

Rehabilitation Guidelines for ACL Reconstruction in the Adult Athlete

Anterior cruciate ligament (ACL) injuries occur in both men and women with varying activity levels and athletic participation.

About the Anterior Cruciate Ligament (ACL)

The knee is stabilized by 4 major ligaments: anterior cruciate ligament, posterior cruciate ligament (PCL), medial collateral ligament (MCL), and lateral collateral ligament (LCL). The ACL is located inside the knee along with the PCL. The ACL helps stabilize against knee rotation, which occurs with pivoting and cutting motions. The ACL also acts as a restraint against hyperextension. This ligament works to stabilize the knee in two ways: (1) it acts as, a passive restraint; (2) it directly functions to limit excess mobility at the knee joint. The ACL has proprioceptors and mechanical nerve receptors, which function to sense the position of the joint. When normal range of a joint is exceeded, proprioceptors send a signal to the brain and spinal cord to activate the appropriate muscles to stabilize the knee joint.

Mechanism of Injury

An ACL injury is commonly a non-contact injury, meaning there was not contact from another person causing the injury. Often, ACL injuries occur as a deceleration injury, where an athlete plants his/her foot on the ground to cut and/or change directions. This mechanism can lead to a force that is greater than what the ACL can tolerate, resulting in injury to the ACL, and an associated feeling of knee “buckling” or “giving out.” The ACL can also be injured with forceful knee hyperextension, as with landing from a jump.

An ACL injury commonly results in pain and swelling in the knee joint. Athletes may feel or hear a “pop” at the time of injury. After an ACL injury it can be difficult/painful to bend and straighten the knee. People may feel the knee is

unstable when moving around, like it “gives out”.

Causes of ACL injuries are multi-factorial, and research is ongoing to determine which factors are most relevant in predicting an increased injury risk.

Diagnosis of an ACL Injury

There are different methods used to diagnose ACL injuries. Clinically, a sports medicine physician, physical therapist or athletic trainer will assess the knee through physical exam. They will use evidence-based exam techniques to examine the laxity of the joint (how much it moves compared the uninjured side), to assess asymmetry as a result of injury. There are also diagnostic tests and images to assess the integrity of the ACL. A magnetic resonance image (MRI) will be ordered to visualize the soft tissue (muscles, tendons, and ligaments) and is relatively accurate at predicting an ACL tear (figure 1). A diagnostic arthroscopy is the most definitive and minimally invasive method to determine an ACL injury. During a diagnostic arthroscopy, an orthopedic surgeon can confirm injury using an arthroscopic camera to assess the inside of the knee joint.

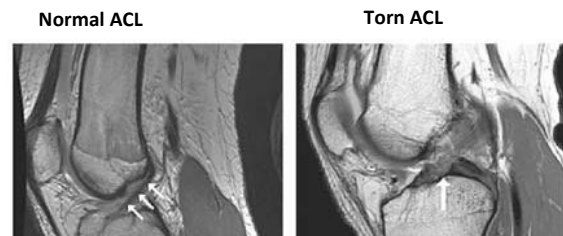


Figure 1: MRI of ACL in the knee.

Treatment options for an ACL Injury

Treatment choices are individualized to the patient with consideration of age, activity level, and desire to return to sports requiring pivoting, cutting and high-speed movements.

Conservative treatment can consist of activity modifications: discontinuing participation in sports requiring pivoting and cutting (basketball, soccer) and replaced with sports not requiring that motion (running, swimming). Conservative treatment can also include rehabilitation.

Rehabilitation for an athlete with an ACL injury consists of improving proprioception and reactive muscular stability to protect the knee joint. It is important to control the instability of the knee joint. Repeated episodes of knee instability can hinder sports performance and can also cause injury to the cartilage, other ligaments and structures stabilizing the knee. If instability persists, the athlete and surgeon may decide to perform an ACL reconstruction surgery to return these athletes to sport and activity.

Surgical reconstruction involves replacing the torn ACL with a graft. The reconstruction involves drilling holds in the femur and tibia. Graft choices include tendons from your body (autograft) such as: hamstring tendon, patellar tendon, and quadriceps tendon (figure 2) or a donor graft (allograft) such as: anterior tibialis tendon, Achilles tendon, patella tendon. The graft is placed through tunnels drilled in the bone and then secured (figure 3). Consulting with a surgeon to determine the best graft choice. Factors contributing to this decision can include: concurrent injuries to knee (medial collateral ligament and/or meniscus), pre-existing injuries, sport/work requirements, and age.

