Meniscus Repair — Root & Radial Tear
Post-Operative Rehabilitation Protocol

Outpatient Physical Therapy | Evidence-Based | Return-to-Sport Focused

Procedure	Meniscal Root Repair (Transtibial Pull-Out or All-Inside) / Radial Tear Repair
Setting	Outpatient Physical Therapy
Frequency	2–3 sessions per week
Protocol Type	Criteria-based and time-guided
Date Issued	October 2026

Clinical Note

Progression requires meeting ALL criteria for the current phase before advancing. Individualize based on surgeon intraoperative findings, tear location, fixation method, limb alignment, and patient response. Consult the operating surgeon prior to advancing loading parameters or if unexpected joint reactivity occurs.

Biomechanical Rationale

Why This Protocol Differs from Standard Meniscus Repair

Root and radial tears disrupt the circumferential collagen fiber ring of the meniscus, eliminating the hoop stress mechanism that normally converts compressive knee loads into outward tension. Until the repair heals and circumferential continuity is restored, axial loading transmits unresisted compressive and shear forces directly across the repair site. Biomechanical studies demonstrate increased suture loading and repair loosening with early partial weight-bearing initiated at ≤4 weeks post-operatively (Moews et al., *Arthroscopy* 2026). Touchdown weight-bearing (TDWB) limits axial compressive load to approximately 10–20% body weight while preserving proprioceptive input and avoiding the complications of strict non-weight-bearing.

There are **NO range-of-motion restrictions** in this protocol — unrestricted motion in all positions is permitted from Day 1 and actively encouraged to promote synovial fluid nutrition, collagen remodeling, and prevention of arthrofibrosis. All weight-bearing protection is load-based, not ROM-based.

General Principles & Precautions

Apply throughout all phases.

- **TDWB × 6 weeks:** Maintain touchdown weight-bearing with bilateral axillary crutches for 6 full weeks. Permit approximately 10–20% body weight through the limb — toe or forefoot contact for balance only. Do not advance to partial or full WB before week 6 regardless of subjective comfort level.
- **No motion restrictions:** Range of motion is UNRESTRICTED in all positions from Day 1. Encourage full, comfortable range of motion immediately post-operatively in both non-weight-bearing and weight-bearing positions. Avoid artificially limiting ROM — early mobility supports synovial nutrition and prevents capsular contracture.

- **Avoid isolated resisted hamstring exercises for 6–8 weeks:** The semimembranosus attaches directly to the posterior medial meniscal root — resisted knee flexion generates direct tensile stress at the repair site (LaPrade & Monson, *IJSPT* 2025).
- **Avoid tibial rotation for 12 weeks:** Prohibit pivoting and twisting; these movements generate rotational shear across the repair site.
- **Monitor joint reactivity:** Assess for effusion and posterior/joint-line tenderness at every session. Effusion or pain >24 hours following any activity indicates excessive load — reduce intensity and notify surgeon.
- **Quadriceps priority:** Quadriceps weakness is the primary functional impairment after meniscal repair and a risk factor for repair failure and OA progression — prioritize quad activation from Day 1 (Kawada et al., *BMC Musculoskelet Disord* 2023).
- **Varus alignment:** Patients with varus limb alignment may require a medial unloader brace through week 16 — consult surgeon at initial evaluation.
- **Cryotherapy:** Apply 15–20 minutes with compression and elevation after each session and PRN throughout the day.
- **NMES:** Apply neuromuscular electrical stimulation (NMES) to the quadriceps if voluntary quad set is insufficient in early phases.
- **Biological timeline:** Meniscal tissue healing is time-dependent. Functional improvements do not indicate tissue healing — adhere to phase timelines even when the patient feels ready to advance.

