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## **REHABILITATION PROTOCOL: High Tibial Osteotomy**

This protocol is intended to guide clinicians through the post-operative course for High Tibial Osteotomy. This protocol is time based (dependent on tissue healing) as well as criterion based. Specific intervention should be based on the needs of the individual and should consider exam findings and clinical decision making. The timeframes for expected outcomes contained within this guideline may vary based on surgeon's preference, additional procedures performed, and/or complications. If a clinician requires assistance in the progression of a post-operative patient, they should consult with the referring surgeon.

The interventions included within this protocol are not intended to be an inclusive list of exercises. Therapeutic interventions should be included and modified based on the progress of the patient and under the discretion of the clinician.

### **Post-operative considerations**

Many different factors influence the post-operative high tibial osteotomy rehabilitation outcomes, including the presence of additional surgical procedures. It is recommended that clinicians collaborate closely with the referring physician regarding protocol.

If you develop a fever, intense calf pain, excessive drainage from the incision, uncontrolled pain or any other symptoms you have concerns about you should call your doctor.

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**PHASE I: IMMEDIATE POST-OP (0-6 WEEKS AFTER SURGERY)**

<b>Rehab Goals</b>	<ul style="list-style-type: none"> <li>▪ Protect the anatomic repair</li> <li>▪ Monitor wound healing</li> <li>▪ Minimize knee effusion</li> <li>▪ Increase tibial-femoral and patella-femoral mobility</li> <li>▪ Restore quadriceps control</li> <li>▪ Gently increase ROM per guidelines – emphasis on extension</li> </ul>
<b>Precautions</b>	<ul style="list-style-type: none"> <li>▪ No active knee extension</li> <li>▪ No resisted closed chain or open chain until 6 weeks post-op</li> </ul>
<b>Weight Bearing</b>	<ul style="list-style-type: none"> <li>▪ Week 0-4: <b>NWB/ TDWB with brace locked in extension</b></li> <li>▪ Week 4-6: <b>TDWB with brace locked in extension progressing to PWB</b> <ul style="list-style-type: none"> <li>○ Progress to brace unlocked in PWB if have full extension and good quadriceps control</li> </ul> </li> </ul>
<b>Brace</b>	<ul style="list-style-type: none"> <li>▪ Hinged knee brace locked in 0 degrees extension for all mobility and gait until at least 4 weeks post-op, full knee extension achieved and good quad control.</li> <li>▪ Brace may be unlocked when sitting or in bed</li> </ul>
<b>Interventions</b>	<p><b>Swelling Management</b></p> <ul style="list-style-type: none"> <li>▪ Ice, compression, elevation (check with MD re: cold therapy)</li> <li>▪ Retrograde massage</li> <li>▪ <a href="#">Ankle pumps</a></li> </ul> <p><b>Range of motion/Mobility</b></p> <ul style="list-style-type: none"> <li>▪ Knee AAROM/PROM – Passive extension only           <ul style="list-style-type: none"> <li>○ Week 0-4: 0-90 degrees</li> <li>○ Week 4-6: 0-120 degrees</li> <li>○ Prone hangs, supine knee extension with heel prop, heel slides with PROM for knee extension, knee flexion in sitting with P/AAROM for knee extension</li> </ul> </li> </ul> <p><b>Strengthening</b></p> <ul style="list-style-type: none"> <li>▪ <a href="#">Quad sets</a></li> <li>▪ Gluteal sets</li> <li>▪ Ankle pumps</li> <li>▪ Side-lying hip ABD – with brace until elimination of quad lag</li> <li>▪ Prone Hip Extension – with brace until elimination of quad lag</li> <li>▪ SLR – per MD recommendation, depending on surgical approach, may be inappropriate           <ul style="list-style-type: none"> <li>○ Perform with brace locked in extension, D/C brace when performed without a lag</li> </ul> </li> <li>▪ Side-lying Hip Adduction – with brace until elimination of quad lag</li> <li>▪ Clam shell</li> <li>▪ Hamstring stretch</li> </ul>

