

ADVANCED HIGH TIBIAL OSTEOTOMY (HTO) PROTOCOL

Rehabilitation following High Tibial Osteotomy (HTO) is an essential part of a full recovery and this process is comparatively prolonged versus alternative knee surgeries such as uni-compartmental and total knee arthroplasties. This protocol is intended to provide the user with instruction, direction, rehabilitative guidelines and functional goals. The physiotherapist must exercise their best professional judgment to determine how to integrate this protocol into an appropriate treatment plan. Some exercises may be adapted depending on the equipment availability at each facility. As an individual's progress is variable and each will possess various pre-operative deficiencies, this protocol must be individualized for optimal return to activity. There may be slight variations in this protocol if there are limitations imposed from the surgery and quality of individuals healing.

CLINICAL INDICATIONS FOR HTO SURGERY

High tibial osteotomy is an effective surgery for the treatment of knee malalignment with associated pain and stiffness from arthritis in middle-aged active patients. The normal anatomical load-bearing axis of the knee ranges from five to seven degrees of valgus. The medial side of the knee transmits 60% of the force through the joint and the remaining 40% is transmitted through the lateral compartment.^{1,15} Associated ligament instability can further increase the load on the medial compartment by adding a lateral thrust or an adduction moment.¹ The goal of an osteotomy is to relieve medial compartment knee pain and slow down the arthritic progression by redistributing the weight bearing line as near normal as possible to reduce the stress through the medial and lateral compartments or the ligamentous structures in the knee.^{1,2,9,15} Clinical indications for this procedure often includes standing varus alignment coupled with:

1. arthrosis of the medial compartment causing limiting pain
2. arthrosis of the medial compartment plus ligament deficiency with clinical instability causing limiting pain (i.e. ACL, PCL, posterolateral corner or a combination).
3. arthrosis of the medial compartment plus a medial meniscus deficiency or articular cartilage defects causing limiting pain.^{1,3,4,13}

Some conditions related to poorer outcomes include: increased severity of arthritis, under or overcorrection of alignment, advanced age, patellofemoral arthrosis, noticeably decreased range of motion (<90° knee flexion and flexion contracture >15°), previous arthroscopic debridements, joint instability, loss of correction, and lateral tibial thrust.^{1,2,4,9}

PATIENT EDUCATION, WEIGHT BEARING AND GAIT RETRAINING

Typically, weight bearing instructions post-operatively are: protected weight bearing (crutches) with a tracker/hinge brace for up to 6 weeks.^{1,3,5,9,12,14} The guidelines for the allowed weight-bearing limit are given by the individual surgeon and are based on numerous factors including the amount of correction and the hardware used for the osteotomy. Patients should follow the suggested guidelines and be instructed to progress activity/exercise as tolerated, using pain, swelling and warmth over the osteotomy site as a guide. For unstable osteotomies, or if there are complications related to healing, patients may be required to keep on crutches for a longer period of time and weight bearing strengthening exercises may be delayed.

RETURN TO ACTIVITY/SPORT

Complete recovery after HTO, defined as pain-free return to full activity, including unlimited exercise can take up to 6 months or longer.³ Data on limb alignment, rate of bone union, time to return to weight-bearing, walking speed, stride length, kinematics, dynamic knee joint load and patient-reported measures of pain, function, and quality of life at six, 12, 18 and 24 months postoperative HTO (and longer) has been published.^{5,6,7,8,10,11,13,14,15}

Phase 1: Immediate Post-Op, 0-2 WEEKS

GOALS

- Patient education re: crutches with surgeon instructed weight-bearing limit, hinge brace used at all times, including sleeping; can be removed during therapy for ROM exercises
- Decrease pain and swelling
- ROM: encourage 90° flexion and near full extension by 2 weeks
- Maintain flexibility of hamstrings, calves
- Gluteal and quadriceps activation

EXERCISE SUGGESTIONS

ROM & Flexibility

- Heel slides (+/- slider board) in supine and in seated position
- Seated active assisted knee flexion (towel slides with heel on floor)
- Seated calf stretch with towel - knee bent (soleus), knee straight (gastrocnemius)
- Seated hamstring stretch (back straight)

Muscle Strength & Endurance

Quadriceps:

- Quadriceps isometrics in standing/sitting/lying +/- muscle stimulation or biofeedback
- Quads over roll

Hip/Gluteals:

- Gluteal squeezes supine or standing
- S/L clam shells
- Standing hip flexion/extension, abduction/adduction (do not allow a lot of trunk swaying)
- Straight leg raise (on bed) with pelvic stability (all 4 planes)
- Prone knee flexion

