

Original Research

Administering the ACL-RSI Before or After ACL Functional Testing: Does It Matter?

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Background

Psychological readiness after anterior cruciate ligament reconstruction (ACLR), as measured by the Anterior Cruciate Ligament–Return to Sport after Injury (ACL-RSI) scale, has become a critical factor in determining an athlete's ability to return to sport. While the ACL-RSI is widely used, the influence of the timing of its administration in relation to physical performance testing has not been studied.

Purpose/Hypothesis

The primary aim of this study was to investigate the differences in ACL-RSI scores and subscale scores assessed up to one week before versus immediately after exposure to objective physical performance testing, but prior to reviewing the results with the athlete.

Study Design

Prospective case series.

Methods

Fifty athletes recovering from ACLR participated in this study. The ACL-RSI questionnaire was administered within one week prior to and immediately after completing a return-to-sport physical performance testing battery. The testing included elements assessing maximum volitional force production, explosiveness, and hopping and landing ability. Changes in overall ACL-RSI scores and its subscales (emotions, confidence in performance, and risk appraisal) were analyzed.

Results

No significant differences were found in ACL-RSI scores pre- to post return to sport testing (-2.27 , $p=0.125$). However, there was a significant decrease in the emotions subscale (-5.08 , $p=0.006$), suggesting that physical testing may negatively impact emotional readiness. The confidence in performance and risk appraisal subscales did not show significant changes. Despite no statistical differences in ACL-RSI scores pre- to post return to sport testing, 20% of participants exhibited a change in ACL-RSI scores that exceeded the minimal clinically important difference (MCID), highlighting individual variability in psychological responses to testing.

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Conclusion

The findings suggest that administering the ACL-RSI after physical performance testing may provide a more accurate assessment of some athletes' psychological readiness to return to sport. The significant reduction in the emotions subscale underscores the need for further research into the emotional impact of physical testing.

Level of Evidence

3b

INTRODUCTION

Anterior cruciate ligament (ACL) injury, reconstruction, and rehabilitation remain among the most extensively studied orthopedic conditions. Such injuries significantly disrupt athletes' activities, potentially curtailing careers, reducing playing time, and leading to a gradual decrease in activity over time.^{1,2} The incidence of ACL injuries has been rising, reported at 30 to 68 per 100,000 person-years.³

The primary goals following ACL reconstruction (ACLR) include restoring knee stability, range of motion, and strength to facilitate the return to daily activities, recreation, and sports. Recent evidence highlights the significant psychological and emotional impacts associated with ACL injuries, surgeries, and rehabilitation. Barriers to full recovery include fear of re-injury, lack of confidence in the affected limb, persistent knee symptoms, motivation issues, and kinesiophobia.⁴⁻⁹ Fear of re-injury and lack of confidence were identified as limiting factors for returning to sports by 62% of female soccer players.¹ Furthermore, these psychological factors can affect neuromuscular performance, as individuals with higher fear of re-injury demonstrate altered motor planning strategies during tasks like the single-leg rebound side-hop.¹⁰

The Anterior Cruciate Ligament–Return to Sport after Injury (ACL-RSI) scale is a validated tool used to assess an athlete's psychological readiness to return to sports following ACLR and rehabilitation.¹¹ Comprising 12 questions, the ACL-RSI evaluates emotions (5 questions), confidence in performance (5 questions), and risk appraisal (5 questions) (Table 1). Each question is typically scored on a scale of 0-100 in either 5 or 10 point increments.^{11,12} The descriptions "extremely" or "not at all" are placed at opposite ends of the scale and higher scores reflect a more positive psychological response. A total score is calculated by adding the score from each question and averaging among all scores resulting in a score between 0-100.¹¹ For each subscale, the total score from questions of the subscale was summed and averaged resulting in a score between 0-100. Previous literature has shown an association between higher ACL-RSI scores and self-reported knee function,¹³ as well as return to sport rates.⁸ Additionally, lower ACL-RSI scores have been associated with reinjury rates as Mcpherson et al.¹⁴ reported a score of 71.5 ± 19.3 in a cohort that did not sustain reinjury versus 60.8 ± 19.1 in those that did go on to reinjure their ACL. Conversely, Zarzycki et al.¹⁵ reported those that went on to sustain a second ACL injury had higher scores than those that did not sustain a second ACL injury (82.2 ± 10.9 versus 70.3 ± 19.3 respectively). The authors postulated that this may be