Phase Structure Overview

Phase	Timeframe	WB Status	ROM	Primary Goal
Phase 1	Weeks 0–6	TDWB with bilateral crutches	Unrestricted	Protect repair; restore quad activation; control effusion
Phase 2	Weeks 6–8	Progressive WB; crutch wean	Unrestricted	Normalize gait; initiate closed-chain strength
Phase 3	Weeks 8–16	Full WB	Unrestricted	Progressive strengthening; neuromuscular control
Phase 4	Weeks 16–24 (Months 4–6)	Full WB	Unrestricted	Return-to-run; sport-specific training; RTS clearance

PHASE 1 — Protection & Neuromuscular Activation | Weeks 0–6

Phase 1 Goals

- Protect root/radial repair site during biological early-healing phase
- Control pain and effusion
- Restore full passive knee extension — highest priority
- Achieve strong, lag-free quadriceps activation
- Maintain and advance full unrestricted ROM
- Initiate proximal hip and core strengthening in NWB positions
- Maintain cardiovascular fitness

Weight-Bearing Status

TOUCHDOWN WEIGHT-BEARING (TDWB) with bilateral axillary crutches × 6 weeks. Allow approximately 10–20% body weight through the limb — toe or forefoot contact only. Crutches always bear the majority of load during ambulation. **Do NOT advance to partial or full WB before week 6.**

Brace

Apply hinged knee brace or TROM brace per surgeon preference. Unlock at surgeon discretion. Remove for supervised PT and hygiene.

Range of Motion

UNRESTRICTED — pursue full comfortable range immediately from Day 1. Prioritize full passive extension. Encourage active and passive flexion through full available range in all positions. No angle limits apply.

Therapeutic Exercises

- Perform ankle pumps — 10 reps every waking hour (DVT prophylaxis)
- Perform passive heel props, supine — maintain 5–10 min per session to restore full extension
- Perform prone knee hangs — gravity-assisted terminal extension
- Perform quadriceps sets — isometric contraction 10 × 10-second holds; multiple knee angles
- Apply NMES to quadriceps (long-sitting or supine) — use until voluntary quad set is robust
- Perform straight-leg raises, 4 planes — discontinue flexion SLR only if extensor lag >5° is present
- Perform patellar mobilizations, all 4 directions — begin after suture site clearance
- Perform supine heel slides — full available range, unrestricted, patient-guided to end-range daily
- Perform wall slides — gravity-assisted full flexion; deepen daily as comfort allows
- Perform seated active ROM — full flexion and extension, gravity-assisted
- Perform side-lying hip abduction/adduction — begin bodyweight; progress to resistance band
- Perform prone hip extension — gluteal activation; no resisted knee flexion
- Perform supine bridges — bilateral bodyweight; progress to single-leg bridges as strength allows
- Perform dead bug, transverse abdominis activation — core stability in NWB position
- Use upper body ergometer (UBE) — cardiovascular conditioning, seated NWB
- Initiate stationary bike — begin when comfortable passive flexion is sufficient for pedaling; elevate seat; apply no resistance × first 1–2 weeks; progress resistance as tolerated

Phase 1 Precautions

- TDWB ONLY — no partial or full WB through week 6
- No isolated resisted hamstring exercises (no hamstring curls, no Nordic curls)
- No tibial rotation, pivoting, or torsional loading
- No plyometric or ballistic activity
- Resolve extensor lag before progressing flexion SLR

Criteria to Advance to Phase 2

- 6 full weeks post-operative — **TIME REQUIREMENT IS NON-NEGOTIABLE**
- Surgeon clearance at 6-week post-operative visit
- Full passive knee extension (0°) — no extensor lag

- Strong quadriceps set; SLR in all planes without lag
- Minimal to trace effusion at rest
- Pain ≤ 2/10 at rest and with TDWB ambulation
- Comfortable full ROM in NWB positions

PHASE 2 — Graded Loading & Gait Restoration | Weeks 6–10

Phase 2 Goals

- Safely restore progressive weight-bearing with crutch wean
- Normalize heel-to-toe gait pattern
- Initiate closed-chain lower extremity strengthening
- Advance hamstring strengthening (begin week 8)
- Continue cardiovascular conditioning
- Maintain full unrestricted ROM

Weight-Bearing Progression

- **Week 6-8:** Advance to full WB; discharge crutch when normalized heel-to-toe gait is confirmed
- Apply no hard WB flexion depth limit this phase — progress based on pain, effusion, and tissue reactivity

Brace

Continue brace per surgeon direction through the 6-week visit; typically discontinue at 6 weeks.

Range of Motion

Full, unrestricted in all positions. No angle limits.

