

## Rehabilitation s/p ACL Reconstruction

Saint Louis University – SSM Health Physical Therapy Orthopedic Residency  
in Collaboration with SLUCare Physicians



SLUCare<sup>®</sup>  
Physician Group

### Physician Referral for Physical Therapy

Patient Name: \_\_\_\_\_

Date: \_\_\_\_\_

Referring DX: ACLR ( PTB      HS      )

Recommended Frequency: 1 – 3 visits/ wk

Total Duration: 4 months

*These guidelines, treatments, and milestones have been established to assist in guiding rehabilitation based on the most current available evidence. They are not intended to be substitute for sound clinical judgement with consideration of the individual contextual features of the patient and the demands of various functions/sports.*

**Pre-operative goals:** Full knee extension range of motion (ROM), absent or minimal joint swelling, no knee extension lag with straight leg raise (SLR), educate the patient on what to expect following surgery, and protect the joint.

Timeline	Milestones	Treatment Recommendations
<b>Week 1</b> (Day 0-7)	<ul style="list-style-type: none"> <li>• AROM/PROM = 0-90°                             <ul style="list-style-type: none"> <li>○ Recommend not emphasizing hyperextension equal to contralateral side, as patient should achieve this over time</li> </ul> </li> <li>• Active quadriceps contraction with superior patellar glide</li> </ul>	<ul style="list-style-type: none"> <li>• Wall slides</li> <li>• Patellar mobilization</li> <li>• Gait training</li> <li>• Stationary bike for ROM</li> <li>• <u>Home Program</u></li> <li>• Self applied ROM</li> <li>• Self patellar mobilizations</li> <li>• Quad sets</li> <li>• Long arc quads (90-30° flexion)</li> <li>• SLR [may use electrical stimulation to assist with quad activation]<sup>33</sup></li> </ul>
<b>Week 2</b> (Day 7-14)	<ul style="list-style-type: none"> <li>• Flexion &gt;110°</li> <li>• Gait without crutches</li> <li>• Use of bike without difficulty</li> <li>• Walking with full extension</li> <li>• Reciprocal stair climbing (with hand rail use)</li> <li>• Maintain knee extension of 0°</li> <li>• Double limb sit to stand from 17" seat</li> </ul>	<ul style="list-style-type: none"> <li>• Step ups in pain free ROM</li> <li>• Scar mobilizations when skin is healed</li> <li>• Wall squats/sits</li> <li>• Prone hangs or bag hangs for full extension ROM (if not already achieved)</li> <li>• Patellar mobilizations in flexion (if flexion ROM limited)</li> </ul>
<b>Weeks 3-5</b> (Day 14-35)	<ul style="list-style-type: none"> <li>• Flexion to within 10° of contralateral</li> <li>• Reciprocal stair climbing (without hand rail use)</li> <li>• Quad strength 4+/5 or greater (test @ 45° flexion)</li> <li>• Maintain knee extension of 0°</li> <li>• Within one SD of 5x Sit to Stand test norm for age group<sup>7</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Patellar &amp;/or Tibiofemoral mobilizations (as appropriate)</li> <li>• Progress bike and stair master duration to 10-minute minimum</li> <li>• Begin balance and proprioception</li> </ul>
<b>Weeks 6-8</b> (Day 35-56)	<ul style="list-style-type: none"> <li>• Normalized gait pattern</li> </ul>	<ul style="list-style-type: none"> <li>• Progressive resistive exercises</li> </ul>

