

Criteria for Return to Sport after ACL Injury

Kailai Chen*

Shenzhen Yaohua Experimental School, Shenzhen, 518034, China

*Corresponding author: mihong@ldy.edu.rs

Abstract. This review study seeks to give a general overview of the requirements for ACL (anterior cruciate ligament) recovery and return to sports. ACL tears are a common occurrence in athletes, and deciding whether it is safe for the players to return to play presents considerable hurdles. This paper examines the current understanding of various considerations and tests involved in the decision-making process. These considerations encompass functional assessments, including ligament stability tests, balance tests, single-leg hop tests, psychological factors, and so on. The review concludes with some prevalent and valid tests. The predictive value in assessing the risk of reinjury can guide the patient back to play. It is necessary for patients to follow those criteria in order to back to sport safely. Additionally, some other considerations, such as pain and psychological factors, can determine if a patient can return to sports and predict the possibility of re-injury.

Keywords: ACL injury; recovery test; rehabilitation.

1. Introduction

One of the four primary ligaments of the knee, the anterior cruciate ligament, is a crucial internal articular ligament component. The femur and tibia are joined by the ACL, which is an elastic band of dense fibrous tissue. The critical role of the ACL is to limit posterior rolling of the femoral condyle on the tibial platform during flexion, prevent knee hyperextension, and prevent forward displacement of the tibia under the femur.

ACL injuries usually occur during sports that can put high pressure on the knee, like basketball, football, soccer, and tennis. There are different situations that may cause ACL tears. First, suddenly changing direction, which is usually called cutting in sports. Second, stop suddenly. Third, bad landing during a jump, which is usually accompanied by a knee buckle. Fourth, having a crash on the knee, such as a tackle in American football. Women and people who wear fitting shoes or use unsuitable sports equipment are more likely to develop injuries.

When the ACL injury happens, the injured typically hear a pop sound in the knee. Within a few hours or days, the knee will begin to swell and the patient will experience pain. The knee will also become unstable and lose its flexibility. As a result, the patient will be unable to engage in any intense exercise and even have discomfort around the joint while walking. The doctor will determine whether the surgery is necessary for the patient or not depending on the extent of the tear. The stability of the joint's structural design and the tear.

Rehabilitation training is essential for patients to resume their daily life and sports activities, regardless of whether they require surgery or not. The focus of rehabilitation is to aid in the recovery of knee range of motion, strength, basic movements such as walking, running, jumping, squatting, agility, and even mental health concerns such as fear of re-injury. Ultimately, the goal is for the patient to regain enough strength to participate in regular activities and sports. However, determining the criteria for returning to sports is a multifaceted and controversial issue. For instance, it is difficult to decide when a patient can start running and how to measure the strength of the affected side without a precise instrument. Therefore, the lack of clear and simple criteria has become a problem for ordinary people and even professional athletes to judge whether they can return to sports. This article aims to give a summary of the criteria that patients must meet before they can safely return to sports.

2. Considerations

2.1. Ligament Structural Healing and Knee Structural Stability

The quality of ACL rehabilitation is partly determined by the ligament structural healing and knee structural stability. An MRI image can show the condition of the knee, show the patients if their ACL ligaments are healed, and if they have any ligament laxity. A study demonstrates that deep learning-based MRI significantly enhances the capacity to identify ACL damage [1]. The ligament recovery can be seen by comparing MRI images at different times. However, another study found manual diagnosis had higher diagnostic accuracy than MRI for detecting ACL tears. Both of the two studies claimed that more studies need to be conducted to verify their research result. Therefore, regardless of the accuracy, in the situation of rehabilitation, clinical tests are more suitable for people to observe the recovery. Clinical tests offer several advantages over MRI to normal people for assessing ligament function. They are more convenient as patients can even conduct the tests themselves. Additionally, they are cost-free. With a sensitivity of 87% and a specificity of 93%, the Lachman test is thought to be the most reliable for determining ACL integrity. The damaged knee is flexed during the Lachman test while an anterior force is delivered to the tibia on its proximal side while the patient is lying down. Excessive anterior tibial translation and the absence of a clear endpoint are signs of a positive test. For stability, a modified Lachman can be utilized. The examiner then grasps the proximal tibia with one hand while supporting the distal femur with the other. The proximal tibia then distributed an anterior force in an effort to subluxate it forward while keeping the femur immobile [2]. During the rehabilitation phase, the ligament's function is of great importance to the patient. If clinical tests show that the ligament is stable, the recovery process is significant, and the patient need not worry too much about its internal structure. If a patient has any ligament laxity, it is important for them to consult with their doctor to determine the appropriate solution. Increasing the strength of the hamstring can be one method to address this issue. Depending on the degree of laxity, ACL reinforcement surgery may be necessary. In addition, patients need to be careful not to do too many clinical tests, otherwise, the stability of the knee joint may be reduced.

