

TIBIAL TUBERCLE OSTEOTOMY

Physical Therapy Protocol

PATIENT

SURGEON

Andrew L. Merritt, MD

DATE OF SURGERY

PT START DATE

For the patient

Your surgery moved the bony bump below your kneecap (the tibial tubercle) to improve how your kneecap tracks in its groove. The bone is held with screws and heals like a broken bone. **For 6 weeks, only a toe-touch:** your foot can rest on the floor for balance (about 10 to 15 pounds), and your crutches carry your weight. After your 6-week X-ray shows the bone is healing, you start adding weight. You come off crutches first, then the brace. Strengthening your inner thigh muscle is the focus all the way through, because it helps hold your kneecap in place.

PROTOCOL AT A GLANCE

WEIGHT BEARING	Toe-touch only for 6 weeks (about 10–15 lb, for balance). Weight advances only after the 6-week X-ray shows healing; crutches come off first
BRACE	Locked straight for walking for 6 weeks. Off for bending exercises, rest, and sleep. Stops after you walk confidently without crutches
MOTION GOALS	Sitting or lying down only. 0–90° by 6 weeks, not past 90°. Then 0–120° or more by week 12
PHYSICAL THERAPY	Starts 5 to 7 days after surgery, 2 times a week at first
KEY PRECAUTIONS	No standing exercises, squats, or steps for 6 weeks. No anti-inflammatory medicines for 6 weeks. Bike: rocking only until the 90° limit lifts
RUNNING · SPORT	Jogging from about weeks 14 to 16. Return to sport at 6 months ; cutting and pivoting sports at 9 months

Recovery Timeline

Phase	When	PT visits	Focus
1	Weeks 0–6	2× a week	Toe-touch, brace locked for walking, motion to 90°, wake up the quad and VMO
2	Weeks 6–12	2× a week	After the 6-week X-ray: add weight, crutches off, then brace off; early strength
3	Weeks 12–20	1–2× a week + home program	Squats, single-leg work, jogging, early plyometrics, symmetry testing
4	Weeks 20–24+	As needed	Sport training and testing; sport at 6 months, cutting at 9 months

For the Therapist

Check the surgeon notes first. They override anything else in this protocol. Questions or setbacks: call (425) 656-5060.

Surgeon notes and special instructions

General principles

- **What the surgery does.** TTO treats recurrent patellar instability or chronic patellofemoral pain with an elevated TT-TG distance (typically >15–20 mm). Medialization reduces the lateral pull on the patella; anteriorization (Fulkerson type) also unloads the patellofemoral joint. The tubercle is a controlled fracture fixed with screws, and bone healing is the rate-limiting constraint in every phase.
- **Toe-touch for 6 weeks** (about 10–15 lb, for balance), dictated by osteotomy biology. This is not negotiable without direction from Dr. Merritt.
- **Loading starts only after the 6-week X-ray** confirms healing. It then progresses at a patient-guided pace based on comfort at the osteotomy site, confidence, and quad control, not a fixed calendar; some advance in a few days, others take 1–2 weeks.
- **Crutches are weaned before the brace.** Once the patient walks confidently with the brace unlocked and without crutches, the brace is stopped.
- **The brace is locked straight for walking during the toe-touch phase; it is not used to control motion.** Motion exercises are done out of the brace from day 1, non-weight-bearing; no flexion past 90° for 6 weeks. The brace is off for sleep.
- **Stationary bike under the 90° cap:** rocking or partial revolutions within the cap only. Full revolutions once the cap lifts after 6 weeks.
- **No anti-inflammatory medicines (NSAIDs) for 6 weeks, including topical ones;** they can slow bone healing.
- **Quad activation is the top early priority.** Toe-touch immobility plus arthrogenic muscle inhibition compounds quad shutdown. BFR is approved; **NMES** is provided at each PT visit from the first visit (no home unit).
- **VMO emphasis and no valgus in every phase.** The VMO is the main dynamic patellar stabilizer; hip abductor and external rotator strengthening is required throughout.
- **Cold compression:** 20 minutes on, 20 minutes off. **Lateral retinacular lengthening** is a standard part of TTO and does not change the protocol; therapist-performed glides are enough.

PHASE

1

Bone Protection and Quad Activation

Weeks 0–6

For the patient: what to expect

For 6 weeks you use crutches and only **touch your foot to the floor for balance** (about 10 to 15 pounds). This protects the bone while it heals. Your brace is locked straight when you walk, but you take it off to bend your knee during exercises, to rest, and to sleep. **Don't bend past 90° for 6 weeks.** No standing exercises yet. Your most important job is waking up your thigh muscle; your therapist will use a muscle stimulator at your visits. Don't take anti-inflammatory medicines, including creams or gels, for 6 weeks.