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	<ul style="list-style-type: none"> <li>• Full ROM compared to contralateral (recommend not emphasizing hyperextension)</li> <li>• No greater than 1+ effusion using the Stroke test<sup>35</sup></li> <li>• 5x Sit to stand: normal values for age group<sup>7</sup></li> <li>• ≤ 2 errors on SL squat<sup>3,15</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Begin running progression on treadmill (progression based on the Soreness Rules)<sup>10</sup></li> </ul>
<b><u>Weeks 9-12</u></b> (Day 56-84)	<ul style="list-style-type: none"> <li>• Hop tests &gt;85%</li> <li>• Maintain ROM</li> <li>• Trace to Zero effusion grade using the stroke test</li> <li>• ≤ 1 errors on SL squat (week 10)<sup>3,15</sup></li> <li>• Zero errors on SL squat (week 12)<sup>3,15</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Sport specific exercises</li> <li>• Agility activities</li> <li>• Functional testing</li> <li>• Closed chain core strengthening</li> <li>• Running progression</li> </ul>
<b><u>Weeks 13-Return to Sport</u></b>	<ul style="list-style-type: none"> <li>• All hop tests symmetry &gt;90%<sup>11</sup></li> <li>• Modified Star Excursion Balance Test symmetry ≤ 4cm<sup>14</sup></li> <li>• Acute to chronic workload ratio &lt; 1.5<sup>13,16,17</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Sport specific exercises</li> <li>• Agility activities</li> <li>• Functional testing</li> <li>• Closed chain core strengthening</li> <li>• Running progression</li> </ul>
<b><u>Follow up functional testing</u></b>	<ul style="list-style-type: none"> <li>• 4, 5, 6, and 12-month post-op testing</li> <li>• Progression towards power activities as needed</li> </ul>	<ul style="list-style-type: none"> <li>• Maintain gains in strength</li> <li>• Hop tests (90-100% of contralateral)</li> <li>• Maintain ROM</li> </ul>

### **Precautions/Additional information**

Graft protection:

- Brace use and graft type are at the discretion of the surgeon.
- Stress to ACL with passive ROM 0-120° is minimal. Most strain occurs in last 30° of NWB extension<sup>2,5,9,15</sup>.

Adjunct treatments:

- NMES may be instrumental in improving muscular performance for those not responding to traditional strengthening<sup>33</sup>.
- If concomitant injury present at the same time, that injury dictates rehab progression:
  - meniscal injury with repair:
    - Full PROM is allowed. Ambulate WBAT with brace locked at 0° until week 5
    - No loaded knee flexion beyond 45° until week 5, none beyond 90° until week 8
    - No forced knee hyperextension if anterior horn repair /No forced knee flexion if posterior horn repair
    - Avoid OKC exercise from 0-30° and CKC exercise from 90-120° if patient shows signs/symptoms of patellofemoral irritation<sup>4,5</sup>
  - chondral damage: restrict WB for 3-4 weeks to avoid stressing the healing cartilage. Beware that prolonged weight bearing restriction may result in difficulty recovering ROM and quad activation<sup>20</sup>.
  - partial meniscectomy: no modification of guideline (symptom management)<sup>12</sup>.
  - MCL: If surgical repair, avoid directly stressing the MCL, and consider sagittal plane limitations if needed<sup>24,31</sup>.

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- PCL: follow PCL guidelines

### Treatment Progression/Success:

- Factors that can impact rehabilitation success include the following: psychosocial issues, motivation, swelling, quad activation failure, acute reconstruction<sup>21</sup>, involvement of other structures<sup>22</sup>.
- Success measured by: 1. Less than mild effusion, 2. >90% hamstring and 3. quad strength, 4. Absence of giving way episodes, 5. Participation in 1-2 seasons of sports at previous activity level, 6. Patient reported outcomes<sup>20</sup>.
- Patient Reported Outcome Measure: Consider using SANE score, as it correlates well with Cincinnati Knee Rating System<sup>29</sup>.
- Consider using Stoke Test Grading for Effusion to determine whether to progress<sup>35</sup>. Use this tool to assist with grading activity. *I.e. - increased effusion by 2 grades would lead to a decrease in activity until the effusion decreases to the previous level.*
- Weight bearing exercises alone are not enough for optimal outcomes. Graded increases in load, appropriate to the phase of healing, should be considered.<sup>33</sup>

<p><b>For questions regarding the patient’s medical care, new orders, or insurance questions:</b></p> <p>please contact your physician's office directly</p>	<p><b>For additional questions, comments, or concerns regarding the implementation of these physical therapy guidelines,</b> please contact</p> <p>Chris Sebelski, PT, DPT, PhD, OCS, Director of the SLU – SSM Health Physical Therapy Residency 314 977 8724 OR <a href="mailto:chris.sebelski@health.slu.edu">chris.sebelski@health.slu.edu</a></p>
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Please respond to our anonymous survey regarding these guidelines to assist in improving patient care and advocacy.



