



Posterior Cruciate Ligament Reconstruction Rehabilitation Protocol*

This rehabilitation protocol was developed for patients who have posterior cruciate ligament (PCL) reconstruction with a high strength graft and secure internal fixation (quadriceps tendon-bone autograft, Achilles tendon-bone allograft).

The protocol is divided into 7 phases according to postoperative weeks (for instance, Phase I = Postoperative Weeks 1-2). Each phase has several categories including:

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

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

- v Control joint pain, swelling, hemarthrosis (minimal or none)
- v Regain normal knee flexion and extension
- v Regain a normal gait pattern and neuromuscular stability for ambulation
- v Regain normal quadriceps, hamstring lower extremity muscle strength
- v Regain normal proprioception, balance, and coordination for desired activities
- v 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:

- v Swelling of the knee joint or soft tissues
- v Abnormal pain response
- v Abnormal gait pattern with or without assistive device
- v Insufficient flexion or extension motions, limited patellar mobility
- v Weakness (strength/control) of the lower extremity, especially the quadriceps/hamstrings
- v Insufficient lower extremity flexibility
- v Abnormal AP displacement (joint arthrometer/stress testing > 3 mm) early postoperatively

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)

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

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

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

0 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 0 8-10 hrs/day	0 0 0 hrs/day	0 0 0 hrs/day	0 0 0 times/day	0 0 0 times/day	0 0 0 times/day	0 0 0-5 lbs
1 0 6-7 hrs/day	2 0 1 hrs/day	2 0 1 hrs/day	1 0 1-5 times/day	2 0 1 flight 2 times/day	1 0 1-5 times/day	1 0 6-10 lbs
2 0 4-5 hrs/day	4 0 2-3 hrs/day	4 0 2-3 hrs/day	2 0 6-10 times/day	4 0 3 flights 2 times/day	2 0 6-10 times/day	2 0 11-20 lbs
3 0 2-3 hrs/day	6 0 4-5 hrs/day	6 0 4-5 hrs/day	3 0 11-15 times/day	6 0 10 flights/ ladders	3 0 11-15 times/day	3 0 21-25 lbs
4 0 1 hrs/day	8 0 6-7 hrs/day	8 0 6-7 hrs/day	4 0 16-20 times/day	8 0 ladders with weight 2-3 days/week	4 0 16-20 times/day	4 0 26-30 lbs
5 0 0 hrs/day	10 0 8-10 hrs/day	10 0 8-10 hrs/day	5 0 > 20 times/day	8 0 ladders daily with weight	5 0 > 20 times/day	5 0 > 20 lbs

_____ points x 2 = _____ total points

Occupation Rating

Total Points

0 Disabled	0
0 Very light	1-20
0 Light	21-40
0 Moderate	41-60
0 Heavy	61-80
0 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
7	27-52	2	4
Total		11	21

*Physician Notification

The physician is 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) develops abnormal AP displacement on objective testing (> 3 mm difference), (5) complains of giving-way, (6) has difficulty with ambulation, or (7) has a limitation of knee motion or patellar mobility.

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 \geq 85% of opposite limb

Function testing: 2 hop tests, limb symmetry \geq 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 \geq 80% of opposite limb

Function testing: 2 hop tests, limb symmetry \geq 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 \geq 70% of opposite limb

Function testing: 2 hop tests, limb symmetry \geq 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.

References

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Cincinnati Sportsmedicine and Orthopaedic Center Rehabilitation Protocol Summary for Posterior Cruciate Ligament Reconstruction

	Postoperative Weeks					Postoperative Months			
	1-2	3-4	5-6	7-8	9-12	4	5	6	7-12
Hinged long-leg p.o. brace	X	X	X	X					
Functional brace			(X)	(X)	X			X	X
Range of motion minimum goals:									
0°-90°	X								
0°-110°		X							
0°-120°			X						
0°-135°				X					
Weight bearing:									
1/4 body weight	X								
1/2 body weight		X							
Full			X						
Patella mobilization	X	X	X	X					
Modalities:									
Electrical muscle stimulation (EMS)	X	X	X	X	X				
Pain/edema management (cryotherapy)	X	X	X	X	X	X	X	X	X
Stretching:									
Hamstring, gastroc-soleus, iliotibial band, quadriceps	X	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	X	
Knee flexion hamstring curls (90°)					X	X	X	X	X
Knee extension quads (90°-30°)	X	X	X	X	X	X	X	X	X
Hip abduction-adduction, multi-hip		X	X	X	X	X	X	X	X
Leg press (70°-10°)		X	X	X	X	X	X	X	X
Balance/proprioceptive training:									
Weight-shifting, mini-trampoline, BAPS, BBS, plyometrics			X	X	X	X	X	X	X
Conditioning:									
UBC	X	X	X	X	X				
Bike (stationary)		X	X	X	X	X	X	X	X
Aquatic program					X	X	X	X	X
Swimming (kicking)						X	X	X	X
Walking					X	X	X	X	X
Stair climbing machine					X	X	X	X	X
Ski machine					X	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), BBS = Biodex Balance System (Biodex Medical Systems, Inc, Shirley, NY), UBC = upper body cycle (Biodex Medical Systems, Inc, Shirley, NY).

