ACL Reconstruction Rehabilitation Program

The Gundersen Health System Sports Medicine ACL Reconstruction Rehabilitation Program is an evidence-based and soft tissue healing dependent program allowing patients to progress to vocational and sports-related activities as quickly and safely as possible. Individual variations will occur depending on surgical technique and the patient's response to treatment**.**
If a **meniscus repair is performed in conjunction with the ACL reconstruction**, follow the meniscus repair program for the first 7-8 weeks and then transition to the ACL reconstruction program.
If a **hamstring/gracilis autograft** is utilized, avoid isolated hamstring strengthening for 6 weeks.
If a **patellar tendon graft** is utilized, work on patella mobilizations to prevent excessive scaring.
If an **allograft** is utilized, patients may need to be cautioned not to advance too quickly as post-operative pain may be less.

Please contact us at 1-800-362-9567 ext. 58600 if you have questions or concerns.

Phase I: 0-6 weeks	**Immediate post op maximum protection phase**
Goals	• Protect surgical graft • Minimize knee joint effusion • Gently increase ROM per guidelines, emphasis on extension • Encourage quadriceps function • Prevent negative effects of immobilization • Normalization of walking with good heel-toe pattern
Brace	• Not all patients will utilize a post-operative brace. • wks 0-1: 0-90 deg, locked for ambulation and sleeping • wks 1+: 0-120 deg, unlocked for ambulation when good quadriceps control and ext ROM • wk 4: D/C brace
ROM	• wks 0-2: 0-90 degrees, emphasis on extension initially with gradual progression of flexion • wks 2-3: 0-110 degrees • wks 3-4: 0-120 degrees • wks 6+: Full ROM
WB	• wk 0-1: WBAT with brace locked into extension • wk 1-4: WBAT with brace unlocked if good quadriceps control and knee extension ROM. D/C crutches when can ambulate with normal heel-to-toe pattern.
Precautions	• If hamstring/gracilis autograft, no isolated resistance to knee flexion until wk 6. Start isometrics at wk 5. Progress to isotonics at wk 6. Also apply ice to posterior knee to minimize muscle spasm. • Encourage AROM and WB to promote healing, prevent atrophy of soft tissue and bone, prevent a decrease in collagen content, and to align fibroblast and collagen fibrils. • Emphasis on regaining extension ROM ASAP to prevent arthrofibrosis and decrease stress to the PF joint during ambulation. • Avoid descending stair reciprocally until adequate quadriceps control and lower extremity alignment • Avoid twisting and pivoting motions for 6-8 weeks to minimize shear forces to the healing graft. • Avoid any isolated OKC resisted knee extension until 6 weeks
Modalities	• Cryotherapy 15 minutes in duration 3x/day • IFC for pain/effusion if needed • NMES quadriceps if needed **Updated 11/2019**

Treatment Recommendations Guidelines for progression based on tolerance	• Active warm-up (Bike AAROM progress to Bike with resistance, Nu Step) • Stretching to attain full extension with gradual progression of flexion. Goal of full ROM by wk 6. Emphasis on full return of knee extension ASAP. Low-load long duration stretching for extension with heat if needed (1st TERT= Total End Range Time) Manual stretching for extension with overpressure / recurvatum Patellar mobilizations PROM / AAROM / AROM Manual stretching into flexion (initially limited by knee joint effusion) wk 4: WB stretch on leg press for knee flexion ROM • Flexibility exercises for hamstring, gastoc-soleus • Scar tissue massage • Consider personalize blood flow restriction therapy if appropriate. • Therapeutic exercises. Gentle strengthening protecting the surgical graft. **No isolated OKC resisted knee extension**. Exercise in a pain-free manner. Encourage quadriceps activation. Avoid dynamic valgus during strengthening and functional activities (focus on hip abductor and external rotator strengthening). Incorporate total leg strengthening and balance / proprioception exercises. Work on gait drills (step-overs, march walk). . Biofeedback QS, SLR (if no lag), CKC knee extension Hip 4 way SLR, sidelying hip ER Gastroc soleus strengthening Hamstring OKC isotonics 0-90 deg in seated position CKC exercises: Heel raises, weight shifts, leg press and wall squats (0-60 deg) wk 2: Leg press and wall squats (0-90 deg), lateral step-overs, step-ups, partial BW squats with UE support as needed, retro TM walking for knee ext, forward TM walking for gait training wk 3: Partial lunges front and lateral, leg press 2:1, BW squats progress ROM and balance wk 4: Elliptical Runner, leg press 2:1 and 1:1 wk 5: Resisted sidestep with T-band, partial dead lifts, Bosu partial squats 0-60 deg Total leg strengthening Balance / Proprioception training: Double leg progress to single leg, static progressing to dynamic activities. Perturbation exercises CV conditioning / Core Stability • IFC for pain/effusion, NMES for quadriceps activation and control as needed • Ice (in stretch for extension if needed) 2nd TERT • HEP for 3rd TERT
Phases of graft remodeling	Revascularization and ligamentization occur over 12 month period with peak maturity evident between 6 to 12 months following surgery. • wk 0-3: Graft necrosis with gradual replacement cells. Graft is nourished by synovial fluid so ROM is crucial. • wk 1-6-16: Graft revascularization begins, continuing through wk 16. (Based on canine study) • wk 3-24: Cellular repopulation begins, continuing through wk 24. • wk 6-52: Collagen structural formation with remodeling occurring up to 1 year.

