Kinesiophobia Is Negatively Associated With Psychological Readiness to Return to Sport in Patients Awaiting Anterior Cruciate Ligament Reconstruction

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Purpose: To identify the factors associated with anterior cruciate ligament return to sport after injury (ACL-RSI) scores in patients awaiting ACL reconstruction (ACLR). **Methods:** This was a retrospective cross-sectional observational study conducted at a single clinical center. We recruited patients scheduled for primary ACLR, aged 16−45 years, and with modified Tegner activity scale scores ≥5 before ACL injury. The main outcome was psychological readiness to return to sport (RTS), as measured using the ACL-RSI scale. Participants' personal and injury-related information were obtained, and their psychological status (Tampa Scale for Kinesiophobia [TSK] and athletic identity measurement scale) and knee functions (effusion, range of motion, joint stability, and knee flexion angle during a single-leg squat) were examined. All variables were assessed the day before the surgery. **Results:** A total of 105 patients (median [interquartile range]: age, 20.0 [9.0] years; body mass index, 22.8 [4.3] kg/m^2; days from injury to surgery, 63.0 [65.0] days; 44% female) were enrolled. Univariate analysis indicated that only the TSK score was associated with the ACL-RSI scores ($r = -0.305$; $P = .02$). Multiple regression analysis of factors, including sex, preinjury Tegner activity scale score, and days from injury to surgery, further showed that only the TSK score was associated with the ACL-RSI scores ($P = .002$; 95% confidence interval −1.738 to −0.394). **Conclusions:** In patients awaiting ACLR, kinesiophobia was moderately negatively associated with psychological readiness to RTS, while other factors were not. **Level of Evidence:** Level III, retrospective cross-sectional observational study.

Introduction

Psychological readiness to return to sport (RTS) is one of the factors associated with RTS following anterior cruciate ligament reconstruction (ACLR).[1] A representative scale that can be used to assess psychological readiness to RTS is the ACL-RTS after injury (ACL-RSI) scale.[2] Several studies have shown that ACL-RSI scores of those unable to return to their preinjury competitive level sports following ACLR are lower than the scores of those who are able to achieve full RTS.[3-9] Therefore, identifying factors associated with psychological readiness to RTS in post-ACLR patients could help improve their RTS score.

Preoperative psychological readiness to RTS is crucial for postoperative RTS. In a previous study analyzing the association between ACL-RSI scores and RTS to preinjury level sports 12 months after ACLR, preoperative ACL-RSI scores were associated with RTS 12 months after ALCR.[4] Previously, in a cohort study, the preoperative ACL-RSI scores were compared with the ACL-RSI scores 6 months post-ACLR.[10] In the aforementioned study,[10] the ACL-RSI score was used to classify patients into high- and low-score groups based on the scores obtained by the patients 6 months after ACLR (cutoff: 56 points[4]). The results were summarized as follows: ACL-RSI scores increased significantly from those preoperatively to those 6 months post-ACLR in the high-score group; however, the ACL-RSI scores did not show a significant increase in the low-score group.

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This result suggests that a low preoperative ACL-RSI score may be less likely to improve postoperatively. These findings suggest that the factors associated with preoperative ACL-RSI scores still need to be clarified.

Several studies have previously analyzed the factors associated with ACL-RSI scores; however, these studies were conducted in post-ACLR patients.[11-14] Excessive knee laxity and asymmetry of muscle strength or single-leg hop distance were all negatively associated with ACL-RSI scores in post-ACLR patients.[11-14] Laxity differs between knees with damaged ACLs and postreconstruction knees due to structural changes.[15] In a study comparing preoperative and postoperative knee function, the postoperative percentage of limb symmetry index (LSI) ≤85% for single-leg hop distance was improved compared with that observed preoperatively, despite a greater percentage of knee muscle weakness (deficit ≥20%) observed post-ACLR compared with pre-ACLR. These results suggest that the factors affecting the preoperative ACL-RSI score may be different from those affecting the postoperative ACL-RSI score, because of the different functional and structural characteristics before and after ACLR.