Rehabilitation Following Surgical Intervention

All athletes will undergo nine to twelve months of physical therapy, commonly divided into five phases beginning post-operatively. Phase I consists of decreasing swelling, achieving full

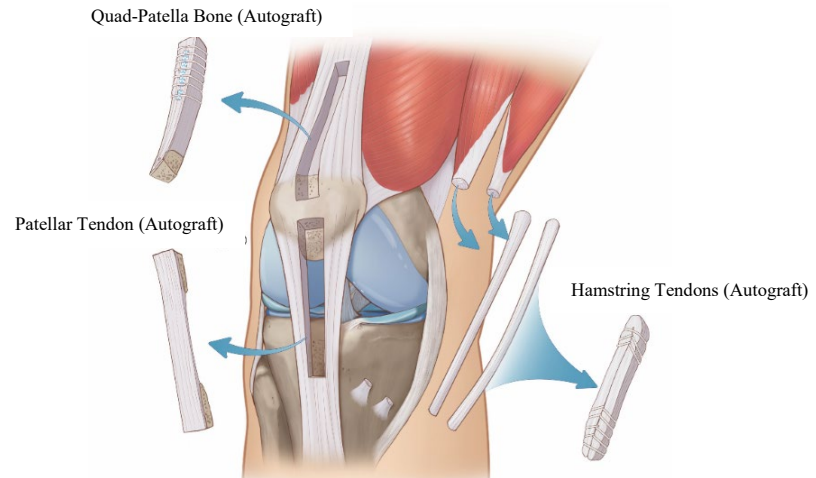


Figure 2: Donor sites for quad-patella bone, patellar tendon, and hamstring tendon grafts.

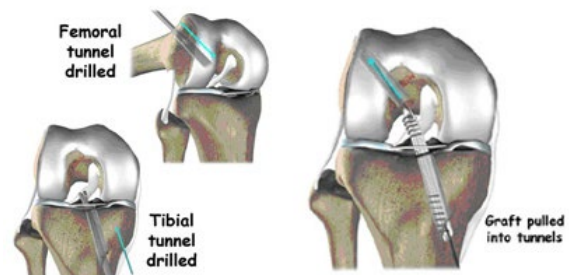


Figure 3: Example of graft placement

knee extension (straightening) and increased flexion (bending). It is important to achieve full knee extension to promote functional mobility required for walking and to prevent scar tissue from forming and limiting motion permanently. Phase II will focus on maintenance of knee motion and management of joint swelling. You will begin to focus on overall core and leg stability in this phase. Phase III goals include achieving control with more dynamic activities and continuing to improve balance and proprioception. In phase IV the athlete will work to improve confidence in single leg activities and be able to demonstrate improved control and reaction to change of direction to allow for transition into phase IV. During phase IV the athlete transitions into cutting, pivoting, sprinting, and sport specific drills in a controlled environment, working towards reactive and unpredictable sport specific environments.

With return to sport and high-level activity, there is always a risk of knee injury, and associated re-tear of the new ACL. There is a 15-30% higher risk in those less than 18 years old. Based on current research, reasons for ACL re-tear are multifactorial and hypothesized to be related to surgery type, time to return to sport, lower extremity muscle strength, athletes who are still growing, and athletes who return to participate in more years of high-level activities and sports. Evidence shows the risk of re-injury decreases significantly when passing return to sport testing and not returning to sport too early. Your structured and individualized rehabilitation

program will work to put you in the best position to return to sport with minimal risk for re-injury. Your physician, physical therapist, and athletic trainer will put you through a series of criterion based, progressive tests to determine safe return to sport. Even with satisfactory performance on these functional tests, athletes will benefit from continued strength and conditioning programs for return to pre-injury performance levels. In conjunction with return to sport, a referral may be made to a strength and conditioning specialist to return athletes to this level of performance.

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These rehabilitation guidelines were developed by Samaritan Athletic Medicine Physical Rehabilitation. Please be aware the information provided is not intended to replace the care or advice given by your physician or health care provider. It is neither intended or implied to be a substitute for professional advice. Call your health care provider immediately if you think you have a medical emergency. Always seek advice from your health care provider before starting any new treatment or with any questions you may have regarding a medical condition.

Phase I: 0-2 week post-operative	
Appointments	Surgeon/Physician Assistant follow-up: 7-10 days Start Physical therapy at: 1-10 days post op
Precautions	<u>Brace</u> : worn at all times * <ul style="list-style-type: none"> • unlocked, unless full extension is lacking then keep locked at 0° <u>Weightbearing</u> : crutches until cleared by therapist <u>Hamstring grafts</u> : No active hamstring tasks, avoid aggressive stretching of hamstrings
Rehabilitation Goals	<ul style="list-style-type: none"> ▪ Swelling at $\leq 2+$ on sweep test ▪ Restore range of motion and mobility with full extension and flexion as tolerated – <i>flexion is limited to 90° for 4 weeks with concomitant meniscus repair</i> ▪ Achieve good quadriceps activation
Range of Motion	Emphasis on restoring knee extension to help normalize walking
Therapeutic Exercises	Focus on quad activation without gluteal co-activation Restore patellar mobility Exercise examples: <ul style="list-style-type: none"> • <u>Knee extension</u>: prone hangs, supine bag hangs, calf stretch • <u>Knee flexion</u>: wall slides, heel slides, seated heel slides • Quad sets (at varying speeds) • Straight leg raises (all 4 planes) • Neuromuscular re-education using electrical stimulation (NMES) at 60° knee flexion (Isometrically contract)