Phase II: 6-12 weeks	Moderate protective phase
Goals	• Minimize knee joint effusion • Gently increase ROM with goal of full ROM by 6-8 weeks • Gradual progression of therapeutic exercises for strengthening, stretching, and balance • Implement low level foot placement drills working on control
ROM / Brace	• Progress to full ROM by 6-8 weeks. • Knee sleeve may be utilized depending on patient activities
Modalities	• Cryotherapy 15 minutes in duration 1-2x/day • IFC for pain/effusion if needed. NMES quadriceps if needed
Precautions	• Avoid overloading the fixation site by utilizing low amplitude low velocity movements. • Avoid quick twisting and pivoting motions for 10-12 wks to minimize shear forces. • Implement quadriceps isotonic strengthening from 30-90 deg to avoid shear forces to the healing graft. • Implement low level foot placement focus on control at week 9.
Treatment Recommendations Guidelines for progression based on tolerance	• Active warm-up: Bike with resistance, Nu Step, Treadmill walking • Stretching for full extension and flexion as needed. Low-load long duration stretching with heat if needed (1st TERT= Total End Range Time) Manual stretching for extension and/or flexion Leg press stretch for flexion • Flexibility exercises as needed • Therapeutic exercises: **Focus on N-M control and strengthening exercises**. Avoid dynamic valgus during strengthening and functional activities. Incorporate total leg strengthening, focus on hip/glutes, quadriceps, and hamstring. Progress with balance / proprioception exercises. Correct assymetrical loading patterns Total leg strengthening and CV conditioning Hip and core strengthening to prevent knee valgus Hamstrings isotonics prone 0-90 deg. Balance / Proprioception training: Single leg stance activities static progressing to dynamic activities. Perturbation exercises CKC exercises: Leg press 1:1, step-ups/step downs, squats, shallow squats with lateral shifting, Split squats, squat progression double leg to single leg, lunge progression, deadlifts, sidestep/sideshuffle with T band wk 8: Hamstring curls with physio ball Balance exercises: add in external focus of attention (ball catch, plyo back throws) wk 9: Quadriceps isotonics 30-90 deg if minimal chondrosis Isokinetic quadriceps/hamstrings 30-90 deg; VSRP 180-300 deg/sec sub-max to max; progressing to 60-300 deg/sec • Low level foot placement drills starting at wk 9 • IFC for pain/effusion / NMES for quadriceps activation and control as needed • Ice (in stretch if needed) 2nd TERT • HEP for 3rd TERT if needed
Independent strengthening	• wk 12: Can progress to independent strengthening program with monthly or bi-monthly visits if good ROM, minimal effusion, and good muscle control.

