

## 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.

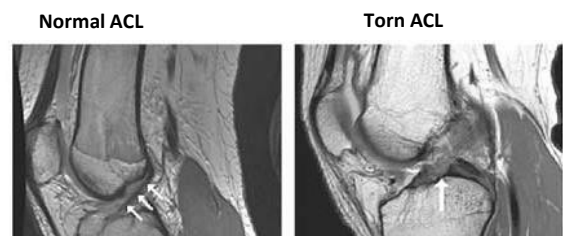


Figure 1: MRI of ACL in the knee.

## 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

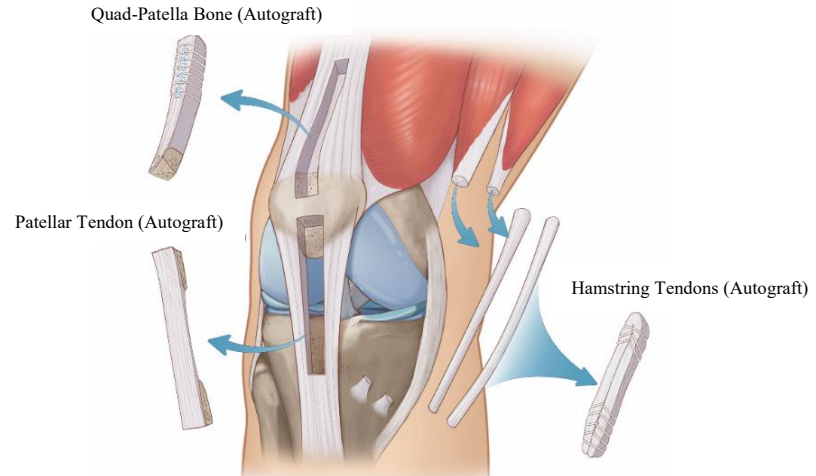


Figure 2: Donor sites for quad-patella bone, patellar tendon, and hamstring tendon grafts.

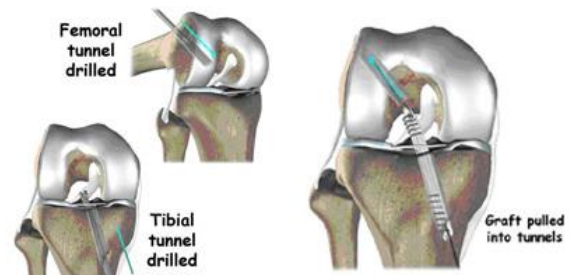


Figure 3: Example of graft placement

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.

## References

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

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

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

Phase III: 4-6 weeks post-operative	
<b>Appointments</b>	Surgeon: 6 weeks after surgery PT: 1-2 times/week
<b>Precautions</b>	Brace: ACL brace as directed by surgeon & therapist
<b>Rehabilitation Goals</b>	<ul style="list-style-type: none"> <li>▪ Achieve and maintain full knee range of motion symmetrical to non-operative leg</li> <li>▪ Improve lower extremity strength</li> <li>▪ Progress balance and neuromuscular control</li> </ul>
<b>Therapeutic Exercises</b>	Biking with resistance when full range of motion on bike is achieved Add weight to closed chain exercises: <ul style="list-style-type: none"> <li>• Leg press</li> <li>• Calf press</li> <li>• Partial squats</li> <li>• Step ups</li> <li>• Balance/proprioception activities</li> <li>• Prone knee flexion</li> </ul>
<b>Criteria for Discontinuing Brace</b>	<ul style="list-style-type: none"> <li>✓ Full active knee extension and no pain on overpressure</li> <li>✓ Able to perform strong quad isometrics and superior patellar glide performing 2x10 SLR with no extensor lag</li> <li>✓ Strength: leg press at 70% of non-operative leg</li> <li>✓ Swelling: <math>\leq 2+</math> on sweep test</li> </ul>
<b>Recreational Activities</b>	Golf no sooner than 6 weeks, short irons only from the driving range Biking without use of clip pedals
<b>Criteria for Progression to Next Rehabilitation Phase</b>	<ul style="list-style-type: none"> <li>✓ No sooner than 6 weeks</li> <li>✓ Full range of motion</li> <li>✓ Swelling <math>\leq 2+</math> using sweep test</li> <li>✓ Able to tolerate closed kinetic chain therapeutic exercise program without increased pain and swelling <math>\leq 2+</math> using sweep test</li> <li>✓ Safely perform marching with 5 second balance</li> </ul>

