

Rehabilitation Following Autologous Chondrocyte Implantation

I. PHASE I – Early Protection Phase (Weeks 0-6)

Goals: Protect healing tissue from load and shear forces

Decrease pain and effusion

Restoration of full passive knee extension

Gradually improve knee flexion

Regain quadriceps control

Brace:

- Locked at 0° during weight-bearing activities
- Sleep in locked brace for 2-4 weeks

Weight-Bearing:

Weightbearing status varies based on lesion location and size

- For femoral condyle lesions: Non weightbearing for 1-2 weeks, may begin toe-touch weightbearing immediately per physician if lesion < 2.0 cm²; begin toe touch weight-bearing (approx. 20-30 lbs.) weeks 2-3; progress to partial weight-bearing (approx. ¼ body weight) at week 4-5
- For patellofemoral lesions: Immediate toe-touch weightbearing of ~25% body weight with brace locked in full extension; progress to 50% WB at week 2 and 75% WB week 3-4 with brace locked in full extension

Range of Motion:

Immediate motion exercise day 1

- Full passive knee extension immediately
- Initiate CPM day 1 for total of 8-12 hours/day (0-60°; if patellofemoral lesion > 6.0 cm², 0-40°)
- Progress CPM ROM as tolerated 5-10° per day
- May continue CPM for total of 6-8 hours per day for up to 6 weeks
- Patellar mobilization (4-6 times per day)
- Motion exercises throughout the day
- Passive knee flexion ROM at least 2-3 times daily
- Passive knee range of motion as tolerated
- For femoral condyle lesions, knee flexion ROM goal is 90° by 1-2 weeks, 105° week 3, 115° week 4, and 120-125° by week 6
- For patellofemoral lesions, knee flexion ROM goal is 90° by week 2-3, 105° by 3-4 weeks and 120° by week 6
- Stretch hamstrings and calf

Strengthening Program:

- Ankle pump using rubber tubing
- Quad setting
- Multi-angle isometrics (co-contractions Q/H)
- Active knee extension 90-40° for femoral condyle lesions (no resistance)
- Straight leg raises (4 directions)
- Stationary bicycle when ROM allows – low resistance
- Electrical muscle stimulation and/or biofeedback during quadriceps exercises
- Isometric leg press at week 4 (multi-angle)

- May begin use of pool for gait training and exercises week 4
- Initiate weight shifting exercises with knee in extension week 2-3 for patellofemoral lesions
- NO active knee extension exercises for patellofemoral lesions

Functional Activities:

- Gradual return to daily activities
- If symptoms occur, reduce activities to reduce pain and inflammation
- Extended standing should be avoided

Swelling Control:

- Ice, elevation, compression, and edema modalities as needed to decrease swelling

Criteria to Progress To Phase II:

- Full passive knee extension
- Knee flexion to 120°
- Minimal pain and swelling
- Voluntary quadriceps activity

II. PHASE II – Transition Phase (Weeks 6-12)

Goals: Gradually increase ROM
Gradually improve quadriceps strength/endurance
Gradual increase in functional activities

Brace:

- Discontinue brace at week 6
- Consider unloading knee brace for femoral condyle lesions

Weight-Bearing:

- Progress weight-bearing as tolerated
- For femoral condyle lesions: ½ body weight with crutches at 6 weeks; progress to full weight-bearing at 8-9 weeks, discontinue crutches
- For patellofemoral lesions: Progress to full weight-bearing week 6-8, discontinue crutches

Range of Motion:

- Gradual increase in ROM
- Maintain full passive knee extension
- Progress knee flexion to 125-135° by week 8
- Continue patellar mobilization and soft tissue mobilization, as needed
- Continue stretching program

Strengthening Exercises:

- Progress closed kinetic chain exercises
- Initiate weight shifts week 6 for femoral condyle lesions,
- Leg press week 7-8
- Mini-squats 0-45° week 8
- Toe-calf raises week 6 for patellofemoral lesions, week 8 for femoral condyle lesions
- Progress balance and proprioception drills
- Initiate front lunges, wall squats, front and lateral step-ups week 8-10
- For femoral condyle lesions, progress open kinetic chain knee extension, 1 lb./week
- For patellofemoral lesion, may begin open kinetic chain knee extension without resistance in a range of motion that does not allow for articulation of the lesion

- Stationary bicycle, low resistance (gradually increase time)
- Treadmill walking program week 10-12
- Continue use of electrical muscle stimulation and or biofeedback as needed
- Continue use of pool for gait training and exercise

Functional Activities:

- As pain and swelling (symptoms) diminish, the patient may gradually increase functional activities
- Gradually increase standing and walking

Criteria to Progress to Phase III:

- Full range of motion
- Acceptable strength level
- Hamstrings within 20% of contralateral leg
- Quadriceps within 30% of contralateral leg
- Balance testing within 30% of contralateral leg
- Able to walk 1-2 miles or bike for 30 minutes

III. PHASE III: Remodeling Phase (Weeks 12-26)

Goals: Improve muscular strength and endurance
Increase functional activities

Range of Motion:

- Patient should exhibit 125-135° flexion

Exercise Program:

- Leg press (0-90°)
- Bilateral squats (0-60°)
- Unilateral step-ups progressing from 2" to 8"
- Forward lunges
- Walking program
- Progress open kinetic chain extension (0-90°), for patellofemoral lesions perform from 90-40° or avoid angle where lesion articulates
- Progress 1 pound every 2 weeks beginning week 20 if no pain or crepitation – must monitor symptoms
- Continue progressing balance and proprioception
- Bicycle
- Stairmaster
- Swimming
- Nordic-Trak/Elliptical

Functional Activities:

- As patient improves, increase walking (distance, cadence, incline, etc.)

Maintenance Program:

- Initiate at week 16-20
- Bicycle – low resistance, increase time
- Progressive walking program
- Pool exercises for entire lower extremity
- Straight leg raises
- Leg press
- Wall squats

- Hip abduction / adduction
- Front lunges
- Step-ups
- Stretch quadriceps, hamstrings, calf

Criteria to Progress to Phase IV:

- Full non-painful ROM
- Strength within 80-90% of contralateral extremity
- Balance and/or stability within 75-80% of contralateral extremity
- No pain, inflammation, or swelling

IV. PHASE IV – MATURATION PHASE (WEEKS 26-52)

Goals: Gradual return to full unrestricted functional activities

Exercises:

- Continue maintenance program progression 3-4x/week
- Progress resistance as tolerated
- Emphasis on entire lower extremity strength & flexibility
- Progress agility and balance drills
- Impact loading program should be specialized to the patient's demands
- Progress sport programs depending on patient variables

Functional Activities:

- Patient may return to various sport activities as progression in rehabilitation and cartilage healing allows.
- Generally, low-impact sports such as swimming, skating, rollerblading, and cycling are permitted at about 6 months.
- Higher impact sports such as jogging, running, and aerobics may be performed at 8-9 months for small lesions or 9-12 months for larger lesions.
- High impact sports such as tennis, basketball, football and baseball are allowed at 12-18 months.