

Noyes Knee Institute Rehabilitation Protocol for
Primary ACL Reconstruction: Early Return to Strenuous Activities

	Postoperative Weeks					Postoperative Months			
	1-2	3-4	5-6	7-8	9-12	4	5	6	7-12
Brace: immobilizer for patient comfort	X	(X)							
Range of motion minimum goals: 0°-110° 0°-120° 0°-135°	X	X	X						
Weight bearing: 1/2 body weight Full	X	X							
Patella mobilization	X	X	X						
Modalities: Electrical muscle stimulation Pain/edema management (cryotherapy)	X X	X X	X X	X X	X 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: Quadriceps isometrics, straight leg raises, active knee extension Closed-chain: gait retraining, toe raises, wall sits, mini-squats Knee flexion hamstring curls (90°) Knee extension quadriceps (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 X X X	X X X X X X	X X X X X X
Balance/proprioceptive training: Weight-shifting, cup walking, BBS BBS, BAPS, perturbation training, balance board, mini-trampoline	X	X	X	X X	X X	X X	X X	X X	X X
Conditioning: UBC Bike (stationary) Aquatic program Swimming (kicking) Walking Stair climbing machine Ski machine Elliptical 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 X	X X X X
Running: straight					X	X	X	X	X
Cutting: lateral carioca, figure-8's						X	X	X	X
Plyometric training						X	X	X	X
Full sports							X	X	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

General Observation	50% weight bearing with 2 crutches when: - Postoperative pain controlled - Hemarthrosis controlled - Voluntary quadriceps contraction achieved	
Factors Evaluated	Pain Hemarthrosis Patellar mobility Range of motion (minimum) Quadriceps contraction & patella migration Soft tissue contracture Joint arthrometer (day 14)	Goals Controlled Mild Good 0°-110° Good None < 3 mm
<p>Frequency 3-4 x/day 10 minutes</p> <p>3 x/day 15 minutes</p> <p>3 x/day 5 minutes</p> <p>1-2 x/day 5 minutes</p> <p>As required</p>	<p>Range of motion Range of motion passive, 0°-90° Patella mobilization Ankle pumps (plantar flexion with resistance band) Hamstring, gastroc-soleus stretches</p> <p>Strengthening Straight leg raises (flexion, extension, abduction, adduction) Active quadriceps isometrics (full extension) Knee flexion (active, 0°-90°) Knee extension (active-assisted. 90°-30°) Multi-hip machine (flexion, extension, abduction, adduction) Leg press (70°-10°) Closed-chain - Mini-squats (0°-45°, 1/2 weight bearing)</p> <p>Balance training Weight shift side/side and forward/back</p> <p>Aerobic conditioning UBC</p> <p>Modalities Electrical muscle stimulation Cryotherapy</p>	<p>Duration</p> <p>5 reps x 30 secs</p> <p>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 20 reps</p> <p>5 sets x 10 reps</p> <p>20 minutes 20 minutes</p>
Goals	Range of motion 0°-110° Adequate quadriceps contraction Control inflammation, effusion 50% weight bearing	

Phase 2. Weeks 3 to 4

General Observation	Full weight bearing with 1 crutch when: - Pain controlled without narcotics - ROM 0°-100° - Effusion controlled - Muscle control throughout ROM	
Evaluation	Pain Effusion Patellar mobility Range of motion minimum Muscle control Joint arthrometer (day 28) Inflammatory response	Goals Mild Minimal Good 0°-120° 3/5 < 3 mm None
Frequency 3-4 x/day 10 minutes 2-3 x/day 20 minutes 3 x/day 5 minutes 1-2 x/day 5 minutes 2 x/day 5 minutes As required	Range of motion Range of motion passive, 0°-120° Patella mobilization Ankle pumps (plantar flexion with resistance band) Hamstring, gastroc-soleus stretches Strengthening Straight leg raises (flexion, extension, abduction, adduction) Isometric training: multi-angle (90°, 60°, 30°) Heel raise/toe raise Hamstring curls (active, 0°-90°) Knee extension (active, 90°-30°) Closed-chain - Wall sits - Mini-squats Multi-hip machine (flexion, extension, abduction, adduction) Leg press (70°-10°) Balance training Weight shift side/side and forward/back Balance board/2 legged Cup walking Single leg stance (level surface) Aerobic conditioning UBC Water walking Stationary bicycling (patellofemoral precautions) Modalities Electrical muscle stimulation Cryotherapy	Duration 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 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
Goals	Range of motion 0°-125° Muscle control Arthrometer within 3 mm Control inflammation, effusion 100% weight bearing	

