

Noyes Knee Institute Rehabilitation Protocol: Posterior Cruciate Ligament Reconstruction

|   | Postoperative Weeks |     |     |     |      | Postoperative Months |   |   |      |
|---|---------------------|-----|-----|-----|------|----------------------|---|---|------|
|   | 1-2                 | 3-4 | 5-6 | 7-8 | 9-12 | 4                    | 5 | 6 | 7-12 |
| <b>Hinged long-leg p.o. brace</b>                                 | X                   | X   | X   |     |      |                      |   |   |      |
| <b>Patellar knee sleeve</b>                                       |                     |     |     | X   | X    | X                    | X |   |      |
| <b>Functional brace</b>   |                     |     |     |     |      |                      |   | X | X    |
| <b>Range of motion minimum goals:</b>                             |                     |     |     |     |      |                      |   |   |      |
| 0°-90°  | X                   |     |     |     |      |                      |   |   |      |
| 0°-110°   |                     | X   |     |     |      |                      |   |   |      |
| 0°-120°   |                     |     | X   |     |      |                      |   |   |      |
| 0°-135°   |                     |     |     | X   |      |                      |   |   |      |
| <b>Weight bearing:</b>  |                     |     |     |     |      |                      |   |   |      |
| 25% body weight   | X                   |     |     |     |      |                      |   |   |      |
| 50% body weight   |                     | X   |     |     |      |                      |   |   |      |
| Full  |                     |     | X   |     |      |                      |   |   |      |
| <b>Patella mobilization</b>                                       | X                   | X   | X   | X   |      |                      |   |   |      |
| <b>Modalities:</b>  |                     |     |     |     |      |                      |   |   |      |
| Electrical muscle stimulation (EMS)                               | X                   | X   | X   | X   | X    |                      |   |   |      |
| 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, 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°-0°)                             |                     |     |     |     | X    | X                    | X | X | X    |
| Knee extension quads (90°-30°)                                    |                     | 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    |
| <b>Balance/proprioceptive training:</b>                           |                     |     |     |     |      |                      |   |   |      |
| Weight-shifting, cup walking, BBS                                 |                     |     | X   | X   |      |                      |   |   |      |
| BBS, BAPS, perturbation training, balance board, mini-trampoline  |                     |     |     | X   | X    | X                    | X | X | X    |
| <b>Conditioning:</b>  |                     |     |     |     |      |                      |   |   |      |
| UBC   | X                   | X   | X   | X   | X    |                      |   |   |      |
| Bike (stationary)   |                     |     | 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    |
| 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: Noyes FR, Barber-Westin SD, Heckmann TP: Chapter 23: Rehabilitation of posterior cruciate ligament and posterolateral reconstructive procedures. *Noyes' Knee Disorders: Surgery, Rehabilitation, Clinical Outcomes*, Saunders, Philadelphia, 2009, pp. 631-657.**

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

|   |  |  |
|---|--|--|
| <b>General Observation</b>                  | Toe-touch to 25% weight bearing<br>Brace   |  |
| <b>Evaluation</b>                           | Pain<br>Hemarthrosis<br>Patellar mobility<br>ROM minimum<br>Quadriceps contraction & patella migration<br>Soft tissue contracture  | <b>Goals</b><br>Controlled<br>Mild<br>Good<br>0°-90°<br>Good<br>None |
| <b>Frequency</b><br>3-4 x/day<br>10 minutes | <b>Range of motion</b><br>ROM 0°-90° (active extension/passive flexion with 10 lb. anterior drawer)<br>Patella mobilization<br>Ankle pumps (plantar flexion with resistance band)<br>Hamstring, gastroc-soleus stretches | <b>Duration</b><br>20 cycles<br>10 x/30 secs<br><br>5 reps x 30 secs |
| 3 x/day<br>15 minutes                       | <b>Strengthening</b><br>Straight leg raises (flexion, 0-5 lb ankle wt.)<br>Active quadriceps isometrics<br>Knee extension (active-assisted, 70°-0°, 0-7.5 lb wt.)  | 3 sets x 10 reps<br>1 set x 10 reps<br>3 sets x 10 reps              |
| 2 x/day<br>10 minutes                       | <b>Aerobic conditioning</b><br>UBE   |  |
| As required                                 | <b>Modalities</b><br>Electrical muscle stimulation<br>Cryotherapy  | 20 minutes<br>20 minutes   |
| While sleeping                              | <b>Activities of daily living</b><br>Knee brace to avoid sudden knee flexion while asleep  |  |
| <b>Goals</b>                                | ROM 0°-90°<br>Adequate quadriceps contraction<br>Control inflammation, effusion<br>Prevent tissue contracture<br>Protect ligament reconstruction at insertion sites  |  |