Calves:

- Ankle pumping +/- with leg elevation
- Plantarflexion with theraband

Modalities

- Ice / Cryo-cuff / Game Ready 15-25 minutes
- Interferential current therapy (pain relief)

Phase II: Progressive Weight-Bearing and Strengthening, 2-6 WEEKS

GOALS

- Patient education: Continue with crutches and surgeon instructed weight-bearing limit for 6 weeks post-op to allow for bony healing, activity is guided by pain, swelling and warmth over osteotomy site
- ROM: encourage >120° flexion and full extension by end of 6 weeks
- Continue with brace at surgeon discretion
- Monitor, normalize and retrain gait over given timeframe
- Weight-bearing strengthening of lower extremity: hip, hamstrings, quadriceps, calves
- Baseline (2 legged) proprioceptive/balance re-education

EXERCISE SUGGESTIONS

ROM

- Continue as needed with slider board, up wall, bike.....

Extension

- Sitting passive leg extension with roll under heel
- Prone leg hangs off end of bed/plinth
- Patellar and/or tibial-femoral joint mobilizations if needed to achieve terminal ROM

Flexion

- Supine with legs up wall – heels slides (knee flexion) with gravity assisted
- Supine legs up on swiss ball – roll heels towards buttocks
- Prone assisted knee flexion (belt, opposite leg)
- Bike pendulums: high seat ½ circles forward/backward → full circles – lower seat as tolerated

Flexibility

- Assisted quadriceps stretch in side-lying, prone or in standing as tolerated
- Standing stretches (partial to full weight-bearing as tolerated) for gastrocnemius (knee straight) and soleus (knee bent), ensure back foot is straight

Weight Bearing & Gait

- Progress from 2 crutches → single crutch → full weight bearing as tolerated always maintaining normal walking pattern
- Weight shifting (the allowed weight) on affected leg by use of 2 weigh scales (side-to-side and forward/backward) → progress to equal weight bearing as tolerated
- Weigh scales: when 50%WB mini squat with equal weight bearing

Muscle Strength & Endurance

Quadriceps:

- Mini wall squat (30°) progress to 60°-90° (+/- wall)
- Shuttle™: (one bungee cord) – 2 leg squat (¼ - ½ range) and 2 leg calf raises, may progress slowly and as tolerated from 2-1 leg squats/calf raises, increasing ROM and resistance
- Sit to stand 2 legs with high seat height +/- with muscle stimulation
- Leg press machine: low weight 2 legs (½ – ¾ range)
- Standing closed-chain terminal extension with tubing at knee – forward facing (active terminal extension) and backward facing (passive terminal extension)

Hamstrings/Gluteals:

- Standing hip flexion/extension, abduction/adduction with pulleys/bands (watch for excessive trunk shift/sway)
- Supine bridging: 2 legs → 1 leg
- Supine on floor legs on swiss ball: bridging → bridging plus knee flexion (heels to buttocks)
- Prone active hamstring curls → progress with 1-2 lb weights
- Quadruped fire hydrant
- Sitting and standing hamstring curls with weight/light tubing/pulley system for resistance as tolerated

Calves:

- Standing 2 legged calf raises with/without support (table/chair/crutch)

Proprioception

With balance drills on unstable surfaces, be aware of and correct poor balance responses such as hip hiking with INV/EVER and trunk extension with DF/PF.

- Wobble boards with support (table, bars, poles) through full ROM: side-to-side, forward/backward
- Standing on ½ foam roller: balance → rocking forward/backward

Modalities

- Ice/IFC/Game Ready

Phase III: Advanced Strengthening, 6-12 WEEKS

GOALS

- Full weight-bearing
- Full and pain free knee range of motion
- Continue and advance strengthening: lower chain concentric/eccentric strengthening of gluteals, quadriceps & hamstrings
- Initiate cardiovascular conditioning
- Progress proprioception

EXERCISE SUGGESTIONS

Muscle Strength & Endurance

Quadriceps:

- Sit to stand 2 legs → progress by decreasing height of seat
- Bungee™ cord walking: forward/backward/side step with slow control on return as tolerated
- Static Lunge (¼ - ½ range) → progress to dynamic lunge step (¼ - ½ range) with proper alignment (shoulders over knees over toes) as tolerated
- Step ups and down 2-4" height: lateral, forward

Hamstrings/Gluteals:

- Continue hip strengthening with increased weights/tubing resistance
- Chair walking/stool pulls

Calves:

- Standing calf raises → progress to single leg
- Toe walking as tolerated (when full weight bearing)

