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## Anterior Cruciate Ligament Reconstruction: Delayed Rehabilitation Protocol\*

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This rehabilitation protocol was developed for patients who have anterior cruciate ligament (ACL) reconstruction and one of the following:

- Concomitant meniscal repair, complex or in avascular region
- Concomitant ligament reconstruction
- Concomitant patellofemoral realignment procedure
- Significant articular cartilage lesion
- ACL revision reconstruction
- Marked physiological laxity (expect high ACL forces postoperatively)

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:

- *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:

- 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
- Abnormal AP displacement (joint arthrometer 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)*

- 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 <input type="checkbox"/> 8-10 hrs/day	0 <input type="checkbox"/> 0 hrs/day	0 <input type="checkbox"/> 0 hrs/day	0 <input type="checkbox"/> 0 times/day	0 <input type="checkbox"/> 0 times/day	0 <input type="checkbox"/> 0 times/day	0 <input type="checkbox"/> 0-5 lbs
1 <input type="checkbox"/> 6-7 hrs/day	2 <input type="checkbox"/> 1 hrs/day	2 <input type="checkbox"/> 1 hrs/day	1 <input type="checkbox"/> 1-5 times/day	2 <input type="checkbox"/> 1 flight 2 times/day	1 <input type="checkbox"/> 1-5 times/day	1 <input type="checkbox"/> 6-10 lbs
2 <input type="checkbox"/> 4-5 hrs/day	4 <input type="checkbox"/> 2-3 hrs/day	4 <input type="checkbox"/> 2-3 hrs/day	2 <input type="checkbox"/> 6-10 times/day	4 <input type="checkbox"/> 3 flights 2 times/day	2 <input type="checkbox"/> 6-10 times/day	2 <input type="checkbox"/> 11-20 lbs
3 <input type="checkbox"/> 2-3 hrs/day	6 <input type="checkbox"/> 4-5 hrs/day	6 <input type="checkbox"/> 4-5 hrs/day	3 <input type="checkbox"/> 11-15 times/day	6 <input type="checkbox"/> 10 flights/ ladders	3 <input type="checkbox"/> 11-15 times/day	3 <input type="checkbox"/> 21-25 lbs
4 <input type="checkbox"/> 1 hrs/day	8 <input type="checkbox"/> 6-7 hrs/day	8 <input type="checkbox"/> 6-7 hrs/day	4 <input type="checkbox"/> 16-20 times/day	8 <input type="checkbox"/> ladders with weight 2-3 days/week	4 <input type="checkbox"/> 16-20 times/day	4 <input type="checkbox"/> 26-30 lbs
5 <input type="checkbox"/> 0 hrs/day	10 <input type="checkbox"/> 8-10 hrs/day	10 <input type="checkbox"/> 8-10 hrs/day	5 <input type="checkbox"/> > 20 times/day	8 <input type="checkbox"/> ladders daily with weight	5 <input type="checkbox"/> > 20 times/day	5 <input type="checkbox"/> > 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
7	27-52	2	4
Total		11	21

### \*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) develops abnormal AP displacement on arthrometer 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 Delayed ACL Reconstruction

	Postoperative Weeks					Postoperative Months			
	1-2	3-4	5-6	7-8	9-12	4	5	6	7-12
<b>Brace:</b> postoperative & functional	X	X	X	X	X			X	X
<b>Range of motion minimum goals:</b> 0°-90° 0°-120° 0°-135°		X	X	X					
<b>Weight bearing:</b> Toe touch 1/4 - 1/2 body weight 3/4 - Full	X	X	X						
<b>Patella mobilization</b>	X	X	X						
<b>Modalities:</b> Electrical muscle stimulation (EMS) Pain/edema management (cryotherapy)	X X	X X	X X	X X	X	X	X	X	X
<b>Stretching:</b> Hamstring, gastroc-soleus, iliotibial band, quadriceps	X	X	X	X	X	X	X	X	X
<b>Strengthening:</b> Quad isometrics, quad-ham isometrics co-contraction, straight leg raises, active knee extension Closed-chain: gait retraining, toe raises, wall sits, mini-squats Knee flexion hamstring curls (90°) Knee extension quads (90°-30°) Hip abduction-adduction, multi-hip Leg press (70°-10°)	X  X	X  X	X  X X X X	X  X X X X	X  X X X X	X  X X X X	X  X X X X	X  X X X X	X  X X X X
<b>Balance/proprioceptive training:</b> Weight-shifting, mini-trampoline, BAPS, KAT, plyometrics			X	X	X	X	X	X	X
<b>Conditioning:</b> UBE Bike (stationary) Aquatic program Elliptical machine Swimming (kicking) Walking Stair climbing machine Ski machine		X	X X	X X X	X X X X	X X X X	X X X X	X X X X	X X X X
Running: straight								X	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: ACL – Delayed**  
**Phase 2. Weeks 3-4 (Visits: 2-4)**