Therefore, this study aimed to identify the factors associated with ACL-RSI scores in patients awaiting ACLR. We hypothesized that, in addition to knee dysfunction, psychological factors, such as kinesiophobia, sex, activity level, and length of time since the injury, would be associated with ACL-RSI scores in patients waiting for ACLR.

Methods

Protocol Approval

This study was approved by the Institutional Ethics Committee (approval number: M2019-019-01). Patients admitted prior to November 2019 were given the opportunity to opt out of the study, and patients admitted after December 2019 provided written consent at the time of measurement.

Study Design and Participants

This retrospective cross-sectional observational study was conducted at a single center. All participants in the study were patients scheduled to undergo primary ACLR between March 2017 and April 2021. The inclusion criteria were based on similar previous studies and considering the information that middle-aged patients have very low activity levels and ACL-RSI scores, regardless of their postoperative recovery[16-18]: 1) age 16−45 years at the time of surgery, and 2) participation in sports with a modified Tegner activity scale score[19] of ≥5 before ACL injury. Participants were excluded if they met the following criteria: 1) the exact date of injury was unknown, 2) injury occurred with dislocation of the knee joint, 3) patients underwent another surgery that affected sports participation within the 6 months prior to ACLR, 4) inability to understand the content of the questionnaire due to language barriers, 5) no planned RTS after ACLR, and 6) missing ACL-RSI data.

Procedures

Participants' personal and injury-related information were collected, and their psychological status and knee functions were measured. Any data regarding age, sex, body mass index on the day before ACLR, activity level,[19] type of sport at the time of injury,[20] participation level,[21] and number of days per week spent participating in sports were obtained from participants' medical records. Injury-related information, including date of injury, injury scene,[22,23] type of injury (multiple ligament injuries, meniscus injury, articular cartilage lesion[24]), history of giving way, locking, or catching after injury, and presence of preoperative rehabilitation, were obtained from patients' medical records and questionnaires. Psychological status, including the ACL-

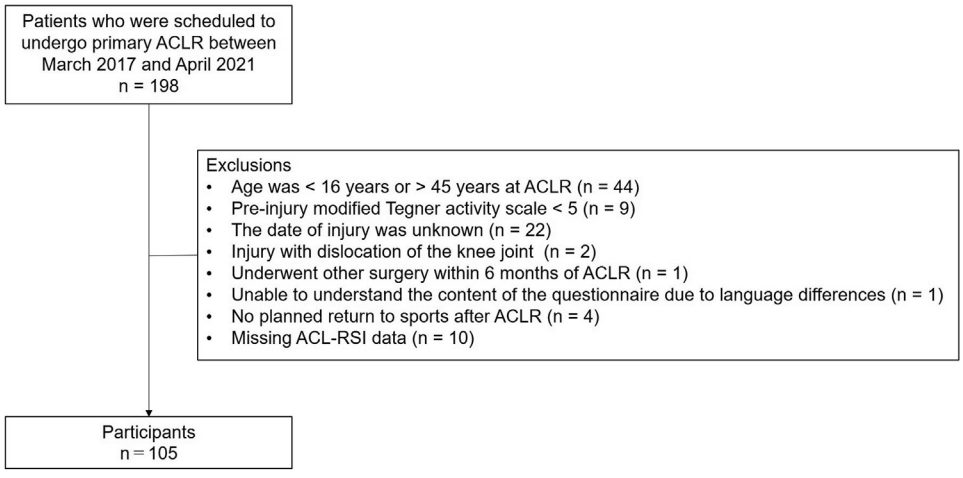

Fig 1. Flowchart showing the participant enrollment process of this study. ACLR, anterior cruciate ligament reconstruction; ACL-RSI, anterior cruciate ligament return to sport after injury scale.