WEIGHT BEARING	Toe-touch (about 10–15 lb, for balance) with 2 crutches, weeks 0–6. No partial or full weight bearing in this phase
BRACE	Hinged brace locked in full extension for all walking. Off for motion exercises, rest, and sleep
MOTION	From day 1, supine or seated, out of the brace. 0–90°; no flexion past 90° for 6 weeks

Goals

- Protect the osteotomy fixation while soft callus forms
- 20 straight-leg raises in a row without an extension lag
- VMO activation, with biofeedback or NMES as needed
- Motion 0–90°, non-weight-bearing
- Pain and effusion controlled; patellar mobility kept

Move on when

- ☐ 20 straight-leg raises in a row without an extension lag
- ☐ Active motion 0–90° supine
- ☐ VMO activation confirmed by palpation or biofeedback
- ☐ Effusion trace or absent at rest
- ☐ Stationary bike rocking or partial revolutions within 90°, pain-free

Exercises

Exercise	How
Quad sets	3 × 15, 5-sec hold, 3–4× a day from day 1; NMES over the quad at each PT visit if activation is absent or weak
BFR quad activation	Low-load quad sets or short-arc quads with the BFR cuff from weeks 1–2; 30/15/15/15 reps, low resistance
Straight-leg raises	Supine, 3 × 15, once a quad set is present; goal 20 without a lag by weeks 4–6
Heel slides	Supine, pain-limited, 3 × 15, within 90°. The main early motion exercise
Short-arc quads	0–30° over a towel roll, 3 × 15; start week 2
Patellar mobilization	Superior, inferior, medial, and lateral glides, 1–2 min per direction per session from day 1
Stationary bike	No resistance, seat set for pain-free motion; from weeks 2–3 once 60–75° of flexion is reached. Rocking or partial revolutions within 90° only
Hip · glutes · ankle	Supine hip abduction 3 × 15 from week 2; glute sets 3 × 15; ankle pumps 2 × 20
Cold compression	After each session, 20 min on, 20 min off

Precautions

- No weight bearing beyond toe-touch for any reason in weeks 0–6; the screws hold the tubercle, but early axial load can disrupt fixation or delay union. Only Dr. Merritt can change this
- No weight-bearing closed-chain exercise (squats, step-ups, lunges) and no standing motion work (wall slides, gravity-assisted flexion); motion and quad work supine or seated only
- Use NMES aggressively at PT if activation is absent or there is an extension lag; prolonged quad inhibition after TTO delays everything that follows
- Extension lag beyond week 4: increase NMES at PT and notify Dr. Merritt; a lag at the end of Phase 1 delays Phase 2
- No full bike revolutions while flexion is capped at 90°

Why: Bone heals in sequence: inflammation (days 0–10), soft callus (weeks 2–6), then bridging or hard callus (weeks 6–12). Load before bridging callus forms can cause fixation failure, malunion, or nonunion. Toe-touch keeps neuromuscular input without exceeding what early callus can take.

PHASE

2

Progressive Weight Bearing and Early Strengthening

Weeks 6–12

For the patient: what to expect

Once your 6-week X-ray shows the bone is healing, you start putting more weight on your leg. You set the pace: add as much as feels safe and comfortable, but stop if you feel pain where the bone was cut. First goal: walking without crutches with the brace on and unlocked. Once you do that confidently, the brace comes off. You will also start mini squats and step exercises, and you can pedal the bike all the way around now that the bending limit is lifted.

WEIGHT BEARING	Advances only after the 6-week X-ray confirms healing. Then as tolerated at a patient-guided pace; do not push through pain at the osteotomy site
BRACE	Crutches first, then the brace: once walking is confident with the brace unlocked and without crutches, stop the brace
MOTION	Full active motion (0–120° or more). Full bike revolutions now allowed

Goals

- From toe-touch to full weight bearing at a patient-guided pace
- Off crutches, then out of the brace, in that order
- Full active motion (0–120° or more)
- Start closed-chain strengthening: mini squats, step-ups
- Single-leg balance on a firm surface; quad and VMO toward 70% LSI

Move on when

- ☐ Full weight bearing without crutches (brace locked at first, then unlocked)
- ☐ Walking with the brace unlocked, without crutches or apprehension; then brace off
- ☐ Full motion 0–120° or equal to the other side
- ☐ Mini squats to 45° pain-free with neutral alignment
- ☐ 10 step-ups on a 4-inch step with a hold, no compensation
- ☐ Single-leg stance 20 sec on a firm surface