Table 1. ACL-RSI Questions by Subscale

<i>Emotions</i>
Are you nervous about playing your sport?
Do you find it frustrating to have to consider playing your sport?
Do you feel relaxed about playing your sport?
Are you fearful of re-injuring your knee by playing your sport?
Are you afraid of accidentally injuring your knee by playing your sport?
<i>Confidence in performance</i>
Are you confident that your knee will not give way by playing your sport?
Are you confident that you could play your sport without concern for your knee?
Are you confident about your knee holding up under pressure?
Are you confident that you can perform at your previous level of sport participation?
Are you confident about your ability to perform well at your sport?
<i>Risk appraisal</i>
Do you think you are likely to re-injure your knee by participating in your sport?
Do thoughts of having to go through surgery and rehabilitation again prevent you from playing your sport?

due to some athletes being overconfident in their abilities and returning to sport before they are ready. Previous articles have reported a minimal clinically important difference (MCID) in ACL-RSI score for a group ranging from 2.0 – 2.6 and an MCID at the individual level to be 15.3 – 15.8,^{16, 17} while others have suggested an MCID of 10 based on face validity.¹³ Practitioners can utilize it throughout the rehabilitation process to gauge an athlete's self-perceived progress towards their goals and readiness to resume their previous level of activity.

Athletes who successfully return to their prior level of sport or activity tend to score higher on various patient-reported outcome measures, with the ACL-RSI being the most reliable indicator of return to pre-injury function in some populations.¹⁸ Higher pre-operative and four-month post-operative ACL-RSI scores have been predictive of returning to sport by 12 months post-injury.⁸ Interestingly, females have previously been shown to have lower ACL-RSI scores and lower return to sport rates following injury compared to male counterparts.¹⁹

The relationship between objective testing scores and psychological readiness has been explored in several studies with mixed results. In a cohort of 635 participants post-ACLR, greater symmetry in the single hop for distance test correlated with higher ACL-RSI scores.¹⁹ Additionally, greater quadriceps strength has been associated with higher psychological readiness.²⁰ Ueda et al. (2022) found that achieving over 90% limb symmetry index (LSI) for isokinetic hamstring strength and single hop for distance was linked to higher ACL-RSI scores, though this was not the case for quadriceps strength.²¹ Sugarman et al.²² observed greater isometric hamstring strength in individuals with ACL-RSI scores above 74 but found no association between ACL-RSI scores and quadriceps strength, triple hop distance, or triple crossover hop distance. Similarly, O'Connor et al.²³ reported minimal relationships between ACL-RSI scores and various strength and power metrics nine months post-ACLR. Della Villa et al.²⁴ suggested that the injury mechanism might confound the relationship between psychological readiness and quadriceps strength symmetry, noting a positive correlation in non-contact injuries but not in contact injuries.

A potential confounding factor in the inconsistent findings regarding the association between objective physical measures and psychological readiness may be the timing of assessment completion. Clinical practice varies, with some practitioners administering the ACL-RSI as intake paperwork prior to objective testing, while others do so post-testing. It is plausible that exposure to objective testing itself, rather than the test results, influences psychological readiness. Completing objective tests may expose athletes to sport-specific physical demands such as maximum volitional force production, explosiveness, and hopping and landing ability, positively affecting psychological readiness if they perceive their performance as good, or negatively if perceived poorly. Although ACL-RSI scores generally improve over time in athletes intending to return to sports,²⁵ the timing of completing the ACL-RSI in relation to objective testing exposure has not been previously investigated.

Therefore, the primary aim of this study was to investigate the differences in ACL-RSI scores and subscale scores assessed up to one week before versus immediately after exposure to objective physical performance testing, but prior to reviewing the results with the athlete. The authors hypothesized that psychological readiness scores will significantly differ before versus after completing objective physical performance testing.

