

PHYSICAL THERAPY PROTOCOL

# Meniscus Repair — Unstable Tear Patterns

*Root · Radial · Complex · Horizontal Cleavage*

FOR THE PHYSICAL THERAPIST

## Overview and Goals

This protocol governs rehabilitation following repair of **unstable, hoop-disrupting** meniscus tear patterns — root, radial (transverse), complex multiplanar, and horizontal cleavage tears. These patterns share a defining biomechanical consequence: they interrupt the circumferential collagen fibers that convert axial load into hoop stress, so the repair is functionally equivalent to a meniscectomy until healed, and axial loading tends to **distract** (pull apart) the repair rather than compress it.<sup>1,2</sup> For this reason the protocol is intentionally more conservative than that for stable patterns (vertical longitudinal, bucket-handle, ramp), where axial load compresses and reduces the tear.

The protocol reflects current evidence and the published 2024 ESSKA-AOSSM-AASPT consensus, which stratifies meniscus rehabilitation by tear pattern: hoop-preserving tears may load early, whereas hoop-disrupting tears require restricted weight-bearing and ROM through the early healing window.<sup>1,3</sup>

Progression between phases is criterion-based. Time ranges represent typical windows. Patients who do not meet criteria should remain in the current phase regardless of elapsed time. Patients who meet criteria early should not advance prematurely during the protected period (Phase 1) — early biological healing is time-dependent.

### THIS PROTOCOL IS FOR UNSTABLE / HOOP-DISRUPTING PATTERNS

Use this protocol for root, radial, complex, and horizontal cleavage repairs. **Stable, hoop-preserving patterns** — vertical longitudinal, bucket-handle, and ramp lesions — heal under compression and follow the less restrictive **Meniscus Repair — Stable Tear Patterns** protocol instead. Contact Dr. Roth's office if the tear pattern is uncertain.

### CONCOMITANT ACL RECONSTRUCTION — READ FIRST

If the meniscus repair was performed alongside ACL reconstruction, **do not use this protocol**. Refer to the ACL Reconstruction Rehabilitation Protocol, which incorporates meniscus repair modification callouts. Contact Dr. Roth's office if uncertain about concomitant procedures.

## Rehabilitation Phases

| PHASE                                                               | WEIGHT BEARING                                                                                                                                  | BRACE                                                                                                                                                                                                               | ROM GOALS                                                                                                                                                                                                | EXERCISES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | CRITERIA TO ADVANCE                                                                                                                                                                                                                                     |
|---------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>PHASE 1</b><br>Weeks 0–6<br><i>Protection &amp; early motion</i> | <ul style="list-style-type: none"><li>• Toe-touch weight bearing (TTWB) for the full 6 weeks.</li><li>• Crutches required throughout.</li></ul> | <ul style="list-style-type: none"><li>• Hinged knee brace set to 0–90° during ambulation. Required throughout.</li><li>• Not rigid — permits motion within the 0–90° arc and prevents flexion beyond 90°.</li></ul> | <b>Goals by end of Phase 1:</b> <ul style="list-style-type: none"><li>• Full passive extension (0°)</li><li>• Flexion to 90° (no further during this phase)</li><li>• Symmetrical extension to</li></ul> | <b>Swelling / pain control:</b> <ul style="list-style-type: none"><li>• Cryotherapy, elevation, NMES to quadriceps</li></ul> <b>ROM (within 0–90°):</b> <ul style="list-style-type: none"><li>• Heel slides, wall slides, prone hangs, towel-roll passive extension, patellar mobilization, tibiofemoral mobs into extension<sup>1,4</sup></li><li>• No flexion beyond 90°</li><li>• No deep squatting in any plane</li></ul> <b>Strengthening:</b> <ul style="list-style-type: none"><li>• Quad sets with knee support</li></ul> | <ul style="list-style-type: none"><li>• Full passive knee extension (0°)</li><li>• Flexion to 90°</li><li>• Effusion ≤ 1+</li><li>• SLR without extension lag</li><li>• Tolerates TTWB without compensation</li><li>• Minimum 6 weeks elapsed</li></ul> |