[https://slu.az1.qualtrics.com/jfe/form/SV\\_bpX7Z9AaVTzGblj](https://slu.az1.qualtrics.com/jfe/form/SV_bpX7Z9AaVTzGblj)

### Appendices of referenced assessments

<b>Soreness Rules</b> Adapted from Fees et al. 1998 <sup>10</sup>	
Criterion	Action
1. Soreness during warm-up that continues	2 days off, drop down 1 step
2. Soreness during warm-up that goes away	Stay at step that led to soreness
3. Soreness during warm-up that goes away from redevelops during session	2 days off, drop down 1 step
4. Soreness the day after lifting (not muscle soreness)	1 day off, do not advance program to the next step
5. No soreness	Advance 1 step per week or as instructed by healthcare professional

Age (n)	Mean ± SD (95%CI)	Min-Max
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- 5xSTS Normative Values<sup>7</sup>

14–19 (25)	6.5 ± 1.2 (6.0–7.0)	4.7–9.7
20–29 (36)	6.0 ± 1.4 (5.6–6.5)	3.9–11.2
30–39 (22)	6.1 ± 1.4 (5.5–6.8)	4.1–10.4
40–49 (15)	7.6 ± 1.8 (6.6–8.6)	5.6–13.2
50–59 (20)	7.7 ± 2.6 (6.5–8.9)	4.2–12.1
60–69 (25)	7.8 ± 2.4 (6.8–8.7)	4.7–15.1
70–79 (24)	9.3 ± 2.1 (8.4–10.1)	5.5–13.3
80–85 (14)	10.8 ± 2.6 (9.3–12.3)	5.8–17.6

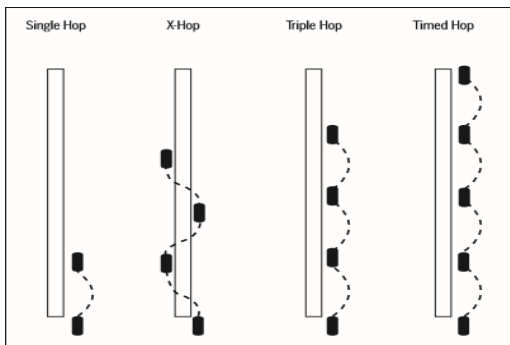
Errors (Impairments) seen in Single Leg Squat Movement Adapted from (Liebenson 2002) <sup>18</sup> in (Bailey et al 2010) <sup>3</sup>		
Midfoot collapse	Early heel rise	Poor control of knee with ascent
Femoral adduction, IR	Pelvic drop	Excessive trunk flexion or knee extension on ascent

Running Program<sup>1</sup>:

Level	Treadmill	Track
1	0.1-mile walk/0.1-mile jog, repeat 10 times	Jog straights/walk curves (2 miles)
2	Alternate 0.1-mile walk/0.2-mile jog (2 miles)	Jog straights/jog 1 curve every other lap (2 miles)
3	Alternate 0.1-mi walk/0.3-mi jog (2 miles)	Jog straights/jog 1 curve every lap (2 miles)
4	Alternate 0.1-mi walk/0.4-mi jog (2 miles)	Jog 1.75 laps/walk curve (2 miles)
5	Jog full 2 miles	Jog all laps (2 miles)
6	Increase workout to 2.5 miles	Increase workout to 2.5 miles
7	Increase workout to 3 miles	Increase workout to 3 miles
8	Alternate between running/jogging every 0.25 miles	Increase speed on straights/jog curves

- Hop tests<sup>1</sup>:

Return to sport dosing should consider Acute-to-chronic workload<sup>13, 16-17</sup>



Each session calculated by multiplying RPE (0-10) by duration (minutes) to obtain workload (augmented units). For example, RPE of 6 x 60 minutes = workload of 360 AUs.