Phase III: 12-24 wks (3-6 months)	**Advanced Strengthening and Functional Activities**
Goals Make sure patient is enrolled in MyCare for IKDC survey (6M, 9M, 1Y, 2 Y, 5Y)	• Progress muscle strength, endurance, and balance activities. Ideally 3x/week of exercises at a fitness center, step-down, or home program. At 4 months, progress to quadriceps OKC with no extension block. • Progress to higher level activities depending on functional demands and MD approval • Address fear avoidance beliefs by graded exercise progression, cuing, positive reinforcement, referral if necessary. • Initiate a return to running program at 3-4 months if passes criteria and has no compensations with running pattern. • Initiate working on landing mechanics and control at 4-5 months if passes criteria on the following page • Progress agility drills at 4-5 months
Brace	• Your MD may recommend a knee sleeve or functional brace to be used until 12 months from your surgery for higher level activities
Modalities	• Cryotherapy 15 minutes 1x/day or after strenuous activity
Treatment Recommendations **<u>Return to Running Benchmarks</u>:** 4 months Passes testing criteria - See next page **<u>Return to Landing Drills Benchmarks:</u>** 4 months Passes testing criteria - See next page **<u>During Landing drills</u>: Focus on:** 1.Soft landing with knee flexion > 30 deg 2. no medial collapse/knee valgus 3. no hip IR/ pelvic drop 4. Dynamic postural control	• Active warm-up: • Continue with stretching and flexibility exercises as needed • Strengthening and endurance exercises**: Focus on strengthening and N-M control activitie**s. Advance as tolerated with emphasis on functional strengthening. Focus on soft landing with knee flexion, no medial collapse/knee valgus, and postural control. Progress with balance / proprioception exercises. Progress to working on landing mechanics and some agility drills as appropriate. Correct assymetrical loading patterns Total leg strengthening: hip/quadriceps/hamstring Hip strengthening – neuromuscular control to prevent knee valgus Core strengthening – prevent frontal plane trunk lean during landing/SLS Hamstring full ROM isotonics Quadriceps: with OKC exercises, limit extension to 30 deg. **At 4 months progress to isotonics and/or isokinetics full motion with no extension block**. CKC exercises: lunge progression, squat progression, step-up/downs progress with double leg / off-set foot position / single leg progress single direction to multiple directions. Balance exercises: Single leg, progress to dynamic and reactive **Return to running program** if passes benchmarks- see next page • 4 months-5 months: continue with strengthening and dynamic balance progress to the following exercises if clinical appropriate (see side bar) o Landing drills: Low amplitude sub-max drills Shallow jump landings, double to single line jumps, squat jumps progress to higher level if meets criteria (see sidebar) o Agility drills: Low amplitude low velocity drills: skipping F/B, jogging F/B, skaters, carioca progress to higher level with speed and complexity (when appropriate) agility ladder drills, cutting/pivoting (changing directions), changing speeds, anticipated to un-anticipated

Phase IV: 6-9 months	**Return to Higher Level Activities and Sport Phase**
Goals	• Continue to progress with strengthening, landing and agility drills to pass return to sports criteria – see testing algorithm • Progress to sport specific drills • Address fear avoidance beliefs by graded exercise progression, cuing, positive reinforcement, referral if necessary. • **Return to sports at 9-12 months if passes criteria – see testing algorithm.** Sports progression may take 2-4 weeks for full clearance back to full competition
Brace	Your MD may recommend a knee sleeve or functional brace to be used until 12 months from your surgery for higher level activities
Treatment recommendations	Specific interventions and treatments will depend on the testing results. Address areas of deficits and sport specific demands. • Strengthening exercises (if strength scores <90%) • Dynamic balance exercises if indicated (Y balance <4cm, poor control) • Landing/jumping/hopping drills if limb symmetry <90% on hop test and/or faulty movement patterns (stiff knee landing, assymetrical loading, knee valgus, poor postural control. • Progress agility drills • Progress to sport specific exercises and drills 9 months+: possible clearance for return to sport, depending on testing -see next pages for testing algorithm
Return-to-Sports Progression: (2-4 weeks, depending on tolerance)	Step 1: 1 on 1 drills (non-contact) sport specific activities Step 2: 1 on 1 drills (contact) full speed sport specific activities Step 3: Team scrimmage (non-contact) Step 4: Team scrimmage no restrictions Step 5: Game activities with restricted playing time Step 6: Game activities with no restrictions

ACL Return-to-Running and Return-to-Sport Testing Algorithm

Return to running and return to sport depends on:
Timeframe from surgery
Test performance
MD and PT approval

