Cincinnati SportsMedicine and Orthopaedic Center

High Tibial Osteotomy Rehabilitation Protocol*

This rehabilitation protocol was developed for patients who have high tibial osteotomy. Protection against any weight bearing is required for the first 4 postoperative weeks, as these forces could result in small changes in angulation which could alter the limb alignment obtained at surgery. These knees have a high risk for developing patella infera and peripatellar contractures since the osteotomy is done adjacent to the tibial tubercle and patellar tendon. The surgeon must use radiographic criteria to determine healing at the osteotomy site in order to advance weight bearing.

The protocol is divided into 6 phases according to postoperative weeks (for instance, Phase I = Postoperative Weeks 1-2). Each phase has several categories including:

- *General observation* of the patient's condition (weight bearing, pain, hemarthrosis, muscle control)
- *Evaluation* of specific variables with *goals* identified for each
- Treatment and exercise program, according to *frequency* and *duration*
- *Rehabilitation goals* which must be achieved to enter into the next phase

The **overall goals** of the reconstruction and rehabilitation are to:

- Control joint pain, swelling, hemarthrosis (minimal or none)
- Regain normal knee flexion and extension
- Regain a normal gait pattern and neuromuscular stability for ambulation
- Regain normal quadriceps, hamstring lower extremity muscle strength
- Regain normal proprioception, balance, and coordination for desired activities
- Achieve optimal functional outcome based on orthopaedic and patient goals

The supervised rehabilitation program is supplemented with a *home self-management program* which the patient performs on a daily basis. The therapist must evaluate the patient thoroughly to implement the enclosed protocol and should see the patient in the clinic for therapeutic procedures and modality treatments which are required for rehabilitation. The majority of this protocol can be accomplished at home provided patient cooperation and follow through are present. The approximate number of rehabilitation visits required for each phase are provided. Additional supervision may be required if a complication develops.

Important postoperative signs to monitor include:

- Loss of correction, reoccurrence of varus malalignment
- Swelling of the knee joint or soft tissues
- Abnormal pain response
- Abnormal gait pattern with or without assistive device
- Insufficient flexion or extension motions, limited patellar mobility
- Weakness (strength/control) of the lower extremity, especially the quads/hamstrings
- Insufficient lower extremity flexibility
- Delayed union/nonunion
- Peroneal nerve palsy

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The patient is placed into one of four **sports activity** and **occupational activity categories** based on the following scales. It is expected that patients who follow this protocol desire to return to sports activity levels I or II, or very heavy/heavy occupations.

1. Cincinnati Knee Rating System Sports Activity Scale

(check one)

❑ Level I - jumping, hard pivoting, cutting sports (basketball, volleyball, football, gymnastics, soccer)

❑ Level II - running, twisting, turning (tennis, racquetball, handball, ice/field hockey, skiing, wrestling)

❑ Level III - light recreational sports (bicycling, swimming - no running, twisting, jumping)

❑ Level IV - no sports, activities of daily living only

2. Cincinnati Knee Rating System Occupational Rating Scale

Factor 1 sitting	**Factor 2** standing/ walking	**Factor 3** walking on uneven ground	**Factor 4** squatting	**Factor 5** climbing	**Factor 6** lifting/ carrying	**Factor 7** pounds carried
0 ❑ 8-10 hrs/day	*0* ❑ 0 hrs/day	*0* ❑ 0 hrs/day	*0* ❑ 0 times/day	*0* ❑ 0 times/day	*0* ❑ 0 times/day	*0* ❑ 0-5 lbs
1 ❑ 6-7 hrs/day	*2* ❑ 1 hrs/day	*2* ❑ 1 hrs/day	*1* ❑ 1-5 times/day	*2* ❑ 1 flight 2 times/day	*1* ❑ 1-5 times/day	*1* ❑ 6-10 lbs
2 ❑ 4-5 hrs/day	*4* ❑ 2-3 hrs/day	*4* ❑ 2-3 hrs/day	*2* ❑ 6-10 times/day	*4* ❑ 3 flights 2 times/day	*2* ❑ 6-10 times/day	*2* ❑ 11-20 lbs
3 ❑ 2-3 hrs/day	*6* ❑ 4-5 hrs/day	*6* ❑ 4-5 hrs/day	*3* ❑ 11-15 times/day	*6* ❑ 10 flights/ ladders	*3* ❑ 11-15 times/day	*3* ❑ 21-25 lbs
4 ❑ 1 hrs/day	*8* ❑ 6-7 hrs/day	*8* ❑ 6-7 hrs/day	*4* ❑ 16-20 times/day	*8* ❑ ladders with weight 2-3 days/week	*4* ❑ 16-20 times/day	*4* ❑ 26-30 lbs
5 ❑ 0 hrs/day	*10* ❑ 8-10 hrs/day	*10* ❑ 8-10 hrs/day	*5* ❑ > 20 times/day	*8* ❑ ladders daily with weight	*5* ❑ > 20 times/day	*5* ❑ > 20 lbs