2.2. Range of Motion

After an ACL injury, the patient's knee may become stiff, and the joint's motion may become limited. Therefore, the recovery of the knee's range of motion is crucial in ACL rehabilitation, and it is a fundamental aspect of returning to sports after ACL injury. To achieve a full range of motion and proper hyperextension, the patient must try their best. During the initial phase of recovery, patients need to attention that the range of motion is not limited, and the only limit to obtaining a full range of motion is patient tolerance [3]. Moreover, it should be emphasized that obtaining a range of motion as large as possible is not the goal. Instead, it is more important to have a symmetric range of motion. In conclusion, the ultimate objective and criteria for returning to the sport of restoring the mobility of the knee is to make the angle the same as the healthy side.

2.3. Strength Test

Strength is another crucial factor that determines if a patient can back to sports after an ACL injury. Strength is the basic determination of athletic performance as well as injury-preventing ability. A 2023 paper strength test as a test of maxima load successfully lifted through a predetermined range of motion for a specific number of repetitions indicates an athlete's maximal force [4]. A strength test must be done before the patient returns to sport. However, it is a challenge for people to test their strength and it is also a problem for people to judge if their strength is safe to back to sports. Isometric strength can be tested with an isokinetic dynamometer. This procedure has been used to quantify QF torque in people with ACL injury and reconstruction and produce reliable measurements and it is a relatively safe test [5]. The peak torque is the most typical evaluation in plenty of articles. Still, an article suggests testing the angle-specific torque, total work, average power, and rate of force development as well. The article also claims that the quick force-generating ability is a key factor in

muscular performance and successful return to play. The proximal tibia is subsequently exposed to an anterior uploded in an effort to subluxate it forward while retaining stability in the femur. Although an isokinetic dynamometer is available in many cities, in most of the cities, especially in developing countries, there are no machines for normal people to use. What's more, the price could be a problem as well. A test with an isokinetic machine is accurate but it is not suitable for everyone due to the availability and the cost. However, there are some other tests that can measure the patients' strength as well. For example, back-squat and deadlift. Comparing the 1RM weight can reflect the overall strength level of the patient. Additionally, comparing the strength of the healthy leg with another leg can help determine the difference in strength between the two limbs and decide whether it is safe for the patient to resume sports activities. A hand-held dynamometer can be used to test the strength too [7]. In conclusion, the strength test should be able to the overall strength and the single leg strength of the patients.

2.4. Balance Test

The Star Excursion Balance Test (SEBT) is a method to evaluate neural muscle control flaws (the test procedure is illustrated in Fig 1). Balance is significant for the dynamic stability as well. It affects the landing stability, jumping stability, and so on. For this test, the Front, right back, and left back distance will be measured. A study shows that Upon returning to sport, individuals who underwent ACLR had limited performance when compared to healthy subjects. The reach distances are affected by muscle strength in the lower extremity [7]. This test is good for reflecting the dynamic stability of the patient. When patients test by themselves, they can compare the injured side and the healthy side to determine if their single-leg stability is good enough to return to sport. Additionally, SEBT can not only be a test, it can be used as training, to improve the patient's ability.

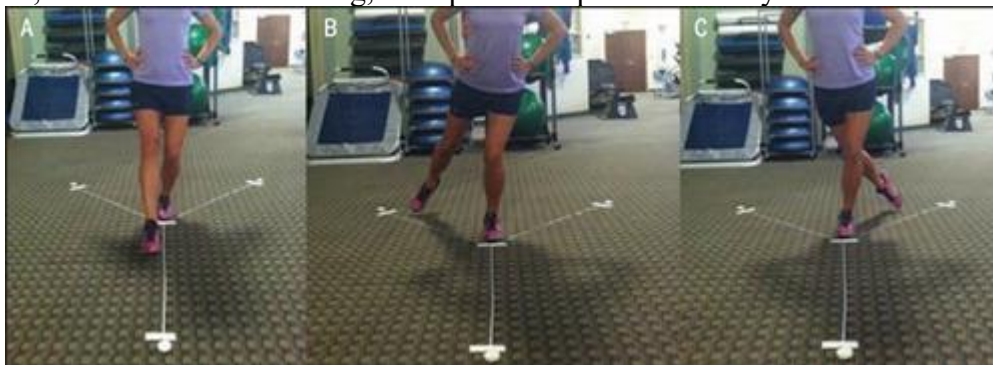


Fig. 1 SEBT image [7].