# KEVIN M. ROTH, MD

## ORTHOPAEDIC SPORTS MEDICINE

| PHASE                                                                            | WEIGHT BEARING                                                                                                                                                                                                                                                | BRACE                                                                                                                                                                               | ROM GOALS                                                                                                                                                                                                               | EXERCISES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | CRITERIA TO ADVANCE                                                                                                                                                                                                                                     |
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|                                                                                  |                                                                                                                                                                                                                                                               | <ul style="list-style-type: none"> <li>• Patient may remove for PT and home exercises.<sup>1,3,4</sup></li> </ul>                                                                   | contralateral side                                                                                                                                                                                                      | <ul style="list-style-type: none"> <li>• SLR (all 4 planes)</li> <li>• Hamstring sets / digs (gentle, no resisted flexion early)</li> <li>• Hip abduction, adduction, extension</li> <li>• Ankle pumps, plantarflexion / dorsiflexion</li> <li>• OKC knee extension 90°–40° only (terminal arc quads, no resistance)</li> <li>• No closed-chain weight-bearing exercises — no leg press, mini-squats, or step-ups during Phase 1</li> </ul> <p><b>Aerobic:</b></p> <ul style="list-style-type: none"> <li>• Upper body ergometer only. No stationary bike during Phase 1 (cycling loads the meniscus through the flexion arc).<sup>1,4</sup></li> </ul>                                                                                                                                                                                |                                                                                                                                                                                                                                                         |
| <b>PHASE 2</b><br>Weeks 6–12<br><i>Progressive loading &amp; ROM advancement</i> | <ul style="list-style-type: none"> <li>• Progress from TTWB → partial → full weight bearing over weeks 6–8 as gait quality and quad control allow.<sup>1,3</sup></li> <li>• Wean from crutches as patient demonstrates symmetrical, painless gait.</li> </ul> | <ul style="list-style-type: none"> <li>• Discontinue at the start of Phase 2 (6 weeks).</li> <li>• By this point the brace is no longer providing meaningful protection.</li> </ul> | <ul style="list-style-type: none"> <li>• Progressive flexion beyond 90°. Goal: full, symmetrical, pain-free flexion by week 12.</li> <li>• Avoid loaded deep flexion (squat past 90°) throughout this phase.</li> </ul> | <p><b>Closed-chain progression (gradual):</b></p> <ul style="list-style-type: none"> <li>• Mini-squats to 60° (week 8 onward)</li> <li>• Leg press, limited range (~0–60°), low resistance</li> <li>• Step-ups (low step) → progressive height</li> <li>• Heel raises, weight shifting</li> </ul> <p><b>Open-chain:</b></p> <ul style="list-style-type: none"> <li>• Continue terminal arc quads (90°–40°). Add light-resistance hamstring curls when comfortable.</li> </ul> <p><b>Aerobic:</b></p> <ul style="list-style-type: none"> <li>• Stationary bike may begin.</li> </ul> <p><b>BFR:</b></p> <ul style="list-style-type: none"> <li>• May begin as an optional adjunct (see BFR section below).</li> </ul>                                                                                                                   | <ul style="list-style-type: none"> <li>• Full symmetrical, pain-free ROM</li> <li>• Quad LSI ≥ 70%</li> <li>• No effusion</li> <li>• Normal gait without assistive device</li> <li>• Tolerates closed-chain loading without pain or effusion</li> </ul> |
| <b>PHASE 3</b><br>Months 3–4<br><i>Strengthening &amp; neuromuscular control</i> | <ul style="list-style-type: none"> <li>• Full weight bearing.</li> </ul>                                                                                                                                                                                      | <ul style="list-style-type: none"> <li>• None.</li> </ul>                                                                                                                           | Full, pain-free ROM.<br><b>Continue to avoid loaded deep flexion (squats past 90°, deep lunges) until end of Phase 3.</b>                                                                                               | <p><b>Progressive resistance training:</b></p> <ul style="list-style-type: none"> <li>• Single-leg press, single-leg squat progression</li> <li>• Step-downs (lateral and forward)</li> <li>• Lunges to 90° (no deeper)</li> <li>• Eccentric hamstring loading (Nordic curls late phase)</li> <li>• Hip strengthening: glute bridges, clamshells, side-lying abduction, monster walks</li> </ul> <p><b>Neuromuscular training:</b></p> <ul style="list-style-type: none"> <li>• Single-leg balance, perturbation, foam surface, dynamic balance progressions</li> </ul> <p><b>Aerobic conditioning:</b></p> <ul style="list-style-type: none"> <li>• Bike (progressive resistance), elliptical, swimming, pool running</li> </ul> <p><b>Core:</b></p> <ul style="list-style-type: none"> <li>• Core and trunk stabilization</li> </ul> | <ul style="list-style-type: none"> <li>• Quad LSI ≥ 80%</li> <li>• Hamstring LSI ≥ 80%</li> <li>• No pain or effusion with progressive loading</li> <li>• Single-leg balance ≥ 30 sec</li> <li>• Symmetrical step-down mechanics</li> </ul>             |
| <b>PHASE 4</b><br>Months 4–6<br><i>Running, plyometrics &amp; agility</i>        | <ul style="list-style-type: none"> <li>• Full weight bearing.</li> </ul>                                                                                                                                                                                      | <ul style="list-style-type: none"> <li>• None.</li> </ul>                                                                                                                           | Full, pain-free ROM. Deep loaded flexion permitted as tolerated.                                                                                                                                                        | <p><b>Running initiation (Quad LSI ≥ 80%, no effusion):</b></p> <ul style="list-style-type: none"> <li>• Treadmill walk/run intervals → continuous running</li> <li>• Track straights → curves → full track</li> </ul> <p><b>Plyometrics progression:</b></p> <ul style="list-style-type: none"> <li>• Double-leg jumps in place → broad jumps</li> <li>• Box jumps, lateral bounds</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                         | <ul style="list-style-type: none"> <li>• Quad LSI ≥ 85%</li> <li>• Hop test battery LSI ≥ 85%</li> <li>• Safe single-leg landing mechanics</li> <li>• No pain or effusion with impact activity</li> </ul>                                               |