_____ *points x 2 =*_____ *total points*

Occupation Rating	Total Points
❑ Disabled	0
❑ Very light	1-20
❑ Light	21-40
❑ Moderate	41-60
❑ Heavy	61-80
❑ Very heavy	> 80

Physical Therapy Visit Timeline*

Phase	Weeks Postoperative	Minimum # Visits	Maximum # Visits
1	1-2	2	4
2	3-4	2	4
3	5-6	1	2
4	7-8	1	2
5	9-12	1	2
6	13-26	2	3
Total		9	17

*Physician Notification

The physician will be notified if the patient (1) fails to meet the expected goals for each phase of the protocol, (2) has a persistent joint effusion, (3) develops a chronic pain syndrome, (4) has difficulty with ambulation, (5) has a limitation of knee motion or patellar mobility, or (6) develops other complications associated with osteotomy and fracture healing.

These problems could result in a modification of this protocol and necessitate further visits to the physical therapist.

Discharge Criteria **(If goals for sports and occupation place patient into different categories, use category with highest functional demand criteria. For symptoms, use Symptom Rating Form found on next page.)**

*Sports Activity Level I or Heavy/Very Heavy Occupational Rating**

No pain, swelling, giving-way with level 10 on Symptom Rating Form
KT-2000 < 3 mm (I-N, 134 N, total A/P)
Biodex strength testing: quadriceps & hamstrings strength ≥ 85% of opposite limb
Function testing: 2 hop tests, limb symmetry ≥ 85%

*Sports Activity Level II or Moderate Occupational Rating**

No pain, swelling, giving-way with level 8 on Symptom Rating Form
KT-2000 < 3 mm (I-N, 134 N, total A/P)
Biodex strength testing: quadriceps & hamstrings strength ≥ 80% of opposite limb
Function testing: 2 hop tests, limb symmetry ≥ 85%

Sports Activity Level III or Light Occupational Rating

No pain, swelling, giving-way with level 6 on Symptom Rating Form
KT-2000 3-5 mm (I-N, 134 N, total A/P)
Biodex strength testing: quadriceps & hamstrings strength ≥ 70% of opposite limb
Function testing: 2 hop tests, limb symmetry ≥ 75%

Sports Activity Level IV (ADL) or Very light Occupational Rating

No pain, swelling, giving-way with level 4 on Symptom Rating Form
KT-2000 3-5 mm (I-N, 134 N, total A/P)
Biodex strength testing: quadriceps & hamstrings strength < 70% of opposite limb
Function testing: 2 hop tests, limb symmetry < 75%

*patients desiring to return to sports or strenuous work activities may require 4-6 more physical therapy visits during postoperative weeks 25-52 for advanced neuromuscular, strength, and activity-specific training to prevent reinjury.