Therapeutic Exercises — Weeks 6–8

- Continue all Phase 1 exercises — advance resistance and volume
- Progress stationary bike resistance and duration toward 20–30 min continuous
- Perform weight shifts — bilateral; progress depth gradually based on comfort and reactivity
- Perform mini-squats / wall sit — bilateral, pain-free; progress depth incrementally
- Perform standing heel raises — bilateral; progress to single-leg
- Perform step-ups — begin 4-inch step; advance height as quad strength allows
- Perform lateral band walking — hip abduction; maintain minimal squat depth
- Perform clamshells, banded hip abduction — progress resistance band
- Perform prone hip extension with resistance
- Perform hip thrusts — bilateral bodyweight; progress to weighted
- Perform gait training — level surface; eliminate Trendelenburg, lateral trunk sway, and vaulting
- Perform aquatic therapy (cleared incision, surgeon approved): waist-deep pool walking forward/retro, marching, lateral stepping — sagittal plane, no torsion

Therapeutic Exercises — Weeks 8–10 (Add to Above)

- **BEGIN HAMSTRING STRENGTHENING — MINIMUM WEEK 8:**

  - Perform standing hip extension with resistance band (no resisted knee flexion)
  - Perform isometric hamstring contraction at 0° and 30° knee flexion
  - Perform Romanian deadlift (RDL) — bilateral, light load; progress gradually
  - Do NOT begin seated/prone hamstring curls (resisted knee flexion) until Phase 3
- Perform leg press — bilateral, full comfortable range; progress load gradually
- Use elliptical trainer — low resistance, low ramp

Phase 2 Precautions

- No isolated resisted knee flexion through end of Phase 2 (week 10)
- No pivoting, twisting, or tibial rotation
- No running, hopping, or jumping
- Reduce load if effusion or posterior joint-line tenderness occurs post-activity

Criteria to Advance to Phase 3

- Full WB with normalized heel-to-toe gait — no assistive device
- No reactive effusion after WB activity
- Full, pain-free ROM in all positions and planes
- No posterior joint-line tenderness with loading
- Quad MMT grade ≥ 4+/5; SLR without lag all planes
- Surgeon clearance at approximately 8–10 week post-op visit

PHASE 3 — Progressive Strengthening & Neuromuscular Control | Weeks 10–16

Phase 3 Goals

- Achieve quadriceps limb symmetry index (LSI) ≥ 75–80%
- Restore full symmetric strength and neuromuscular control
- Advance proprioception and dynamic balance
- Prepare for return-to-run criteria
- Initiate sport-specific movement patterns

Weight-Bearing Status & ROM

Full, unrestricted. No brace required. ROM: Full, unrestricted all positions.

Therapeutic Exercises

- Progress stationary bike to full resistance and duration (20–30 min); decrease seat height for deeper ROM as comfort allows
- Perform leg press — bilateral advancing to unilateral; full comfortable range; progress load
- Perform step-ups/step-downs — advance step height (4" → 6" → 8" → 10")
- Perform lateral step-downs — controlled eccentric descent; advance depth
- Perform forward and lateral lunges — full range; advance load progressively
- Use retro treadmill walking — promotes quad activation; reduces compressive loads

- Use forward treadmill walking — advance speed and incline gradually
- Perform single-leg balance — static → foam pad → BOSU → perturbation → eyes closed → dual-task
- Perform Y-Balance Test training — anterior reach emphasis; document asymmetry
- Progress hip/gluteal program — single-leg RDL (bilateral → unilateral); lateral step-downs; weighted hip thrusts
- **Hamstring progression:**
  - Perform seated hamstring curls — begin conservatively; progress load
  - Introduce Nordic curl — eccentric-only, bilateral, low volume (2 × 3–5 reps)
  - Perform Swiss ball hamstring curl — bilateral
  - Perform RDL — bilateral → unilateral with load
- **Core progression:** Perform full plank (bilateral → single-leg); Pallof press; anti-rotation; dead bug with resistance; Copenhagen plank
- Swim freestyle/backstroke — NO breaststroke or whip kick through month 5
- Apply blood flow restriction (BFR) training — low-load BFR quad and hamstring exercises; evidence-supported adjunct for hypertrophy with minimal joint stress
- Progress proprioception — progressive perturbation training; sport-relevant balance challenges