6 weeks
1.Knee ROM
2.Hip strength:
Abduction MMT
3.SL 30 deg Stork test
4.FOTO

8 weeks:
1.Knee ROM
2.Hip strength:
Abduction MMT/dynamometry
Hip Abduction Side plank test
3.SL 30 Stork test
4.Y balance
5. Squat WB symmetry: Force plate

12 weeks (3 months)
1. Knee ROM
2.SL 60 deg Stork test
3.Hip strength:
Abduction MMT/ dynamometry /
Hip Abduction Side plank test
4.Biodex test :
20 deg extension block
2 speeds: 180 deg/sec (5 reps) 300 deg/sec (30 reps)
5.Y balance test
6.Squat WB symmetry: Force plate
7.FOTO

16 weeks (4 months) – RETURN to RUNNING
Repeat previous tests not passed
For Biodex test:
20 deg extension block
3 speeds: 60 d/sec (5 reps)
180 d/sec (5 reps) 300 d/sec (30 reps)
***if adequate strength scores for return to running**
(quads at least 75%, hamstrings: at least 75%)
1.Anterior lateral hop to stabilization
2.Sub-Max Jump test : no arm swing
3.Sub-Max Single Hop Assessment : no arm swing
For apprehension and control
4.Trial of running
5. Screen for fear avoidance/kinesiophobia
(ACL-RSI survey)

Return to Running Benchmarks:

1.Time: at least 4 months post-op:
2. MD / PT clearance
3. No knee joint effusion
4. ROM: limb symmetry:
extension within 5 deg
flexion within 10 deg
5.Biodex: Limb symmetry of PT:
Quad: 75%
Hams: 75%
6. Anterior lateral hop to stabilization drill completed with no apprehension and good movement control
7. Assess running form: Treadmill running (sub-max at self selected speed)

Recommendations:
1.Biodex:
Quad PT/BW: +/- 5%
Males: 95%,75%, 50% at 60,180,300deg/sec
Females: 85%, 65%, 35% at 60,180,300deg/sec
H/Q ratio: +/- 5%: 65%, 75%, 90% at 60,180,300deg/sec
Total work at 300 deg/sec:
Quad: limb symmetry 75%
Hams: limb symmetry:75%
2. SL 60 deg stork test:
Limb symmetry: 90%
3. Hip Abductor strength: MMT 5/5 or dynamometry 90%
4. Squat WB symmetry with near equal WB
5. Y balance: Limb symmetry: < 4cm

Return to Jumping/Landing Drills Benchmarks:

1.Time: at least 4-6 months
2.MD/ PT clearance
3.No knee joint effusion
4.Biodex: Limb symmetry of PT:
Quadriceps and hamstrings: 75-85% = sub-max landing drills
Quadriceps and hamstrings: 85-90% = max landing drills
Minimize the following 4 variables with landing drills:
1. Stiff landing (< 30 deg knee flexion)
2. Knee valgus
3. Hip IR / pelvic drop
4. Loss of Dynamic balance

ACL Return-to-Running and Return-to-Sport Testing Algorithm

Return to sport depends on:
Timeframe from surgery
Test performance
MD and PT approval

24 weeks (6 months)
Repeat previous tests not passed
1. Biodex test: Full ROM with no ext block
3 speed test: 60 deg/sec (5 reps),
180 deg/sec (5 reps),
300deg/sec (30 reps
2. Squat WB symmetry: force plate
3. Landing Assessment: qualitative*
a. Broad jump - 2D – no arm swing
a. Land Vertical Jump – 2D (front and side)
b. Sub-max Single leg Hop –2D (front and side) – no arm swing
progress to max if:
strength 90%
limited landing mechanic variable
4.FOTO and IKDC (Mycare)
5. Screen for fear avoidance/kinesiophobia
(ACL-RSI survey)

*Landing mechanic variables at impact for potential injury risk:
1. Stiff landing (< 30 deg knee flexion)
2. Knee valgus
3. Hip IR / pelvic drop
4. Decreased dynamic balance
(poor trunk control, increased # reps to complete)

