TIME TO RETURN AFTER ACLR

How long does it take to get back to full sports participation after ACL-Reconstruction (ACLR) surgery? Based off the best available data published at this point, the physicians at ISMI believe the general answer is 9 to 12 months for high-risk sports like soccer, basketball, and football. Although we look at several factors when considering a return to play (muscle strength, neuromuscular function and psychological readiness), time is the primary limiting factor.

50% reduction in rate of reinjury with each month that you wait to go back to sports.

A study out of Norway (Grindem H, et al. Br J Sports Med. 2016; 50:804-808) looked at reinjury rates when athletes returned to high-risk sports at 5 to 9+ months after ACLR surgery. In this study, 100% of those who returned to sports at 5 months had a reinjury within 2 years. Each month that the return to play was delayed (up to 9 months) saw a 51% reduction in the reinjury rate. After 9 months, the reinjury rate remained fairly constant.

In this study, a battery of tests was used to assess the readiness for return to sports. The tests included a Biodex test to assess quadriceps strength symmetry between injured and uninjured knees, a variety of hop tests, and a written test ranking self-reported assessment of symptoms and function in activities of daily function (KOS-ADLS).

The quadriceps strength test provided the best differentiation between the group of patients who got re-injured and the group that did not get injured. The “No reinjury” group had a quadriceps strength symmetry of 84%; that is, the involved leg had 84% of the strength (or, 16% deficit) of the uninvolved leg) and the “Reinjury” group had 75% symmetry, or a 25% deficit. Note that equal strength is within 10%. In this group of athletes, even at 2 years after surgery only 66% had quadricep deficit $\leq$ 10%.

The key is that TIME is needed to restore normal strength in the quadriceps, hamstrings and hip/core muscles after ACLR surgery. As part of a research project at ISMI, we recently collected strength and hop data on ACLR patients at ISMI. Patients were tested at three separate times: 5 to 7 months post-op (average of 6.7 months), 8 to 10 months post-op (average of 9 months) and 11 to 13 months post-op (average of 11.5 months). The quadriceps at 6.7 months had a 28.7% deficit. By 11.5 months, the deficit had decreased to 18.7%. We typically find that it may require 15 to 18 months to get the quadricep deficit below 15%. For a full return to sports participation, we want a quadricep deficit under 20%. Hamstring strength was back to normal by 6.7 months. Hop symmetry was 76.5% at 6.7 months and 89% by 11.5 months.

Bone bruises need time to heal.

The knee joint itself is often injured at the moment when the ACL is ruptured. The large external forces that result in the ACL rupture also cause violent impact between the tibial and femoral articular cartilage. Those impact forces are transferred to the bone causing a bone bruise in the subchondral bone of the tibia and femur. When the impact loads are combined with rotation, the meniscal cartilage is also at high-risk for damage. Bone bruises occur in roughly 80% of the ACL injuries. The location of the bone bruises can provide insight into the mechanism of the ACL injury. Bone bruises are often seen on the lateral femoral condyle and on the posterior lateral tibial plateau.

Time is needed for the bone bruise to heal. Depending on the severity of the bone injury, healing may require 4 to 8 weeks. However, long-term consequences (articular thinning and depression) can be evident even at 2 years. The bone bruise and damage to the articular cartilage and meniscus are the root causes for developing osteoarthritis (OA) in the future. High impact training before the bone bruise has healed may accelerate the development of OA. Muscle strength, and especially the quadriceps, help protect the joint by acting as a shock absorber. Again, time is needed to restore muscle strength to help protect the joint.

Time is needed for the new ACL to mature.

When we talk about time being required to return to sports, our primary concern is the strength of the new ACL. To actually measure the strength of the ligament, we would need to put a load on it until it breaks and record the load needed to break the ligament. While it would be nice to have this data for each month after surgery, it does not exist. Instead we use knee stability tests and patient-reported outcome measures (who and what timeframe after surgery had a reinjury or did not have an injury) to evaluate the success of ACLR and the timing for a return to different sports. Research using MRI studies are on-going to try and assess the ACL maturity at various times after surgery by looking at what is termed the signal-to-noise quotient. The imaging techniques used have not been consistent, so making conclusions is difficult. Even then, the image does not provide an actual strength measurement. So, we rely more on anecdotal evidence – who gets reinjured and when they get reinjured.