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	<ul style="list-style-type: none"> <li>▪ ITB stretch</li> <li>▪ Gastroc-soleus stretch</li> <li>▪ Bike – No resistance</li> </ul> <p><b>Aquatic therapy – if available</b></p> <ul style="list-style-type: none"> <li>▪ Deep water (chest/shoulder height) – walking and ROM exercises           <ul style="list-style-type: none"> <li>○ Core stability and UE exercises</li> </ul> </li> </ul> <p><b>Manual Therapy</b></p> <ul style="list-style-type: none"> <li>▪ Patella mobilizations – immediately post-op</li> <li>▪ Gentle STM – 2-3 weeks post-op</li> </ul> <p><b>Modalities</b></p> <ul style="list-style-type: none"> <li>▪ NMES for quadriceps re-education/biofeedback.</li> <li>▪ Cryotherapy for swelling and pain management.</li> <li>▪ Taping – pain and swelling management</li> </ul>
<b>Criteria to Progress</b>	<ul style="list-style-type: none"> <li>▪ Knee PROM: 0-120 degrees</li> <li>▪ Adequate pain control</li> <li>▪ Minimal swelling</li> <li>▪ Able to perform SLR without quadriceps lag</li> </ul>

**PHASE II: PROTECTION PHASE (7-12 WEEKS AFTER SURGERY)**

<b>Rehab Goals</b>	<ul style="list-style-type: none"> <li>▪ Increase mobility</li> <li>▪ Restore quadriceps control</li> <li>▪ Restoration of full ROM by week 8-12</li> <li>▪ Progress weight bearing</li> <li>▪ Normalize gait pattern without assistive device – goal of 2 miles at 15min/mile pace on a treadmill</li> <li>▪ Gradual progression of therapeutic exercises for strengthening, stretching and balance</li> </ul>
<b>Precautions</b>	<ul style="list-style-type: none"> <li>▪ No weight bearing stretching into knee flexion until week 8</li> <li>▪ Avoid descending stairs reciprocally until adequate quadriceps control as demonstrated by SLR</li> <li>▪ Avoid exercises/activities with excessive patella-femoral compression forces (deep squats, resisted open chain terminal knee extension)</li> <li>▪ Avoid medial collapse due strengthening and functional activities</li> <li>▪ No running, jumping or plyometrics until 4-6 months post-surgery</li> <li>▪ Do not overload the surgical site</li> <li>▪ Modify activity level if increased pain, edema or catching occurs</li> </ul>
<b>Weightbearing</b>	<ul style="list-style-type: none"> <li>▪ WBAT per MD, based on X-ray</li> </ul>
<b>Brace</b>	<ul style="list-style-type: none"> <li>▪ Brace unlocked for ambulation if there is good quad control, crutches as needed</li> </ul>

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	<ul style="list-style-type: none"> <li>▪ Hinge brace until week 8 then replace with patellofemoral brace with lateral buttress</li> </ul>
<p><b>Additional Interventions</b>          *Continue with Phase I interventions</p>	<p><b>Modalities</b></p> <ul style="list-style-type: none"> <li>▪ NMES for quadriceps re-education – as needed</li> <li>▪ Cryotherapy for edema and pain management</li> </ul> <p><b>Range of motion/Mobility</b></p> <ul style="list-style-type: none"> <li>▪ Progress PROM/AAROM/AROM of knee as tolerated</li> <li>▪ Hamstring stretch</li> <li>▪ Gastroc -Soleus stretch</li> <li>▪ Prone Quadriceps with strap</li> </ul> <p><b>Strengthening</b></p> <ul style="list-style-type: none"> <li>▪ TKE – 0-40 degrees</li> <li>▪ Leg press</li> <li>▪ Partial range wall squats               <ul style="list-style-type: none"> <li>○ 0-45 degrees</li> </ul> </li> <li>▪ Forward step ups, Lateral step ups</li> <li>▪ Forward, Lateral, Retro step downs</li> <li>▪ Bridge with physioball</li> <li>▪ Romanian Deadlifts – Week 7               <ul style="list-style-type: none"> <li>○ Standing upright to weight just below knees.</li> </ul> </li> <li>▪ Band walks – Week 8</li> <li>▪ Stool walks – Week 8</li> <li>▪ BOSU Partial squat – Week 9               <ul style="list-style-type: none"> <li>○ 0-60 degrees</li> </ul> </li> <li>▪ Prone Hamstring curl – 10 weeks               <ul style="list-style-type: none"> <li>○ Begin with ankle weights and progress to weight machine</li> </ul> </li> </ul> <p><b>Cardiovascular Exercise</b></p> <ul style="list-style-type: none"> <li>▪ Stationary Bike – light resistance</li> <li>▪ Treadmill – forward and backwards</li> <li>▪ Elliptical – week 9-10</li> </ul> <p><b>Aquatic Therapy</b></p> <ul style="list-style-type: none"> <li>▪ Flutter kicks</li> <li>▪ Straight leg scissor kicks</li> <li>▪ Running in waist deep water</li> </ul> <p><b>Balance/proprioception</b></p> <ul style="list-style-type: none"> <li>▪ Progress from double to single leg balance</li> </ul>