Phase 3. Weeks 5 to 6

General Observation	Independent ambulation when: - Pain controlled - Effusion controlled - ROM 0°-120° - Muscle control throughout ROM	
Evaluation	Pain Effusion Patellar mobility ROM Muscle control Inflammatory response Gait	Goals No RSD Minimal Good 0°-135° 4/5 None Symmetrical
Frequency 3 x/day 10 minutes 2 x/day 20 minutes 3 x/day 5 minutes 2 x/day 10 minutes As required	Range of motion Range of motion passive, 0°-135° Patella mobilization Hamstring, gastroc-soleus stretches Strengthening Straight leg raises (ankle weight, not to exceed 10% of 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°-30°) Closed-chain - Wall sits - Mini-squats Multi-hip machine (flexion, extension, abduction, adduction) Leg press (70°-10°) Balance training Balance board/2 legged Lateral step-ups: 2-4” Aerobic conditioning (patellofemoral precautions) UBC Stationary bicycling Water walking Stair machine (low resistance, low stroke) Ski machine (short stride, level, low resistance) Elliptical (low resistance) Modalities Cryotherapy	Duration 5 reps x 30 secs 3 sets x 10 reps 3 sets x 10 reps 2 sets x 10 reps 3 sets x 20 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 20 minutes
Goals	Range of motion 0°-135° Control inflammation, effusion Muscle endurance Recognition complications (motion loss, pain syndrome, increased AP displacement) Recognition patellofemoral changes Full weight bearing, normal gait	

Phase 4. Weeks 7 to 8

General Observation	No effusion, painless ROM, joint stability Performs activities of daily living, can walk 20 minutes without pain	ROM 0°-135° Full weight bearing	
Evaluation	<ul style="list-style-type: none"> ■ Manual muscle test Hamstrings, quadriceps, hip abductors/adductors/flexors/extensors ■ Swelling ■ Joint arthrometer (8 weeks) ■ Patellar mobility ■ Crepitus 		<p align="center">Goals</p> <p>4/5</p> <p>None < 3 mm Good None/slight</p>
Frequency			Duration
2 x/day 10 minutes	Range of motion Hamstring, gastroc-soleus stretches		5 reps x 30 secs
2 x/day 20 minutes	Strengthening Straight leg raises, rubber tubing Hamstring curls (active, 0°-90°) Knee extension with resistance (90°-30°) Leg press (70°-10°) Multi-hip machine (flexion, extension, abduction, adduction) Closed-chain <ul style="list-style-type: none"> - Wall sits - Mini-squats 		<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> <p>5 reps 3 sets x 20 reps</p>
3 x/day 5 minutes	Balance training Balance board/2 legged Single leg stance Resistance band walking Plyoback ball toss Perturbation training		
1-2 x/day 15-20 minutes	Aerobic conditioning (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)		
As required	Modalities Cryotherapy		20 minutes
Goals	Increase strength and endurance		

Phase 5. Weeks 9 to 12

General Observation	No effusion, painless ROM, joint stability Performs activities of daily living, can walk 20 minutes without pain	ROM 0°-135° Full weight bearing	
Evaluation	<ul style="list-style-type: none"> ■ Manual muscle test Hamstrings, quadriceps, hip abductors/adductors/flexors/extensors ■ Isometric test (12 wks, mean avg torque/% deficit quads & hams) ■ Swelling ■ Joint arthrometer (12 weeks) ■ Patellar mobility ■ Crepitus 		Goals 4/5 30 None < 3 mm Good None/slight
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 Hamstring curls (active, 0°-90°) Knee extension with resistance (90°-30°) Leg press (70°-10°) Multi-hip machine (flexion, extension, abduction, adduction) Closed-chain <ul style="list-style-type: none"> - 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 5 reps 3 sets x 20 reps 3 sets x 10 reps
3 x/day 5 minutes	Balance training Balance board/2 legged Single leg stance Resistance band walking Plyoback ball toss Perturbation training		
3 x/week 15 -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) Elliptical machine (low resistance)		
3 x/week 10 minutes	Running program (straight) Jog Walk Backward walk		1/4 mile 1/8 mile 20 yards
As required	Modalities Cryotherapy		20 minutes
Goals	Increase strength and endurance		

