# A Comprehensive Functional Capacity Evaluation for the Determination of Safe Return to Play Following ACL Reconstruction

*Christopher G. Larsen[1], Cody S. Lee[2], Christopher O'Hara[1], Kurt A. Gengenbacher[3], Steven C. Chudik, MD[4]*

*Loyola University Chicago Stritch School of Medicine[1], University of Chicago Pritzker School of Medicine[2], ATI Physical Therapy[3], Orthopaedic Surgery and Sports Medicine Teaching and Research Foundation[4]*

## Introduction

Accounting for up to 64% of knee ligament injuries incurred in cutting and pivoting sports, anterior cruciate ligament (ACL) tears are one of the most common knee ligament injuries in athletes[1]. Patients lacking an intact ACL have a significant risk of functional instability, damage to the menisci and articular cartilage, and osteoarthritis; therefore, reconstruction of the torn ACL is often performed with the goal of restoring stability to the knee and decreasing risk of subsequent injury[2,3]. Advances in ACL reconstruction (ACLR) and rehabilitation have led to improved outcomes and expedited return to play (RTP), however there is a tremendous amount of variability in the criteria used by physicians to give clearance for RTP following ACLR[4]. A systematic review by Barber-Westin and Noyes[5] reported that out of 264 studies, 40% failed to provide any criteria for RTP after surgery and only 13% utilized objective criteria. Furthermore, although some studies suggest that most patients are able to RTP within the first year after ACLR, RTP rates have not been consistently reported in the literature and when reported it is often unclear if the definition of RTP includes safety and reinjury rates.[4,6] In this study, we describe a comprehensive Functional Capacity Evaluation (FCE) developed to include the assessment tools that have the most validity according to the literature and evaluate its ability to predict safe RTP.

**Figure 1:** Patient performing landing-form assessment as part of FCE.

## Methods

The FCE consists of three separate components: subjective, clinical, and functional. The subjective component is comprised of questionnaires to track self-reported outcomes (IKDC, KOS-ADL, and KOS-sport)[7,8,9]. The clinical component includes assessment for effusion, active ROM, passive ROM, and strength of the muscles surrounding the knee. The functional component consists of a landing form assessment (Figure 1), hop testing, and three task specific qualitative assessments: hop testing, shuttle run, and vertical jump. All components are administered sequentially once the patient's physician has determined that the patient might be ready to RTP. If at any point during the FCE the patient fails a component, the test ends and recommendations are given to the patient so that they can address deficiencies before retaking the FCE with additional rehabilitation. Testing was performed on 54 randomly selected subjects who previously underwent ACLR performed by the senior author (SCC). A total of 72 FCEs were administered to the subjects with a mean age of 22.51 (range 11-58) years at time of evaluation. Error is reported as standard deviations and statistical analysis was performed using heteroscedastic student's t-tests and Chi-squared tests using Microsoft Excel.

| | Passed | Failed |
|---|---|---|
| **Number of patients** | 39 | 26 |
| **Number of FCEs** | 41 | 31 |
| **Age (years)†** | 20.0±9.8 | 25.8±12.7 |
| **Female:Male** | 1.28 | 1.82 |
| **Days post-op prior to FCE** | 237.6±92.8 | 276.1±204.4 |
| **IKDC†** | 90.9±7.8 | 79.5±11.4 |
| **KOS-ADL†** | 95.8±6.5 | 89.3±11.2 |
| **KOS-sport†** | 93.1±10.1 | 83.9±14.2 |
| **QI*†** | 94.5±5.5 | 77.5±16.7 |
| **Ipsilateral reinjury†** | 1 (2.6%) | 4 (24%#) |
| **Contralateral reinjury** | 2 (5.1 %) | 0 (0.0%) |

*Score of 90 needed to pass

#Percentage of patients who never passed FCE or were known to RTP before passing

†$p < 0.05$

**Table 1:** Summary table of the data collected from Functional Capacity Evaluations.

| | No reinjury | Ipsilateral reinjury |
|---|---|---|
| **IKDC†** | 78.3±6.2 | 87.3±5.8 |
| **KOS-ADL** | 88.6±11.8 | 94.2±3.5 |
| **KOS-Sport** | 83.3±14.1 | 86.5±16.6 |

†$p < 0.05$

**Table 2:** Comparison of self-reported subjective scores for patients who failed the FCE. Those who sustained ipsilateral knee reinjury had higher subjective scores on all three questionnaires.

