

PHYSICAL THERAPY PROTOCOL

Tibial Spine Fracture Repair

Pediatric · ACL Avulsion Fracture · Arthroscopic Fixation

FOR THE PHYSICAL THERAPIST

Overview and Goals

This protocol governs rehabilitation following arthroscopic repair of a tibial spine (tibial eminence) fracture — an ACL avulsion injury in which the ligament pulls off its bony attachment from the tibial eminence rather than tearing through its midsubstance. The injury predominantly affects skeletally immature patients between ages 8 and 14 and results from a strength imbalance between a structurally intact ligament and incompletely ossified bone.^{1,2}

The fragment is anatomically reduced and fixed arthroscopically using sutures, a screw, or a combination construct. Because the ACL itself is intact, the primary rehabilitation concern is bony union of the fragment — not ligament graft biology. The protocol is therefore bone-healing gated: toe-touch weight-bearing and brace immobilization protect fixation during the healing window, while early motion is initiated aggressively within that window to prevent arthrofibrosis, the most common complication of this injury.^{3,4}

ARTHROFIBROSIS IS THE PRIMARY COMPLICATION — START MOTION EARLY

Historical data show that immobilizing the knee longer than 4 weeks results in a 12× higher odds of arthrofibrosis and a doubling of time to full activity.³

Begin active-assisted and passive ROM within the first week. Do not sacrifice motion for the sake of weight-bearing caution — the two are independent parameters. The brace controls weight-bearing; ROM is exercised freely within it.^{3,4}

Radiographic confirmation of healing is the gate to advancing weight-bearing and brace discontinuation. The surgeon's assessment at the 4-week visit is the decision point. PT should not advance beyond TTWB without that clearance.

Because the ACL is anatomically restored (not reconstructed with a graft), full ACL function is expected after healing. Return to sport follows functional criteria rather than the graft-maturation timeline of ACL reconstruction. Most pediatric patients return to sport at 4–6 months.^{2,5}

Rehabilitation Phases

PHASE	WEIGHT BEARING	BRACE	ROM GOALS	EXERCISES	CRITERIA TO ADVANCE
PHASE 1 Weeks 0–4 <i>Protection & early motion</i>	• Toe-touch weight bearing (TTWB) through week 4. • Crutches required at all times. No advancement without radiographic healing confirmation and Dr. Roth's, his PA's or his	• Hinged knee brace locked in full extension (0°) for all ambulation and sleeping. • Brace may be removed during PT sessions and for supine home exercises under supervision.	Goals by end of Phase 1: • Full passive extension (0° — essential; extension loss is the primary complication to prevent) • Flexion to 90° minimum — target 100–120° by	Swelling / pain control: • Cryotherapy and elevation after every session • NMES to quadriceps (arthrogenic inhibition is common after hemarthrosis) ROM (highest priority in Phase 1): • Begin active-assisted and passive flexion/extension within the first PT visit — do not delay.³ • Heel slides, wall slides, prone knee hangs, gravity-assisted flexion • Towel-roll passive extension, patellar mobilization (superoinferior and mediolateral)	• Full passive extension (0°) • Flexion ≥ 90° (target 100–120°) • Effusion ≤ 1+ • SLR without lag • Radiographic confirmation of bony healing at the 4-week visit^{2,3} • Dr. Roth's, his PA's or his NP's clearance to advance weight-bearing

