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Translation and validation of the simplified Chinese version of the anterior cruciate ligament-return to sport after injury (ACL-RSI)

Zhen-yu Jia[1] · Jin Cui[1] · Wei Wang[2] · Chen-chen Xue[1] · Tian-ze Liu[1] · Xuan Huang[1] · Wei-Dong Xu[1]

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Abstract

Purpose The aim of this study is to obtain a translation and adaptation of the anterior cruciate ligament-return to sport after injury (ACL-RSI) into simplified Chinese and validate the simplified Chinese version.

Methods Translation and adaptation were performed according to the guidelines of the American Academy of Orthopaedic Surgeons Outcome Committee. A total of 122 patients who were diagnosed with an ACL injury and underwent primary arthroscopic anterior cruciate ligament reconstruction (ACLR) between 2015 and 2016 were included in this study. The simplified Chinese version of the ACL-RSI (SC-ACL-RSI), Knee injury and Osteoarthritis Outcome Score (KOOS), Lysholm score and International Knee Documentation Committee (IKDC) subjective knee form were completed. Psychometric evaluations included score distribution, internal consistency, test–retest reliability, and construct and discriminant validity.

Results SC-ACL-RSI scores exhibited a normal distribution without ceiling and floor effects. Internal consistency was high (Cronbach's alpha = 0.94). The intraclass correlation coefficient was 0.98, indicating excellent test–retest reliability. SC-ACL-RSI scores were correlated with all KOOS subscales ($r = 0.30$ to 0.69, $p < 0.001$), the IKDC subjective knee form ($r = 0.46$, $p < 0.001$) and the Lysholm score ($r = 0.56$, $p < 0.001$). The mean scores between patients who returned to the same preinjury level of sport (65.1 ± 14.3) and those who could not return to the same level (51.0 ± 15.0) were significantly different ($p < 0.001$).

Conclusions The SC-ACL-RSI is a reliable and valid instrument to evaluate the psychological impact of a patient returning to sport after ACLR. It is important to evaluate patients' ability to return to sport after an ACL injury. The information provided by the SC-ACL-RSI will affect decisions regarding treatment and rehabilitation plans, which are more likely to influence clinical outcomes.

Level of evidence II.

Keywords Anterior cruciate ligament · Return to sport · Reliability · Validity · Instrument

Introduction

Anterior cruciate ligament (ACL) injury is one of the most common knee injuries, especially in young sports-active people [16]. With an increasing number of adolescents engaging in high-level athletics and older individuals remaining active longer, the incidence of ACL injury could be higher than previously reported [12, 19]. Currently, anterior cruciate ligament reconstruction (ACLR) is the gold-standard surgical technique for ACL injury [21]. One important goal for ACLR is for the patient to quickly return to the same sport at the same intensity level as that before the injury [2]. Key factors that increase the possibility of a successful return to a preinjury level of sport include symmetrical hop test performance, younger age, male gender,

Zhen-Yu Jia, Jin Cui and Wei Wang are co-first authors and contributed equally.

✉ Xuan Huang
11791709@qq.com

✉ Wei-Dong Xu
ch_prof_xu@163.com

[1] Department of Orthopedics, Changhai Hospital, Second Military Medical University, Shanghai, China

[2] Department of Orthopedics, Chengdu Military General Hospital, Chengdu, China

playing an elite sport, and a positive psychological response [1, 22]. However, psychological factors, such as fear of reinjury, anxiety and lack of confidence, cannot be evaluated by professional tools in China.

Most studies report good knee functions after ACLR but a low proportion of patients who return to preinjury sports [4]. Psychological impact might be an essential reason for the low rate of return to sport [9]. The anterior cruciate ligament-return to sport after injury (ACL-RSI) scale was developed in 2008 to specifically evaluate the psychological impact on return to sport [30]. Recently, the ACL-RSI was translated and validated in Swedish, Dutch, French, and Turkish, but the ACL-RSI has not been translated and validated in Chinese [7, 13, 17, 24]. In mainland China, assessments of the ability to return to sport after an ACL injury have not received sufficient attention. Furthermore, to date, reliable and valid tools or instruments have not been introduced in China. To evaluate the ability of a patient to return to sport after an ACL injury and attract necessary attention to the return to sport, it was important to translate and cross-culturally adapt a widely used instrument into Chinese. The purpose of our study was to perform a cross-cultural adaptation and translation of the original version of the ACL-RSI into simplified Chinese and validate the simplified Chinese version.