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	<ul style="list-style-type: none"> <li>▪ Progress from static to dynamic:           <ul style="list-style-type: none"> <li>○ BAPS</li> <li>○ Ball toss</li> <li>○ Body blade</li> <li>○ Fitter</li> <li>○ Slide board</li> </ul> </li> </ul>
<b>Criteria to Progress</b>	<ul style="list-style-type: none"> <li>▪ Full range of motion</li> <li>▪ Elimination of swelling</li> <li>▪ Restoration of normal gait</li> <li>▪ Quad strength &gt; 70% of uninvolved leg</li> </ul>

**PHASE III: ADVANCED STRENGTHENING (13-16 WEEKS AFTER SURGERY)**

<b>Rehab Goals</b>	<ul style="list-style-type: none"> <li>▪ Normal tibial-femoral and patella-femoral mobility</li> <li>▪ Restoration of quadriceps control</li> <li>▪ Progress muscle strength, endurance, and balance activities</li> </ul>
<b>Precautions</b>	<ul style="list-style-type: none"> <li>▪ No running, jumping or plyometrics till 4-6 months post-op</li> <li>▪ May continue with patellofemoral hinged brace until 12 months post-op for lighter level activities – Based on MD recommendation.</li> </ul>
<b>Additional Interventions</b> *Continue with Phase I-II Interventions	<p><b>Strengthening</b></p> <ul style="list-style-type: none"> <li>▪ Total leg strengthening</li> <li>▪ Single leg strengthening</li> <li>▪ Hamstring isotonic exercises through full ROM</li> <li>▪ Quadriceps isotonic exercises</li> </ul> <p><b>Balance/proprioception</b></p> <ul style="list-style-type: none"> <li>▪ Single leg balance           <ul style="list-style-type: none"> <li>○ Stable and unstable surfaces</li> </ul> </li> <li>▪ Single leg balance with leg swings</li> <li>▪ Single leg balance with ball toss</li> <li>▪ Single leg balance with UE perturbations</li> </ul> <p><b>Cardio</b></p> <ul style="list-style-type: none"> <li>▪ 8 weeks: Elliptical, stair climber, flutter kick swimming, pool jogging</li> </ul>
<b>Criteria to Progress</b>	<ul style="list-style-type: none"> <li>▪ Full, symmetrical pain-free ROM</li> <li>▪ Strength: 80%+ of uninvolved leg</li> <li>▪ Satisfactory clinical exam</li> <li>▪ MD approval to progress to next phase</li> </ul>

