

**DR. CARL DIRAIMONDO**  
**AUTOLOGOUS CHONDROCYTE IMPLANTATION POST-OP THERAPY PROTOCOL**

**Phase 1 – Protection Phase (0-6 weeks)**  
**(continued on next page)**

Goals for Phase 1	Precautions for Phase 1	Criteria to Progress to Phase 2
<ul style="list-style-type: none"> <li>• Protect healing surfaces from shear forces</li> <li>• Restore full passive knee extension with gradual increase in flexion</li> <li>• Control postoperative pain and swelling</li> <li>• Regain quadriceps control</li> </ul>	<ul style="list-style-type: none"> <li>• Weeks 0-2: PROM only; limited knee flexion 0-40 deg</li> <li>• No active knee extension from 40-70 deg</li> <li>• No repetitive closed chain knee flexion from 40-70 deg</li> </ul>	<ul style="list-style-type: none"> <li>• SLR with no lag (without brace)</li> <li>• Full passive knee extension</li> <li>• Knee flexion to 90 deg by week 4, greater than 120 deg by week 6</li> <li>• Normal patellofemoral mobility</li> <li>• Controlled swelling</li> </ul>

**Brace**

- Locked in 0 deg when weight bearing and at night
- Remove for CPM machine and exercises
- Gradually open up brace with WB as quad control improves
- Weeks 4-6: unlock 20-30 deg with ambulation if able to perform SLR without lag
- Can discharge brace at 6 weeks if SLR without lag

**Weight Bearing**

- Tibial Tubercle Osteotomy for trochlea patella:
  - TTWB in locked brace
- No osteotomy for trochlea patella:
  - **Immediately post op:** 25% WB in locked brace
  - **Week 2:** progress to 50% WB in locked knee brace
  - **Weeks 3-4:** progress to 75% WB in locked knee brace
  - **Weeks 5-6:** progress to WBAT in unlocked knee brace
- Femoral Condyle lesions:
  - Sleep in locked brace for 2 weeks
  - NWB (2 weeks)
  - TTWB (week 2-3)
  - Partial 25% WB (week 4-5)
- May change based on the size of the lesion if it involves two opposing surfaces (i.e. patella and trochlea) and stability. Please reach out to physician for clarification.

**CPM**

- **Weeks 0-2:** 0-40 deg
  - Increase CPM range by 5-10 deg per day afterward based on tolerance
- CPM 6-8 hours/day in 2-hour blocks (minimum of one hour daily)
- Can vary based on physician preference. So please reach out to physician for clarification.

## Phase 1 – Protection Phase (0-6 weeks)

### Therapeutic Exercise

- Heel prop with quad set
- Seated knee flexion AAROM (limit 0-40 deg weeks 0-2)
- Heel slides (limit 0-40 deg weeks 0-2) passive and/or active
- Hamstring and glute isometrics
- Four-way SLR sequence
- Stationary bike with elevated seat height (start at week 4 only if patient has 90 deg knee flexion)
- Blood flow restriction therapy
- NMES for quad strength
- Gentle patellar mobility in all directions
- Pool walking starting at week 4 if incision is fully healed

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**Phase 2 – Transition Phase (6-12 weeks)**

<b>Goals for Phase 2</b>	<b>Precautions for Phase 2</b>	<b>Criteria to Progress to Phase 3</b>
<ul style="list-style-type: none"> <li>• Protect healing graft</li> <li>• Achieve full knee flexion</li> <li>• Return to full WB with normalized gait pattern</li> <li>• Progress quad strength and lower extremity control</li> </ul>	<ul style="list-style-type: none"> <li>• No active open chain knee extension from 40-70 deg</li> <li>• Avoid repetitive closed chain knee flexion from 40-70 deg</li> </ul>	<ul style="list-style-type: none"> <li>• Full knee ROM</li> <li>• Minimal/no swelling at baseline</li> <li>• Normal gait mechanics</li> <li>• Pain-free sit to stand</li> </ul>

**Weight Bearing**

- Trochlea Patella
  - At 6 weeks, progress WBAT to full weight bearing by weeks 8-9
- Femoral Condyle lesions:
  - Partial 50% WB (week 6-7)
  - Discharge crutches at week 6-8

**Therapeutic Exercise**

- Short arc quad (may begin at week 9)
- Standing heel raise
- Bridging
- Terminal knee extension
- Mini squats
- Wall slides
- Step ups
- Lateral step down
- Resisted side stepping (band at thighs)
- Weighted knee flexion (week 8)
- Stretching quadriceps musculature (weeks 9-10)

**Balance/Proprioception Exercise**

- Double leg balance from 6-8 weeks
- Single leg balance begin at week 8
  - Static or dynamic challenges on and off compliant surfaces as tolerated
  - With upper extremity reach (begin week 10)