| PHASE                                                   | WEIGHT BEARING                                                         | BRACE                                                   | ROM GOALS                                                              | EXERCISES                                                                                                                                                                                                                                                                                                                                                                                                                     | CRITERIA TO ADVANCE                                                                                                                                                                                                         |
|---------------------------------------------------------|------------------------------------------------------------------------|---------------------------------------------------------|------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                         |                                                                        |                                                         |                                                                        | <ul style="list-style-type: none"> <li>Single-leg hops in multiple planes (late phase)</li> </ul> <b>Agility:</b> <ul style="list-style-type: none"> <li>Ladder drills, carioca, sport-cord lateral drills, deceleration training</li> </ul> <b>Sport:</b> <ul style="list-style-type: none"> <li>Sport-specific drills (non-contact)</li> <li>Continue progressive resistance training — close strength asymmetry</li> </ul> | <ul style="list-style-type: none"> <li>Minimum 6 months from surgery for full RTS clearance</li> </ul>                                                                                                                      |
| <b>PHASE 5</b><br>Months 6–9+<br><i>Return to sport</i> | <ul style="list-style-type: none"> <li>Full weight bearing.</li> </ul> | <ul style="list-style-type: none"> <li>None.</li> </ul> | <ul style="list-style-type: none"> <li>Full, pain-free ROM.</li> </ul> | <ul style="list-style-type: none"> <li>Sport-specific training and conditioning at progressive intensity</li> <li>Full cutting, pivoting, lateral maneuvers (month 6 for non-impact athletes; month 9 for cutting / pivoting / contact)</li> <li>Return to practice/training (non-contact → contact)</li> <li>Home maintenance strength program established</li> </ul>                                                        | <i>See Return-to-Sport Criteria section below.</i> <ul style="list-style-type: none"> <li>≥ 6 months for non-impact (running, swimming, cycling).</li> <li>≥ 9 months for cutting, pivoting, and contact sports.</li> </ul> |

## Procedure-Specific Considerations

### Tear Patterns Covered by This Protocol

All patterns below share the same rehabilitation principle: because the circumferential collagen fibers are interrupted, axial load tends to **distract** the repair, and the meniscus cannot bear hoop stress until the construct heals. The notes that follow refine the same conservative framework for each pattern.

### Root Tears

Root tears disrupt the meniscus's ability to convert axial load into hoop stress and are functionally equivalent to a total meniscectomy until healed.<sup>1,2</sup> Lax healing of the repair construct — termed *failure with continuity* — is common: second-look arthroscopy demonstrates complete or stable healing in only 60–70% of repairs, with persistent meniscal extrusion in the majority of cases.<sup>3</sup> Even repairs that heal laxly slow radiographic OA progression versus meniscectomy and are associated with lower rates of conversion to total knee arthroplasty.<sup>2,6</sup> The protocol applies to both medial and lateral root repairs; lateral roots heal somewhat more favorably in published series, but rehabilitation does not differ substantively.<sup>1,3</sup>

Many root tears occur in patients in their 50s–70s through degenerative mechanisms. TTWB (rather than strict NWB) is preferred because compliance, fall risk, and deconditioning during prolonged NWB carry meaningful risk in this population — TTWB still protects the repair while allowing safer ambulation.<sup>4</sup>

### Radial (Transverse) Tears

Radial tears cut directly across the circumferential fibers. A complete radial tear abolishes hoop tension and behaves as a functional meniscectomy until healed; the side-to-side repair is vulnerable to **distractive** (gapping) under axial load and deep flexion — the same biomechanical risk as a root tear, which is why radial repairs follow this conservative protocol rather than the stable-pattern one.<sup>1,12</sup> Protect the repair from early loading and loaded deep flexion exactly as outlined in Phase 1.