METHODS

SUBJECTS

Participants were recruited in this prospective cohort as a convenience sample from patients who were scheduled to undergo return-to-sport testing following ACLR at the study's institution between May 2020 and March 2023. Patients were included if they intended to return to their pre-injury sporting activity and were completing the facility's return to sport testing battery for the first time. Exclusion

criteria were the injury occurring in a non-sport related activity, the participant having previously completed the facility's return to sport testing battery, and any prior ACL injuries on the ipsilateral or contralateral limb. This study was approved by the Lawrence Memorial Hospital Institutional Review Board (IRB). Verbal explanation of the study was provided to the participants and they were given the opportunity to ask any study-related questions prior to participating and opt out if they chose. The IRB determined that written consent was not necessary as the study involved standard clinical procedures and the data collected was considered minimal risk, so verbal consent would suffice. All participants gave verbal consent prior to participation. Participant demographics were obtained from the medical record.

PROCEDURES

Within seven days prior to completing return to sport testing, participants completed the ACL-RSI questionnaire. For those that had a physical therapy session in that time frame, the questionnaire was completed at the facility in written format. For those that did not have an appointment in that time frame, the questionnaire was emailed to them to complete. This time frame was chosen as it was reasonably expected that participants' objective physical qualities would not significantly change in one week. At the return to sport testing appointment, testing was conducted by any of nine staff physical therapists that were currently trained in administering the facility's standard testing protocol. The testing protocol can be viewed in detail in Appendix A. Briefly, it involved several tests to objectify participants' lower extremity maximum volitional force production (isokinetic knee flexion and extension), explosiveness (single leg vertical jump and single leg drop vertical jump), and hopping and landing ability (single forward hop, triple forward hop, triple crossover hop, 6 meter timed hop, lateral 3-cone hop, and ACL side hop). Upon completion of testing but prior to receiving test results and feedback from the therapist, the participants again completed the ACL-RSI.

STATISTICAL ANALYSIS

The researchers performed an *a priori* power analysis to determine sample size using G*Power (Version 3.1.9.3). Using data for psychological readiness for return to sport from Webster et al.,²⁶ a sample size of 40 was calculated to detect a moderate effect ($d=0.5$) with an alpha level of 0.05 and a power of 0.8. Participant demographics were reported using means with standard deviations for continuous variable and frequencies for nominal variables. Paired t-tests were used to determine differences in total ACL-RSI score and the individual subscales pre- to post return to sport testing. All statistical tests were performed with an alpha level of 0.05. Effect sizes were calculated using Cohen's d , with cutoffs of 0.2, 0.5, and 0.8 defined as small, medium, and large respectively.

Table 2. Participant Demographics

	Mean	SD
Age (years)	22.3	7.7
Height (cm)	173.8	10.9
Weight (kg)	77.2	20.5
BMI	25.4	5.5
	Frequency	
Sex (Female/Male)	22/28	
Concomitant Surgery (meniscus repair/other)	26/9	
Sport		
Basketball	15	
Football	12	
Soccer	10	
Ultimate Frisbee	2	
Volleyball	3	
Tennis	1	
Baseball	2	
Wrestling	3	
Other	2	
Level of competition (Rec/HS/ College)	17/23/10	
Involved limb (Left/Right)	22/28	
Graft type (ham/BPTB/allograft)	45/1/4	

BPTB=bone patellar tendon bone autograft, cm=centimeters, ham=hamstring autograft, HS=high school, kg=kilograms, Rec=recreational, SD=standard deviation

RESULTS

Fifty individuals participated in this study (Table 2). The difference in ACL-RSI score from pre- to post return to sport testing was not significant (-2.27 , $p=0.125$). The change in score from pre- to post return to sport testing was significant for the emotions subscale (-5.08 , $p=0.006$), but not the confidence in performance (-0.68 , $p=0.689$) or risk appraisal subscales (0.80 , $p=0.688$) (Table 3).

As a secondary analysis, the authors investigated how many participants showed a change in ACL-RSI score that exceeded the MCID. Previous articles have reported an

MCID for a group ranging from $2.0 - 2.6$ and an MCID at the individual level to be $15.3 - 15.8$.^{16,17} Ten participants (20%) did exhibit a change in score that exceeded these previously established individual MCIDs (Figure 1). This was only investigated for the total ACL-RSI score and not any of the subscales since MCIDs have not been established for the subscales to the authors' knowledge.