Cincinnati Sportsmedicine and Orthopaedic Center Rehab Protocol: PCL
Phase I. Weeks 1-2 (Visits: 2-4)

General Observation	<ul style="list-style-type: none"> v Toe-touch weight bearing v Brace 	
Evaluation	<ul style="list-style-type: none"> v Pain v Hemarthrosis v Patellar mobility v ROM minimum v Quadriceps contraction & patella migration v Soft tissue contracture 	<p align="center">Goals</p> Controlled Mild Good 0°-90° Good None
<p>Frequency</p> 3-4 x/day 10 minutes	<p>Range of motion</p> ROM 0°-90° (active extension/passive flexion with 10 lb. anterior drawer) Patella mobilization Ankle pumps (plantar flexion with resistance band) Hamstring, gastroc-soleus stretches	<p align="center">Duration</p> 20 cycles 10 x/30 secs 5 reps x 30 secs
3 x/day 15 minutes	<p>Strengthening</p> Straight leg raises (flexion, 0-5 lb ankle wt.) Active quadriceps isometrics Knee extension (active-assisted, 70°-0°, 0-7.5 lb wt.)	3 sets x 10 reps 1 set x 10 reps 3 sets x 10 reps
2 x/day 10 minutes	<p>Aerobic conditioning</p> UBE	
As required	<p>Modalities</p> Electrical muscle stimulation Cryotherapy	20 minutes 20 minutes
While sleeping	<p>Activities of daily living</p> Knee brace to avoid sudden knee flexion while asleep	
Goals	<ul style="list-style-type: none"> v ROM 0°-90° v Adequate quadriceps contraction v Control inflammation, effusion v Prevent tissue contracture v Protect ligament reconstruction at insertion sites 	

Cincinnati Sportsmedicine and Orthopaedic Center Rehab Protocol: PCL
Phase 2. Weeks 3-4 (Visits: 2-4)

General Observation	v Partial (25%) weight bearing when: v Brace - Pain controlled - Hemarthrosis controlled - Muscle control throughout ROM - ROM 0°-90°	
Evaluation	v Pain v Effusion v Patellar mobility v ROM minimum v Quadriceps contraction & patella migration v Soft tissue contracture	Goals Controlled Mild Good 0°-110° Good None
Frequency 3-4 x/day 10 minutes 2-3 x/day 20 minutes 2 x/day 10 minutes As required While sleeping	Range of motion ROM (passive, 0°-110°, 10# anterior drawer) Patella mobilization Ankle pumps (plantar flexion with resistance band) Hamstring, gastroc-soleus stretches Strengthening Straight leg raises (flexion, adduction) Isometric training: multi-angle (0°, 60°) Knee extension (active-assisted, 90°-0°, 0-7.5 lbs. wt.) Aerobic conditioning UBC Stationary bicycling Modalities Electrical muscle stimulation Cryotherapy Activities of daily living Knee brace to avoid sudden knee flexion while asleep	Duration 20 cycles 10 x, 30 secs 5 reps x 30 secs 3 sets x 10 reps 1 set x 10 reps 3 sets x 10 reps 20 minutes 20 minutes
Goals	v ROM 0°-110° v Control inflammation, effusion v Muscle control v Prevent soft tissue contracture v Protect ligament reconstruction at insertion sites	

Cincinnati Sportsmedicine and Orthopaedic Center Rehab Protocol: PCL
Phase 3. Weeks 5-6 (Visits: 1-2)