Table 1. Demographic Characteristics of the Study Participants and Their Knee Function

Personal Variables	Age[a]	20.0 (9.0)
	Sex (female/male), *n*	46/59
	Body mass index [a]	22.8 (4.3)
	Preinjury Tegner score [a]	8.0 (2.0)
	Sports classification, *n*	
	Collision	21
	Contact	47
	Limited contact	18
	Noncontact	13
	Fixed-object high-impact rotational landing	6
	Preinjury participation level, *n*	
	Recreation	13
	Competitive	55
	Elite	37
	Days of participation per week [a]	5.0 (3.0)
Injury-related variables	Injury scene, *n*	
	Contact	19
	Indirect	18
	Noncontact	62
	Other	6
	In-sports injury, *n* (%)	104 (99%)
	Multiple-ligament injury (yes/no), *n*	12/93
	Meniscus injury (yes/no), *n*	76/29
	Articular cartilage lesion $\geq$ grade 2 (yes/no), *n*	24/81
	History of giving way after injury (yes/no), *n*	58/47
	History of locking or catching after injury (yes/no), *n*	19/86
	Days from injury to surgery [a]	63.0 (65.0)
	Preoperative rehabilitation (yes/no), *n*	61/44
Psychological variables	TSK [b]	37.7 $\pm$ 5.0
	AIMS [b]	36.0 $\pm$ 7.9
	ACL-RSI [b]	56.4 $\pm$ 17.5
Knee function		
Effusion	Stroke test, *n* (*n* = 104)	
	Zero	60
	Trace	7
	1+	22
	2+	15
	3+	0
Range of motion	Extension deficits (°) (*n* = 105) [b]	−1.1 $\pm$ 2.6
	Flexion deficits (°) (*n* = 102) [b]	−5.2 $\pm$ 6.1
Joint stability (injured side)	Lachman test (absent/firm), *n* (*n* = 101)	95/6
Single-leg squat	Maximum knee flexion angle (injured side) (*n* = 98) [b]	75.2 $\pm$ 15.3
	Limb symmetry index (%) (*n* = 98) [b]	90.1 $\pm$ 13.0

For knee functions, if assessments could not be made due to pain or excessive fear, they were assumed to be missing.

ACL-RSI, anterior cruciate ligament return to sport after injury scale; AIMS, athletic identity measurement scale; TSK, Tampa scale for kinesiophobia.

[a]Data are reported as median (interquartile range) as they are nonnormally distributed.

[b]Data are reported as means $\pm$ SD as they are normally distributed.

RSI score, was measured using questionnaires administered the day prior to surgery. Functional assessment of the knee was performed the day before surgery.

Psychological Questionnaire

In the present study, kinesiophobia (fear of pain due to movement) and athletic identity (self-perception as an athlete) were evaluated as psychological variables potentially related to psychological readiness to RTS. Kinesiophobia was measured using the Japanese version of the Tampa Scale for Kinesiophobia (TSK).[25] The TSK is a 17-item questionnaire with elements scored on a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). Total scores range from 17 to 68, with higher scores indicating greater kinesiophobia. TSK has previously been reported to exhibit strong internal consistency.[26] Athletic identity was assessed using the Japanese version of the

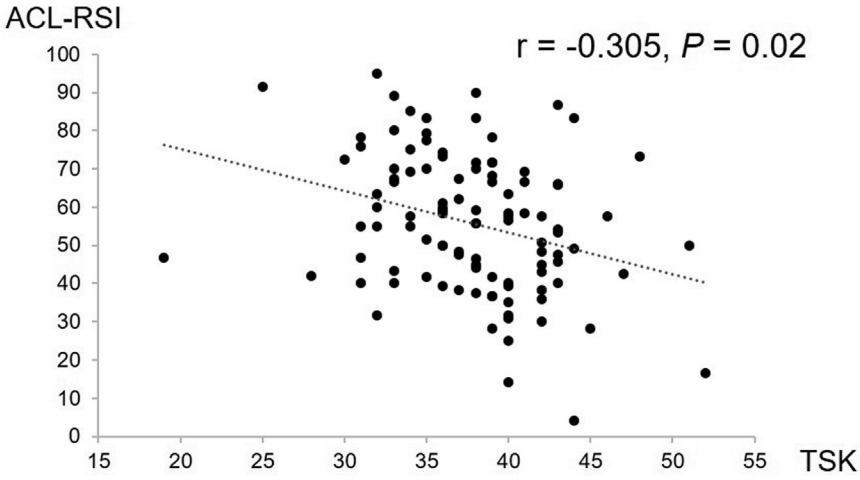

Fig 2. Scatterplots of ACL-RSI scale and TSK and their correlation. ACL-RSI, anterior cruciate ligament return to sport after injury scale; TSK, Tampa scale for kinesiophobia. Regression lines were created from the scatterplots using the least-squares method.