Phase II: 2-4 weeks post-operative	
Appointments	PT appointments: 1-2 times/week
Precautions	<u>Brace</u> : No sooner than 1-2 weeks: discontinue use of full leg brace, if able to wear ACL brace (otherwise, see brace discharge criteria below) <u>Weightbearing</u> : crutches as needed
Rehabilitation Goals	<ul style="list-style-type: none"> ▪ Decrease swelling $\leq 2+$ on sweep test ▪ Progress range of motion to be symmetrical to non-operative leg ▪ Normalize gait
Range of Motion	No restrictions full range of motion expected at 3-4 weeks
Therapeutic Exercises	Emphasis on quad activation without glute co-activation Gait training Exercise examples: <ul style="list-style-type: none"> • Bicycle without resistance • Prone knee flexion • Leg press • Heel raises • Terminal knee extensions (standing, prone, marching) Core stabilization exercises
Criteria for Discharging Assistive Device and Progression to Next Rehabilitation Phase	<ul style="list-style-type: none"> ✓ No sooner than 4 weeks ✓ Full range of motion ✓ Strength: able to perform strong quadriceps activation and perform 2x10 SLR with no extensor lag ✓ Tolerate full weight bearing ambulation with no visible gait deviations

*Protocol may be different if concurrent meniscus repair. Please consult surgeon for protocol.

Phase III: 4-16 weeks post-operative	
Appointments	Surgeon: 6 weeks after surgery PT: 1-2 times/week
Precautions	Brace: ACL brace as directed by surgeon & therapist
Rehabilitation Goals	<ul style="list-style-type: none"> ▪ Achieve and maintain full knee range of motion symmetrical to non-operative leg - <i>If SLR doesn't reach neutral extension (0°) by 2 weeks post-op, increase frequency of PT and notify the physician</i> ▪ Improve lower extremity strength ▪ Progress balance and neuromuscular control
Therapeutic Exercises (Examples, but not limited to)	<p>Progress strengthening:</p> <ul style="list-style-type: none"> • Leg press (single leg) • OKC knee extension from 90-60° with ankle cuff weights • Step-ups • Step-downs • Bridges • Hamstring curls • Wall slides <p>Stretching exercises and manual therapy if flexion or extension is still limited</p> <p>Cardio</p> <ul style="list-style-type: none"> • Bike • Elliptical <p>Gait training on treadmill progressing to fast treadmill walking</p> <p>Aquatic therapy (if available)</p> <ul style="list-style-type: none"> • 4-way straight leg raises • Squats • Bicycle kicking • Fast walking progressing to a jog <p>Progress strengthening to include</p> <ul style="list-style-type: none"> • OKC knee extension (90-60° for the first 10 weeks, 90-45° for weeks 10-16) • Single leg squats • Lunges • Mini-band walking • Deadlifts • Step and holds • Perturbation training
Criteria for Discontinuing Brace	<ul style="list-style-type: none"> ✓ Full active knee extension and no pain on overpressure ✓ Able to perform strong quad isometrics and superior patellar glide performing 2x10 SLR with no extensor lag ✓ Demonstrates normal pain-free walking ✓ Swelling: ≤1+ on sweep test
Recreational Activities	Biking without use of clip pedals
Criteria for Progression to Next Rehabilitation Phase	<ul style="list-style-type: none"> ✓ No sooner than 6 weeks ✓ Full range of motion ✓ Swelling ≤ 2+ using sweep test ✓ Able to tolerate closed kinetic chain therapeutic exercise program without increased pain and swelling ≤ 2+ using sweep test ✓ Safely perform marching with 5 second balance

