

Noyes Knee Institute Rehabilitation Protocol for ACL Reconstruction:  
Revision Knees, Allografts, Complex Knees

	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	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 Pain/edema management (cryotherapy)	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			
<b>Balance/proprioceptive training:</b> Weight-shifting, cup walking, BBS BBS, BAPS, perturbation training, balance board, mini-trampoline	X	X	X	X	X	X	X	X	X
<b>Conditioning:</b> UBC Bike (stationary) Aquatic program Elliptical machine Swimming (kicking) Walking Stair climbing machine Ski machine		X	X	X					
Running: straight								X	X
Cutting: lateral carioca, figure 8's									X
Plyometric training									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).

SOURCE: Heckmann T, Noyes FR, Barber-Westin SD: Rehabilitation of primary and revision anterior cruciate ligament reconstructions. *Noyes' Knee Disorders: Surgery, Rehabilitation, Clinical Outcomes*, Saunders, Philadelphia, 2009, pp. 306-336.

**Phase 1. Weeks 1 to 2**

<b>General Observation</b>	Toe-touch weight bearing to 25% body weight when: <ul style="list-style-type: none"> <li>- Pain controlled</li> <li>- Hemarthrosis controlled</li> <li>- Voluntary quadriceps contraction achieved</li> <li>- 0° extension</li> </ul>	
<b>Evaluation</b>	Pain Hemarthrosis Patellar mobility Range of motion minimum Quadriceps contraction & patella migration Soft tissue contracture	<b>Goals</b> Controlled Mild Good 10°-80° Good None
<b>Frequency</b> 3-4 x/day 10 minutes    3 x/day 15 minutes   As required	<b>Range of motion</b> Range of motion passive Meniscus repair (complex), MCL, revision, EA = 0°-90° Patellar realignment = 0°-75° Posterolateral procedure = 0°-90° (unless exam shows hyperelastic tissue type, then hold 15°-70° for 2 weeks postop) Patella mobilization Ankle pumps (plantar flexion with resistance band) Hamstring, gastroc-soleus stretches  <b>Strengthening</b> Straight leg raises (flexion) Active quadriceps isometrics (based on ROM limits) Knee extension (active-assisted)  <b>Modalities</b> Electrical muscle stimulation Cryotherapy	<b>Duration</b>         5 reps x 30 secs   3 sets x 10 reps 1 set x 10 reps 3 sets x 10 reps   20 minutes 20 minutes
<b>Goals</b>	Range of motion (see above, depends on procedure) Adequate quadriceps contraction Control inflammation, effusion	

EA, iliotibial band extra-articular procedure

## Phase 2. Weeks 3 to 4

<b>General Observation</b>	50% weight bearing when: - Pain controlled - Hemarthrosis controlled - Voluntary quadriceps contraction achieved	
<b>Evaluation</b>	Pain Effusion Patellar mobility ROM minimum Quadriceps contraction & patella migration Soft tissue contracture Joint arthrometer (3 weeks, 20 lbs)	<b>Goals</b> 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> Range of motion 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 - Mini-squats (0°-45°, 50% weight bearing) - Wall sits - Wall sits with EMS</p> <p><b>Aerobic conditioning</b> UBC</p> <p><b>Modalities</b> Electrical muscle stimulation Cryotherapy</p>	<p><b>Duration</b></p> <p>5 reps x 30 secs</p> <p>3 sets x 10 reps</p> <p>1 set x 10 reps</p> <p>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</p> <p>20 minutes 20 minutes</p>
<b>Goals</b>	Range of motion 0°-110° Control inflammation, effusion Adequate quadriceps contraction 50% weight bearing	

### Phase 3. Weeks 5 to 6

<b>General Observation</b>	Full weight bearing when: - Pain controlled without narcotics - Effusion controlled - ROM 0°-100° - Muscle control throughout ROM - Dynamic control varus/valgus	
<b>Evaluation</b>	Pain Effusion Patellar mobility Range of motion Muscle control Inflammatory response Joint arthrometer (6 weeks, 30 lb.s)	<b>Goals</b> Mild Minimal Good 0°-120° 3/5 None < 3 mm
<b>Frequency</b> 3 x/day 10 minutes  2-3 x/day 20 minutes  3 x/day 5 minutes  1-2 x/day 5 minutes  2 x/day 10 minutes  As required	<b>Range of motion</b> Range of motion passive, 0°-120° Patella mobilization Ankle pumps (plantar flexion with resistance band) Hamstring, gastroc-soleus stretches  <b>Strengthening</b> Straight leg raises (ankle weight, < 10% of body weight) Isometric training: multi-angle (90°, 60°, 30°) Heel raise/toe raise Hamstring curls (active, 0°-90°) Knee extension (90°-45°, with resistance) Closed-chain - Wall sits - Mini-squats - Lunge (no resistance) Multi-hip machine (flexion, extension, abduction, adduction) Leg press (70°-10°)  <b>Balance training</b> Weight shift side/side and forward/back Balance board/2 legged Cup walking Single leg stance – stable platform  <b>Aerobic conditioning</b> UBC Water walking Stationary bicycling (patellofemoral precautions)  <b>Modalities</b> Electrical muscle stimulation Cryotherapy	<b>Duration</b>  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 10 reps  5 reps 3 sets x 20 reps  3 sets x 10 reps 3 sets x 10 reps  5 sets x 10 reps  5 reps  20 minutes 20 minutes
<b>Goals</b>	ROM 0°-125° Control inflammation, effusion Muscle control Full weight bearing Early recognition complications (motion loss, RSD, increased AP displacement, patellofemoral)	

