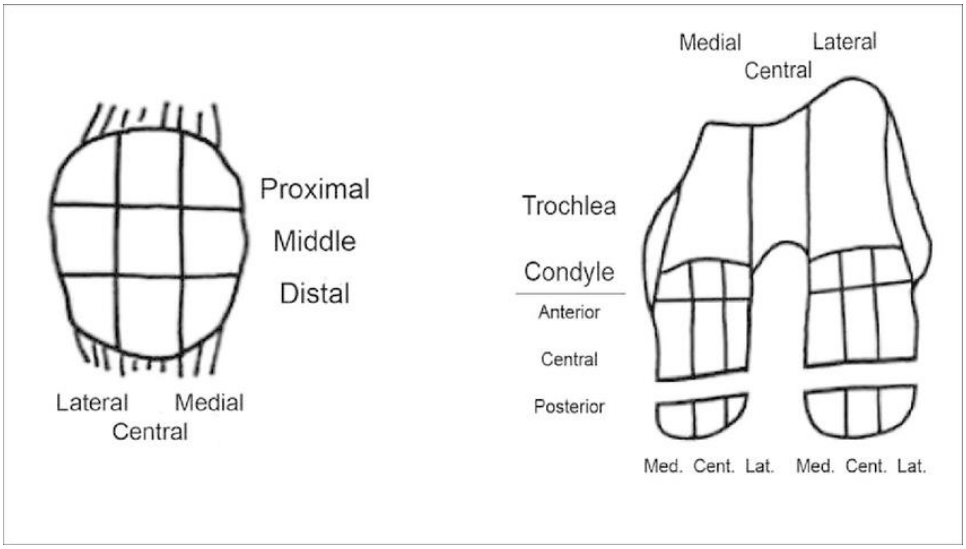
Rehabilitation Protocol for ACI Femoral Condyle

This protocol is intended to guide clinicians through the post-operative course for Femoral Autologous Chondrocyte Implantation (ACI), a surgical procedure for the treatment of full thickness chondral lesions of the knee joint. The first stage is an arthroscopic procedure in which a sample of healthy cartilage is harvested from a non-weight bearing surface of the knee joint. These cartilage cells are preserved and cultivated onto a scaffolding which is sized according to the individual's defect. The second stage (performed openly 3-5 weeks later) involves the implantation of these cartilage cells / scaffolding into the defect and sealed with fibrin glue. The cells grow / mature to eventually form hard cartilage tissue over the next 24 months. Overall, the phases of the protocol are based on the 4 stages of cartilage maturation: Proliferation, Transition, Remodeling, Maturation. The size and location of an individual's defect guides the rehabilitation progression and may change the duration of the phases. Specific intervention should be based on the needs of the individual and should consider exam findings and clinical decision making. The timeframes for expected outcomes contained within this guideline may vary based on surgeon's preference, additional procedures performed, and/or complications. If a clinician requires assistance in the progression of a post-operative patient, they should consult with the referring surgeon.

The interventions included within this protocol are not intended to be an inclusive list of exercises. Therapeutic interventions should be included and modified based on the progress of the patient and under the discretion of the clinician.

Considerations for the Post-operative ACI Femoral Condyle

Many different factors influence the post-operative ACI femoral condyle rehabilitation outcomes, including the origin, size, and location of the defect as well as concomitant injury. Additional procedures influencing precautions/restrictions include high tibial/distal femoral osteotomy and tibial tubercle osteotomy (TTO). It is recommended that clinicians collaborate closely with the referring physician.



PHASE I: IMMEDIATE POST-OP (Day 0 - 6 WEEKS AFTER SURGERY)

Rehabilitation Goals	• Protect healing graft / tissue (joint surface & wound) • Decrease knee / lower extremity (LE) swelling • Enhance volitional control of quad • Achieve full knee extension • Gradually restore knee flexion range of motion (ROM) • Restore patellofemoral joint mobility
Weightbearing Status/ Brace / Things to Avoid	*Weight Bearing:* • Weeks 0-4: Touch down weight bearing (20-30%) in locked knee brace • Weeks 5-6: Progress weight bearing as tolerated with bilateral axillary crutches in unlocked knee brace, unless otherwise directed by physician or based on defect location ○ Progress gradually as long there is no persistent pain / swelling and good gait pattern *Brace:* • Locked at 0 degrees for weightbearing (WB) activities for first 2 weeks • Removed for continuous passive motion / exercises • Gradually open up brace with WB as quad control improves • Can discharge brace at 6 weeks if SLR without lag *Things to Avoid:* • Closed chain exercises involving knee flexion • Open chain extension exercises • Forceful motion into pain (some mild pain with passive extension is acceptable)

