

CARTILAGE RESTORATION REHAB PROTOCOL



Background

Cartilage restoration is a complex and ever changing field of orthopedic surgery, with the ultimate goal to heal cartilage injuries of the knee with normal hyaline cartilage. This involves multiple types of cartilage grafts, including a patient's own cartilage (autologous chondrocyte implantation, aka MACI), or donor cartilage (allograft). This may also involve repairing the cartilage after an injury in younger patients after an osteochondral fracture.

Summary of Recommendations

Expectations	<ul style="list-style-type: none"> ● PT and CPM should begin between postop day 1-7 ● Return to sport: 12-15 months
Concomitant Procedures	<ul style="list-style-type: none"> ● Do not change protocol based on multiple defects, meniscus repair, or ligamentous reconstruction <ul style="list-style-type: none"> ○ If multiple defects include patellofemoral lesion, follow the patellofemoral precautions ● TTO adjustments <ul style="list-style-type: none"> ○ Open brace to 0-35° at weeks 5-6
Weight Bearing Progression	<ul style="list-style-type: none"> ● Tibiofemoral (no brace) <ul style="list-style-type: none"> ○ Phase 1 (week 1): NWB ○ Phase 2 (week 2-3): 25% WB ○ Phase 3 (week 4-5): 60% WB ○ Phase 4 (week 6-7): 90 - 100% WB ○ Phase 5 (week 8-10): full WB with normal gait ● Patellofemoral (TROM extension brace) <ul style="list-style-type: none"> ○ Phase 1-3 (weeks 1-5): full WB, brace locked in extension <ul style="list-style-type: none"> ■ Open brace at week 5-6 ○ Phase 4 (weeks 6-7): discontinue brace ○ PHase 5 (weeks 8-10): normal gait without brace
Range of Motion Progression	<ul style="list-style-type: none"> ● Phase 1-2 (week 1-3): 0-45° (week 2) to 0-90° (week 3) ● Phase 3 (week 4-5): 0-105° (week 4) to 0-120° (week 5) ● Phase 4 (week 6-7): 0-125° (week 6) to 0-135° (week 7) ● Phase 5 (week 8-10): Full AROM
Criteria to Discharge Assistive Device	<ul style="list-style-type: none"> ● <u>ROM</u>: Full active knee extension; no pain on passive overpressure ● <u>Strength</u>: Able to perform strong quad isometric with full tetany and superior patellar glide and able to perform 2x10 SLR without quad lag ● <u>Effusion</u>: 1+ or less is preferred (2+ acceptable if all other criteria are met) ● <u>Weight Bearing</u>: Demonstrates pain-free ambulation without visible gait deviation
Criteria to Initiate Running and Jumping	<ul style="list-style-type: none"> ● <u>ROM</u>: full, pain-free knee ROM, symmetrical with the uninvolved limb ● <u>Strength</u>: Isokinetic testing 80% or greater for hamstring and quad at 60°/sec and 300°/sec ● <u>Effusion</u>: 1+ or less ● <u>Weight Bearing</u>: normalized gait and jogging mechanics ● <u>Neuromuscular Control</u>: Pain-free hopping in place

Criteria for Return to Sport	<ul style="list-style-type: none"> ● <u>ROM</u>: full, pain free knee ROM, symmetrical with the uninvolved limb ● <u>Strength</u>: Isokinetic testing 90% or greater for hamstring and quad at 60°/sec and 300°/sec ● <u>Effusion</u>: No reactive effusion ≥ 1+ with sport-specific activity ● <u>Weight Bearing</u>: normalized gait and jogging mechanics ● <u>Neuromuscular control</u>: appropriate mechanics and force attenuation strategies with high level agility, plyometrics, and high impact movements ● <u>Functional Hop Testing</u>: LSI 90% or greater for all tests ● <u>Physician Clearance</u>
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Rehab Protocol

Phase I: Weeks 0-1

Goal	<ul style="list-style-type: none"> ● Maintain joint mobility and muscle tone while adhering to all post-operative precautions
Range of motion	<ul style="list-style-type: none"> ● 0-45° ● CPM to start at day 2-10
Weight Bearing	<ul style="list-style-type: none"> ● <u>Tibiofemoral</u>: ≤20% BW ● <u>Patellofemoral</u>: Full BW, brace locked in full extension
Interventions	<ul style="list-style-type: none"> ● Ankle pumps ● Quadriceps, hamstring and gluteal isometrics ● Diaphragmatic breathing ● Effusion management strategies, including RICE