Proprioception

- Wobble boards side-to-side, forward/backward: without support, without vision
- Single leg stance 30-60 seconds (when full WB) → progress to unstable surface, with and without vision

Cardiovascular Fitness

- Bike with increasing time parameters
- Elliptical trainer
- Stairmaster™ if adequate strength has been achieved (must not have hip hiking when pressing down on step)

Modalities

- Ice/IFC/Game Ready

Phase IV: Return to Activity, 3-6+ Months

GOALS

- Dynamic lower chain strengthening
- Sport specific training
- Progress cardiovascular conditioning

EXERCISE SUGGESTIONS

Muscle Strength & Endurance

Quadriceps:

- Sit to stand → lower bed height (watch mechanics) → single leg
- Progress resistance of Shuttle™ working on strength & endurance, 2 → 1 leg
- Lunging in Bungee™ → add speed and direction change as tolerated
- Static Lunge (full range) → dynamic lunge → lunge walking
- Forward and lateral step-ups 4-6-8" (watch for hip hiking or excessive ankle dorsiflexion)
- Eccentric lateral step down on 2-4-6" step with control (watch for hip hiking or excessive ankle dorsiflexion)

Hamstrings/Gluteals:

- Fitter™: hip abduction and extension (poles for support) → progress side-to-side
- Shuttle™ standing kick backs (hip/knee extension)
- Tubing kickback (mule kicks)
- Stool pulls/Chair walking
- Continue hip and hamstring strengthening with increased weights/tubing resistance

Calves:

- Shuttle™ eccentric heel drops 2 legs → 1 leg
- Calf raises with heel drop off steps 2 legs → 1 leg

Proprioception

- Continue on wobble boards and begin to add basic upper body skills (i.e. throwing, use of racquet in hand)
- Single leg stance on unstable surface i.e. pillow, mini-tramp, BOSU™, Airex™, Dynadisc™ with/without support - progress to no vision
- Standing 747 eyes open/closed – progress to mini trampoline
- Single leg stance performing higher end upper body skills specific to patient goal(s)

Cardiovascular Fitness

- Bike: increasing time or resistance progress to outdoor cycling
- Stairmaster™ variable programs
- Fitter™: 'slalom skiing' with/without ski pole support
- Treadmill – walk +/- incline⁽²⁹⁾ → quick walk → increased speed
- Swimming or pool running in shallow water
- Functional sport pattering with increased speed, reps, etc.... as needed/tolerated

Advanced HTO: Guidelines for Manual Therapy and Exercise

	Phase I	Phase II	Phase III	Phase IV
ROM & Flexibility:				
Ankle pumping +/- leg elevation	●			
Heel Slides (+/-slider board, up wall)	●	●		
Seated active assisted knee flexion	●	●		
Seated calf & hamstring stretches	●	●		
Passive extension with roll under heel		●		
Prone hangs (leg off bed)		●		
Stationary bike		●	●	
Joint Mobilizations (patellar, tib-femoral)		●	●	
Quad stretches		●	●	
Standing weight-bearing calf stretches: gastroc, soleus		●	●	
Muscle Strength & Endurance				
Quadriceps:				
Isometric quads	●	●		
Quad over roll		●		
Closed chain terminal extension with tubing: forward/backward facing		●	●	
Squats: wall, mini, 60°-90°		●	●	●
Shuttle: leg press & calf press - 2 legs, 1leg (progress with ↑resistance/reps)		●	●	●
Sit to stand: high seat, low seat, 2 legs, single leg		●	●	●
Leg press machine: 2-1 leg		●	●	●
Bungee cord walking: forward, backward, side step, lunging			●	●
Static Lunge: ¼-½-full, dynamic			●	●
Step ups (concentric):2-4-6-8"			●	●
Step down (eccentric):2-4-6-8"			●	●
Hamstrings and Gluteals:				
Gluteal squeezes (supine or standing)	●	●		
Standing hip flexion/extension, abduction/adduction	●	●	●	
Supine SLR x four directions	●	●		
S/L: clam shells	●	●		
Prone knee flexion	●	●		
Quadruped fire hydrant		●		
Supine bridging: double, single, ball, +knee flexion		●	●	●
Hamstring curls: prone, sitting, standing		●	●	●
Chair walking/stool pulls			●	●
Hip strengthening: weights, pulleys, tubing		●	●	●
Tubing kickbacks (mule kicks)			●	●
Shuttle standing kick backs (hip/knee extension)				●
Pro-fitter (abduction, extension, side-to-side)				●

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