Cincinnati Knee Rating System Symptom Rating Form

Scale	Description
10	Normal knee, able to do strenuous work/sports with jumping, hard pivoting
8	Able to do moderate work/sports with running, turning and twisting; symptoms with strenuous work/sports
6	Able to do light work/sports with no running, twisting or jumping; symptoms with moderate work/sports
4	Able to do activities of daily living alone; symptoms with light work/sports
2	Moderate symptoms (frequent, limiting) with activities of daily living
0	Severe symptoms (constant, not relieved) with activities of daily living

1. PAIN (circle one)

10 — 8 — 6 — 4 — 2 — 0

2. SWELLING (circle one)

10 — 8 — 6 — 4 — 2 — 0

3. PARTIAL GIVING-WAY (circle one) (partial knee collapse, no fall to the ground)

10 — 8 — 6 — 4 — 2 — 0

4. FULL GIVING-WAY (circle one) (knee collapse occurs with actual falling to the ground)

10 — 8 — 6 — 4 — 2 — 0

Return to Activities Warning

Return to strenuous activities after major knee ligament surgery carries the definite risk of a repeat injury or the potential of compounding the original injury. These risks cannot always be scientifically assessed. Patients are warned to return to athletic activities carefully and to avoid any activity in which pain, swelling, or a feeling of instability is present.

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Cincinnati SportsMedicine and Orthopaedic Center

Rehabilitation Protocol Summary for

High Tibial Osteotomy

	Postoperative Weeks					Postop Months		
	1-2	3-4	5-6	7-8	9-12	4	5	6
Brace: Bledsoe, fracture	X	X	X	X	X			
Range of motion minimum goals:								
0°-110°	X							
0°-130°		X						
0°-135°			X					
Weight bearing:								
None to toe touch	X							
1/4 body weight		X						
1/2 to 3/4 body weight			X					
Full				X				
Patella mobilization	X	X	X	X				
Modalities:								
Electrical muscle stimulation (EMS)	X	X	X					
Pain/edema management (cryotherapy)	X	X	X	X	X	X	X	X
Stretching:								
Hamstring, gastroc-soleus, iliotibial band, quadriceps	X	X	X	X	X	X	X	X
Strengthening:								
Quad isometrics, straight leg raises, active knee extension	X	X	X	X	X			
Closed-chain: gait retraining, toe raises, wall sits, mini-squats		X	X	X	X	X		
Knee flexion hamstring curls (90°)				X	X	X	X	X
Knee extension quads (90°-30°)				X	X	X	X	X
Hip abduction-adduction, multi-hip				X	X	X	X	X
Leg press (70°-10°)			X	X	X	X	X	X
Balance/proprioceptive training:								
Weight-shifting, mini-trampoline, BAPS, KAT, plyometrics					X	X	X	X
Conditioning:								
UBE		X	X	X				
Bike (stationary)			X	X	X	X	X	X
Aquatic program			X	X	X	X	X	X
Swimming (kicking)					X	X	X	X
Walking					X	X	X	X
Stair climbing machine					X	X	X	X
Ski machine					X	X	X	X
Running: straight								X
Cutting: lateral carioca, figure 8's								X
Full sports								X

BAPS = Biomechanical Ankle Platform System (Camp, Jackson, MI), KAT = Kinesthetic Awareness Trainer (Breg, Inc., Vista, CA), UBE = upper body ergometer.

Cincinnati SportsMedicine and Orthopaedic Center Rehab Protocol: HTO

Phase 1. Weeks 1-2 (Visits: 2-4)

General Observation	■ Non weight bearing ■ Bledsoe or fracture brace 0°-90°	
Evaluation	■ Pain ■ Hemarthrosis ■ Patellar mobility ■ ROM minimum ■ Quadriceps contraction & patella migration ■ Soft tissue contracture	**Goals** Controlled Mild Good 0°-90° Good None
Frequency		**Duration**
3-4 x/day 10 minutes	**Range of motion** ROM (0°-90°) Patella mobilization Ankle pumps (plantar flexion with resistance band) Hamstring, gastroc-soleus stretches	 5 reps x 30 secs
3 x/day 15 minutes	**Strengthening** Straight leg raises (flexion) Active quadriceps isometrics Knee extension (active-assisted, 90°-30°)	 3 sets x 10 reps 1 set x 10 reps 3 sets x 10 reps
As required	**Modalities** Electrical muscle stimulation Cryotherapy	 20 minutes 20 minutes
Goals	■ ROM 0°-90° ■ Adequate quadriceps contraction ■ Control inflammation, effusion	