Acute workload = average workload over the course of 1 week

Chronic workload = average workload over course of 4 weeks

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1. Adams D, Logerstedt DS, Hunter-Giordano A, Axe MJ, Snyder-Mackler L. Current concepts for anterior cruciate ligament reconstruction: a criterion-based rehabilitation progression. *J Orthop Sports Phys Ther.* 2012;42(7):601-14.
2. Arms SW, Pope MH, Johnson RJ, Fischer RA, Arvidsson I, Eriksson E. The biomechanics of anterior cruciate ligament rehabilitation and reconstruction. *Am J Sports Med.* 1984;12(1):8-18.
3. Bailey R, Selfe, J, Richards J. The single leg squat test in the assessment of musculoskeletal function: a review. *Physiother Ireland.* 2010;13(1):18-23.
4. Barber FA, Click SD. Meniscus repair rehabilitation with concurrent anterior cruciate reconstruction. *Arthroscopy.* 1997;13(4):433-7.
5. Beynonn BD, Johnson RJ, Fleming BC, Stankewich CJ, Renström PA, Nichols CE. The strain behavior of the anterior cruciate ligament during squatting and active flexion-extension. A comparison of an open and a closed kinetic chain exercise. *Am J Sports Med.* 1997;25(6):823-9.
6. Bohannon RW. Knee extension strength and body weight determine sit-to-stand independence after stroke. *Physiotherapy theory and practice.* 2007; 23(5):291-7.
7. Bohannon RW, Bubela DJ, Magasi SR, Wang YC, Gershon RC. Sit-to-stand test: Performance and determinants across the age-span. *Isokinetics and exercise science.* 2010; 18(4):235-240.
8. Chen FS, Rokito AS, Pitman MI. Acute and chronic posterolateral rotatory instability of the knee. *J Am Acad Orthop Surg.* 2000; 8:97-110.
9. Chester R, Smith TO, Sweeting D, Dixon J, Wood S, Song F. The relative timing of VMO and VL in the aetiology of anterior knee pain: a systematic review and meta-analysis. *BMC Musculoskelet Disord.* 2008;9:64.
10. Fees M, Decker T, Snyder-Mackler L, Axe MJ. Upper extremity weight-training modifications for the injured athlete. A clinical perspective. *Am J Sports Med.* 1998;26:732-742.
11. Fitzgerald GK, Lephart SM, Hwang JH, Wainner RS. Hop tests as predictors of dynamic knee stability. *J Orthop Sports Phys Ther.* 2001;31:588-597.
12. Fitzgibbons RE, Shelbourne KD. "Aggressive" nontreatment of lateral meniscal tears seen during anterior cruciate ligament reconstruction. *Am J Sports Med.* 1995;23(2):156-9.
13. Gabbett TJ, Kennelly S, Sheehan J, et al. If overuse injury is a 'training load error', should undertraining be viewed the same way? *Br J Sports Med.* 2016;50:1017-1018.
14. Garrison J, Bothwell J, Wolf G, et al. Y balance test anterior reach symmetry at three months is related to single leg functional performance at time of return to sports following anterior cruciate ligament reconstruction. *Int J Sports Phys Ther.* 2015;(10)5:602-611.
15. Henning CE, Lynch MA, Glick KR. An in vivo strain gage study of elongation of the anterior cruciate ligament. *Am J Sports Med.* 1985;13(1):22-6.
16. Hulin BT, Gabbett TJ, Blanch P, et al. Spikes in acute workload are associated with increased injury risk in elite cricket fast bowlers. *Br J Sports Med.* 2014;48:708-712.
17. Hulin BT, Gabbett TJ, Caputi P, et al. Low chronic workload and the acute:chronic workload ratio are more predictive of injury than between-match recovery time: a two-season prospective cohort study in elite rugby league players. *Br J Sports Med.* 2016;50:1008-12.
18. Liebenson C. Functional exercises. *J Bodywork and Movem Ther.* 2002;6(2):108-13
19. Lindenfeld TN, Hewett TE, Andriacchi TP. Decrease in knee joint loading with unloader brace wear in patient with medial compartment gonarthrosis [abstract]. *Proc Annual Meeting American Academy of Orthopaedic Surgeons.* 1996:243
