

PHYSICAL THERAPY PROTOCOL

Osteochondral Allograft (OCA) Transplantation

Fresh or Preserved Osteochondral Allograft of the Knee — Bone-Incorporation Pathway

FOR THE PHYSICAL THERAPIST

Overview and Goals

This protocol governs rehabilitation after osteochondral allograft (OCA) transplantation of the knee. OCA differs fundamentally from surface resurfacing (microfracture, MACI, DeNovo NT, chondral Cartiform): the graft is a plug of **bone and cartilage**, so healing requires **bone-to-bone incorporation** of the osseous base in addition to protection of the cartilage surface. That extra requirement is what sets OCA apart — a longer protected weight-bearing period, an imaging checkpoint to confirm incorporation before impact, and a later return to sport.

Lesion location still modifies the emphasis, exactly as it does for resurfacing. A **condylar or tibial-plateau** graft is loaded during stance, so weight-bearing is the tighter constraint while range of motion is comparatively free. A **trochlear or patellar** graft is loaded by flexion, so flexion is restricted (0–30° early) while weight-bearing advances a little sooner — but the bone-incorporation timeline governs both. Dr. Roth designates the graft location and size at surgery; larger (>4 cm²), multisurface, or bipolar grafts warrant longer protection.¹

Continuous passive motion is used for all cases beginning on the day of surgery or the first postoperative day, kept within any location-specific flexion limit. Quadriceps weakness is the most significant long-term functional deficit; aggressive, prolonged quadriceps rehabilitation is essential.⁵ Patient compliance with the protected period is the single largest factor in postoperative range-of-motion lag or loss — counsel accordingly.¹

Progression is criterion-based and gated on graft incorporation. An MRI at approximately six months is recommended to assess incorporation before clearing impact; return to sport is typically 9–12 months, and pivoting, cutting, and contact are withheld until incorporation is confirmed and clearance given.^{1,2}

READ BEFORE STARTING — SCOPE & BONE INCORPORATION

This protocol applies to fresh or preserved osteochondral allograft of the knee (and to Cartiform used to fill a deeper osteochondral defect with bone involvement).

- Bone-to-bone healing is required — the protected weight-bearing period is longer than for surface resurfacing. Respect it strictly.
- Confirm the **graft location** with Dr. Roth: condylar/plateau grafts are weight-bearing–restricted with freer ROM; trochlear/patellar grafts are flexion-restricted (0–30° early) with earlier weight-bearing.
- Larger (>4 cm²), multisurface, or bipolar grafts may require longer protection — follow Dr. Roth's written instruction.
- CPM begins POD 0–1. An MRI at ~6 months assesses incorporation before impact is cleared.

Rehabilitation Phases

PHASE	WEIGHT BEARING	BRACE / CPM	ROM GOALS	EXERCISES	CRITERIA TO ADVANCE
PHASE 1	• Toe-touch	• Hinged	Condylar/	Quadriceps activation:	• Quadriceps