Intervention	*Pain/Effusion Management:*
	• Electrical stimulation for quadriceps
	• Ice, compression, elevation (check with MD: cold therapy)
	• Retrograde massage
	• Ankle pumps
	
	ROM:
	• Restore full passive extension ASAP
	• Patellofemoral joint (PFJ) mobilization
	• Gradually progress flexion ROM:
	  ○ Week 2: 90 degrees
	  ○ Week 3: 105 degrees
	  ○ Week 4: 115 degrees
	  ○ Week 6: 120 degrees
	
	Continuous Passive Motion (CPM):
	• Start 1 cycle per minute at 0-40 degrees
	• Increase CPM range by 5-10 degrees per day based on tolerance
	• Use CPM 6-8 hrs/day in 2-hour blocks
	• Discharge at week 6
	
	Therapeutic Exercise:
	• Heel prop
	• Gluteal sets
	• Heel slides
	• Supine knee flexion
	• Quad sets
	• Hamstring isometrics
	• Straight leg raise (SLR)
	• Sidelying hip abduction
	• Stationary bike (start at Week 2)

	Additional Interventions: • Biofeedback for quad/VMO control • Blood Flow Restriction Therapy (BFRT) with quad set and SLR after 2 weeks to allow superficial wound healing • Pool walking – axilla/chest deep (25% body weight at Week 4, if wound fully closed)
Criteria to Progress	• SLR with no lag • Full knee extension • Knee flexion >120 degrees by Week 6 • Normal patellofemoral mobility • Controlled swelling

PHASE II: INTERMEDIATE POST-OP (6 – 12 WEEKS AFTER SURGERY)

Rehabilitation Goals	• Protect healing graft • Return to full weightbearing with normalized gait pattern • Progress quad strength and lower extremity control • Good mechanics without pain during sit to stand, squats, and stair climb

Weightbearing Status / Precautions	*Weight Bearing:*
	• Weeks 6-9: continue to progress weight bearing as tolerated. Crutches and unlocked knee brace as needed to maintain proper gait patten and protect graft
	  ○ Progress gradually as long there is no persistent pain / swelling and good gait pattern
	
	Precautions:
	• No weightbearing flexion >90 degrees
	  ○ *Anterior Femoral Condyle Lesions:* May perform exercises in deeper range of motion (not >90 degrees) but avoid hyperextension
	  ○ *Posterior Femoral Condyle Lesions:* Avoid exercises in flexion >45 degrees until Phase III

Additional Intervention **Continue with Phase I interventions as indicated*	*Therapeutic Exercise:*
	**ensure proper dynamic control with all exercises to avoid excessive shear on joint*
	• Standing heel raise
	• Bridging
	• Terminal knee extension
	• Short arc knee extension
	• Mini squats, Wall slides, Sit to Stand
	  ○ Begin at Week 8 for anterior grafts, Week 12 for posterior grafts
	• Step ups
	• Lateral step down: begin at Week 10 (0-45 degrees flexion at most for posterior graft until Week 12)
	• Resisted side stepping (band at thighs)
	
	Balance/Proprioception Exercise:
	• Single leg balance: begin at Week 8
	  ○ Static – shoes on / eyes open
	  ○ Varied surface
	  ○ Vision – eye / head movements, eyes closed
	  ○ Task (throw and catch)
	• Single leg balance with lower extremity swings
	• Single leg balance with upper extremity reach: Begin at Week 10
	
	Aerobic Exercise:
	• Stationary bike – continue to build time with minimal resistance
	• Deep water running
	• UBE

Criteria to Progress	• Full knee ROM • Minimal/no swelling at baseline • Normal gait mechanics • Pain-free sit to stand and alternating stair climb with normal mechanics