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ORTHOPAEDIC SPORTS MEDICINE

PHASE	WEIGHT BEARING	BRACE	ROM GOALS	EXERCISES	CRITERIA TO ADVANCE
	NP's clearance at the 4-week visit.	Do not unlock for walking. ^{3,4}	- week 4 • Quad activation with SLR without lag	• Tibiofemoral anterior glides to restore extension • Stationary bike (low seat, minimal resistance) when flexion $\geq 100^\circ$ Strengthening: • Quad sets with knee fully supported in extension • SLR (all 4 planes) with brace locked • Hamstring sets (gentle, no resisted flexion) • Hip abduction, adduction, extension (side-lying and prone) • Ankle pumps and ankle strengthening Aerobic: • Upper body ergometer; stationary bike when ROM permits	
PHASE 2 Weeks 4–10 <i>Weight-bearing & strength progression</i>	• Begin weight-bearing progression at week 4 once radiographic healing is confirmed.^{2,3} • Weeks 4–6: advance from TTWB to 50% partial weight bearing, then to a single crutch, then off crutches. • Off crutches and fully weight bearing by week 6, provided gait is symmetric and quad control is adequate.	• Unlock brace and begin progressive ROM during ambulation once Dr. Roth, his PA or his NP clears weight-bearing at the 4-week visit. • Wean brace over 2–3 weeks as quad control returns and gait normalizes.	• Advance toward full, symmetric ROM. • No restrictions once brace is weaned.	Closed-chain strengthening: • Mini-squats ($0\text{--}60^\circ$), leg press (limited range, low resistance), step-ups (low step $\rightarrow$ progressive height) • Heel raises bilateral $\rightarrow$ unilateral • Weight shifting and single-leg stance progression Open-chain: • Terminal arc quad extension with progressive resistance • Hamstring curls with progressive resistance Neuromuscular: • Single-leg balance, balance board, perturbation training Aerobic: • Stationary bike (progressive resistance), pool walking, elliptical (late Phase 2)	• WBAT without assistive device • Full, symmetric ROM • No effusion • Adequate quad control for single-leg activities • Minimum ~10 weeks from surgery
PHASE 3 Weeks 10–16 <i>Progressive strengthening</i>	• Full weight bearing. No restrictions.	• Brace discontinued.	• Full, unrestricted ROM.	Progressive strengthening: • Leg press full range, step-downs, lunges, single-leg squats (partial $\rightarrow$ full depth) • Nordic hamstring curls (eccentric), Romanian deadlifts • Hip strengthening: lateral band walks, single-leg bridges, clamshells Aerobic: • Stationary bike, elliptical, pool laps • Straight-line jogging begins at approximately week 12 when quad LSI $\geq 70\%$ and gait fully symmetric.^{4,5} Neuromuscular / proprioception: • Single-leg balance with perturbation, agility ladder (non-impact), lateral shuffles	• Quad LSI $\geq 80\%$ • Hamstring LSI $\geq 80\%$ • Controlled single-leg squat • Pain-free running gait • No effusion • Minimum ~16 weeks from surgery
PHASE 4 Months 4–6	• No restrictions.	• None.	• No restrictions.	Plyometrics (progressive): • Double-leg jumping at ~week 16;	• Quad LSI $\geq 85\%$ • Hamstring LSI $\geq$

PHASE	WEIGHT BEARING	BRACE	ROM GOALS	EXERCISES	CRITERIA TO ADVANCE
Return-to-sport preparation				single-leg hopping at ~week 20; cutting and pivoting at ~week 20–24. ^{4,5} • Box jumps, lateral bounds, deceleration drills Sport-specific conditioning: • Agility patterns specific to patient's sport (carioca, shuttle, change-of-direction) • Sport-specific ball / equipment skills re-introduction Strength maintenance: • Continue progressive loading; single-leg press, deadlifts, sport-specific movement patterns	85% • Hop test battery LSI ≥ 85% • Pain-free sport-specific movement • No effusion • Dr. Roth's clearance; typically 4–6 months from surgery ⁵

Procedure-Specific Considerations

Radiographic Gating — Do Not Advance Without Imaging Confirmation

Unlike ACL graft reconstruction, where the biology of graft incorporation is inferred from time and clinical testing, tibial spine fracture healing can and should be confirmed radiographically before advancing weight-bearing. The standard check is plain radiographs at the 4-week post-op visit. If healing is not visible radiographically, weight-bearing advancement is deferred regardless of clinical appearance. Communicate directly with Dr. Roth, his PA or his NP if there is any uncertainty about healing status before changing the weight-bearing prescription.^{2,3}

Arthrofibrosis Prevention — The Primary Risk

Arthrofibrosis — defined as loss of $\geq 5^\circ$ extension or $\geq 25^\circ$ flexion compared with the contralateral side — is the most common complication of tibial spine fracture surgery, occurring in a substantial minority of patients under traditional delayed-motion protocols.³ The key protective measure is aggressive early ROM within the first week, without waiting for swelling to fully resolve. Extension is more important than flexion: loss of full extension produces a quadriceps-disadvantaged gait pattern and is substantially harder to recover than flexion loss. Any patient who cannot achieve full passive extension by the end of week 2 should be flagged for Dr. Roth's review.