Phase IV: 16-20 weeks post-operative	
Appointments	Surgeon: 12 week follow up after surgery PT: 1 times/week – every other week
Rehabilitation Goals and Criteria for Return to Run	<ul style="list-style-type: none"> ▪ No abnormal gait patterns while walking as fast as they can on the treadmill for 15 minutes ▪ 30 step and holds without loss of balance or excessive motion outside of the sagittal plane ▪ 10 consecutive single leg squats to 45° of knee flexion without loss of balance, abnormal trunk movement, Trendelenburg sign, femoral IR or the knee deviating medially causing the tibial tuberosity to cross an imaginary vertical line over the medial border of the foot ▪ ≥ 80% 1-repetition maximum (1-RM) on the leg press (90-0°) ▪ ≥ 80% 1-repetition maximum (1-RM) on the knee extension machine (90-45°) ▪ ≥ 90% composite score on Y-balance test. Composite score = (anterior reach + posteromedial reach + posterolateral reach)/(3 x limb length)
Therapeutic Exercises (Examples, but not limited to)	<p>Progressive strengthening:</p> <ul style="list-style-type: none"> • CKC exercises should be progressed to ~60-75° of knee flexion if this does not cause any patellofemoral pain. • OKC exercises should be progressed to full range 90-0° if this does not cause any patellofemoral pain. • Prepare to pass screening exam to begin running

Phase IV: 5-7 months post-operative	
Appointments	Surgeon: 6 month visit PT: 1 time/week - every other week
Rehabilitation Goals and Criteria for Return to Agility	<ul style="list-style-type: none"> ▪ ≥ 85% 1-RM on the leg press (90-0°) ▪ ≥ 85% 1-RM on the knee extension machine (90-0°) or Biodex testing if available ▪ 10 consecutive single leg squats >45° of knee flexion without loss of balance, abnormal trunk movement, Trendelenburg sign, femoral IR or the knee deviating medially causing the tibial tuberosity to cross an imaginary vertical line over the medial border of the foot while holding ≥ 75% extra weight compared to the other side (dumbbells, weight vest, etc.) Body weight is not part of the equation ▪ 100% composite score on Y-balance test. Composite score = (anterior reach + posteromedial reach + posterolateral reach)/(3 x limb length) ▪ Be able to run 2 miles continuously without pain, swelling, warmth or gait deviations ▪ Clearance from surgeon ▪ <i>If patient is not planning on return to sport, discharge from PT once they are able to do agility training at sub-max speeds without new inflammation.</i>
Therapeutic Exercises (Examples, but not limited to)	<p>Progressive strengthening</p> <p>Initiate agility training</p> <ul style="list-style-type: none"> • Lateral shuffling • Forward/backward shuttle runs • Carioca • Ladder drills

Phase IV: 6-9 months post-operative	
Appointments	Surgeon: 6 month visit PT: 1 time/every other week – 1/month
Rehabilitation Goals	<ul style="list-style-type: none"> ▪ $\geq 90\%$ 1-RM on the leg press ($90-0^\circ$) ▪ $\geq 90\%$ 1-RM on the knee extension machine ($90-0^\circ$) or Biodex testing if available ▪ Progress jumping ▪ Progress to hopping and cutting
Criteria for Return to Jumping	<ul style="list-style-type: none"> ▪ $\geq 90\%$ 1-RM on the leg press ($90-0^\circ$) ▪ $\geq 90\%$ 1-RM on the knee extension machine ($90-0^\circ$) or Biodex testing if available ▪ 10 consecutive single leg squats to 60° of knee flexion without loss of balance, abnormal trunk movement, Trendelenburg sign, femoral IR or the knee deviating medially causing the tibial tuberosity to cross an imaginary vertical line over the medial border of the foot while holding $\geq 85\%$ extra weight compared to the other side (dumbbells, weight vest, etc.). Body weight is not part of the equation ▪ No compensation patterns with deceleration during agility drills performed at near 100% effort
Criteria for Return to Cutting and Hopping	<ul style="list-style-type: none"> ▪ 10 consecutive single leg squats to 60° without loss of balance, abnormal trunk movement, Trendelenburg sign, femoral IR or the knee deviating medially causing the tibial tuberosity to cross an imaginary vertical line over the medial border of the foot while holding $\geq 90\%$ extra weight compared to the other side (dumbbells, weight vest, etc.). Body weight is not part of the equation ▪ No display of medial collapse of the knees when loading into or landing from jumps, and equal weight distribution when initiating and landing the jumps
Therapeutic Exercises (Examples, but not limited to)	<p>Progressive strengthening</p> <p>Initiate jumping training</p> <ul style="list-style-type: none"> • Vertical jumps with double leg take off and landing • Forward/backward shuttle runs • Carioca • Ladder drills

Criteria for return to sport

1. Range of motion: pain free symmetrical to non-operative leg
2. Strength: isometric strength test 90% or greater for hamstring and quadriceps at multiple angles of knee flexion compared to non-operative leg
3. Swelling: no reactive swelling $\geq 1+$ with sport-related activity
4. Running: normalized gait mechanics
5. Neuromuscular control: appropriate mechanics and force attenuation strategies with high level agility, plyometrics and high impact movements
 - o Y-balance: within 90% non-operative leg
 - o Functional Hop Testing: appropriate mechanics, 90% symmetrical non-operative leg using force plate/jump mat
 - o Complete the agility program if returning to a cutting sport
6. Physician clearance