Athletic Identity Measurement Scale (AIMS).[27] The AIMS is a 7-item questionnaire scored on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). Total scores range from 7 to 49, with higher scores indicating stronger athletic identity. The Japanese version of AIMS has previously demonstrated strong internal consistency and good criterion- and construct-related validity.[27]

Measurement of Knee Function

Knee functions, such as effusion, range of motion (ROM), joint stability, and single-leg squat performance, were all measured. These evaluations had moderate-to-high intra- and inter-rater reliabilities.[28-31] Effusion was assessed using a stroke test,[28] which evaluates the degree of effusion on a 5-point scale (zero/trace/1+/2+/3+), with higher scores, indicating a greater degree of effusion.

Knee flexion and extension active-assistive ROM were measured in increments of 1° using a goniometer.[29] The angle obtained by subtracting the uninjured side's value from the injured side's value was defined as the ROM deficit.

Joint stability was assessed using the Lachman test. Endpoints were graded as firm (hard) or absent (soft). The classification of this endpoint has high inter-rater reliability and provides an accurate assessment of ACL status.[30]

The maximum knee flexion angle during single-leg squats were measured as the single-leg squat performance.[31] The participants crossed their arms to eliminate the effects of their movements. Participants squatted twice at a voluntary speed, and the examiner measured the maximum knee flexion angle using a goniometer. The LSI (involved side/uninvolved side × 100 [%]) was calculated.

Table 2. Correlation Between ACL-RSI Score and Other Variables

		ACL-RSI	
		Correlation [*r* or ρ] (95% Confidence Interval)	*P* Value
Personal variables	Age*	−0.099 (−0.285−0.095)	.313
	Body mass index*	0.101 (−0.092−0.287)	.303
	Preinjury Tegner Score*	0.166 (−0.027−0.347)	.090
	Days of Participation per Week*	0.098 (−0.095−0.284)	.329
Injury-related variable	Days from Injury to Surgery*	−0.111 (−0.296−0.082)	.258
Psychological variables	TSK	−0.305 (−0.469−0.120)	.002
	AIMS	0.066 (−0.127−0.254)	.502
Range of motion	Extension deficits	−0.104 (−0.293−0.894)	.292
	Flexion deficits	0.032 (−0.163−0.225)	.751
Single-leg squat	Knee flexion angle (injured side)	0.084 (−0.116−0.278)	.410
	Limb symmetry index	0.038 (−0.162−0.234)	.714

ACL-RSI, anterior cruciate ligament return to sport after injury scale; AIMS, athletic identity measurement scale; ROM, range of motion; TSK, Tampa scale for kinesiophobia.

*Spearman's rho (ρ) was calculated for the analysis of the non-normally distributed scale.

Table 3. Univariate Regression to Identify Factors Associated With ACL-RSI Score

	Independent Variable	β Coefficient (95% Confidence Interval)	*P* Value
Personal variables	Sex	1.771 (−5.303−8.846)	.620
	Sports classification	1.167 (−1.996−4.329)	.466
	Preinjury participation level	−2.082 (−7.464−3.299)	.445
Injury-related variables	Injury scene	−0.032 (−4.093−4.158)	.988
	In-sports injury	14.319 (−21.753−50.392)	.433
	Multiple-ligament injury	−1.788 (−12.828−9.251)	.749
	Meniscus injury	2.006 (−5.844−9.855)	.613
	Articular cartilage injury	1.690 (−6.672−10.052)	.689
	History of giving way after injury	2.030 (−5.026−9.086)	.570
	History of locking or catching after injury	3.472 (−5.631−12.574)	.451
	Preoperative rehabilitation	−1.410 (−8.527−5.706)	.695
Effusion	Stroke test	−1.563 (−4.580−1.453)	.306
Joint stability	Lachman test	−0.370 (−15.653−14.913)	.962

ACL-RSI, anterior cruciate ligament-return to sport after injury scale.