2.5. Measure Knee Pain and Symptoms

KOOS is a PROM for adults with knee pain. It tracks disease progression and treatment outcomes. It has five subscales: Pain, Symptoms, ADL, Sport/Rec function, and QoL. Each subscale is scored on a scale of 0 to 100. A shorter version, KOOS-PS, was derived from ADL and Sport/Rec subscales [8]. Pain is an important indicator of whether you can return to exercise. While doing tests and sports, the pain must be bearable. If there is any acute pain while doing the test and exercise, the patients must stop doing it immediately. Pain management is also important. According to a study conducted in 2021, a period of isometric training can help you alleviate your knee pain to a great extent and improve semantic function. Isometric exercise is a cost-free, convenient, and safe exercise program that has no side effects. It is a good choice for controlling and reducing pain [9]. When returning to sports, pain management is crucial for optimal recovery.

2.6. Motion and Mechanism

Having good motion and mechanism is crucial for people to do sports because it can not only help people obtain a better athletic performance but also help people prevent injury. Therefore, learning proper motion is a prime goal in the rehabilitation of ACL injury. When rehabbing, learning a proper

motion first can help the patient reduce pain when moving, progress faster, and give them more confidence. What's more, it can prevent over-use injury of the joint, such as chondromalacia patella, which is an irreversible injury. The patient should master proper walking motion, running motion, jumping motion, landing motion, twisting motion, quoting motion, sidesteps slide, and so on. Heavy eccentric quadriceps contractions and knee adduction moments, according to a recent study, can boost joint compressive force and reduce the risk of injury. Strong eccentric quadriceps contractions and knee position of moments, according to a recent study, can boost joint compressive force and reduce the risk of injury. [10]. So, it is important to reduce knee abduction when running, jumping, and landing to prevent re-injury.

2.7. Single-leg Hop Test

Single-leg hop is typically used in testing the functional performance of patients with ACL injury and it has been proven to be a reliable measurement to test if the patient can back to play after that injury. When doing the measurement, the participant is told to jump forward by using one leg and land stably [11]. The patient will start with a onefold hop, a cubic hop then a timed jump, and finally a triple side hop (Fig 2 shows those forms of hop test). After measuring the hop distances of the healthy leg and the injured leg, the patient can decide whether to make a return to play decision or not. A paper shows that the 6m timed hop and the single hop distance have the best prediction of who is safer to return to play, and the triple hop distance scores showed the strongest anticipative possibility for re-injury. The paper also recommended the hop test not only as a tool for reducing re-injury risks but also as an aim to help the patient achieve previous athletic performance [12]. In conclusion, the single-leg hop test is a measurement with high accuracy and reliability. Also, it is easy to do in a simple place without complex equipment and is fully cost-free.

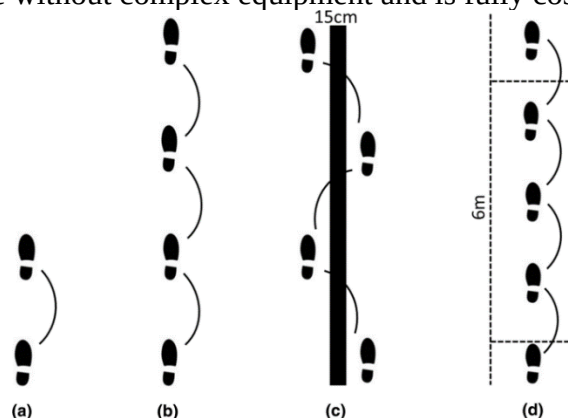


Fig. 2 Single-leg hop test image [11].

2.8. Psychological Factor

Most individuals are unaware of the crucial role that psychology plays. In a 2019 study involving 2918 patients, it was shown that two-thirds of patients were able to return to play (RTP), however one-third of these patients were unable to function as well as they had been able to before their injury. 514 of 795 patients who were not able to resume sports did so due to psychological difficulties. The majority of them (76.7%) displayed re-injury dread. Other psychological factors include despair, a lack of drive, and lack of confidence in the injured knee [13]. The outcomes of all of these studies demonstrate that psychological issues frequently get a factor in a patient's decision to return to sport or not. The paper recommended mental rehabilitation besides physical rehabilitation to help the athlete better return to play [14]. Therefore, no matter whether a player returns to play or not, they should keep monitoring their psychological condition in order to predict future reinjury possibilities. In addition, psychological improvement and physical improvement could have a mutual effect, which means a better mindset can promote the patient's training, and performance and finally let them return to play. Also, better training performance can give patients more confidence and adjust and improve their mentality. However, when bad physical performance and bad mentality occur, negative

interactions may come up too. In conclusion, Patients should strive to maintain a balance between their mindset and physical well-being and cultivate a positive psychological outlook. It is important to pay attention to both mental and physical health in order to achieve overall wellness and return to play.