DISCUSSION

The primary aim of this study was to assess changes in ACL-RSI scores taken before and immediately after exposure to objective physical performance testing. The findings indicate that the overall change in ACL-RSI scores from pre- to post return to sport testing was not statistically significant (-2.27 , $p=0.125$). However, a significant decrease was observed in the emotions subscale (-5.08 , $p=0.006$), suggesting that exposure to physical performance testing may impact athletes' emotional responses. In contrast, the confidence in performance (-0.68 , $p=0.689$) and risk appraisal (0.80 , $p=0.688$) subscales did not show significant changes.

The significant reduction in the emotions subscale may be important as Webster and Feller²⁶ found the emotions subscale to be a strong predictor for adolescents successfully returning to sport while the confidence in performance and risk appraisal subscales showed poor predictive ability. The authors suggested that a subset of adolescent athletes may have a strong identity based on their athletic role which could relate to more emotional disturbance following an ACL injury. Additionally, McPherson et al.¹⁴ reported that adolescent athletes who scored lower on the emotions subscale at 12 months after surgery were associated with a higher risk of sustaining an ACL reinjury. While our cohort was not strictly adolescents, it is plausible that if an athlete perceived that they tested poorly, their immediate response may more closely reflect emotions rather than their confidence or risk. In a large network analysis of 441 individuals, Liew et al.²⁷ reported the ACL-RSI items regarding fear of re-injury and being relaxed about playing sport, both of which are emotions subscale questions, to best describe return to sport readiness. These findings warrant further investigation of the emotions subscale in relation to exposure to return to sport testing.

Table 3. Pre- to Post Return to Sport Testing Change in ACL-RSI and Subscales Scores

Change in ACL-RSI and Subscales						
	Mean	SD	p value	95% CI		Effect Size (Cohen's d)
ACL-RSI	-2.27	10.27	0.125	-5.18	0.65	-0.221
Subscales						
Emotions	-5.08	12.45	0.006*	-8.62	-1.54	-0.408
Confidence in Performance	-0.68	11.94	0.689	-4.07	2.71	-0.057
Risk Appraisal	0.80	14.01	0.688	-3.18	4.77	-0.057

*=statistically significant ($p<0.05$), CI=confidence interval, SD=standard deviation