Phase IV: 6-12 weeks post-operative	
<b>Appointments</b>	Surgeon: 12 week follow up after surgery PT: 1-2 times/week
<b>Precautions</b>	Brace: ACL brace as directed by surgeon/therapist No active open chain extension
<b>Rehabilitation Goals</b>	<ul style="list-style-type: none"> <li>▪ Maintain full knee range of motion</li> <li>▪ Return to activities of daily living without reactive pain and swelling</li> </ul>
<b>Therapeutic Exercises</b>	Initiate active hamstring exercises at 6 weeks Progress strengthening and neuromuscular retraining Examples: <ul style="list-style-type: none"> <li>• Hamstring curl</li> <li>• Squats</li> <li>• Shuttle/Leg Press</li> <li>• Lunges</li> <li>• Step-up/downs</li> <li>• Single leg balance</li> </ul>
<b>Recreational Activities</b>	Swimming at 12 weeks (no whip kick) No jumping, twisting or pivoting
<b>Criteria for Progressing to Next Rehabilitation Phase</b>	<ul style="list-style-type: none"> <li>✓ No sooner than 12 weeks</li> <li>✓ Full range of motion including plantar flexion mobility</li> <li>✓ Swelling <math>\leq 1+</math></li> <li>✓ Neuromuscular control: demonstrate appropriate lower extremity mechanics with lower extremity exercises (bilaterally)</li> </ul>

Phase V: 12 weeks and beyond post-operative	
<b>Appointments</b>	Surgeon: 6 months after surgery PT: 1x/week
<b>Precautions</b>	Brace: ACL brace as directed by surgeon/therapist
<b>Rehabilitation Goals</b>	<ul style="list-style-type: none"> <li>▪ Maintain full range of motion</li> <li>▪ Jumping and running without reactive pain</li> <li>▪ Hop tests at 90% contralateral values</li> <li>▪ Normal multi-planar high velocity without side to side differences</li> <li>▪ Normal double leg and single leg landing mechanics</li> </ul>
<b>Therapeutic Exercises</b>	<p>Progress quadriceps, hamstrings, and trunk stability</p> <ul style="list-style-type: none"> <li>• Squats, leg curls, leg press, deadlift, lunges, rotational trunk exercises, use of BOSU/unstable surfaces</li> </ul> <p>No sooner than 15 weeks: open chain knee extension                      No sooner than 15 weeks: begin lateral work under controlled conditions                      No sooner than 20 weeks: progress power, agility, plyometrics and return to performance</p> <ul style="list-style-type: none"> <li>• Agility: side shuffling, carioca, zig-zags</li> </ul> <p><u>Plyometrics</u>: double leg drop downs, single leg hop downs, double leg and single leg jump turns, repeated tuck jumps</p>
<b>Criteria to Initiate Running</b>	<ul style="list-style-type: none"> <li>✓ Timeline: No sooner than 14 weeks</li> <li>✓ Range of motion: symmetrical knee flexion and extension</li> <li>✓ Strength: hamstring and quadriceps at least 80% of non-operative leg</li> <li>✓ SL squat 2x10 with normal mechanics; pain-free hopping in place</li> <li>✓ Normalized gait and jogging mechanics</li> </ul>
<b>Recreational Activities</b>	<p>Cutting and twisting at 6 months if quad strength is 90% of non-operative leg  <b>Return to sports no sooner than 9 months and must pass criterion-based return to sport testing (see below)</b></p>

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