PHASE III: LATE POST-OP (12 – 24 WEEKS AFTER SURGERY)

Rehabilitation Goals	• Protect healing graft • Progress single leg strength, control, and load tolerance • Initiate aerobic exercise • Progress balance/proprioception work in all 3 planes of motion
Precautions / Things to Avoid	*Precautions:* • Significant pain during activity • Significant swelling after activity • Post activity soreness > 24 hours *Things to Avoid:* • Exercises into knee flexion > 90 degrees • Plyometrics • Cutting/pivoting • Sport-specific activities
Additional Intervention **Continue with Phase I-II Interventions as indicated*	*Therapeutic Exercise*: • Single leg heel raise • Single leg dead lift • Leg press <90 degrees flexion • Single leg squat • Seated hamstring curl machine • Mini lunge <90 degrees flexion • Lateral lunge <90 degrees flexion *Balance/Proprioception Exercise*: • Progress single leg balance with lower extremity reaching *Aerobic Exercise:* • Elliptical • UBE • Aqua jogging • Stationary bike
Criteria to Progress	• Bilateral squat to 90 degrees flexion with good mechanics without pain • Single leg squat depth to at least 60 degrees knee flexion with good control without pain • All activities of daily living (ADLs) performed without pain or swelling

PHASE IV: ADVANCED STRENGTHENING (6-9 MONTHS AFTER SURGERY)

Rehabilitation Goals	• Hamstring and calf strength within 80% of the contralateral limb • Ability to ambulate long distance (5-10 km) without pain • Ability to effectively negotiate uneven terrain • Return to pre-operative low-impact recreational activities
Additional Intervention	• Progression of phase II-III exercises incorporating increased knee flexion (now permitted to flex >90 degrees as appropriate)
Criteria to Progress	• No effusion/pain after exercise • Return to low-impact recreational activities without pain or swelling • Ability to perform bilateral and single leg squat in increased range of motion with good control without pain • LSI of Quads, Hamstring and Glute Med all >80%

PHASE V: EARLY RETURN TO SPORT (9-12 MONTHS AFTER SURGERY)

Rehabilitation Goals	• Quadriceps strength within 90% of the contralateral limb • Ability to perform all activities of daily living pain free • Initiate return to running program

Additional Intervention **Continue with Phase II-IV interventions as indicated*	• Begin sub-maximal sport-specific training in the sagittal plane
	• Initiate small hops beginning double leg and progressing to single leg, gradually increasing impact
	• Interval running Program
	  ○ Return to Running Program
	  ○ Can begin when above criteria are met as well as able to perform small SL vertical hop with proper form
	• Progress to plyometric and agility program
	  ○ Agility and Plyometric Program

Criteria to Progress	• Clearance from MD and ALL milestone criteria have been met
	• Completion of jog/run program without pain/effusion/swelling
	• Functional Assessment:
	  ○ Quadricep/hamstring/glute index >90% HHD mean or isokinetic testing at 60 degrees/second
	  ○ Hamstring/quad ratio >66%
	  ○ Hop testing >90% compared to contralateral side, demonstrating good landing mechanics

PHASE VI: UNRESTRICTED RETURN TO SPORT (12-18 MONTHS AFTER SURGERY)

Rehabilitation Goals	• Continue strengthening and proprioceptive exercises • Symmetrical performance with sport-specific drills • Safely progress to full sport
Additional Intervention **Continue with Phase II-V interventions as indicated*	• Multi-plane sport-specific plyometrics program • Multi-plane sport-specific agility program • Include hard cutting and pivoting depending on the individuals' goals • Non-contact practice → full practice → full play

Criteria to Progress	• Functional Assessment:
	  ○ Quadricep/hamstring/glute index >90% HHD mean or isokinetic testing at 60 degrees/second
	  ○ Hamstring/quad ratio >66%
	  ○ Hop testing >90% compared to contralateral side, demonstrating good landing mechanics
	• KOOS-sports questionnaire > 90%
	• International Knee Committee Subjective Knee Evaluation > 93

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Contact	Please email MGHSportsPhysicalTherapy@partners.org with questions specific to this protocol

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