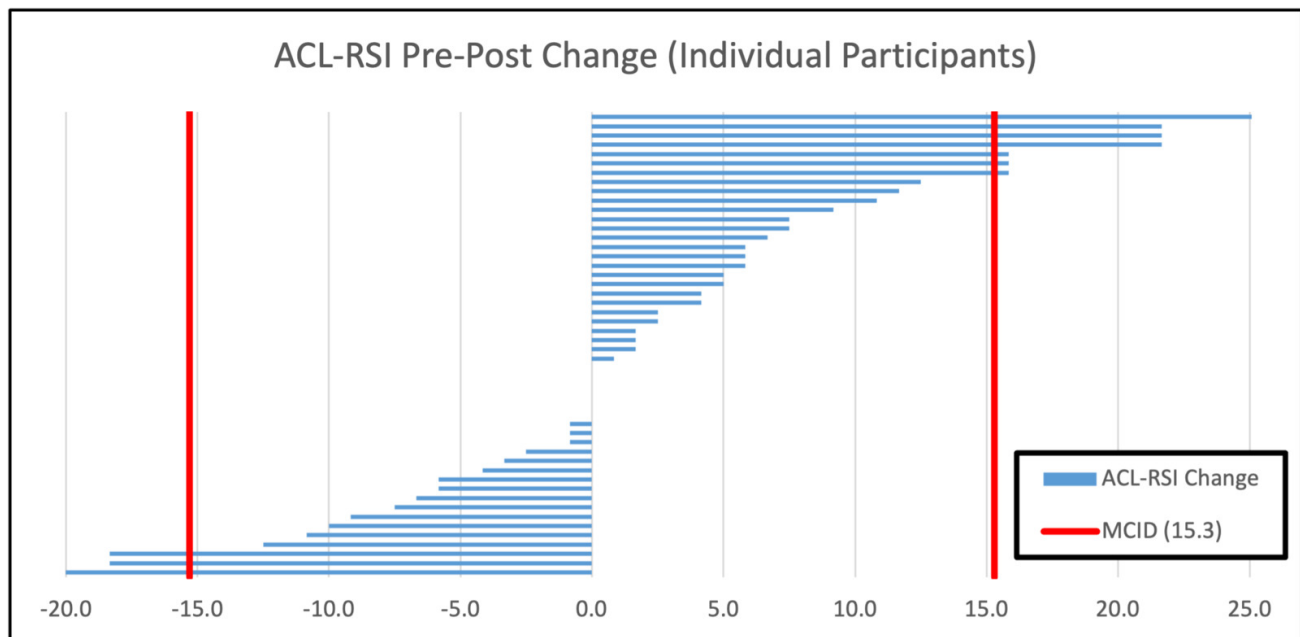


Figure 1. Change in ACL-RSI score from pre- to post return to sport testing by individual. Some individuals scored higher on the post test, some scored lower, and some scored the same as this figure represents. The red line represents the MCID for an individual as previously established by Slagers et al.¹⁶ as 15.3.

In previous studies by Slagers et al.¹⁶ and Faleidi et al.,¹⁷ the minimal clinically important difference (MCID) for an individual rather than a group was determined to be 15.3 and 15.8 respectively.^{16,17} Interestingly, despite the non-significant overall change in ACL-RSI scores, 20% of participants (10 out of 50) exhibited a change that exceeded the MCID. This finding underscores the individual variability in psychological responses to exposure to return-to-sport testing and highlights that a subset of athletes experienced clinically meaningful changes in their self-perceived psychological readiness post-testing. Similar individual variability in psychological responses has been noted in other studies, emphasizing the need for personalized approaches in rehabilitation.^{8,14} It may be that the individuals exceeding the MCID had not previously been exposed to situations in rehabilitation involving maximum volitional force production, explosiveness, and hopping and landing ability, and testing was their first exposure to one or more of these stimuli. Those who had already been exposed to these stimuli may have a more accurate representation of their self-perceived readiness to return to sport. This is just speculation as the rehabilitation process was not controlled for in this study.

Based on the current findings, the authors suggest that the ACL-RSI should be completed after exposure to physical performance testing rather than before. Completing the ACL-RSI post-testing may provide a more accurate assessment of an athlete's self-perceived readiness to return to sport. This approach may help clinicians better tailor rehabilitation programs to address both the physical and psychological needs of athletes recovering from ACL reconstruction. This recommendation is supported by recent findings that the timing of psychological assessments

across the duration of rehabilitation can significantly influence the outcomes.²⁵

Overall, the results of the current study indicate that while the average change in ACL-RSI scores was not significantly different between pre- and post-physical performance testing, a subset of participants experienced significant changes that could impact their rehabilitation outcomes. Clinicians should also be aware of the potential emotional impact of physical performance testing and consider incorporating psychological support as part of comprehensive ACL rehabilitation programs. Future research should explore the factors contributing to the variability in psychological responses and develop strategies to mitigate negative emotional impacts. Longitudinal studies are also needed to understand the long-term effects of physical performance testing on psychological readiness and return-to-sport outcomes.

This study has several limitations. While testing occurred at one location, rehabilitation was conducted at various locations and not standardized. While this may increase ecological validity, it also could reasonably have resulted in participants having differing levels of exposure to circumstances involving maximum volitional force production, explosiveness, and hopping and landing ability prior to completing their return to sport test. Additionally, while participants completed their pre-testing ACL-RSI within one week prior to return to sport testing, some completed it the same day of testing. This could have introduced a recency bias where they marked nearly the same scores when filling out the ACL-RSI after testing.

CONCLUSION

The results of this study showed that exposure to return to sport testing involving maximal volitional force production, explosiveness, and hopping and landing ability did not influence overall ACL-RSI scores in a group of 50 individuals after ACLR, however the emotions subscale score decreased after testing. A meaningful proportion of participants (20%) did exhibit a clinically important change in ACL-RSI score.

DISCLOSURES

The authors declare no conflicts of interest.

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SUPPLEMENTARY MATERIALS

Appendix A

Download: <https://ijspt.scholasticahq.com/article/138310-administering-the-acl-rsi-before-or-after-acl-functional-testing-does-it-matter/attachment/283661.docx>