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

|  |  |  |
|--|--|--|
| <b>General Observation</b>   | 50% weight bearing when:<br>- Pain controlled<br>- Hemarthrosis controlled<br>- Muscle control throughout ROM<br>Brace   |  |
| <b>Evaluation</b>  | Pain<br>Effusion<br>Patellar mobility<br>ROM minimum<br>Quadriceps contraction & patella migration<br>Soft tissue contracture  | <b>Goals</b><br>Controlled<br>Mild<br>Good<br>0°-110°<br>Good<br>None  |
| <b>Frequency</b><br>3-4 x/day<br>10 minutes<br><br>2-3 x/day<br>20 minutes<br><br>2 x/day<br>10 minutes<br><br>As required<br><br>While sleeping | <b>Range of motion</b><br>ROM (passive, 0°-110°, 10# anterior drawer)<br>Patella mobilization<br>Ankle pumps (plantar flexion with resistance band)<br>Hamstring, gastroc-soleus stretches<br><br><b>Strengthening</b><br>Straight leg raises (flexion, adduction, abduction)<br>Isometric training: multi-angle (0°, 60°)<br>Knee extension (active-assisted, 90°-0°, 0-7.5 lbs. wt.)<br><br><b>Aerobic conditioning</b><br>UBC<br><br><b>Modalities</b><br>Electrical muscle stimulation<br>Cryotherapy<br><br><b>Activities of daily living</b><br>Knee brace to avoid sudden knee flexion while asleep | <b>Duration</b><br><br>20 cycles<br>10 x, 30 secs<br><br>5 reps x 30 secs<br><br>3 sets x 10 reps<br>1 set x 10 reps<br>3 sets x 10 reps<br><br>20 minutes<br>20 minutes |
| <b>Goals</b>   | ROM 0°-110°<br>Control inflammation, effusion<br>Muscle control<br>Prevent soft tissue contracture<br>Protect ligament reconstruction at insertion sites   |  |

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

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

**Phase 4. Weeks 7-8 (Visits: 1-2)**

|   |  |  |
|---|--|--|
| <b>General Observation</b>                  | Full weight bearing<br>Brace   |  |
| <b>Evaluation</b>                           | Pain<br>Effusion<br>Patellar mobility<br>ROM<br>Muscle control<br>Inflammatory response<br>Joint arthrometer (8 weeks), 20° 89N and 70° 89N  | <b>Goals</b><br>Mild/No RSD<br>Minimal<br>Good<br>0°-135°<br>4/5<br>None<br>< 3 mm               |
| <b>Frequency</b><br>3-4 x/day<br>10 minutes | <b>Range of motion</b><br>ROM (passive, 0°-135°)<br>Patellar mobilization<br>Hamstring, gastroc-soleus stretches   | <b>Duration</b><br><br>5 reps x 30 secs  |
| 3 x/day<br>15 minutes                       | <b>Strengthening</b><br>Straight leg raises (flexion, abduction, adduction)<br>Straight leg raises, rubber tubing<br>Knee extension (active, 90°-0°)<br>Knee flexion (active 0° to 90°)<br>Leg press (50°-10°)<br>Closed-chain<br>- Wall sits<br>- Mini-squats (rubber tubing, 0°-30°)<br>Multi-hip machine (flexion, extension, abduction, adduction) | 3 sets x 10 reps<br>3 sets x 30 reps<br>3 sets x 10 reps<br>3 sets x 10 reps<br>3 sets x 10 reps |
| 3 x/day<br>5 minutes                        | <b>Balance training</b><br>Balance board/2 legged<br>Single leg stance   | 5 reps<br>3 sets x 20 reps<br>3 sets x 10 reps   |
| 2 x/day<br>10-15 minutes                    | <b>Aerobic conditioning</b><br>UBC<br>Stationary bicycling   |  |
| As required                                 | <b>Modalities</b><br>Electrical muscle stimulation<br>Cryotherapy  | 20 minutes<br>20 minutes   |
| While sleeping                              | <b>Activities of daily living</b><br>Knee brace to avoid sudden knee flexion while asleep  |  |
| <b>Goals</b>                                | Full weight bearing, normal gait<br>Control inflammation, effusion<br>Muscle control<br>ROM 0°-135°  |  |

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

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

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

|  |  |  |
|--|--|--|
| <b>General Observation</b>   | No effusion, painless ROM, joint stability<br>Performs activities of daily living,<br>can walk 20 minutes without pain<br>ROM 0°-135°<br>Brace optional  |  |
| <b>Evaluation</b>  | Pain<br>Manual muscle test<br>Swelling<br>Joint arthrometer<br>Patellar mobility<br>Crepitus<br>Gait<br>Isometric test (% difference quads & hams)   | <b>Goals</b><br>Minimal/No RSD<br>5/5<br>Minimal<br>< 3 mm<br>Good<br>None/slight<br>Symmetrical<br>30   |
| <b>Frequency</b><br>2-3 x/day<br>10 minutes<br><br>2 x/day<br>20 minutes<br><br>2 x/day<br>5 minutes<br><br>1 x/day<br>20 minutes<br><br>As required | <b>Range of motion</b><br>Hamstring, gastroc-soleus, quad, ITB stretches<br><br><b>Strengthening</b><br>Hamstring curls with resistance (0°-90°)<br>Knee extension with resistance (90°-30°)<br>Leg press (70°-10°)<br>Multi-hip machine (flexion, extension, abduction, adduction)<br>Closed-chain:<br>- Mini-squats (0°-40°)<br>- Wall sits<br>- Lateral step-ups (2-4" block)<br><br><b>Balance training</b><br>Balance board/2 legged<br>Single leg stance<br><br><b>Aerobic conditioning</b> (patellofemoral precautions)<br>Stationary bicycling<br>Water walking<br>Swimming (kicking)<br>Walking<br>Stair machine (low resistance, low stroke)<br>Ski machine (short stride, level, low resistance)<br><br><b>Modalities</b><br>Cryotherapy<br><br><b>Activities of daily living</b><br>Avoid squats, walking down hills & ramps, running down stairs, sudden deceleration movements | <b>Duration</b><br><br>5 reps x 30 secs<br><br>3 sets x 10 reps<br>3 sets x 10 reps<br>3 sets x 10 reps<br>3 sets x 10 reps<br><br>3 sets x 20 reps<br>to fatigue x 3 reps<br>3 sets x 10 reps<br><br><br><br><br><br><br><br><br><br><br><br>20 minutes |
| <b>Goals</b>   | Increase strength and endurance  |  |

**Phase 7. Weeks 27-52 (Visits: 2-3)**

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