### Complex & Horizontal Cleavage Tears

Complex (multiplanar) tears and horizontal cleavage tears are biomechanically heterogeneous and often degenerative. Where circumferential fiber continuity is disrupted, they warrant this conservative protocol; when in doubt, default to more protection.<sup>1,12</sup> Individualize ROM and loading progression to the specific repair, and contact Dr. Roth's office if the tear morphology or repair construct is unclear before initiating rehabilitation.

### Bracing — What It Is & Isn't For

Current evidence does not support post-operative bracing as an independent driver of better outcomes after knee surgery.<sup>9</sup> In this protocol, the brace serves a specific mechanical purpose: enforcing the 0–90° ROM limit and reinforcing weight-bearing restrictions during ambulation. Compliance with these restrictions — not the brace itself — is what protects the repair.

### Blood Flow Restriction (BFR) Training — Optional Adjunct

BFR training may be considered as an optional adjunct beginning in Phase 2, particularly for patients with persistent quadriceps weakness or atrophy.<sup>5</sup> Evidence specifically for unstable-pattern meniscus repair is limited; the rationale derives from the broader knee-surgery rehabilitation literature, where low-load BFR has demonstrated meaningful gains in muscle strength and hypertrophy when high-load training is contraindicated. Standard parameters (60–80% AOP, 20–30% 1RM, 4 sets of 30-15-15-15) are reasonable defaults — see Dr. Roth's ACL Reconstruction Rehabilitation Protocol for full BFR parameters and contraindications. Because these repairs restrict loaded flexion and closed-chain exercise more than ACLR, BFR exercise selection should favor open-chain terminal arc quads and SLR-based loading early, advancing as Phase 2 closed-chain work is introduced.

### Return-to-Sport Criteria

Return to activity should be both time-based and criterion-based, consistent with the 2024 ESSKA-AOSSM-AASPT consensus.<sup>3,4</sup> All criteria below should be met before sport-specific clearance, and minimum time thresholds must be respected even when criteria are achieved early.

| Domain                              | Criterion                                                                                                                                                                      |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Range of motion                     | Full, symmetrical, pain-free flexion and extension <sup>1,3</sup>                                                                                                              |
| Joint signs                         | No effusion (trace or less). No joint-line tenderness — persistent tenderness or effusion may indicate delayed or failed healing and warrants surgeon evaluation. <sup>1</sup> |
| Quadriceps strength                 | LSI ≥ 90% on isokinetic or handheld dynamometer testing <sup>3,7</sup>                                                                                                         |
| Hamstring strength                  | LSI ≥ 90% <sup>3,7</sup>                                                                                                                                                       |
| Hop test battery                    | LSI ≥ 90% on the four-test battery: single hop, triple hop, crossover hop, side hop <sup>1</sup>                                                                               |
| Single-leg squat                    | Controlled, pain-free, symmetrical depth comparable to contralateral side <sup>1</sup>                                                                                         |
| Time — non-impact                   | ≥ 6 months for running, swimming, cycling, low-load fitness <sup>1,3</sup>                                                                                                     |
| Time — cutting / pivoting / contact | ≥ 9 months for sports involving cutting, pivoting, deceleration, or contact <sup>1,3</sup>                                                                                     |

#### WHY TIME AND CRITERIA BOTH MATTER

These unstable tear patterns function biomechanically as meniscectomies until the repair has healed and integrated. Healing biology is time-dependent and cannot be accelerated by faster strength gains. A patient who hits  $\geq 90\%$  LSI at 4 months is still loading a repair that is biologically incomplete. Conversely, a patient at 9 months with persistent strength deficits is biologically ready but functionally not — and should not return until criteria are met.