<b>General Observation</b>	<ul style="list-style-type: none"> <li>■ 50% weight bearing when:               <ul style="list-style-type: none"> <li>- Pain controlled</li> <li>- Hemarthrosis controlled</li> </ul> </li> <li>- Voluntary quadriceps contraction achieved</li> </ul>	
<b>Evaluation</b>	<ul style="list-style-type: none"> <li>■ Pain</li> <li>■ Effusion</li> <li>■ Patellar mobility</li> <li>■ ROM minimum</li> <li>■ Quadriceps contraction &amp; patella migration</li> <li>■ Soft tissue contracture</li> <li>■ Joint arthrometer (3 weeks, 20 lbs)</li> </ul>	<p align="center"><b>Goals</b></p> Controlled Mild Good 0°-90° Good None < 3 mm
<p><b>Frequency</b> 3-4 x/day 10 minutes</p> <p>2-3 x/day 20 minutes</p> <p>2 x/day 10 minutes</p> <p>As required</p>	<p><b>Range of motion</b> ROM (passive, 0°-90°) Patella mobilization Ankle pumps (plantar flexion with resistance band) Hamstring, gastroc-soleus stretches</p> <p><b>Strengthening</b> Straight leg raises (flexion, extension, adduction) Isometric training: Multi-angle (0°, 60°) Active quadriceps (full extension) Quad/ham co-contraction with EMS Toe raises/heel raises Knee extension (90°-45°, no resistance) Knee flexion (active, 0°- 90°) Multi-hip machine (flexion, extension, abduction, adduction) Leg press (70°-10°) Closed-chain  <ul style="list-style-type: none"> <li>- Mini-squats (0°-45°, 50% weight bearing)</li> <li>- Wall sits</li> <li>- Wall sits with EMS</li> </ul> </p> <p><b>Aerobic conditioning</b> UBE</p> <p><b>Modalities</b> Electrical muscle stimulation Cryotherapy</p>	<p align="center"><b>Duration</b></p> 5 reps x 30 secs  3 sets x 10 reps  1 set x 10 reps  3 sets x 10 reps 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  20 minutes 20 minutes
<b>Goals</b>	<ul style="list-style-type: none"> <li>■ ROM 0°-110°</li> <li>■ Control inflammation, effusion</li> <li>■ Adequate quadriceps contraction</li> <li>■ 50% weight bearing</li> </ul>	



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

<b>General Observation</b>	<ul style="list-style-type: none"> <li>■ Independent ambulation when:</li> <li>- Pain controlled                      - Effusion controlled</li> <li>- ROM 0°-120°                              - Muscle control throughout ROM</li> <li>- Dynamic control varus/valgus</li> </ul>	
<b>Evaluation</b>	<ul style="list-style-type: none"> <li>■ Pain</li> <li>■ Effusion</li> <li>■ Patellar mobility</li> <li>■ ROM</li> <li>■ Muscle control</li> <li>■ Inflammatory response</li> <li>■ Gait</li> <li>■ Joint arthrometer (8 weeks)</li> </ul>	<p align="center"><b>Goals</b></p> <p>No RSD  Minimal  Good  0°-135°  4/5  None  Symmetrical  &lt; 3 mm</p>
<p><b>Frequency</b>  2 x/day  10 minutes</p> <p>2 x/day  20 minutes</p> <p>3 x/day  5 minutes</p> <p>2 x/day  10 minutes</p> <p>As required</p>	<p><b>Range of motion</b>  Hamstring, gastroc-soleus stretches</p> <p><b>Strengthening</b>  Straight leg raises (ankle weight, &lt; 10% body weight)  Straight leg raises, rubber tubing  Isometric training: multi-angle (90°, 60°, 30°)  Heel raise/toe raise  Hamstring curls (active, 0°-90°)  Knee extension with resistance (90°-45°)  Leg press (70°-10°)  Closed-chain  - Wall sits  - Mini-squats (rubber tubing, 0°-30°)  - Lunge  Multi-hip machine (flexion, extension, abduction, adduction)  Leg press (70°-10°)</p> <p><b>Balance training</b>  Balance board/2 legged  Lateral step-ups: 2-4"</p> <p><b>Aerobic conditioning</b> (patellofemoral precautions)  UBE  Stationary bicycling  Water walking  Stair machine (low resistance, low stroke)  Ski machine (short stride, level, low resistance)  Elliptical machine (low resistance)</p> <p><b>Modalities</b>  Cryotherapy</p>	<p align="center"><b>Duration</b></p> <p>5 reps x 30 secs</p> <p>3 sets x 10 reps  3 sets x 30 reps  3 sets x 20 reps  3 sets x 10 reps  3 sets x 10 reps  3 sets x 10 reps  3 sets x 10 reps</p> <p>3 sets x 20 reps  to fatigue x 3</p> <p>3 sets x 10 reps  3 sets x 10 reps</p> <p>20 minutes</p>
<b>Goals</b>	<ul style="list-style-type: none"> <li>■ ROM 0°-135°                      ■ Full weight bearing, normal gait</li> <li>■ Control inflammation, effusion</li> <li>■ Muscle endurance</li> <li>■ Recognize complications  (motion loss, RSD, increased AP displacement)</li> <li>■ Recognition patellofemoral changes</li> </ul>	