Phase II: weeks 2-3

Goals	<ul style="list-style-type: none"> ● The patient should achieve pain-free and full passive knee extension. Focus is placed on maintaining muscle tone, ensuring proper wound healing and effusion management.
Range of Motion	<ul style="list-style-type: none"> ● 0-90° ● CPM and AAROM (heel slides, wall slides, AAROM row machine)* ● Total volume: 300+ repetitions per day ● Goal: early AROM though safe range
Weight Bearing	<ul style="list-style-type: none"> ● <u>Tibiofemoral</u>: 30% to 50% BW ● <u>Patellofemoral</u>: Full BW, brace locked in full extension
Suggested Interventions	<ul style="list-style-type: none"> ● Ankle pumps ● Quadriceps, hamstring and gluteal isometrics ● Prone TKE ● SLR-4 way ● Patellar mobilization in all directions ● Gait training ● Extension ROM: Seated towel stretch, prone hang, bag hang ● Flexion ROM: heel slides, wall slides, AAROM row machine ● Recumbent cycling- for ROM only (week 3)

	<ul style="list-style-type: none"> ● SAQ (no resistance) ● LAQ (no resistance, through protected ROM (90-45 degrees)) ● Continue CPM, effusion management and NMES in long sitting ● For PF lesions only: <i>(Must be performed in locked knee brace)</i> <ul style="list-style-type: none"> ○ Weight shifting ○ DL heel raise ○ SL balance ● NMES in long sitting
Criteria to Progress to Phase 3	<ul style="list-style-type: none"> ● By the end of week 3: <ul style="list-style-type: none"> ○ Pain-free knee flexion of 90° ○ Pain-free and full passive knee extension ○ Proficient heel-to-toe gait with 50% BW for tibiofemoral grafts or full BW for patellofemoral grafts ○ Reduced and well-controlled post-operative pain and edema ○ Ability to perform a strong isometric quadriceps contraction (full tetany and superior patellar glide) ○ Proficiency with home-exercise program

Phase III: Weeks 4-6

Goals	<ul style="list-style-type: none"> ● Emphasis is placed on increasing knee flexion ROM and improving quadriceps, gluteal and core strength
Range of Motion	<ul style="list-style-type: none"> ● 0-105° (week 4) to 0-125° (week 6) ● Achieved through CPM and AAROM (heel slides, wall slides, AAROM row machine)* ● Total volume: 300+ repetitions per day ● Goal: early AROM through safe range
Weight Bearing	<ul style="list-style-type: none"> ● <u>Tibiofemoral</u>: 60% BW (week 4) to 80% BW (week 5) ● <u>Patellofemoral</u>: Full BW, open brace at weeks 5-6
Suggested Interventions	<ul style="list-style-type: none"> ● Continue Phase 1 and 2 interventions ● SLR-Flexion progressions <ul style="list-style-type: none"> ○ Semi-reclined or seated ○ Add ER ○ Perform with eyes closed (cortical training) ○ Speed ○ Isometric holds at end-range ● Heel slides ● Clamshells ● Seated or standing hip ab/adduction (depending on WBing status) ● Trunk stability interventions <ul style="list-style-type: none"> ○ TrA isometric progression ○ Prone/side planks ● Upright cycling (weeks 5-6) ● Standing TKE (weeks 6-8) ● Partial BW Shuttle Press (week 6-8) ● OKC Hamstring strengthening (week 6-7) ● Progress NMES to seated with tibia fixed at 60° of knee flexion ● Discharge CPM at 6 weeks ● Continue effusion management strategies
Criteria to Progress to Phase 4	<ul style="list-style-type: none"> ● By the end of week 6: <ul style="list-style-type: none"> ○ Pain-free active knee flexion to 125° ○ Pain-free gait with 80% BW for tibiofemoral grafts or full BW for patellofemoral grafts ○ 3x10 SLR without quadriceps lag

	<ul style="list-style-type: none"> ○ Proficiency with home exercise program
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PHase IV: Weeks 7-12

Goals	<ul style="list-style-type: none"> ● The patient works toward movement independent of ambulation devices and knee braces. Full ROM should be achieved and balance/proprioception interventions are initiated.
Range of Motion	<ul style="list-style-type: none"> ● 0-125° (week 6), 0-135° (week 7) to full ROM (week 8-10)
Suggested Interventions	<ul style="list-style-type: none"> ● Continue Phase 2 and 3 interventions ● Continue ROM interventions until symmetrical ROM is achieved ● Partial BW Shuttle Press (week 6-8) ● OKC Hamstring strengthening (week 6-7) ● Multi-angle isometrics ● Balance and proprioception interventions ● Mini squats: 0-45 degrees (week 8-10) ● Heel Taps: 2-4" (weeks 10-12) ● Step Ups: 6-8" (weeks 10-12) ● Resisted OKC quadriceps strengthening through 90-45° protected ROM (week 10-12) ● Continue NMES (seated with tibia fixed at 60° of knee flexion) ● Continue effusion management strategies as needed
Criteria to Discharge Assistive Device	<ul style="list-style-type: none"> ● <u>ROM</u>: Full active knee extension; no pain on passive overpressure ● <u>Strength</u>: Able to perform strong quad isometric with full tetany and superior patellar glide and able to perform 2x10 SLR without quad lag ● <u>Effusion</u>: 1+ or less is preferred (2+ acceptable if all other criteria are met) ● <u>Weight Bearing</u>: Demonstrates pain-free ambulation without visible gait deviation
Criteria to Progress to Phase 5	<ul style="list-style-type: none"> ● By week 12: <ul style="list-style-type: none"> ○ Pain-free active ROM ○ Pain-free upright cycle ergometry ○ Pain-free ambulation without visible gait deviation ○ Proficiency in home exercise program