## References

1. Monson JK, Tollefson LV, LaPrade CM, LaPrade RF. Current Rehabilitation Principles Following Meniscus Repairs. *Curr Rev Musculoskelet Med*. 2025;18(9):331–343.
2. Athiviraham A. Editorial Commentary: Failure With Continuity — Redefining Healing With Meniscal Root Repair. *Arthroscopy*. 2019;35(11):3087–3089.
3. Pujol N, Giordano AO, Wong SE, et al. The Formal EU-US Meniscus Rehabilitation 2024 Consensus: An ESSKA-AOSSM-AASPT Initiative. Part I — Rehabilitation Management After Meniscus Surgery. *Knee Surg Sports Traumatol Arthrosc*. 2025.
4. Noailles T, Behr J, Bouguennec N, et al. Postoperative Weight-Bearing, Range-of-Motion Protocols and Knee Biomechanics After Concomitant Posterolateral Meniscal Root Repair With ACL Reconstruction: A Systematic Review. *J Clin Med*. 2026;15(2):542.
5. Albishi W, Al Yami I, Alyami A, Aldosari OA, AlJasser S. Rehabilitation Strategies Following Isolated Meniscal Repair: A Systematic Review of Protocols and Outcomes. *J Clin Med*. 2026;15(4):1616.
6. Lee DR, Lu Y, Reinholz AK, et al. Root Repair Has Superior Radiological and Clinical Outcomes Than Partial Meniscectomy and Nonoperative Treatment in the Management of Meniscus Root Tears: A Systematic Review. *Arthroscopy*. 2025;41(2):390–417.
7. Schwach M, Dergham R, Klasan A, et al. Return-to-Sport Criteria After Isolated Meniscus Suture: Scoping Review of the Literature. *Orthop Traumatol Surg Res*. 2023;109(6):103604.
8. Clifton Willimon S, Busch MT, Murata A, Perkins CA. Transosseous Meniscus Root Repair in Pediatric Patients and Association With Durable Midterm Outcomes and High Rates of Return to Sports. *Am J Sports Med*. 2022;50(8):2070–2074.
9. Culvenor AG, Girdwood MA, Juhl CB, et al. Rehabilitation After Anterior Cruciate Ligament and Meniscal Injuries: A Best-Evidence Synthesis of Systematic Reviews for the OPTIKNEE Consensus. *Br J Sports Med*. 2022;56(24):1445–1453.
10. Prill R, Ma CB, Wong SE, et al. The Formal EU-US Meniscus Rehabilitation 2024 Consensus. Part II — Prevention, Non-Operative Treatment and Return to Sport. *Knee Surg Sports Traumatol Arthrosc*. 2025.
11. Dragoo JL, Konopka JA, Guzman RA, et al. Outcomes of Arthroscopic All-Inside Repair Versus Observation in Older Patients With Meniscus Root Tears. *Am J Sports Med*. 2020;48(5):1127–1133.
12. Cong T, Reddy RP, Hall AJ, Ernazarov A, Gladstone J. Current Practices for Rehabilitation After Meniscus Repair: A Survey of Members of the American Orthopaedic Society for Sports Medicine. *Orthop J Sports Med*. 2024;12(1):23259671231226134.

## Glossary

**1RM** — One-repetition maximum; the heaviest weight a person can lift once with proper form.

**ACLR** — Anterior cruciate ligament reconstruction.

**AOP** — Arterial occlusion pressure; the cuff pressure required to fully occlude arterial flow in a limb, used to set BFR cuff pressure individually.

**BFR** — Blood flow restriction training; low-load resistance training performed with a partially occlusive cuff to drive strength gains at lighter weights.

**FWB** — Full weight-bearing.

**LSI** — Limb Symmetry Index; the operative limb's strength or performance as a percentage of the contralateral limb (operative  $\div$  contralateral  $\times 100$ ).

**NMES** — Neuromuscular electrical stimulation; surface electrical stimulation used to augment voluntary muscle contraction.

**NWB** — Non-weight-bearing; no load placed through the operative limb.

**OA** — Osteoarthritis.

**PWB** — Partial weight-bearing; the patient loads the operative limb to a specified portion of body weight, typically with crutch support.

**ROM** — Range of motion.

**SLR** — Straight leg raise.

**TTWB** — Toe-touch weight-bearing; the operative foot may rest on the floor for balance, but no body weight is loaded through it.

# KEVIN M. ROTH, MD

ORTHOPAEDIC SPORTS MEDICINE

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## Kevin M. Roth, MD

Board-Certified Orthopaedic Surgeon · Subspecialty Certification in Sports Medicine

Dr. Roth completed his orthopaedic surgery residency at Harvard Medical School and his sports medicine fellowship at the Kerlan-Jobe Orthopaedic Clinic in Los Angeles. In practice since 2013, he specializes in advanced arthroscopic techniques and sports medicine procedures, and sees patients at Palo Alto Medical Foundation's Palo Alto and Dublin offices. He welcomes calls from physical therapists about his patients or this protocol.

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