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**PHASE IV: EARLY RETURN TO SPORT PHASE (16+ WEEKS AFTER SURGERY)**

<b>Rehab Goals</b>	<ul style="list-style-type: none"> <li>▪ Progress to higher level activities – based on functional demands and MD approval</li> <li>▪ Return to vocational, recreational and/or sport activities.</li> <li>▪ Run 2 miles at easy pace – if appropriate</li> </ul>
<b>Additional Interventions</b> *Continue with Phase II-III interventions	<p><b>Running: begin at 4 months</b></p> <ul style="list-style-type: none"> <li>▪ Start with light gentle slow-paced running</li> <li>▪ Treadmill running               <ul style="list-style-type: none"> <li>○ Must demonstrate good running form for 5 minutes with equal audibly rhythmic foot strike.</li> </ul> </li> <li>▪ Aquatic running</li> <li>▪ Backwards and forward running</li> <li>▪ Initiate Return to running protocol</li> </ul> <p><b>Plyometrics: 4.5 –to 5 months</b></p> <ul style="list-style-type: none"> <li>▪ Start with double leg drills</li> <li>▪ Progress slowly to single leg drills</li> <li>▪ Ensure good form and proper hip and knee alignment</li> </ul> <p><b>Agility Drills: 4.5 to 5 months</b></p> <ul style="list-style-type: none"> <li>▪ Sub-max foot placement drills</li> <li>▪ Ladder drills</li> <li>▪ Line hops</li> </ul>
<b>Criteria to Progress</b>	<p>Return to sport/play: 7 to 9 months</p> <ul style="list-style-type: none"> <li>▪ Quad and hamstring strength 90% of uninjured</li> <li>▪ Full symmetrical knee range of motion</li> <li>▪ No knee joint effusion</li> <li>▪ Single leg hop test: Limb symmetry of 90%</li> <li>▪ Triple hop test: limb symmetry of 90%</li> <li>▪ Cross-over hop test: limb symmetry of 90%</li> <li>▪ Refer to lower extremity functional assessment</li> </ul>

*\*Acknowledgement: This rehab protocol was largely adopted from the protocols at MGH Sports Medicine Physical Therapy, which can be found at <https://www.massgeneral.org/orthopaedics/sports-medicine/physical-therapy/sports-rehab-protocols>*

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## Return to Running Program

This program is designed as a guide for clinicians and patients through a progressive return-to-run program. Patients should demonstrate > 80% on the Functional Assessment prior to initiating this program (after a knee ligament or meniscus repair). Specific recommendations should be based on the needs of the individual and should consider clinical decision making. If you have questions, contact the referring physician.

### PHASE I: WARM UP WALK 15 MINUTES, COOL DOWN WALK 10 MINUTES Day 1 2 3 4 5 6

Day	1	2	3	4	5	6	7
Week 1	Walk 5 min, Jog 1 min x 5 reps		Walk 5 min, Jog 1 min x 5 reps		Walk 4 min, Jog 2 min x 5 reps		Walk 4 min, Jog 2 min x 5 reps
Week 2		Walk 3 min, Jog 3 min x 5 reps		Walk 3 min, Jog 3 min x 5 reps		Walk 2 min, Jog 4 min x 5 reps	
Week 3	Walk 2 min, Jog 4 min x 5 reps		Walk 1 min, Jog 5 min x 5 reps		Walk 1 min, Jog 5 min x 5 reps		Return to Run

\*\*Only progress if there is no pain or swelling during or after the run

### PHASE II: WARM UP WALK 15 MINUTES, COOL DOWN WALK 10 MINUTES

Day	1	2	3	4	5	6	7
Week 1	20 min		20 min		20 min		25 min
Week 2		25 min		25 min		30 min	

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Week 3	30 min		30 min		35 min		35 min
Week 4		35 min		40 min		40 min	
Week 5	40 min		45 min		45 min		45 min
Week 6		50 min		50 min		50 min	
Week 7	55 min		55 min		55 min		60 min
Week 8		60 min		60 min			

**Recommendations**

- Runs should occur on softer surfaces during Phase I
- Non-impact activity on off days
- Goal is to increase mileage and then increase pace; avoid increasing two variables at once
- 10% rule: no more than 10% increase in mileage per week

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## Agility and Plyometric Program

This program is designed as a guide for clinicians and patients through a progressive series of agility and plyometric exercises to promote successful return to sport and reduce injury risk. Patients should demonstrate > 80% on the Functional Assessment prior to initiating this program. Specific intervention should be based on the needs of the individual and should consider clinical decision making. If you have questions, contact the referring physician.

