- Progress with cardiovascular endurance training while continuing low load methods
- Progress with agility and balance drills
- Progress with sports specific programs
- Collaborate with ATC, performance coach/strength and conditioning coach, skills coach and/or personal trainer to monitor load and volume with return to sport participation

CRITERIA FOR DISCHARGE

- 90% limb symmetry (quadriceps and hamstring) with dynamometry, isokinetic, and functional testing
- Independent with gym strengthening and maintenance program

EMPHASIZE

- Monitor volume in sports related activities
- Collaboration with Sports Performance experts

KNEE ARTICULAR CARTILAGE MACI TIBIOFEMORAL POST-OPERATIVE GUIDELINES

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