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

<b>General Observation</b>	<ul style="list-style-type: none"> <li>■ Full weight bearing</li> <li>■ ROM 0°-135°</li> <li>■ No effusion, painless ROM, joint stability</li> <li>■ Performs ADL, can walk 20 minutes without pain</li> </ul>	
<b>Evaluation</b>	<ul style="list-style-type: none"> <li>■ Manual muscle test Hamstrings, quadriceps, hip abductors/adductors/flexors/extensors</li> <li>■ Swelling</li> <li>■ Joint arthrometer (12 weeks)</li> <li>■ Patellar mobility</li> <li>■ Crepitus</li> </ul>	<p align="center"><b>Goals</b></p> <p>4/5</p> <p>None</p> <p>3 mm</p> <p>Good</p> <p>None/slight</p>
<b>Frequency</b>		<b>Duration</b>
2 x/day 10 minutes	<p><b>Range of motion</b> Hamstring, gastroc-soleus, quad, ITB stretches</p>	5 reps x 30 secs
2 x/day 20 minutes	<p><b>Strengthening</b>            Straight leg raises, rubber tubing            Hamstring curls (active, 0°-90°)            Knee extension with resistance (90°-45°)            Leg press (70°-10°)            Closed-chain                - Wall sits                - Mini-squats (rubber tubing, 0°-40°)                - Lunge            Multi-hip machine (flexion, extension, abduction, adduction)</p>	<p>3 sets x 30 reps</p> <p>3 sets x 10 reps</p> <p>3 sets x 10 reps</p> <p>3 sets x 10 reps</p> <p>3 sets x 20 reps to fatigue x 3</p> <p>3 sets x 10 reps</p> <p>3 sets x 10 reps</p>
3 x/day 5 minutes	<p><b>Balance training</b>            Balance board/2 legged            Single leg stance – unstable platform</p>	
1-2 x/day 15-20 minutes	<p><b>Aerobic conditioning</b> (patellofemoral precautions)            Stationary bicycling            Water walking            Swimming (straight leg kicking)            Walking            Stair machine (low resistance, low stroke)            Ski machine (short stride, level, low resistance)            Elliptical machine (low resistance)</p>	
As required	<p><b>Modalities</b>            Cryotherapy</p>	20 minutes
<b>Goals</b>	<ul style="list-style-type: none"> <li>■ Increase strength and endurance</li> </ul>	

**Cincinnati SportsMedicine and Orthopaedic Center Rehab Protocol: ACL – Delayed**  
**Phase 6. Weeks 13-26 (Visits: 2-3)**