**Aerobic Exercise**

- Stationary bike (no/minimal resistance with emphasis on ROM)
- Treadmill walking
- Aquatic flutter or straight leg kicks with kickboard

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**Phase 3 – Late Post-Op Phase (12-24 weeks)**

<b>Goals for Phase 3</b>	<b>Precautions for Phase 3</b>	<b>Criteria to Progress to Phase 4</b>
<ul style="list-style-type: none"> <li>• Protect healing graft</li> <li>• Progress single leg strength, control and load tolerance</li> <li>• Progress balance work in all 3 planes of motion</li> </ul>	<ul style="list-style-type: none"> <li>• Significant pain during activity</li> <li>• Significant swelling after activity</li> <li>• Post activity soreness &gt; 24 hours</li> <li>• No active knee extension from 40-70 deg</li> <li>• Avoid repetitive closed chain knee flexion from 40-70 deg</li> </ul>	<ul style="list-style-type: none"> <li>• Bilateral squat to 40 deg knee flexion with good mechanics without pain</li> <li>• Single leg squat depth to at least 40 deg knee flexion with good control without pain</li> <li>• All ADLs performed without pain or swelling</li> </ul>

**Therapeutic Exercise**

- Single leg dead lift
- Single leg calf raises
- Initiate bridging exercises
- Leg press < 40 deg flexion
- Single leg squat < 40 deg flexion
- Seated hamstring curl machine
- Standing resisted knee flexion
- Double leg mini squat
- SLR with weight
- Small step up with weight if appropriate

**Balance/Proprioception Exercise**

- Progress single leg balance with lower extremity reaching and perturbations

**Aerobic Exercise**

- Treadmill forward and retro walking
- Aquatics: flutter kicking (no whip kicks) and aqua jogging

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**Phase 4 – Advanced Strengthening (24+ weeks)**

<p><b>Goals for Phase 4</b></p> <ul style="list-style-type: none"> <li>• Progress active knee flexion in full ROM</li> <li>• Hamstring and calf strength within 80% of the contralateral limb</li> <li>• Ability to ambulate long distance (5- 10 km) without pain</li> <li>• Ability to effectively negotiate uneven terrain</li> <li>• Return to pre-operative low-impact recreational activities</li> </ul>	<p><b>Criteria to Progress to Phase 5</b></p> <ul style="list-style-type: none"> <li>• No effusion/pain after exercise</li> <li>• Return to low-level impact recreational activities without pain or swelling</li> <li>• Ability to perform bilateral and single leg squat in increased ROM with good control without pain</li> </ul>
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**Additional Interventions**

- Progression of phase 2-3 exercises incorporating increased knee flexion (now permitted to perform knee flexion 40-70 deg)

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**Phase 5 – Early Return to Sport (9-12 months)**

<p><b>Goals for Phase 5</b></p> <ul style="list-style-type: none"> <li>• Quadriceps strength within 90% of contralateral limb</li> <li>• Ability to perform all activities of daily living pain free</li> <li>• Initiate return to running program</li> </ul>	<p><b>Criteria to Progress to Phase 6</b></p> <ul style="list-style-type: none"> <li>• Clearance from MD and ALL milestone criteria have been met</li> <li>• Completion of jog/run program without pain/effusion/swelling</li> <li>• Functional assessment:             <ul style="list-style-type: none"> <li>○ Quads/hamstring/glute index &gt; 90% HHD mean or isokinetic testing at 60 deg/sec</li> <li>○ Hamstring/quad ratio &gt;66%</li> <li>○ Hop testing &gt; 90% compared to contralateral side, demonstrating good landing mechanics</li> </ul> </li> </ul>
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**Additional Interventions**

- Begin sub-max sport-specific training in the sagittal plane
- Interval running program
- Progress to plyometric and agility program

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**Phase 6 – Unrestricted Return to Sport (12 months+)**

<p><b>Goals for Phase 6</b></p> <ul style="list-style-type: none"> <li>• Continue strengthening and proprioceptive exercises</li> <li>• Symmetrical performance with sport-specific drills</li> <li>• Safely progress to full sport</li> </ul>	<p><b>Criteria to Return to Unrestricted Sport</b></p> <ul style="list-style-type: none"> <li>• Functional assessment:             <ul style="list-style-type: none"> <li>○ Quadricep/hamstring/glut index &gt;90% HHD mean or isokinetic testing at 60 deg/second</li> <li>○ Hamstring/quad ratio &gt;66%</li> <li>○ Hop testing &gt;90% compared to contralateral side, demonstrating good landing mechanics</li> </ul> </li> <li>• KOOS-sport questionnaire &gt;90%</li> <li>• International Knee Committee Subjective Knee Evaluation &gt; 93</li> </ul>
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**Additional Interventions**

- 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