Phase V: Months 3-6

Goals	<ul style="list-style-type: none"> ● The majority of patients return to work either on a part-time or full-time basis. Patients should continue skilled physical therapy to progress functional, CKC strengthening.
Range of Motion	<ul style="list-style-type: none"> ● Full AROM
Weight Bearing	<ul style="list-style-type: none"> ● Full WB, normal gait
Suggested Interventions	<ul style="list-style-type: none"> ● Continue Phase 3 and 4 interventions ● Bridging ● Standing SL calf raises ● Resisted OKC quadriceps strengthening through full ROM (week 12-14) • Lunges ● SL sit to stand, through protected ROM ● Elliptical ● Outdoor cycling if desired (months 5-6) ● Rowing ergometry as tolerated (months 5-6) ● Continue NMES until 80% symmetry is obtained ● Continue effusion management as needed

Criteria to Progress to Phase 6	<ul style="list-style-type: none"> ● By 6 months: <ul style="list-style-type: none"> ○ Ability to negotiate stairs and mild gradients without pain or reactive effusion ○ Return to work, depending on the demands of the job ○ Ability to perform 3x10 heel raise on 6" step with neutral frontal and sagittal plane alignment ○ Proficiency in home exercise program
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Phase VI: Months 6-9

Goals	<ul style="list-style-type: none"> ● Patient progress OKC interventions. Strength testing is performed to determine readiness to initiate light plyometrics and walk-jog progression.
Range of Motion	<ul style="list-style-type: none"> ● Full AROM
Weight Bearing	<ul style="list-style-type: none"> ● Full WB, normal gait
Suggested Interventions	<ul style="list-style-type: none"> ● Continue phase 3-5 interventions ● Progress and increased difficulty of OKC exercises ● Continue to progress SL eccentric strengthening through body weight and machine interventions ● Once strength criteria have been met, perform the following progression: <ul style="list-style-type: none"> ○ PBW jumping on the shuttle (DL → SL) <ul style="list-style-type: none"> ○ Full body weight jumping progression ● Walk-jog program
Criteria to Initiate Running and Jumping	<ul style="list-style-type: none"> ● <u>ROM</u>: full, pain-free knee ROM, symmetrical with the uninvolved limb ● <u>Strength</u>: Isokinetic testing 80% or greater for hamstring and quad at 60°/sec and 300°/sec ● <u>Effusion</u>: 1+ or less ● <u>Weight Bearing</u>: normalized gait and jogging mechanics ● <u>Neuromuscular Control</u>: Pain-free hopping in place ● <u>Functional Hop Testing</u>: LSI 90% greater for all tests ● <u>Physician Clearance</u>
Criteria to Progress to Phase 7	<ul style="list-style-type: none"> ● By 9 months: <ul style="list-style-type: none"> ○ Quadriceps and hamstring symmetry of 80% or greater ○ Ability to tolerate walking distances of 3 miles or greater without reactive pain or effusion ○ Ability to effectively negotiate uneven ground, including soft sand, without reactive pain or effusion ○ Ability to return to pre-operative low-impact recreational activities, including cycling, elliptical and weight training

Phase VII: Months 9-Return to Sport

Goals	<ul style="list-style-type: none"> ● The patient is able to resume all normal functionality and will continue to progress towards return to sport.
Range of Motion	<ul style="list-style-type: none"> ● Full ROM
Weight Bearing	<ul style="list-style-type: none"> ● Full WB, normal gait
Suggested	<ul style="list-style-type: none"> ● Continue phase 3-6 interventions

Interventions	<ul style="list-style-type: none"> ● Step-hold progression to SL hop progression ● Sports-specific training ● Agility ● Plyometrics
Criteria to Return to Sport	<ul style="list-style-type: none"> ● <u>ROM</u>: full, painfree knee ROM, symmetrical with the uninvolved limb ● <u>Strength</u>: Isokinetic testing 90% or greater for hamstring and quad at 60°/sec and 300°/sec ● <u>Effusion</u>: No reactive effusion ≥ 1+ with sport-specific activity ● <u>Weight Bearing</u>: normalized gait and jogging mechanics ● <u>Neuromuscular control</u>: appropriate mechanics and force attenuation strategies with high level agility, plyometrics, and high impact movements ● <u>Functional Hop Testing</u>: LSI 90% or greater for all tests ● <u>Physician Clearance</u>

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