9 months- Possible return to sport
Repeat previous tests not passed
1.Biodex test: Full ROM with no ext block
3 speed test: 60 deg/sec (5 reps),
180 deg/sec (5 reps),
300deg/sec (30 reps)
2. Landing Assessment: quantitative for limb symmetry
qualitative for landing mechanics variables
a. Single leg hop (no arm swing) – 2D (front and side)
b. Triple hop (arm swing) – 2D (front)
c. Cross-over hop (arm swing) – 2D (front)
3. Agility test: LEFT test components or time
4. FOTO and IKDC (Mycare)
5. screen for fear avoidance/kinesiophobia
(ACL-RSI survey)

2 year/ 5 year
IKDC (mycare)

Return to Sport Benchmarks:

1.Time: at least 9-12 months
2.MD/ PT clearance
3.No knee joint effusion
4.ROM: limb symmetry:
extension within 5 deg
flexion within 10 deg
5.Biodex: Limb symmetry of PT:
Quad: 90%
Hams: 90%
6.Landing Assessment:
(Single Hop/ Triple Hop/ Cross-over Hop)
Quantitative: Limb symmetry: 90%
Qualitative variables - no faulty landing mechanics – see previous column*
7.Agility components with no compensation
8. No evidence of fear avoidance

Recommendations:
1.Biodex:
*Quad PT/BW: (+/-5%)
Males: 95%, 75%, 50% at 60, 180, 300 deg/sec
Females: 85%, 65%, 35% at 60,180,300 deg/sec
H/Q ratio: (+/- 5%)
65%, 75%, 90% at 60, 180, 300 deg/sec
Hams PT/BW: (+/- 5%)
Males: 60%, 35%, 25% at 60, 180, 300 deg/sec
Females: 60%, 35%, 25% at 60, 180, 300 deg/sec

Total work: 300 deg/sec
Quads: Limb symmetry:90%
Hams: Limb symmetry: 90%
2. Hip Abductor strength: MMT 5/5 or dynamometry 90%
3.Y balance: Limb symmetry: < 4cm
4. Jump test:
Males: 90%-100% height
Females: 80%-90% height
5. Single hop test:
Males: 80-90% height
Females: 70-80% height

ACL Reconstruction Program References

AcceleratedRehabilitation Following ACL Reconstruction using Ipsilateral Patellar Tendon Graft Protocol printed from SportsMedRx.com, 2003

Beynnon BD, Johnson RJ. Anterior cruciate ligament injury rehabilitation in athletes. Biomechanical considerations. Sports Medicine, 1996; 22(1): 54-64

Brandsson S, Faxen E, Kartus J, et al. A prospective four to seven year follow-up after arthroscopic anterior cruciate ligament reconstruction. Scand J of Med and Science in Sports, 2001; 11(1): 23-27

Davies GJ, Heiderscheit B, Clark M. Open kinetic chain assessment and rehabilitation. Athletic Training: Sports health care perspectives, 1995; 1(4): 347-370

Davies GJ, Zillmer DA: Functional progression of exercise during rehabilitation in Knee Ligament Rehabilitation, Ellenbecker, 2000; 345-360

Delay BS, Smolinski R, Wind WM, Bowman DS. Current practices and opinions in ACL reconstruction and rehabilitation: Results of a survey of the American Orthopaedic Society for Sports Medicine (Summary). Am J of Knee Surgery, 2001; 14(2): 85-91

Fagenbaum R, Darling W. Jump landing strategies in male and female college athletes and the implications of such strategies for ACL injury. Am J of Sports Med, 2003; 31: 233-240

Falconiero RP, DiStefano VJ, Cook TM. Revascularization and ligamentization of autogenous anterior cruciate ligament grafts in humans. Arthroscopy, 1998, 14: 197-205.