### Phase 4. Weeks 7 to 8

<b>General Observation</b>	Independent ambulation when: - Pain controlled - ROM 0°-120° - Dynamic control varus/valgus - Effusion controlled - Muscle control throughout ROM	
<b>Evaluation</b>	Pain Effusion Patellar mobility Range of motion Muscle control Inflammatory response Gait Joint arthrometer (8 weeks)	<b>Goals</b> No RSD Minimal Good 0°-135° 4/5 None Symmetrical < 3 mm
<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) UBC 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><b>Duration</b> 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>	ROM 0°-135° Full weight bearing, normal gait Control inflammation, effusion Muscle endurance Recognize complications (motion loss, RSD, increased AP displacement) Recognition patellofemoral changes	

### Phase 5. Weeks 9 to 12

<b>General Observation</b>	Full weight bearing ROM 0°-135° No effusion, painless ROM, joint stability Performs ADL, can walk 20 minutes without pain	
<b>Evaluation</b>	Manual muscle test Hamstrings, quadriceps, hip abductors/adductors/flexors/extensors Swelling Joint arthrometer (12 weeks) Patellar mobility Crepitus	<b>Goals</b> 4/5 None 3 mm Good None/slight
<b>Frequency</b> 2 x/day 10 minutes  2 x/day 20 minutes  3 x/day 5 minutes  1-2 x/day 15-20 minutes  As required	<b>Range of motion</b> Hamstring, gastroc-soleus, quad, ITB stretches  <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)  <b>Balance training</b> Balance board/2 legged Single leg stance – unstable platform Perturbation training  <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)	<b>Duration</b> 5 reps x 30 secs  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 3 sets x 10 reps
	<b>Modalities</b> Cryotherapy	20 minutes
<b>Goals</b>	Increase strength and endurance	

**Phase 6. Weeks 13 to 26**

<b>General Observation</b>	No effusion, painless ROM, joint stability Performs ADL, can walk 20 minutes without pain ROM 0°-135°	
<b>Evaluation</b>	Isometric test (% difference quads & hams) Swelling Joint arthrometer Patellar mobility Crepitus	<b>Goals</b> 30 None < 3 mm Good None/slight
<b>Frequency</b> 2 x/day 10 minutes	<b>Range of motion</b> Hamstring, gastroc-soleus, quad, ITB stretches	<b>Duration</b> 5 reps x 30 secs
2 x/day 20 minutes	<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)	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	<b>Balance training</b> Balance board/2 legged Single leg stance – unstable platform Plyoback – ball toss Perturbation training	5 reps 3 sets x 20 reps 3 sets x 10 reps
3 x/week 15-20 minutes	<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)	
3 x/week 10 minutes	<b>Running program</b> (6 months, straight, 30% deficit isometric test) Jog Walk Backward run	1/4 mile 1/8 mile 20 yards
As required	<b>Modalities</b> Cryotherapy	20 minutes
<b>Goals</b>	Increase strength and endurance	

### Phase 7. Weeks 27 to 52

<b>General Observation</b>	No effusion, painless ROM, joint stability Performs ADL, can walk 20 minutes without pain	
<b>Evaluation</b>	Isokinetic test (isometric + torque 300°/sec, % diff quads & hams) Swelling Joint arthrometer Patellar mobility Crepitus Single-leg function tests (9 mos: hop distance, timed hop, % inv/uninv)	<b>Goals</b> 10-15 None 3 mm Good None/slight 85
<b>Frequency</b>		<b>Duration</b>
2 x/day 10 minutes	<b>Range of motion</b> Hamstring, gastroc-soleus, quad, ITB stretches	5 reps x 30 secs
1 x/day 20-30 minutes	<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)	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	<b>Balance training</b> Balance board/2 legged Single leg stance Perturbation training	
3 x/week 20-30 minutes	<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)	
3 x/week 15-20 minutes	<b>Running program</b> (straight,) Jog – interval training (20, 40, 60, 100 yards) Walk Backward run	1/4 mile 1/8 mile 20 yards 20 yards
3 x/week	<b>Cutting program</b> – lateral, carioca, figure 8's (20% deficit isokinetic test)	
3 x/week	<b>Functional training</b> Plyometric training: box hops, level, double-leg Sport specific drills (10-15% deficit isokinetic test)	15 secs, 4-6 sets
As required	<b>Modalities</b> Cryotherapy	20 minutes
<b>Goals</b>	Increase function, strength, endurance Return to previous activity level	