3. Conclusion

This review summarizes the various factors that determine whether a patient with an ACL injury can return to playing sports. The criteria for returning to sports after an ACL injury is not fixed and depends on several factors such as the patient's age, gender, height, weight, and previous level of physical activity. Moreover, with the advancement of sports science theory and equipment, the criteria are continuously evolving. Therefore, patients should consider their own conditions, requirements, their doctor's advice, the physical therapist's suggestions, and information from different studies before deciding whether to return to playing sports. If they decide to return to sports, they should also consider the playing frequency, training frequency, and the level they can play safely.

References

- [1] Li Z, Ren S, Zhou R, et al. Deep Learning-Based Magnetic Resonance Imaging Image Features for Diagnosis of Anterior Cruciate Ligament Injury. *Journal of Healthcare Engineering*, 2021, 2021: e4076175.
- [2] Coffey R, Bordoni B. Lachman Test. In: *StatPearls*. Treasure Island (FL): StatPearls Publishing; July 24, 2023..
- [3] Biggs A, Jenkins WL, Urch SE, Shelbourne KD. Rehabilitation for Patients Following ACL Reconstruction: A Knee Symmetry Model. *N Am J Sports Phys Ther*. 2009, 4(1): 2-12.
- [4] Golberg E, Sommerfeldt M, Pinkoski A, et al. Anterior Cruciate Ligament Reconstruction Return-to-Sport Decision-Making: A Scoping Review. *Sports Health: A Multidisciplinary Approach*, 2023: 194173812211475.
- [5] SCHMITT L C, PATERNO M V, FORD K R, et al. Strength Asymmetry and Landing Mechanics at Return to Sport after Anterior Cruciate Ligament Reconstruction. *Medicine & Science in Sports & Exercise*, 2015, 47(7): 1426–1434.
- [6] Dhinakar (Dhinu) J. Jayaseelan, Courtney C A, Kecman M, et al. Lumbar manipulation and exercise in the management of anterior knee pain and diminished quadriceps activation following acl reconstruction: a case report.. *PubMed, National Institutes of Health*, 2014, 9(7): 991–1003.
- [7] Clagg S, Paterno M V, Hewett T E, et al. Performance on the Modified Star Excursion Balance Test at the Time of Return to Sport Following Anterior Cruciate Ligament Reconstruction. *Journal of Orthopaedic & Sports Physical Therapy*, 2015, 45(6): 444–452.
- [8] Collins N J, Prinsen C A C, Christensen R, et al. Knee Injury and Osteoarthritis Outcome Score (KOOS): systematic review and meta-analysis of measurement properties. *Osteoarthritis and Cartilage*, 2016, 24(8): 1317–1329.
- [9] Kangeswari P, Murali K, Arulappan J. Effectiveness of Isometric Exercise and Counseling on Level of Pain Among Patients With Knee Osteoarthritis. *SAGE Open Nursing*, 2021, 7: 237796082199351.
- [10] Boden B P, Sheehan F T. Mechanism of non - contact ACL injury: OREF Clinical Research Award 2021. *Journal of Orthopaedic Research*, 2022, 40(3): 531–540.
- [11] Cristiani R, Mikkelsen C, Edman G, et al. Age, gender, quadriceps strength and hop test performance are the most important factors affecting the achievement of a patient-acceptable symptom state after ACL reconstruction. *Knee Surgery, Sports Traumatology, Arthroscopy*, 2019, 28(2): 369–380.
- [12] Davies W T, Myer G D, Read P J. Is It Time We Better Understood the Tests We are Using for Return to Sport Decision Making Following ACL Reconstruction? A Critical Review of the Hop Tests. *Sports Medicine*, 2019, 50(3): 485–495.

- [13] Nwachukwu B U, Adjei J, Rauck R C, et al. How Much Do Psychological Factors Affect Lack of Return to Play After Anterior Cruciate Ligament Reconstruction? A Systematic Review. *Orthopaedic Journal of Sports Medicine*, 2019, 7(5): 232596711984531.
- [14] Vutescu E S, Orman S, Garcia-Lopez E, et al. Psychological and Social Components of Recovery Following Anterior Cruciate Ligament Reconstruction in Young Athletes: A Narrative Review. *International Journal of Environmental Research and Public Health*, 2021, 18(17): 9267.