Feller JA, Webster KE. A randomized comparison of patellar tendon and hamstring tendon anterior cruciate ligament reconstruction. Am J of Sports Med, 2003; 31, 564-573

Fitzgerald, KG. Open versus closed kinetic chain exercise: Issues in rehabilitation after anterior cruciate ligament reconstructive surgery. Physical Therapy, 1997; 77: 1747-1754

Heckmann TP, Noyes FR, Barber-Westin SD. Autogeneic and allogeneic anterior cruciate ligament rehabilitation. In Knee Ligament Rehabilitation, Ellenbecker 2000: 132-148

Kartus KJ, Stener S, Kohler K, et al. Is bracing after anterior cruciate ligament reconstruction necessary? A 2 year follow-up of 78 consecutive patients rehabilitated with or without a brace. Knee Surgery, Sports Traumatology, Arthroscopy, 1997; 5(3): 157-161

Kuechle DK, Pearson SE, Beach WR, et al. Allograft ACL reconstruction in patients over 40 years of age. Arthroscopy, 2002; 8: 845-853

Linn RM, Fischer DA, Smith JP, et al. Achilles tendon allograft reconstruction of the anterior cruciate ligament deficient knee. Am J of Sports Med, 1993; 21(6): 825-831

Mangine RE, Kremchek TE. Evaluation-based protocol of the anterior cruciate ligament. J of Sport Rehab, 1997; 6: 157-181

Manske RC, Prohaska D, Livermore R. Anterior Cruciate Ligament Reconstruction Using the Hamstring- Gracilis Tendon Autograph. In Postsurgical Orthopedic Sports Rehabilitation of Knee and Shoulder. Ed Manske RC. 2006: 189-206.

Martinek MV, Friederich NF. To brace or not to brace? How effective are knee braces in rehabilitation. Orthopade, 1996; 28(6): 565-570

Neitzel JA, Kernozek TW, Davies GJ: Loading response following ACL reconstruction during the parallel squat exercises. Clinical Biomechanics, 2002; 17(7): 551- 554

McClure PW, Blackburn LG, Dusold C. The use of splints in the treatment of joint stiffness: biological rational and algorithm for making clinical decisions. Phy Ther,1994 74:1101-1107

Millett PJ, Wickiewicz TL, Warren RF. Motion loss after ligament injuries to the knee. Part II: Prevention and treatment. American Journal of Sports Medicine, 2001; 29: 822-828

Mikkelsen C, Werner S, Eriksson E. Closed kinetic chain alone compared to combined open andCKC exercises for quads strengthening after ACL reconstruction with respect to return to sports: a prospective matched follow-up study. Knee Sur, Sports Trau, Arthr, 2000; 8: 337-42

Muneta T, Sekiya I, Ogiuchi T, et al. Effects of aggressive early rehabilitation of the outcome of ACL reconstruction with multi-strand semitendinosus tendon. Internal Orthopaedics, 1998; 22: 352-6

Rebel M, Paessler HH. The effect of knee brace on coordination and neuronal leg muscle control: an early postoperative functional study in ACL reconstructed patients. Knee Surg, Sports Trauma, Arthro, 2001; 9(5): 272- 281

Risberg MA, Mork M, Jenssen HK, Holm I. Design and implementation of a neuromuscular training program following ACL reconstruction. J of Ortho and Sports Phy Ther, 2001; 31: 620-31

Sapega AA, Quedenfeld TC. Biophysical factors in range of motion exercises. Physician and Sports Medicine, 1981; 9: 57-65

Seo JG, Cho DY, Kim KY. Reconstruction of the anterior cruciate ligament with Achilles tendon autograft. Orthopaedic Surgery in Korea, 1993; 16(6): 719-724

Shelburne KB, Pandy MG. Determinants of cruciate-ligament loading during rehabilitation exercise. Clinical Biomechanics, 1998; 13: 403-413

Shelbourne DK, Rask BP: Controversies with anterior cruciate ligament surgery and rehabilitation. American Journal of Knee Surgery, 1998; 11(2): 136-143

Tsaklis P, Abatzides G. ACL rehabilitation program using a combined isokinetic and isotonic strengthening protocol. Isokinetics Exercise Science, 2002; 10: 211-9

Tsuda E, Okamura Y, Ishibashi Y. Techniques for reducing anterior knee symptoms after ACL using a bone-patellar tendon-bone autograft. American Journal Sports Medicine, 2001; 29: 450-456

UW Sports Medicine ACL Reconstruction in Adolescent Athlete Rehab Protocol, accessed on the website 10.24.2018

Wu GK, Ng GY, Mak AF. Effects of knee bracing on the sensorimotor function of subjects with ACL reconstruction. Am J of Sports Med, 2001; 29(5): 641-6