Phase 3 Precautions

- No running until return-to-run criteria fully met (minimum week 16)
- No plyometrics until bilateral hop criteria established
- Reduce load if effusion or posterior joint-line pain occurs post-session

Criteria to Advance to Phase 4 / Initiate Return-to-Run

- Minimum 4 months post-operative
- Surgeon clearance
- Full, pain-free ROM symmetric to contralateral
- No effusion after functional activity; no joint-line tenderness
- Quadriceps LSI ≥ 80% (handheld dynamometry or isokinetic testing)
- Hamstring LSI ≥ 80%
- Single-leg squat to 60°+ with adequate frontal plane control — no Trendelenburg, no medial knee collapse
- Lateral step-down ≤ 3/6 errors at appropriate step height
- Y-Balance Test anterior reach ≤ 4 cm asymmetry

PHASE 4 — Return-to-Run & Return to Sport | Weeks 16–24 | RTS Target: 5–6 Months

Phase 4 Goals

- Complete return-to-run progression
- Achieve ≥ 90% LSI quadriceps and hamstring strength
- Pass full hop testing battery ≥ 90% LSI
- Complete sport-specific training and on-field rehabilitation
- Obtain formal return-to-sport clearance — anticipated 5–6 months based on clinical criteria

Weight-Bearing Status & ROM

Full, unrestricted all positions.

Return-to-Run Protocol

Begin no earlier than Week 16. ALL criteria below must be met before initiating.

Pre-Run Criteria Checklist

1. No pain, effusion, or posterior joint-line tenderness with all Phase 3 activities
2. Quadriceps LSI ≥ 80%
3. Hamstring LSI ≥ 80%
4. Single-leg hop test (single, triple, crossover) ≥ 80% symmetry
5. Y-Balance Test anterior reach ≤ 4 cm asymmetry
6. Surgeon clearance

Running Progression

Week	Running Prescription
Weeks 1–2	Walk/jog intervals — 2 min walk : 1 min jog × 20 min total; flat surface
Weeks 3–4	Reduce walk intervals; increase jog duration → continuous 15–20 min jog
Weeks 5–6	Progress distance and mild incline; introduce pace variation
Weeks 7–8	Progressive distance → change of direction → speed work at 75% max
Week 9+	Sport-specific cutting and pivoting at progressive intensity

Therapeutic Exercises — Phase 4

- Continue all Phase 3 exercises — increase load, volume, and complexity
- Perform walking lunges — forward, lateral, diagonal — full range weighted
- Perform Bulgarian split squat / rear-foot elevated split squat
- Perform full single-leg leg press — progress to sport-relevant loads
- Perform Swiss ball hamstring curls — bilateral → unilateral
- Progress Nordic curl — bilateral eccentric → unilateral eccentric
- **Plyometric progression (bilateral first):**
  - Progress box step-up → bilateral squat jump → bilateral broad jump → bilateral drop jump
  - Assess landing mechanics using LESS (Landing Error Scoring System) < 5 errors before advancing
  - Initiate single-leg plyometrics after bilateral criteria ≥ 90%: single-leg hop-and-hold; single-leg bounding; single-leg drop jump
- Perform carioca, lateral shuffles, backpedaling — after return-to-run milestone
- Perform deceleration and change-of-direction drills — 45° → 90° cuts at progressive speeds
- Perform sport-specific agility drills, reaction training, and on-field rehabilitation

Return-to-Sport Clearance Criteria — Minimum 6 Months Post-Operative

ALL criteria must be met prior to return-to-sport clearance:

1. Surgeon clearance — anticipated 5–6 months post-op based on clinical criteria
2. Full pain-free ROM — symmetric to contralateral
3. Zero effusion after sport-specific activity
4. No posterior or joint-line tenderness with loading
5. Quadriceps LSI ≥ 90% (isokinetic or dynamometry preferred)
6. Hamstring LSI ≥ 90%
7. Single-leg hop battery (single, triple, crossover, 6-meter timed hop) ≥ 90% LSI with acceptable landing mechanics
8. Y-Balance Test — anterior reach ≤ 4 cm asymmetry; composite score ≥ 90%
9. Lateral step-down ≤ 2/6 errors at step height achieving approximately 60° knee flexion
10. LESS score < 5 errors on bilateral and single-leg landing tasks
11. Sport-specific drills completed without pain, swelling, or mechanical symptoms
12. Psychological readiness — ACL-RSI or equivalent score ≥ 65 (adapted for meniscal context)