## Results

Of the 72 FCEs administered, 41 were passed and 31 failed. Of the 31 failed attempts, 20 failed the clinical component (avg. quadriceps index [QI] 69.23), and 11 failed the functional component (2 landing form, 8 shuttle run, and 1 vertical jump). Failed FCEs were found to be associated with significantly increased age and lower self reported scores on all subjective questionnaires (Table 1). Many subjects who failed repeated the FCE after additional physical therapy was completed to address their deficiencies. Of the 26 patients who failed on the first attempt, 11 subsequently passed and 15 never passed. For patients who failed the FCE and then passed on a later attempt, the most notable difference was an increase in their quadriceps strength, improving their quadriceps index (QI) from 74.4 to 93.2 (p=0.008).

Of those who passed and were cleared for RTP, only one subject (2.6%) sustained an injury to the reconstructed knee, for which arthroscopic loose body removal, but not a revision ACLR, was recommended. MRI showed that this patient's ACL graft remained intact. Two patients (5.1%) who passed the FCE subsequently tore their contralateral ACLs, for which both underwent ACLR and then went on to pass another FCE and RTP without reinjury.

Of those patients who failed FCE and chose to RTP before passing the FCE, four sustained reinjury to the ipsilateral knee (24% of patients who never passed FCE or known to RTP before passing). Three had arthroscopic procedures to address damaged menisci and cartilage and one had documented meniscal damage but chose not to undergo another operation. No damage to the ACL graft was reported in any of these patients. Patients who reinjured the ipsilateral leg after failing the FCE reported higher subjective scores with significantly higher IKDC scores and KOS-ADL and KOS-Sport scores that trended higher, but were not significant (Table 2).

Further data regarding long term patient satisfaction and outcomes is currently being gathered from the patients in this cohort.

## Conclusion

The FCE demonstrated a significant ability to determine whether a patient was ready for safe RTP based on ipsilateral reinjury rates (2.6% vs. 15.4%, p = 0.008). Two injuries to the contralateral ACL were seen in patients who passed the FCE, however this may be a consequence of those individuals being susceptible to ACL injury. Patients who passed the FCE reported significantly higher subjective scores and demonstrated greater quadriceps strength than those who failed. In fact, the greatest improvement seen in patients who passed the FCE on a second attempt was in quadriceps strength (QI). Interestingly, patients who failed the FCE and sustained an injury to the operative knee reported significantly higher IKDC scores and KOS-ADL and KOS-Sport scores that trended toward being higher, which supports the idea that subjective scores alone may be misleading and may reflect confidence to return to more high-risk athletic maneuvers. We believe this comprehensive FCE can be utilized to standardize the process of advising patients wishing to RTP following ACLR.

## References

[1]Rishiraj N, Taunton JE, Lloyd-Smith R, et al. The potential role of prophylactic/functional knee bracing in preventing knee ligament injury. *Sports Med.* 2009;39(11):937-960.
[2]Spindler KP, Kuhn JE, Freedman KB, et al. Anterior cruciate ligament reconstruction autograft choice: bone-tendon-bone versus hamstring: does it really matter? A systematic review. *Am J Sports Med.* 2004;32(8):1986-1995.
[3]Kaeding CC, Pedroza AD, Reinke EK, et al. Risk factors and predictors of subsequent ACL injury in either knee after ACL reconstruction. *Am J Sports Med.* 2015;43(7):1583-1590.
[4]Ellman MB, Sherman SL, Forsythe B, et al. Return to play following anterior cruciate ligament reconstruction. *J Am Acad Orthop Surg.* 2015;23(5):283-296.
[5]Barber-Westin SD, Noyes FR. Factors used to determine return to unrestricted sports activities after anterior cruciate ligament reconstruction. *Arthroscopy* 2011;27(12):1697-1705.
[6]Myklebust G, Bahr R. Return to play guidelines after anterior cruciate ligament surgery. *Br J Sports Med.* 2005;39(3):385-401.
[7]Hefti F, Muller W, Jakob RP, et al. Evaluation of knee ligament injuries with the IKDC form. *Knee Surg Sports Traumatol Arthrosc*. 1993;1(3-4):226-234.
[8]Irrgang JJ, Snyder-Mackler L, Wainner RS, et al. Development of a patient-reported measure of function of the knee. *J Bone Joint Surg Am.* 1998;80(8):1132-1145.
[9]Bradbury M, Brosky JA, Walker JF, et al. Relationship between scores from the Knee Outcome Survery and a single assessment numerical rating in patients with patellofemoral pain. *Physiother Theory Pract.* 2013;29(7):531-535.

Orthopaedic Surgery & Sports Medicine Teaching & Research Foundation

LOYOLA UNIVERSITY CHICAGO STRITCH SCHOOL of MEDICINE

ATI PHYSICAL THERAPY

THE UNIVERSITY OF CHICAGO PRITZKER SCHOOL OF MEDICINE

STEVEN CHUDIK MD SHOULDER & KNEE INJURY CLINIC