20. Lynch AD, Logerstedt DS, Grindem H, et al. Consensus criteria for defining 'successful outcome' after ACL injury and reconstruction: a Delaware-Oslo ACL cohort investigation. *Br J Sports Med.* 2015;49(5):335-42.
21. Majors RA, Woodfin B. Achieving full range of motion after anterior cruciate ligament reconstruction. *Am J Sports Med.* 1996;24(3):350-5.
22. Meszler D, Manal TJ, Snyder-Mackler L. Disorders of the tibiofemoral joint. *Orthop Clin North Am.* 1998;7:347-366.
23. Millett PJ, Pennock AT, Sterett WI, Steadman JR. Early ACL reconstruction in combined ACL-MCL injuries. *J Knee Surg.* 2004;17(2):94-8.
24. Noyes FR, Barber-westin SD. The treatment of acute combined ruptures of the anterior cruciate and medial ligaments of the knee. *Am J Sports Med.* 1995;23(4):380-9.
25. Palmitier RA, An KN, Scott SG, Chao EY. Kinetic chain exercise in knee rehabilitation. *Sports Med.* 1991;11(6):402-13
26. Parker MG. Biomechanical and histological concepts in the rehabilitation of patients with anterior cruciate ligament reconstructions. *J Orthop Sports Phys Ther.* 1994;20(1):44-50.
27. Reinold MM, Wilk KE, Macrina LC, Dugas JR, Cain EL. Current concepts in the rehabilitation following articular cartilage repair procedures in the knee. *J Orthop Sports Phys Ther.* 2006;36(10):774-94.
28. Rubinstein RA, Shelbourne KD, Vanmeter CD, Mccarroll JR, Rettig AC, Gloyeske RL. Effect on knee stability if full hyperextension is restored immediately after autogenous bone-patellar tendon-bone anterior cruciate ligament reconstruction. *Am J Sports Med.* 1995;23(3):365-8.
29. Rudolph KS, Eastlack ME, Axe MJ, Snyder-mackler L. 1998 Basmajian Student Award Paper: Movement patterns after anterior cruciate ligament injury: a comparison of patients who compensate well for the injury and those who require operative stabilization. *J Electromyogr Kinesiol.* 1998;8(6):349-62. 1
30. Sailors ME, Keskula DR, Perrin DH. Effect of running on anterior knee laxity in collegiate-level female athletes after anterior cruciate ligament reconstruction. *J Orthop Sports Phys Ther.* 1995;21(4):233-9.
31. Schierl M, Petermann J, Trus P, Baumgärtel F, Gotzen L. Anterior cruciate and medial collateral ligament injury. ACL reconstruction and functional treatment of the MCL. *Knee Surg Sports Traumatol Arthrosc.* 1994;2(4):203-6.
32. Shelbourne, K., Barnes, A., & Gray, T. (2012). Correlation of a Single Assessment Numeric Evaluation (SANE) Rating With Modified Cincinnati Knee Rating System and IKDC Subjective Total Scores for Patients After ACL Reconstruction or Knee Arthroscopy. *The American Journal Of Sports Medicine,* 40(11), 2487-2491.
33. Snyder-mackler L, Delitto A, Stralka SW, Bailey SL. Use of electrical stimulation to enhance recovery of quadriceps femoris muscle force production in patients following anterior cruciate ligament reconstruction. *Phys Ther.* 1994;74(10):901-7.
34. Snyder-mackler L, Delitto A, Bailey SL, Stralka SW. Strength of the quadriceps femoris muscle and functional recovery after reconstruction of the anterior cruciate ligament. A prospective, randomized clinical trial of electrical stimulation. *J Bone Joint Surg Am.* 1995;77(8):1166-73. 2
35. Sturgill, L., Snyder-Mackler, L., Manal, T., & Axe, M. (2009). Interrater Reliability of a Clinical Scale to Assess Knee Joint Effusion. *Journal of Orthopaedic & Sports Physical Therapy,* 39(12), 845-849.
36. Wilk KE. Rehabilitation of isolated and combined posterior cruciate ligament injuries. *Clin Sports Med.* 1994; 13:649-677