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ORTHOPAEDIC SPORTS MEDICINE

PHASE	WEIGHT BEARING	BRACE / CPM	ROM GOALS	EXERCISES	CRITERIA TO ADVANCE
Weeks 0–2 <i>Protection & early motion</i>	weight-bearing, brace locked in extension (both locations).	brace locked in extension for weight-bearing/transfers; unlocked for CPM/ROM within any flexion limit. CPM: Begin POD 0–1	plateau: - PROM/ AAROM 0–90°, advance as tolerated Trochlear/ patellar: - Flexion restricted 0–30° Priority: - Full passive extension; patellar glides	- Quad sets — begin POD 1 - Straight-leg raises in brace locked at 0° - NMES / Russian stim to quadriceps Adjunct: - Ankle pumps - Gluteal sets - Cryotherapy and elevation	activation with SLR (no extensor lag) - Full passive extension - ROM per location within limits - Pain and effusion controlled - Minimum 2 weeks elapsed
PHASE 2 Weeks 2–6 <i>Protected weight-bearing</i>	Toe-touch weight-bearing while the osseous base incorporates (both locations).	- Locked at 0° for gait (both locations); trochlear grafts may unlock to 0–30° for gait once quad control returns. Unlocked for ROM. CPM: - Continue; advance ROM per location	Condylar: - Advance toward full ROM Trochlear: 0–30° through wk 4, then 10–15°/wk Bike: - Low resistance once flexion ~100°	Strengthening: - Progress SLR all planes - Quad sets, co-contractions - Patellar mobilizations Hip / core: - Side-lying abduction, clamshells, core Avoid: - Loaded flexion; resisted open-chain extension (esp. trochlear 45° → full)	- Protected weight-bearing maintained without graft-site pain - ROM per location on track - SLR without extensor lag - No effusion increase - Minimum 6 weeks elapsed
PHASE 3 Weeks 6–12 <i>Weight-bearing advancement (incorporation -gated)</i>	Toe-touch through week 6; then increase ~25% body weight per week to full by ~week 12, as incorporation is supported.	- Wean brace and crutches as weight-bearing and quad control advance. CPM: - Discontinue once full ROM achieved	- Full ROM (condylar) / advancing per restriction (trochlear). Stretching: - Hamstrings, quads, ITB, gastroc/sol eus	Closed-chain: - Squats and leg press (0–60°, progressing), step-ups, lunges Open-chain: - Progressive; trochlear grafts limited to 90–45° until wk 12 Neuromuscular / hip: - Single-leg balance, hip strengthening all planes Conditioning: - Bike, elliptical, swimming	- Progressing to full weight-bearing without graft-site pain - Full ROM (condylar) - No effusion - Quadriceps MMT ≥ 4/5 - Minimum 12 weeks elapsed
PHASE 4 Weeks 12–36 <i>Strengthening & functional — imaging-gated</i>	Full.	None.	Full ROM maintained.	- MRI at ~6 months to assess graft incorporation before impact.¹ Strengthening: - Progressive single-leg squats, press, deadlifts - Full-arc open-chain extension (trochlear: after wk 12) Plyometrics: - Bilateral → unilateral, once incorporation supported Conditioning: - Straight-line jogging once incorporation supported (typically ~6 mo), quad ≥ 80%, no effusion	- Quadriceps strength ≥ 80% of contralateral limb - No pain or effusion with advanced activity - Single-leg hop ≥ 80% limb symmetry - Imaging supports incorporation
PHASE 5 Months 9–	Full.	None.	Full ROM.	Sport-specific progression: Sport-specific drills at full speed	<i>See Return-to-Activity Criteria</i>

PHASE	WEIGHT BEARING	BRACE / CPM	ROM GOALS	EXERCISES	CRITERIA TO ADVANCE
12+ <i>Return to sport</i>				- Non-contact → contact → competition Maintenance: - Continue quadriceps and hip strengthening 2–3×/week indefinitely	<i>below.</i> MRI-confirmed incorporation, all criteria met, and clearance; RTS typically 9–12 months.^{1,2}

Procedure-Specific Considerations

Bone Incorporation Is the Gating Event

Unlike a surface graft, an osteochondral allograft carries an osseous base that must knit to the host bone. Cartilage on the graft is viable from the day of implantation, but the bone requires creeping substitution, and it is incorporation — not the cartilage — that governs when loading and impact are safe. This is why the protected weight-bearing period runs longer than for resurfacing, why an MRI at approximately six months is used to confirm incorporation before clearing impact, and why return to sport lands at nine to twelve months.^{1,2} Published practice varies — higher-volume surgeons tend toward less restrictive protocols — but essentially all employ some protected period; Dr. Roth's course above reflects a standard, incorporation-gated progression.

Location Modifies ROM vs. Weight-Bearing Emphasis

The bone-incorporation spine is uniform, but the surface emphasis follows the same biomechanics as resurfacing. For a **condylar or tibial-plateau** graft, weight-bearing is the tighter constraint and range of motion is advanced freely (avoiding loaded deep flexion early). For a **trochlear or patellar** graft, flexion is the loaded direction, so flexion is capped at 0–30° early and resisted open-chain extension through the 45°-to-full arc is avoided for twelve weeks, while weight-bearing in a low-flexion locked brace can advance a little sooner. Larger, multisurface, or bipolar grafts warrant longer protection regardless of location.¹

Compliance Protects the Result

Non-compliance with the protected period is the largest single contributor to postoperative range-of-motion lag or loss after OCA.¹ Patients should understand that the graft feels usable well before it is biologically ready, and that respecting the weight-bearing and imaging gates is what protects a durable result. Aggressive, prolonged quadriceps rehabilitation — deficits greater than 20% persist in a substantial share of patients — should continue two to three times per week on an ongoing basis.⁵

RED FLAGS — CONTACT DR. ROTH

- Sudden increase in effusion or hemarthrosis.
- Mechanical symptoms — locking, catching, or giving way (concern for graft or fixation problem, or a loose body).
- Loss of previously achieved ROM, especially loss of extension.
- Persistent pain at the graft site with loading (concern for delayed or failed incorporation).
- Signs of wound infection, or failure to progress ROM or strength as expected.