Exercises

Exercise	How
Straight-leg raises	Progressive ankle weight (1–3 lb), 3 × 15
Short-arc quads	Light resistance progression, 3 × 15
Mini squats	0–30°, body weight, 3 × 15, once weight bearing as tolerated is established; knee over the second toe, no valgus, mirror or video feedback. Progress to 45° by weeks 8–10
Wall sits	0–45°, 3 × 20–30-sec holds
Step-ups	4-inch step, surgical leg leads, 3 × 10 with a 5-sec hold; from weeks 8–9 once mini squats are pain-free
Sit-to-stand	3 × 10; progress from armrests to no armrests
Hip strengthening	Side-lying hip abduction 3 × 15–20 with ankle weight; lateral band walks 3 × 15 steps each way; clamshells with band 3 × 15–20
Stationary bike	Full revolutions with light resistance, for aerobic base and quad endurance
Single-leg balance	Firm surface, support nearby, 3 × 20–30 sec per leg, once walking without crutches
Patellar self-mobilization	All directions, 1–2 min a day

Precautions

- Pain at the tibial tubercle with weight bearing is a hard stop: slow the progression and notify Dr. Merritt. Bridging callus is forming but not yet mature
- Do not allow valgus collapse during mini squats or step-ups; it raises lateral patellar force and loads the fixation unevenly. Add hip abductor work if valgus persists
- No step-ups until mini squats to 45° are pain-free and quad control is consistent
- The brace comes off after the crutches, not before; otherwise the patient has neither structural nor walking support

Why: Weeks 6–12 bring bridging callus and early radiographic union. The osteotomy tolerates progressive compression but is still vulnerable to shear and uneven valgus loading. Closed-chain work at the right depth and load helps remodeling (Wolff's law), within a range that does not destabilize the fixation.

PHASE

3

Advanced Strengthening and Neuromuscular Control

Weeks 12–20

For the patient: what to expect

This phase rebuilds your strength and teaches your leg to move correctly under harder loads. You will work up to single-leg squats, start jogging, and begin low-level jumping. Your thigh and hip strength need to get close to your other leg before you move on. Push hard, but pain at the front of the knee or where the bone was cut is always a reason to slow down.

WEIGHT BEARING	Full, with progressive single-leg and impact loading
BRACE	None
RUNNING	Jogging from weeks 14–16 on a flat surface; a pain-free single-leg squat comes first

Goals

- Full-depth two-leg squat and single-leg squat without compensation
- Quad and hamstring strength $\geq 80\%$ LSI; target 90% for Phase 4
- Start and progress two-leg plyometrics (from weeks 14–16)
- No valgus on single-leg squat or step-down; running on a flat surface
- Advanced single-leg proprioception and neuromuscular control

Move on when

- ☐ Single-leg squat to $60^\circ \times 10$ without valgus
- ☐ Step-down: smooth eccentric control, no dynamic valgus
- ☐ Quad strength $\geq 80\%$ LSI (progress to 90% before Phase 4)
- ☐ Single-leg hop for distance $\geq 80\%$ LSI
- ☐ Jogging 20 min continuously on a flat surface, pain-free
- ☐ No osteotomy-site pain with any loading; two-leg plyometrics tolerated pain-free

Exercises

Exercise	How
Squats	Mini squats progressing to full goblet squats ($0\text{--}90^\circ$), $3 \times 12\text{--}15$ with light weight, from weeks 12–13
Step-ups · step-downs	Step-ups (6-inch) 3×15 from weeks 12–13; step-downs (6–8-inch, eccentric) $3 \times 12\text{--}15$ per leg from weeks 14–15; lateral step-ups (8-inch) $3 \times 12\text{--}15$ per leg from week 16
Single-leg mini squats	$0\text{--}30^\circ$, $3 \times 8\text{--}10$ per leg with mirror feedback from weeks 14–15; to 60° by week 18
Bulgarian split squats	$3 \times 10\text{--}12$ per leg; start week 16
Hamstrings · glutes	Nordic curls (assisted to unassisted) $3 \times 6\text{--}10$ from week 16; single-leg glute bridges 3×12 per leg from week 13
Hip · adductors	Copenhagen adduction 3×15 ; lateral band walks with more resistance, 3×20 steps each way
Balance	Single-leg on foam or wobble board, $3 \times 30\text{--}45$ sec per leg; therapist arm perturbations, 3×30 sec per leg
Jogging	From weeks 14–16 on a flat surface; progress distance and pace weekly
Two-leg jumps · bounds	Vertical jump and stick 3×8 from weeks 16–17 (quiet landing, neutral knee); lateral bounds 3×6 each way from weeks 17–18