Note on Return-to-Sport Timeline

Return to sport is anticipated at 5–6 months post-operatively for patients who meet all 12 clearance criteria. Progression is fully criteria-based — patients who meet criteria early may be cleared at 5 months; those requiring additional time to achieve strength symmetry or complete sport-specific training may progress toward 6 months. The 2024 EU-US Meniscus Rehabilitation Consensus (ESSKA-AOSSM-AASPT) supports criteria-driven clearance over fixed time-based return — LSI ≥ 90%, hop testing symmetry, and absence of joint reactivity are the primary gatekeepers for safe return.

Outcome Measures

Measure	Assessment Tool	Benchmark / Target	Phase
Quadriceps strength	Handheld dynamometry or isokinetic testing	≥ 80% LSI (run); ≥ 90% LSI (sport)	Phase 3–4
Hamstring strength	Handheld dynamometry	≥ 80% LSI (run); ≥ 90% LSI (sport)	Phase 3–4
Single-leg hop — single	Single hop for distance	≥ 90% LSI at sport clearance	Phase 4
Single-leg hop — triple	Triple hop for distance	≥ 90% LSI at sport clearance	Phase 4
Single-leg hop — crossover	Crossover hop	≥ 90% LSI at sport clearance	Phase 4
Single-leg hop — timed	6-meter timed hop	≥ 90% LSI at sport clearance	Phase 4
Dynamic balance	Y-Balance Test (anterior reach)	≤ 4 cm asymmetry; composite ≥ 90%	Phase 3–4
Knee ROM	Goniometry	Within 5° of contralateral	All phases
Effusion	Modified Stroke Test / circumference	Zero before progression	All phases
Landing mechanics	LESS	< 5 errors before plyometric progression	Phase 4
Functional movement	Lateral step-down test	≤ 3/6 errors (Phase 3); ≤ 2/6 (sport)	Phase 3–4
Patient-reported outcome	IKDC + KOOS + Tegner	IKDC ≥ 75; Tegner ≥ pre-injury level	Phase 3–4
Psychological readiness	ACL-RSI (adapted)	≥ 65 before RTS clearance	Phase 4

Key Evidence & References

TDWB × 6 weeks: Early partial WB (≤4 weeks) following posterior medial meniscus root repair associated with suboptimal clinical and radiologic outcomes — Moews et al., *Arthroscopy* 2026 (systematic review, Level IV).

Hoop stress disruption rationale: Radial and root tears eliminate circumferential load-bearing; biomechanical studies demonstrate suture loading and repair loosening with early axial WB — LaPrade group, *Current Rehabilitation Principles*, PMC 2025.

No ROM restriction: Unrestricted motion encourages synovial fluid nutrition and collagen remodeling without adding compressive hoop stress — LaPrade & Monson, *IJSPT* 2025.

Hamstring restriction × 6–8 weeks: Semimembranosus direct attachment to posterior medial root generates tensile stress with resisted knee flexion — LaPrade & Monson, *IJSPT* 2025.

Return to sport 5–6 months (criteria-based): 2024 EU-US Meniscus Rehabilitation Consensus (ESSKA-AOSSM-AASPT), GRADE C — LSI ≥ 90% + hop testing + criteria-based clearance recommended.

Quadriceps strength as prognostic factor: Quadriceps weakness predicts increased medial meniscus extrusion progression and OA risk — Kawada et al., *BMC Musculoskelet Disord* 2023; Øiestad et al., systematic review.

This protocol is intended as a general clinical guideline specific to meniscal root and radial tear repairs. Modify based on individual surgical findings, tear characteristics, fixation method, limb alignment, patient age, BMI, activity level, and surgeon direction. Do not apply to vertical longitudinal, bucket-handle, or ramp tears — use the All-Inside Meniscal Repair Protocol for those tear types. Austin V Stone MD PhD | austinstonemd.com