Return-to-Activity Criteria

Progression is criterion-based and gated on graft incorporation. The tiers below are guides; larger, multisurface, or bipolar grafts progress more slowly.

Activity Tier	Criteria & Timing
Full weight-bearing off crutches	Reached by ~week 12 after the toe-touch period (later for large/bipolar grafts); gait normalized, no graft-site pain.
Stationary bike / swimming / elliptical	Flexion adequate (bike ~100°), incisions sealed, no effusion; bike once flexion permits, pool once sealed.
Jogging / running	Imaging supports incorporation (typically ~6 months), quadriceps strength $\geq 80\%$ of contralateral limb, no pain or effusion.
Agility, plyometrics, sport-specific drills	Incorporation supported, quadriceps strength $\geq 80\%$ LSI, single-leg hop $\geq 80\%$ limb symmetry, no effusion with advanced activity.
Full return to sport (cutting, pivoting, contact)	MRI-confirmed incorporation; quadriceps strength index $\geq 90\%$ LSI; hop battery $\geq 90\%$ LSI; no effusion or apprehension; physician clearance. Typically 9–12 months.

REALISTIC EXPECTATIONS

OCA recovery is a bone-healing timeline. The transplanted cartilage is durable hyaline tissue — an advantage over the fibrocartilage of microfracture — but the osseous base must incorporate before the knee can absorb impact, and that biology runs on its own clock regardless of how good the knee feels at three or four months. Impact and sport are therefore gated on the six-month imaging check, not on symptoms. Compliance with the protected period is the strongest predictor of a smooth course, and quadriceps weakness is the deficit most likely to linger, so ongoing strengthening is essential. Persistent graft-site pain with loading, new mechanical symptoms, or loss of extension should prompt re-evaluation by Dr. Roth.^{1,5}

References

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2. Pierson SR, Silverman RM, Knapp B, Brophy RH. Rehabilitation and Return to Play Protocols Following Osteochondral Autograft and Allograft Transplantation for Knee Chondral Lesions in Athletic Populations. Curr Rev Musculoskelet Med. 2026;19(1):40.
3. Vogt S, Angele P, Arnold M, et al. Practice in Rehabilitation After Cartilage Therapy: An Expert Survey. Arch Orthop Trauma Surg. 2013;133(3):311–320.
4. Condello V, Filardo G, Madonna V, et al. Use of a Biomimetic Scaffold for the Treatment of Osteochondral Lesions in Early Osteoarthritis. Biomed Res Int. 2018;2018:7937089.
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Glossary

AAROM — Active-assisted range of motion; the patient initiates motion with assistance.

Bipolar graft — Grafts placed on both sides of a joint (e.g., patella and trochlea), requiring longer protection.

Cartiform — A cryopreserved osteochondral allograft disc; treated as OCA when filling a deeper osteochondral defect.

CKC — Closed kinetic chain; exercises with the foot fixed (squats, leg press).

CPM — Continuous passive motion; a machine that moves the knee through a set arc to nourish cartilage and limit stiffness.

Creeping substitution — The gradual replacement of graft bone by host bone during incorporation.

Hyaline cartilage — Native articular cartilage; transplanted intact with an osteochondral allograft.

Incorporation — Bony union of the graft's osseous base to the host bone — the event that gates loading and impact.

ITB — Iliotibial band.

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ORTHOPAEDIC SPORTS MEDICINE

LSI — Limb Symmetry Index; operative limb as a percentage of the contralateral limb.

MMT — Manual muscle test; a graded (0–5) clinical assessment of strength.

NMES — Neuromuscular electrical stimulation (“Russian stim”) to augment quadriceps activation.

OCA — Osteochondral allograft; a bone-and-cartilage plug transplanted to resurface a defect.

Patellofemoral — The joint between the patella and the trochlear groove; contact stress rises with flexion.

PROM — Passive range of motion; the joint is moved while the patient stays relaxed.

SLR — Straight-leg raise.

TTWB — Toe-touch weight-bearing; light foot contact only.



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