<b>General Observation</b>	<ul style="list-style-type: none"> <li>■ No effusion, painless ROM, joint stability</li> <li>■ Performs ADL, can walk 20 minutes without pain</li> <li>■ ROM 0°-135°</li> </ul>	
<b>Evaluation</b>	<ul style="list-style-type: none"> <li>■ Isometric test (% difference quads &amp; hams)</li> <li>■ Swelling</li> <li>■ Joint arthrometer</li> <li>■ Patellar mobility</li> <li>■ Crepitus</li> </ul>	<p align="center"><b>Goals</b></p> <p>30 None &lt; 3 mm Good None/slight</p>
<b>Frequency</b>		<b>Duration</b>
2 x/day 10 minutes	<p><b>Range of motion</b> Hamstring, gastroc-soleus, quad, ITB stretches</p>	5 reps x 30 secs
2 x/day 20 minutes	<p><b>Strengthening</b> Straight leg raises, rubber tubing Hamstring curls (active, 0°-90°) Knee extension with resistance (90°-45°) Leg press (70°-10°) Multi-hip machine (flexion, extension, abduction, adduction) Closed-chain: Wall sits Mini-squats Lateral step-ups (2-4" block)</p>	<p>3 sets x 30 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps</p>
3 x/day 5 minutes	<p><b>Balance training</b> Balance board/2 legged Single leg stance – unstable platform Plyoback – ball toss</p>	<p>5 reps 3 sets x 20 reps 3 sets x 10 reps</p>
3 x/week 15-20 minutes	<p><b>Aerobic conditioning</b> (patellofemoral precautions) Stationary bicycling Water walking Swimming (kicking) Walking Stair machine (low resistance, low stroke) Ski machine (short stride, level, low resistance)</p>	
3 x/week 10 minutes	<p><b>Running program</b> (6 months, straight, 30% deficit isometric test) Jog Walk Backward run</p>	<p>1/4 mile 1/8 mile 20 yards</p>
As required	<p><b>Modalities</b> Cryotherapy</p>	20 minutes
<b>Goals</b>	<ul style="list-style-type: none"> <li>■ Increase strength and endurance</li> </ul>	

**Cincinnati SportsMedicine and Orthopaedic Center Rehab Protocol: ACL – Delayed**  
**Phase 7. Weeks 27-52 (Visits: 2-3)**

<b>General Observation</b>	<ul style="list-style-type: none"> <li>■ No effusion, painless ROM, joint stability</li> <li>■ Performs ADL, can walk 20 minutes without pain</li> </ul>	
<b>Evaluation</b>	<ul style="list-style-type: none"> <li>■ Isokinetic test (isometric + torque 300°/sec, % diff quads &amp; hams)</li> <li>■ Swelling</li> <li>■ Joint arthrometer</li> <li>■ Patellar mobility</li> <li>■ Crepitus</li> <li>■ Single-leg function tests (9 mos: hop distance, timed hop, % inv/uninv)</li> </ul>	<p align="center"><b>Goals</b></p> <p>10-15 None 3 mm Good None/slight 85</p>
<b>Frequency</b>		<b>Duration</b>
2 x/day 10 minutes	<p><b>Range of motion</b> Hamstring, gastroc-soleus, quad, ITB stretches</p>	5 reps x 30 secs
1 x/day 20-30 minutes	<p><b>Strengthening</b> Straight leg raises, rubber tubing (high speed) Hamstring curls (active, 0°-90°) Knee extension with resistance (90°-45°) Leg press (70°-10°) Multi-hip machine (flexion, extension, abduction, adduction)</p>	3 sets x 30 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps
3 x/day 5 minutes	<p><b>Balance training</b> Balance board/2 legged Single leg stance</p>	
3 x/week 20-30 minutes	<p><b>Aerobic conditioning</b> (patellofemoral precautions) Stationary bicycling Water walking Swimming (kicking) Walking Stair machine (low resistance, low stroke) Ski machine (short stride, level, low resistance)</p>	
3 x/week 15-20 minutes	<p><b>Running program</b> (straight,) Jog – interval training (20, 40, 60, 100 yards) Walk Backward run</p>	1/4 mile 1/8 mile 20 yards 20 yards
3 x/week	<p><b>Cutting program</b> – lateral, carioca, figure 8's (20% deficit isokinetic test)</p>	20 yards
3 x/week	<p><b>Functional training</b> Plyometric training: box hops, level, double-leg Sport specific drills (10-15% deficit isokinetic test)</p>	15 secs, 4-6 sets
As required	<p><b>Modalities</b> Cryotherapy</p>	20 minutes
<b>Goals</b>	<ul style="list-style-type: none"> <li>■ Increase function</li> <li>■ Maintain strength, endurance</li> <li>■ Return to previous activity level</li> </ul>	