Cincinnati SportsMedicine and Orthopaedic Center Rehab Protocol: HTO

Phase 2. Weeks 3-4 (Visits: 2-4)

General Observation	■ None to toe-touch weight bearing (week 4) per x-ray when: - Pain controlled - Hemarthrosis controlled - Voluntary quadriceps contraction achieved	
Evaluation	■ Pain ■ Effusion ■ Patellar mobility ■ ROM minimum ■ Quadriceps contraction & patella migration ■ Soft tissue contracture	**Goals** Controlled Mild Good 0°-110° Good None
Frequency		**Duration**
3-4 x/day 10 minutes	**Range of motion** ROM (passive, 0°-110°) Patella mobilization Ankle pumps (plantar flexion with resistance band) Hamstring, gastroc-soleus stretches	 5 reps x 30 secs
2-3 x/day 20 minutes	**Strengthening** Straight leg raises (flexion, extension) Isometric training: multi-angle (0°, 60°) Knee extension (active-assisted, 90°-30°)	 3 sets x 10 reps 1 set x 10 reps 3 sets x 10 reps
2 x/day 10 minutes	**Aerobic conditioning** UBE	
As required	**Modalities** Electrical muscle stimulation Cryotherapy	 20 minutes 20 minutes
Goals	■ ROM 0°-110° ■ Control inflammation, effusion ■ Muscle control ■ 25% weight bearing	

Cincinnati SportsMedicine and Orthopaedic Center Rehab Protocol: HTO

Phase 3. Weeks 5-6 (Visits: 1-2)

General Observation	■ Partial (25%) weight bearing per x-ray when: - Pain controlled without narcotics - Hemarthrosis controlled - ROM 0°-100° - Muscle control throughout ROM	
Evaluation	■ Pain ■ Effusion ■ Patellar mobility ■ ROM ■ Muscle control ■ Inflammatory response	**Goals** Mild/No RSD Minimal Good 0°-130° 3/5 None
Frequency 3 x/day 10 minutes	**Range of motion** ROM (passive, 0°-130°) Patella mobilization Hamstring, gastroc-soleus stretches	**Duration** 5 reps x 30 secs
2 x/day 20 minutes	**Strengthening** Straight leg raises (ankle weight, not to exceed 10% of body weight) Isometric training: multi-angle (90°, 60°, 30°) Closed-chain - Mini-squats - Wall sits Leg press (70°-10°)	 3 sets x 10 reps 2 sets x 10 reps 3 sets x 20 reps to fatigue x 3 3 sets x 10 reps
2 x/day 10 minutes	**Aerobic conditioning** (patellofemoral precautions) UBE Stationary bicycling Water walking	
As required	**Modalities** Electrical muscle stimulation Cryotherapy	 20 minutes 20 minutes
Goals	■ ROM 0°-130° ■ Control inflammation, effusion ■ Muscle control ■ Early recognition complications ■ 50% weight bearing	

Cincinnati SportsMedicine and Orthopaedic Center Rehab Protocol: HTO
Phase 4. Weeks 7-8 (Visits: 1-2)

General Observation	■ Partial (50-75%) weight bearing per x-ray when: - Pain controlled - Hemarthrosis controlled - ROM 0°-120° - Voluntary quad contraction achieved	
Evaluation	■ Pain ■ Effusion ■ Patellar mobility ■ ROM ■ Muscle control ■ Inflammatory response	**Goals** Mild/No RSD Minimal Good 0°-135° 4/5 None
Frequency		**Duration**
2 x/day 10 minutes	**Range of motion** ROM (0°-135°) Hamstring, gastroc-soleus stretches Patella mobilization	 5 reps x 30 secs
2 x/day 20 minutes	**Strengthening** Straight leg raises (flexion, extension, abduction, adduction) Straight leg raises, rubber tubing Hamstring curls (active, 0°-90°) Knee extension (active, 90°-30°) Leg press (70°-10°) Closed-chain - Wall sits - Mini-squats (rubber tubing, 0°-30°) Multi-hip machine (flexion, extension, abduction, adduction)	 3 sets x 10 reps 3 sets x 30 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 20 reps to fatigue x 3 3 sets x 10 reps
1-2 x/day 15 minutes	**Aerobic conditioning** UBE Stationary bicycling Water walking	
As required	**Modalities** Cryotherapy	 20 minutes
Goals	■ 50-75% weight bearing ■ Muscle control ■ Control inflammation, effusion ■ ROM 0°-135°	