General Observation	v Partial (50%) weight bearing when: v Brace - Pain controlled without narcotics - Hemarthrosis controlled - ROM 0°-90° - Muscle control throughout ROM	
Evaluation	v Pain v Effusion v Patellar mobility v ROM v Muscle control v Inflammatory response v Joint arthrometer (6 weeks), 20° 89N and 70° 89N	Goals Mild/No RSD Minimal Good 0°-120° 3/5 None < 3 mm
Frequency 3-4 x/day 10 minutes 3 x/day 15 minutes 3 x/day 5 minutes 2 x/day 10 minutes As required While sleeping	Range of motion ROM (passive, 0°-120°) Patella mobilization Hamstring, gastroc-soleus stretches Strengthening Straight leg raises (ankle weight, not to exceed 10% of body weight) Isometric training: multi-angle (90°, 60°, 30°) Knee extension (active, 90°-0°) Closed-chain - Heel raise/toe raise - wall sits Multi-hip machine (flexion, extension, abduction, adduction) Leg press (50°-10°) Balance training Weight shift side/side and forward/back Balance board/2 legged Cup walking Single let stance Aerobic conditioning (patellofemoral precautions) UBC Stationary bicycling Modalities Electrical muscle stimulation Cryotherapy Activities of daily living Knee brace to avoid sudden knee flexion while asleep	Duration 5 reps x 30 secs 3 sets x 10 reps 2 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 20 reps 5 reps 3 sets x 10 reps 3 sets x 10 reps 5 sets x 10 reps 20 minutes 20 minutes
Goals	v ROM 0°-120° v 50% weight bearing v Control inflammation, effusion v Muscle control v Early recognition complications (motion loss, RSD, increased AP displacement, patellofemoral)	

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

General Observation	v Full weight bearing when: v Brace - Pain controlled without narcotics - Hemarthrosis controlled - Voluntary quad contraction achieved	
Evaluation	v Pain v Effusion v Patellar mobility v ROM v Muscle control v Inflammatory response v Joint arthrometer (8 weeks), 20° 89N and 70° 89N	Goals Mild/No RSD Minimal Good 0°-135° 4/5 None < 3 mm
Frequency 3-4 x/day 10 minutes 3 x/day 15 minutes 3 x/day 5 minutes 2 x/day 10-15 minutes As required While sleeping	Range of motion ROM (passive, 0°-135°) Patellar mobilization Hamstring, gastroc-soleus stretches Strengthening Straight leg raises (flexion, abduction, adduction) Straight leg raises, rubber tubing Knee extension (active, 90°-0°) Leg press (50°-10°) Closed-chain - Wall sits - Mini-squats (rubber tubing, 0°-30°) Multi-hip machine (flexion, extension, abduction, adduction) Balance training Balance board/2 legged Single leg stance Aerobic conditioning UBC Stationary bicycling Modalities Electrical muscle stimulation Cryotherapy Activities of daily living Knee brace to avoid sudden knee flexion while asleep	Duration 5 reps x 30 secs 3 sets x 10 reps 3 sets x 30 reps 3 sets x 10 reps 3 sets x 10 reps 5 reps 3 sets x 20 reps 3 sets x 10 reps 20 minutes 20 minutes
Goals	v Full weight bearing, normal gait v Control inflammation, effusion v Muscle control v ROM 0°-135°	

Cincinnati Sportsmedicine and Orthopaedic Center Rehab Protocol: PCL

Phase 5. Weeks 9-12 (Visits: 1-2)

General Observation	<ul style="list-style-type: none"> v No effusion, painless ROM, joint stability v Performs activities of daily living without pain v ROM 0°-135° v Brace optional 	
Evaluation	<ul style="list-style-type: none"> v Pain v Manual muscle test Quadriceps, hip abductors/adductors/flexors/extensors v Swelling v Joint arthrometer (12 weeks) 20° 134N and 70° 89N v Patellar mobility v Crepitus v Gait 	<p align="center">Goals</p> <p>Minimal/No RSD 4/5</p> <p>Minimal 3 mm</p> <p>Good</p> <p>None/slight</p> <p>Symmetrical</p>
<p>Frequency</p> <p>3-4 x/day 10 minutes</p> <p>3 x/day 15-20 minutes</p> <p>3 x/day 5 minutes</p> <p>1 x/day 15-20 minutes</p> <p>As required</p>	<p>Range of motion Hamstring, gastroc-soleus, quad, ITB stretches</p> <p>Strengthening Straight leg raises (add extension) Straight leg raises, rubber tubing Hamstring curls Knee extension (active, 90°-0°) Leg press (50°-10°) Closed-chain - Wall sits - Mini-squats (0°-40°) - Lateral step-ups (2-4" block) Multi-hip machine (flexion, extension, abduction, adduction)</p> <p>Balance training Balance board/2 legged Single leg stance</p> <p>Aerobic conditioning (patellofemoral precautions) Stationary bicycling Water walking UBC Stair machine (low resistance, low stroke) Ski machine (short stride, level, low resistance)</p> <p>Modalities Electrical muscle stimulation Cryotherapy</p> <p>Activities of daily living Avoid squats, walking down hills & ramps, running down stairs, sudden deceleration movements</p>	<p align="center">Duration</p> <p>5 reps x 30 secs</p> <p>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</p> <p>to fatigue x 3 reps 3 sets x 20 reps 3 sets x 10 reps 3 sets x 10 reps</p> <p>20 minutes 20 minutes</p>
Goals	<ul style="list-style-type: none"> v Increase strength and endurance v ROM 0°-135° v Return to normal gait, ADL 	