Main Outcome (Psychological Readiness to RTS)

The main outcome of psychological readiness to RTS was measured using the ACL-RSI scale,[2] which includes the following three domains: emotions, confidence in performance, and risk appraisal. Scores ranged from 0 to 100, with higher scores indicating greater psychological readiness. The ACL-RSI scale has shown strong validity in predicting RTS,[2,4,6,7] sports performance,[11,12] and second ACL injury.[32,33] The Japanese version of the ACL-RSI scale was used in this study.[34] The Japanese version of the ACL-RSI scale has previously shown strong internal consistency, reliability, and construct validity.[34]

Statistical Analysis

The distribution and normality of each variable were determined using a histogram and the Shapiro−Wilk normality test. Normally and non-normally distributed variables are shown as the means ± SD and median (interquartile range), respectively. The association between ACL-RSI score and other variables was analyzed using correlation analysis (Pearson's correlation coefficient [*r*] or Spearman's correlation coefficient [ρ]) and univariate regression analysis. For normally distributed variables, the Pearson's *r* value was used, while for variables that were not normally distributed, Spearman's ρ was used. Correlations (effect sizes) were interpreted as follows: trivial (<0.10), low (0.10−0.29), moderate (0.30−0.49), high (0.50−0.69), or very high (0.70−0.89), or nearly perfect to perfect (0.90−1.00).[35] Factors with *P* value <.2 were subsequently included in a multivariate regression analysis (forced entry method). However, in a previous study,[11] sex and days from injury to surgery were found to be associated with ACL-RSI scores; hence, these were also included as independent predictors. The priori alpha (α) level was set at .05. Data were analyzed using SPSS version 27.0 software (IBM Corp, Armonk, NY).

Results

A total of 105 participants were enrolled in this study (Fig 1). Demographic and functional variables are shown in Table 1. The mean ACL-RSI score before ACLR was 56.4 ± 17.5 (Table 1). The TSK score was significantly negatively correlated with the ACL-RSI score, and the effect size was medium ($r = -0.305$; $P = .02$) (Fig 2). No other variables were significantly associated with ACL-RSI scores (Tables 2 and 3).

The results of the multivariate regression analyses are presented in Table 4. Only the TSK score was found to be associated with the ACL-RSI score ($R^2 = 0.344$, $P = .002$). The variance inflation factor did not exceed 10 for any variable, and no variables were found to be multicollinear.

Discussion

The main findings of this study are as follows: TSK was associated with ACL-RSI scores; other personal, injury-related, and knee function variables were not significantly associated with ACL-RSI scores. These results partially support this study's hypothesis.

The mean preoperative ACL-RSI score of the participants in this study was 56.4 ± 17.5; previous studies

Table 4. Multivariate Regression to Identify Factors Associated With ACL-RSI Score

Constants	Partial Regression Coefficient	*P* Value	95% Confidence Interval
Sex	0.537	.882	−6.592−7.666
Preinjury Tegner score	1.831	.143	−0.630−4.292
Days injury to surgery	−0.001	.961	−0.058−0.055
TSK	−1.066	.002	−1.738−−0.394

$R^2 = 0.344$, analysis of variance (ANOVA). $P = .013$.

ACL-RSI, anterior cruciate ligament return to sport after injury scale; AIMS, athletic identity measurement scale; TSK, Tampa scale for kinesiophobia.

have shown that preoperative ACL-RSI scores typically range from 40 to 55.[10,33,36,37] Webster et al.[11] demonstrated that male sex, young age, shorter intervals between injury and surgery, a higher frequency of preinjury, sports participation, greater limb symmetry in the single-leg hop, and higher subjective knee scores were positively associated with ACL-RSI scores approximately 12 months after ACLR. Aizawa et al.[12] showed that subjective running ability, LSI of lateral single-leg hop distance, and TSK scores were associated with ACL-RSI scores approximately 6 months after ACLR. On the other hand, sex, age, number of days between injury and surgery, and frequency of sports participation were not associated with ACL-RSI. These results suggest that ACL-RSI may exhibit different characteristics depending on the time of measurement. The present study partially supports the findings reported by Aizawa et al.,[12] although the timing of the measurements differed.