Concomitant Meniscal Pathology

Meniscal tears or entrapment occur in a portion of tibial spine fractures, particularly in older adolescents.¹ If a concomitant meniscal repair was performed, the weight-bearing and ROM restrictions of this protocol govern the early phase (they are already conservative enough to protect a peripheral repair). Alert Dr. Roth, his PA or his NP if a concurrent meniscal injury was documented so any additional precautions can be confirmed.

Quadriceps Inhibition After Hemarthrosis

Tibial spine fractures invariably produce a hemarthrosis, which causes pronounced arthrogenic quadriceps inhibition. Voluntary quad activation is often markedly impaired in the first 1–2 weeks even after swelling partially subsides. NMES applied to the quadriceps during the early protected phase can partially bypass arthrogenic inhibition and accelerate the return of volitional muscle control.⁴ Priority: achieve an SLR without extension lag before advancing to Phase 2 closed-chain loading.

Skeletally Immature Patients

The standard functional criteria (LSI thresholds, hop testing) remain appropriate gatekeepers in the adolescent population. However, compliance with home exercises and activity restrictions requires

parental engagement, particularly during the protected weight-bearing phase. Weight-bearing restrictions should be explained explicitly to both the patient and accompanying caregivers. Contact sports clearance should involve a family discussion with Dr. Roth, his PA or his NP.

Return-to-Sport Criteria

Return to sport is guided by both time-based gating (bone healing) and criterion-based functional milestones. Published data indicate approximately 75–96% of pediatric patients return to their prior sport level after tibial spine fixation.^{2,5,6} Clearance typically occurs at 4–6 months, gated by radiographic healing, full ROM, and strength symmetry.^{2,3,5}

Domain	Criterion
Range of motion	Full, symmetric, pain-free flexion and extension ^{2,3}
Joint signs	No effusion; no joint-line tenderness ²
Quadriceps strength	LSI ≥ 85% on isokinetic or handheld dynamometer ^{2,5}
Hamstring strength	LSI ≥ 85% ²
Hop test battery	LSI ≥ 85% on four-test battery: single hop, triple hop, crossover hop, side hop ⁵
Single-leg squat	Controlled, pain-free, symmetric depth vs. contralateral side ⁵
Radiographic	Bony union confirmed on imaging (verified at the 4-week post-op visit; may require a 3-month check for delayed healing) ^{2,3}
Time	Typically 4–6 months from surgery; contact sports may require additional time per Dr. Roth’s assessment ^{2,5,6}

WHY THIS IS DIFFERENT FROM ACL RECONSTRUCTION

The ACL itself is intact in a tibial spine fracture — only its bony insertion has been disrupted. Once bony union is confirmed and strength criteria are met, there is no graft maturation window to wait through. The typical 9–12 month ACL reconstruction timeline does not apply. Patients and families should be counseled early that a 4–6 month return to sport is realistic and supported by the literature, contingent on healing and criterion-based readiness.

References

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Glossary

LSI — Limb Symmetry Index; operative limb strength or performance as a percentage of the contralateral limb (operative ÷ contralateral × 100). LSI ≥ 85% means the operative side reaches 85% of the uninvolved side.

NMES — Neuromuscular electrical stimulation; surface electrical stimulation used to augment voluntary muscle contraction, particularly useful when arthrogenic inhibition suppresses voluntary quad activation after hemarthrosis.

ROM — Range of motion.

SLR — Straight leg raise; performed with the brace locked in extension to assess quad activation without joint loading.

TTWB — Toe-touch weight-bearing; crutch-assisted ambulation with only light toe contact — enough to maintain balance without meaningfully loading the operative limb.

WBAT — Weight-bearing as tolerated; the patient loads the operative limb to comfort, weaning assistive devices as gait normalizes.



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