Precautions

- No single-leg plyometrics until single-leg squat mechanics are controlled; poor control under reactive load raises both re-dislocation risk and osteotomy stress
- Anterior knee pain with deep loading (past 90°) may mean patellofemoral irritation with the new tubercle position: reduce squat depth and progress slowly; contact Dr. Merritt if it persists or worsens
- Assess running mechanics before adding distance: dynamic valgus, trunk lean to the same side, and pelvic drop on the other side
- No plyometrics while the osteotomy site is tender with loading; osteotomy pain at week 12+ needs imaging and a call to Dr. Merritt first

Why: By weeks 12–16 bridging callus is forming and most patients show early radiographic union. The osteotomy tolerates progressive closed-chain load and early impact, but neuromuscular control must be retrained around the new patellar tracking.

PHASE

4

Return to Sport

Weeks 20–24+

For the patient: what to expect

This phase is sport preparation: cutting, reacting, and playing at full intensity. Your knee should feel stable, not just strong. You return to sport at about **6 months**, and to cutting and pivoting sports at **9 months**, after strength and hop tests and clearance from Dr. Merritt. If you feel your kneecap is about to slip or you feel nervous during drills, stop and tell your therapist and Dr. Merritt.

WEIGHT BEARING	Full, no restrictions
BRACE	None. A patellar stabilizing sleeve is optional for contact or high-demand sport, at athlete or surgeon preference
STRENGTH WORK	Maintenance through the season

Goals

- Quad and hamstring strength $\geq 90\%$ LSI on formal testing
- Single-leg hop battery $\geq 90\%$ LSI (single, triple, crossover, 6-meter timed)
- Full-speed cutting, pivoting, and deceleration
- No anterior knee pain, instability, or apprehension with sport; confident and without fear
- Formal clearance from Dr. Merritt

Move on when

- ☐ Quad $\geq 90\%$ LSI on isokinetic or handheld dynamometry at $60^\circ/\text{sec}$
- ☐ Single hop, triple hop, crossover hop, and 6-meter timed hop $\geq 90\%$ LSI
- ☐ Y-balance composite $\geq 90\%$ symmetry
- ☐ Full-speed cutting and pivoting without instability or apprehension
- ☐ Athlete confidence $\geq 8/10$; no osteotomy-site symptoms at any level

Exercises

Exercise	How
Single-leg jump and stick	3 × 5–8 per leg; hold the landing
Single-leg lateral hops	3 × 8 each way; progress amplitude
Depth jumps	12-inch box, two legs then one, 3 × 5–6; week 22+
Crossover lateral bounds	3 × 8 strides each way
Sprinting	Full-speed straight-line progression
Cutting drills	45° cuts at progressive speed, planned then reactive (partner-cued); 90° changes of direction (T-drill, 5-10-5 shuttle) at full speed
Sport sequences	Acceleration, cut, deceleration, pivot
Strength maintenance	Through the season: single-leg squats 3 × 12, lateral band walks 3 × 20, Nordic curls 2 × 10 per leg

Precautions

- Return to sport not before 6 months; cutting and pivoting sport at 9 months. Bone remodeling at the osteotomy continues through 9–12 months
- Do not use time alone for clearance; strength below 90% LSI at return is linked to much higher re-dislocation and re-injury rates
- Apprehension with lateral movement or cutting disqualifies; return to Phase 3 training and reassess before reactive drills
- Any post-operative patellar subluxation or dislocation: stop all return-to-sport activity and notify Dr. Merritt for prompt evaluation

Why: Re-dislocation after TTO is 0–5% in well-selected patients at 9–12 months. The main modifiable risks are incomplete strength recovery (LSI <90%), persistent dynamic valgus, and returning to cutting and pivoting before neuromuscular control and bone remodeling are complete.

Return to Sport / Activity

All criteria must be met before clearance.

Measure	Target
Time from surgery	At least 6 months for sport; 9 months for cutting and pivoting sport
Quadriceps strength	≥90% LSI (isokinetic or handheld dynamometry at 60°/sec)
Hamstring strength	≥90% LSI
Single-leg hop for distance	≥90% LSI
Triple hop · crossover hop	≥90% LSI
6-meter timed hop	≥90% LSI
Y-balance composite	≥90% symmetry
Symptoms	No anterior knee pain, patellar apprehension, or osteotomy-site tenderness with sport
Psychological readiness	Athlete confidence ≥8/10
Clearance	Formal clearance from Dr. Merritt

Functional testing

- Strength: isokinetic or handheld dynamometry at 60°/sec
- Hop battery: single hop, triple hop, crossover hop, 6-meter timed hop
- Y-balance test