Cincinnati SportsMedicine and Orthopaedic Center Rehab Protocol: HTO
Phase 5. Weeks 9-12 (Visits: 1-2)

General Observation	■ Full weight bearing per x-ray when: ■ ROM 0°-135° - Pain, effusion controlled - Muscle control throughout ROM	
Evaluation		**Goals**
	■ Pain	Minimal/No RSD
	■ Manual muscle test Hamstrings, quadriceps, hip abductors/adductors/flexors/extensors	4/5
	■ Swelling	Minimal
	■ Patellar mobility	Good
	■ Crepitus	None/slight
	■ Gait	Symmetrical
Frequency		**Duration**
2 x/day 10 minutes	**Range of motion** Hamstring, gastroc-soleus, quad, ITB stretches	5 reps x 30 secs
2 x/day 20 minutes	**Strengthening** Straight leg raises	3 sets x 10 reps
	Straight leg raises, rubber tubing	3 sets x 30 reps
	Hamstring curls (active, 0°-90°)	3 sets x 10 reps
	Knee extension with resistance (90°-30°)	3 sets x 10 reps
	Leg press (70°-10°)	3 sets x 10 reps
	Closed-chain - Wall sits - Mini-squats (rubber tubing, 0°-40°) - Lateral step-ups (2-4" block)	3 sets x 20 reps to fatigue x 3
	Multi-hip machine (flexion, extension, abduction, adduction)	3 sets x 10 reps
3 x/day 5 minutes	**Balance training** Balance board/2 legged Single leg stance	
1 x/day 15-20 minutes	**Aerobic conditioning** (patellofemoral precautions) Bicycling Water walking Swimming (straight leg kicking) Walking Stair machine (low resistance, low stroke) Ski machine (short stride, level, low resistance)	
As required	**Modalities** Cryotherapy	20 minutes
Goals	■ Increase strength and endurance ■ ROM 0°-135°	

Cincinnati SportsMedicine and Orthopaedic Center Rehab Protocol: HTO

Phase 6. Weeks 13-26 (Visits: 2-3)

General Observation	■ No effusion, painless ROM, joint stability ■ Performs activities of daily living, can walk 20 minutes without pain ■ ROM 0°-135°	
Evaluation		**Goals**
	■ Pain	Minimal/No RSD
	■ Manual muscle test	4/5
	■ Swelling	Minimal
	■ Patellar mobility	Good
	■ Crepitus	None/slight
	■ Gait	Symmetrical
	■ Isometric test (mean avg. torque/% deficit quads, hams)	20-30
Frequency		**Duration**
2 x/day 10 minutes	**Range of motion** Hamstring, gastroc-soleus, quad, ITB stretches	5 reps x 30 secs
2 x/day 20 minutes	**Strengthening** Straight leg raises, rubber tubing (high speed)	3 sets x 30 reps
	Hamstring curls (active, 0°-90°)	3 sets x 10 reps
	Knee extension with resistance (90°-30°)	3 sets x 10 reps
	Leg press (70°-10°)	3 sets x 10 reps
	Multi-hip machine (flexion, extension, abduction, adduction)	3 sets x 10 reps
	Closed-chain: Mini-squats (rubber tubing, 0°-40°)	3 sets x 20 reps
1-3 x/day 5 minutes	**Balance training** Balance board/2 legged Single leg stance	
3 x/week 20 minutes	**Aerobic conditioning** (patellofemoral precautions) Stationary bicycling Water walking Swimming (kicking) Walking Stair machine (low resistance, low stroke) Ski machine (short stride, level, low resistance)	
3 x/week 15-20 minutes	**Running program** (6 months, straight, unloader brace) Jog	1/4 mile
	Walk	1/8 mile
	Backward run	20 yards
As required	**Modalities** Cryotherapy	20 minutes
Goals	■ Increase strength and endurance	