There was a significant negative correlation between ACL-RSI and TSK scores. However, the effect size was not large. Kinesiophobia, assessed by TSK, includes aspects of fear of pain and movement. Therefore, TSK is theoretically related to ACL-RSI, including the fear of reinjury. Several studies have previously reported negative correlations between ACL-RSI and TSK scores in patients post-ACLR. For example, Chen et al. ($r = -0.68$), Harput et al. ($r = -0.45$), Hirohata et al. ($r = -0.34$), Kvist ($r = -0.69$), Sara-Barat et al. ($r = -0.50$), and Slagers et al. ($r = -0.45$) all showed this trend.[34,38-41] The effect size of the present study ($r = -0.305$, medium) was small compared with that of previous studies. The ACL-RSI includes questions related to reinjury. Thus, for preoperative patients, these questions are predictive of additional injury at the time of assessment and reinjury after ACLR. It is suggested that this weakens the relevance of ACL-RSI. However, only TSK was a significant factor in the multiple regression analysis, which initially included several other variables, suggesting that kinesiophobia is an important factor related to psychological readiness to RTS in preoperative patients.

Personal variables, injury-related variables, and knee function were not associated with ACL-RSI scores in patients awaiting ACLR. Injury-related variables were included in this study; however, details such as giving way of the joint and preoperative rehabilitation are unclear. An analysis that includes an analysis of the number of patients whose joints give way and the composition of rehabilitation may be necessary. No previous study has yet analyzed the relationship between knee functions and ACL-RSI in preoperative patients. In postoperative patients, single-leg hop limb symmetry has been shown to be associated with ACL-RSI scores.[11,12] These results suggest that the association between psychological readiness to RTS and knee function may be characterized differently in preoperative and postoperative patients. In other words, we suggest that the postoperative data shown in previous studies should not be applied to preoperative patients. As dynamic tasks such as single-leg hop were not included in this study, more data to explore this aspect needs to be accumulated in the future. Knee stability was assessed using only the Lachman test; incorporating the stress test for valgus and varus or the use of the pivot shift test may have resulted in different test scores.

In recent years, the importance of preoperative rehabilitation in improving knee function, such as normalizing ROM, decreasing swelling, increasing knee strength, and improving balance/proprioception, has been emphasized.[42,43] However, the study data show that psychological readiness to RTS is not associated with the presence of preoperative rehabilitation or the severity of preoperative knee dysfunction in patients awaiting ACLR. The results of the present study suggest the need for preoperative rehabilitation to include not only knee function, but also psychological aspects. It has already been shown that psychological interventions, such as relaxation and guided imagery, reduce reinjury anxiety and knee pain after ACLR.[44] In preoperative rehabilitation, psychological intervention in collaboration with a psychologist in addition to interventions for knee function may be necessary.

In the present study, kinesiophobia was found to be associated with psychological readiness to RTS, but the explanation rate was not high (34%). Further studies are required to identify additional factors associated with psychological readiness to RTS in patients awaiting ACLR. It will also be necessary to analyze factors influencing preoperative psychological readiness to RTS in consideration of the above limitations. In addition, qualitative research is needed to develop a theory regarding the lack of psychological readiness to RTS in preoperative patients, and to discover additional factors that may contribute to this.

Limitations

This study has few limitations. First, as the study participants were patients on the waiting list for ACLR, it is unclear whether the results of this study are applicable to those who choose conservative treatment. Second, this was a single-center study, and it is unclear whether the results are generalizable to patients at other institutions. Lastly, several previous studies have evaluated preoperative ACL-RSI scores;[4,10,32,33,37,45] however, no study has yet examined the validity of ACL-RSI scores with a focus on preoperative patients.

Conclusions

In patients awaiting ACLR, kinesiophobia was moderately negatively associated with psychological readiness to RTS, while other factors were not.

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