Cincinnati Sportsmedicine and Orthopaedic Center Rehab Protocol: PCL
Phase 6. Weeks 13-26 (Visits: 2-3)

General Observation	<ul style="list-style-type: none"> v No effusion, painless ROM, joint stability v Performs activities of daily living, can walk 20 minutes without pain v ROM 0°-135° v Brace optional 	
Evaluation	<ul style="list-style-type: none"> v Pain v Manual muscle test v Swelling v Joint arthrometer v Patellar mobility v Crepitus v Gait v Isometric test (% difference quads & hams) 	<p align="center">Goals</p> <ul style="list-style-type: none"> Minimal/No RSD 5/5 Minimal < 3 mm Good None/slight Symmetrical 30
<p>Frequency</p> <ul style="list-style-type: none"> 2-3 x/day 10 minutes 2 x/day 20 minutes 2 x/day 5 minutes 1 x/day 20 minutes 3 x/week 10 minutes As required 	<p>Range of motion</p> <ul style="list-style-type: none"> Hamstring, gastroc-soleus, quad, ITB stretches <p>Strengthening</p> <ul style="list-style-type: none"> Hamstring curls (active, 0°-90°) Knee extension with resistance (90°-0°) Leg press (50°-10°) Multi-hip machine (flexion, extension, abduction, adduction) Closed-chain: <ul style="list-style-type: none"> - Mini-squats (0°-40°) - Wall sits - Lateral step-ups (2-4" block) <p>Balance training</p> <ul style="list-style-type: none"> Balance board/2 legged Single leg stance <p>Aerobic conditioning (patellofemoral precautions)</p> <ul style="list-style-type: none"> Stationary bicycling Water walking Swimming (kicking) Walking Stair machine (low resistance, low stroke) Ski machine (short stride, level, low resistance) <p>Running program (6 months, straight, 30% deficit isometric test)</p> <ul style="list-style-type: none"> Jog Walk Backward run 	<p align="center">Duration</p> <ul style="list-style-type: none"> 5 reps x 30 secs 3 sets x 10 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 reps 3 sets x 10 reps 1/4 mile 1/8 mile 20 yards 20 minutes
Goals	v Increase strength and endurance	

Cincinnati Sportsmedicine and Orthopaedic Center Rehab Protocol: PCL
Phase 7. Weeks 27-52 (Visits: 2-3)

General Observation	<ul style="list-style-type: none"> v No effusion, painless ROM, joint stability v Performs ADL, can walk 20 minutes without pain v Brace optional 	
Evaluation	<ul style="list-style-type: none"> v Isokinetic test (isometric + torque 300°/sec, % diff quads & hams) v Swelling v Joint arthrometer v Patellar mobility v Crepitus v Single-leg function tests (9 mos: hop distance, timed hop, % inv/uninv) 	<p align="center">Goals</p> <p>10-15 None 3 mm Good None/slight 85</p>
<p>Frequency</p> <p>2-3 x/day 10 minutes</p> <p>1 x/day 20 minutes</p> <p>1-2 x/day 5 minutes</p> <p>3 x/week 20 minutes</p> <p>3 x/week up to 20 minutes</p> <p>3 x/week</p> <p>3 x/week 20 minutes</p> <p>As required</p>	<p>Range of motion Hamstring, gastroc-soleus, quad, ITB stretches</p> <p>Strengthening Hamstring curls with resistance (0°-90°) Knee extension with resistance (90°-30°) Leg press (70°-10°) Multi-hip machine (flexion, extension, abduction, adduction)</p> <p>Balance training Balance board/2 legged Single leg stance</p> <p>Aerobic conditioning (patellofemoral precautions) Stationary bicycling Water walking Swimming (kicking) Walking Stair machine (low resistance, low stroke) Ski machine (short stride, level, low resistance)</p> <p>Running program (straight, 30% deficit isokinetic test) Jog Walk Backward run</p> <p>Cutting program (20% deficit isokinetic test) Lateral, carioca, figure 8's</p> <p>Functional training Plyometric training (20% deficit isokinetic test): - box hops, level, double-leg Sport specific drills (10-15% deficit isokinetic test)</p> <p>Modalities Cryotherapy</p>	<p align="center">Duration</p> <p>5 reps x 30 secs</p> <p>3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps</p> <p>1/4 mile 1/8 mile 20 yards</p> <p>20 yards</p> <p>15 secs, 4-6 sets</p> <p>20 minutes</p>
Goals	<ul style="list-style-type: none"> v Increase function v Maintain strength, endurance v Return to previous activity level 	