Phase 6. Weeks 13 to 26

General Observation	No effusion, painless ROM, joint stability Performs activities of daily living, can walk 20 minutes without pain	
Evaluation	Isokinetic test (isometric + torque 300°/sec, % difference quads & hams, tested monthly) Swelling Joint arthrometer Patellar mobility Crepitus Single-leg function tests (hop distance, timed hop, % inv/uninv)	Goals 20-25% None 3 mm Good None/slight 75%
Frequency 2 x/day 10 minutes 1 x/day 20-30 minutes 3 x/day 5 minutes 3 x/week 20-30 minutes 3 x/week 15-20 minutes 3 x/week 3 x/week As required	Range of motion Hamstring, gastroc-soleus, quad, ITB stretches Strengthening (patellofemoral precautions) Straight leg raises, rubber tubing (high speed) Hamstring curls (active, 0°-90°) Knee extension with resistance (90°-30°) Leg press (70°-10°) Multi-hip machine (flexion, extension, abduction, adduction) Balance training Balance board/2 legged \longrightarrow Single leg Single leg stance \longrightarrow Unstable platform Aerobic conditioning (patellofemoral precautions) Stationary bicycling Water walking Swimming (kicking) Walking Stair machine (low resistance, low stroke) Ski machine (short stride, level, low resistance) Elliptical machine (low resistance) Running program (straight) Jog (progression of speed: ½, ¾, full) Walk Backward run Cutting program – lateral, carioca, figure 8's Functional training Plyometric training: box hops, level, double-leg Sport specific drills Modalities Cryotherapy	Duration 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 10 reps 1/4 – 1 mile 1/8 mile 20 yards 20 yards 15 secs, 4-6 sets 20 minutes
Goals	Increase strength and endurance	

Phase 7. Weeks 27 to 52

General Observation	No effusion, painless ROM, joint stability Performs ADL, can walk 20 minutes without pain	
Evaluation	Isokinetic test (torque at 180°/sec & 300°/sec, % difference quads & hams, tested quarterly; isometric if symptomatic PF joint Swelling Joint arthrometer Patellar mobility Crepitus Single-leg function test (hop distance, timed hop, % inv/uninv)	Goals 10-15 None < 3 mm Good None/slight 85
<p>Frequency 2 x/day 10 minutes</p> <p>3-4 x/week 20-30 minutes</p> <p>3 x/day 5 minutes</p> <p>3 x/week 20-30 minutes</p> <p>3 x/week 20 minutes</p> <p>3 x/week</p> <p>3 x/week</p> <p>As required</p>	<p>Range of motion Hamstring, gastroc-soleus, quad, ITB stretches</p> <p>Strengthening (patellofemoral precautions) Straight leg raises, rubber tubing (high speed) Hamstring curls (active, 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 Single leg stance - unstable platform w/secondary activity</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) Elliptical (low resistance)</p> <p>Running program (straight) Interval training (20, 40, 60, 100 yards) Walk/rest phase (3:1 rest: work) Backward run</p> <p>Cutting program – lateral, carioca, figure 8's</p> <p>Functional training Plyometric training: box hops, level, double-leg Sport specific drills</p> <p>Modalities Cryotherapy</p>	<p>Duration</p> <p>5 reps x 30 secs</p> <p>3 sets x 30 reps</p> <p>} 1-2 sets x 8-12 reps</p> <p>20 yards</p> <p>20 yards</p> <p>15 secs, 4-6 sets</p> <p>20 minutes</p>
Goals	Increase function, strength, endurance Return to previous activity level	