Ligamentization

When the ACL is reconstructed with an autograft tendon, a tendon graft (from the patella tendon, or quadriceps tendon, or hamstring tendon) is fixed in position in the joint. Over the next 12 months that tendon is gradually converted into a ligament in a process often termed “ligamentization”. This is 3-stage process: early healing phase, proliferation phase, and maturation phase.

The early healing phase is characterized by graft necrosis (the graft deteriorates to some extent) and no revascularization yet. The blood supply is critical to get nutrients deep into the

maturing graft. The new ACL is at its weakest point during this time. During the proliferation phase, cell infiltration and revascularization take place. In the final maturation phase, the tendon collagen filaments gradually remodel into ligament collagen fibers. Although there is little agreement to the exact length of time for each phase, the evidence suggests that the overall ligamentization requires about 12 months.

As these processes are moving along, the ligament also needs to rebuild the nervous system that innervates the ligament. These nerves provide feedback that monitor loads on the ACL and help the body to make an appropriate response to fire the muscles to help protect the ligament from injury. Returning to sports before the neural network is functioning could contribute to the high reinjury rate observed in the two years after surgery.

The full maturation, which would include restoring the nervous system may require at least 2 years. Athletes often feel that it takes 2 years to fully recover their performance. That second year may be necessary to get the nervous system restored. The length of time to reach maturation probably varies from person to person, and there are no definitive tests to make that judgement. The length of time is perhaps longer in older athletes and definitely longer for people who smoke.

The advancement through the ACLR rehabilitation protocols is largely time-dependent and is based on our experience and research from the sports medicine community. Each step in the progression (running straight ahead → agility drills → sport-specific drills → return to competition) will increase the load on the new ACL. This is a balancing act; the new ligament gets weaker over the first few months, but light, controlled loading can help improve the strength of the ligament. On the other hand, overloading the graft too soon will impair the mechanical strength and may lead to early graft failure.

Muscle strength and neuromuscular function also determine the advancement but will not over-ride the time factor. Even with good muscle strength at 5 months post-op, we do not want athletes back in high-risk sports until the ligament has had more time to mature.

Until this ligamentization process is complete, the strength of the ligament is compromised. Loads on the new ligament prior to full maturation (loads that would normally not rupture an ACL) result in a reinjury or at the very least a stretching out of the ligament to where it no longer provides stability to the knee. Having good strength in the quadriceps, hamstrings, hips and core can help prevent ACL injuries. Strong quads allow the athlete to stop or land with the knees bent (which is safe for the ACL); strong hamstrings prevent anterior translation and rotation of the tibia that ruptures the ACL; and strong hips and core help maintain proper hip/knee/foot alignment which helps decrease strain on the ACL. As stated above, 12 months or more is often required to develop this level of strength.

Young athletes who return to sport before 9 months after ACLR have a rate of new injury 7 times that of those who delay return. (Beischer S, et al. JOSPT 2020; 50(2):83-91)

In this study, even with normal quadricep strength symmetry, the risk of sustaining a second ACL injury was 7 times higher when the return to sports is before 9 months rather than after 9 months post-op. The new injury included both reinjury to the original ACL and ACL rupture in the contralateral knee. Even with normal quadricep strength, before 9 months the ACL ligament is not yet matured and at increased risk of reinjury. This highlights the point that the new ACL ligament requires time to become strong enough to handle the loads imposed by high-risk sports. The injury to the contralateral ACL may be related to the lack of complete recovery from the original ACL injury. When we video athletes jumping and landing after ACLR, until they have full strength and confidence in the injured knee, they usually land first on the opposite leg. Not trusting the originally injured knee places the contralateral knee at higher risk of injury when forced to compensate.

The bottom line is that TIME is the predominant factor that needs to be met for a safe return to sports. Time is what allows the new ACL to mature and get strong. Time is what is needed to get the muscles of the knees and hips and core strong enough to help protect against reinjury. And time is needed to restore neurologic function. These all contribute to becoming physically and psychologically ready to return to sports.

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