### PHASE I: ANTERIOR PROGRESSION

Rehab Goals	<ul style="list-style-type: none"> <li>▪ Safely recondition the knee</li> <li>▪ Provide a logical sequence of progressive drills for pre-sports conditioning</li> </ul>
Agility	<ul style="list-style-type: none"> <li>▪ Forward run</li> <li>▪ Backward run</li> <li>▪ Forward lean in to a run</li> <li>▪ Forward run with 3-step deceleration</li> <li>▪ Figure 8 run</li> <li>▪ Circle run</li> <li>▪ Ladder</li> </ul>
Plyometrics	<ul style="list-style-type: none"> <li>▪ Shuttle press: Double leg alternating leg single leg jumps</li> <li>▪ Double leg:               <ul style="list-style-type: none"> <li>○ Jumps on to a box jump off of a box jumps on/off box</li> <li>○ Forward jumps, forward jump to broad jump</li> <li>○ Tuck jumps</li> <li>○ Backward/forward hops over line/cone</li> </ul> </li> <li>▪ Single leg (these exercises are challenging and should be considered for more advanced athletes):               <ul style="list-style-type: none"> <li>○ Progressive single leg jump tasks</li> <li>○ Bounding run</li> <li>○ Scissor jumps</li> <li>○ Backward/forward hops over line/cone</li> </ul> </li> </ul>
Criteria to Progress	<ul style="list-style-type: none"> <li>▪ No increase in pain or swelling</li> <li>▪ Pain-free during loading activities</li> <li>▪ Demonstrates proper movement patterns</li> </ul>

### PHASE II: LATERAL PROGRESSION

Rehab Goals	<ul style="list-style-type: none"> <li>▪ Safely recondition the knee</li> <li>▪ Provide a logical sequence of progressive drills for the Level 1 sport athlete</li> </ul>
Agility	<ul style="list-style-type: none"> <li>▪ Side shuffle</li> <li>▪ Carioca</li> <li>▪ Crossover steps</li> </ul>

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*Continue with Phase I interventions	<ul style="list-style-type: none"> <li>▪ Shuttle run</li> <li>▪ Zig-zag run</li> <li>▪ Ladder</li> </ul>
Plyometrics *Continue with Phase I interventions	<ul style="list-style-type: none"> <li>▪ Double leg:           <ul style="list-style-type: none"> <li>○ Lateral jumps over line/cone</li> <li>○ Lateral tuck jumps over cone</li> </ul> </li> <li>▪ Single leg (these exercises are challenging and should be considered for more advanced athletes):           <ul style="list-style-type: none"> <li>○ Lateral jumps over line/cone</li> <li>○ Lateral jumps with sport cord</li> </ul> </li> </ul>
Criteria to Progress	<ul style="list-style-type: none"> <li>▪ No increase in pain or swelling</li> <li>▪ Pain-free during loading activities</li> <li>▪ Demonstrates proper movement patterns</li> </ul>

**PHASE III: MULTIPLANAR PROGRESSION**

Rehab Goals	<ul style="list-style-type: none"> <li>▪ Challenge the Level 1 sport athlete in preparation for final clearance for return to sport</li> </ul>
Agility *Continue with Phase I-II interventions	<ul style="list-style-type: none"> <li>▪ Box drill</li> <li>▪ Star drill</li> <li>▪ Side shuffle with hurdles</li> </ul>
Plyometrics *Continue with Phase I-II interventions	<ul style="list-style-type: none"> <li>▪ Box jumps with quick change of direction</li> <li>▪ 90 and 180 degree jumps</li> </ul>
Criteria to Progress	<ul style="list-style-type: none"> <li>▪ Clearance from MD</li> <li>▪ Functional Assessment           <ul style="list-style-type: none"> <li>○ Quad/HS/glut index <math>\geq 90\%</math> contra lateral side (isokinetic testing if available)</li> <li>○ Hamstring/Quad ratio <math>\geq 70\%</math></li> <li>○ Hop Testing <math>\geq 90\%</math> contralateral side</li> </ul> </li> <li>▪ KOOS-sports questionnaire <math>&gt;90\%</math></li> <li>▪ International Knee Committee Subjective Knee Evaluation <math>&gt;93</math></li> <li>▪ Psych Readiness to Return to Sport (PRRS)</li> </ul>