Materials and methods

Cross-cultural adaptation and translation

The cross-cultural adaptation and translation process was performed in five steps according to the recommendations of the American Academy of Orthopaedic Surgeons Outcome Committee [5].

Step 1—Initial translation The English version of the ACL-RSI was translated into simplified Chinese by two independent bilingual translators whose first language was Chinese. One was an orthopaedic surgeon, and the other was an English teacher without a medical background.

Step 2—Synthesis of the translations Discrepancies between the two initial versions were debated, and a consensus was reached.

Step 3—Back translation The initial Chinese version was translated back into English by two independent, bilingual translators whose first language was English and who were not involved in the first step.

Step 4—Expert committee review The initial Chinese version was assessed by an expert committee consisting of two orthopaedic surgeons, two physical therapists and two language professionals. A prefinal Chinese version, renamed the Pilot-ACL-RSI, with conceptual equivalence to the original version was created.

Step 5—Pre-testing The Pilot-ACL-RSI was field tested on 20 individuals who underwent ACLR to determine comprehension of the Chinese version.

Participants

From January 2015 to January 2016, patients who were diagnosed with an ACL injury and underwent primary arthroscopic ACLR in Changhai hospital (Shanghai, China) were recruited. The inclusion criteria were as follows: (1) 16 years of age and older; (2) available for at least 6 months of follow-up visits; (3) able to read simplified Chinese without psychological problems; and (4) willing to participate in the research. The exclusion criteria were as follows: (1) revision ACLR; (2) bilateral knee injuries; (3) a history of knee operation; (4) multi-ligament injuries; (5) severe knee osteoarthritis; and (6) fractures of the knee. All required informed consent documents were signed by each participant.

Demographic data, including age, gender, Tegner score, time from injury to operation and graft type, were retrieved from electronic patient records. All participants were initially asked to complete the SC-ACL-RSI, Knee injury and Osteoarthritis Outcome Score (KOOS), Lysholm score and International Knee Documentation Committee (IKDC) subjective knee form at least 6 months after ACLR [8, 11, 29]. All required instruments were reliable and valid in Chinese. To explore test–retest reliability, we asked all participants to complete the SC-ACL-RSI a second time after a 1-week interval. Based on previous research, the sample size should exceed at least 100 patients for internal consistency analysis, reliability and validity analysis [28].

The research was approved by the clinical research ethics committee of Changhai Hospital of Shanghai (No. CHEC2015-041).

Questionnaires

The ACL-RSI, first presented in 2008, is a 12-item self-administered questionnaire related to returning to sport after ACLR. This questionnaire includes three aspects that cover emotions (five questions), confidence in performance (five questions) and risk appraisal (two questions). Each item in the original ACL-RSI was evaluated with a 10-cm visual analogue scale (VAS) from 0 to 100 [30]. However, the VAS was replaced by an 11-Likert scale with 10-point increments from 0 to 100 [18]. The total score was calculated by adding the scores of all 12 items and transforming the score to a 0–100-point scale.

The KOOS was used to evaluate subjective knee function and is divided into five subscales, including symptoms, pain, activity in daily life (ADL), function during sport and recreational activity (sport), and knee-related quality of life (QoL) [23]. The Lysholm score is an eight-item

questionnaire designed to evaluate patients suffering from knee ligament injuries including pain, locking, swelling, instability, stair climbing, limping, external support, and squatting [27]. The IKDC subjective knee form is a knee-specific instrument used to measure symptoms, function, and sports activity [14].

Psychometric assessment and statistical analysis

The analyses were performed in SPSS version 22.0 for Windows (Chicago, IL, USA). A p value of less than 0.05 was considered statistically significant for all analyses. Descriptive data are presented as the mean ± standard deviation (SD) and percentages. The percentage of missing data was considered acceptable if the value was less than 5%.

Score distribution Floor and/or ceiling effects were considered present if the proportion of the lowest and/or highest scores on the scale was more than 15% [28].

Internal consistency To assess the strength of the interrelated items in the instrument, we derived internal consistency by calculating Cronbach's alpha coefficient. An alpha value ranging from 0.7 to 0.95 was considered adequate [28]. The corrected item-total correlation coefficient was calculated for each item, and the value was expected to exceed 0.4 [25].

Test–retest reliability The intraclass correlation coefficient (ICC) with a 95% confidence interval was calculated to assess the stability of the instrument over time. The outcomes were classified into five grades ($r = 0.81$–1.0 excellent; 0.61–0.80 very good; 0.41–0.60 good; 0.21–0.40 fair; and 0.00–0.20 poor) [20]. A value greater than 0.40 was considered acceptable. The Bland–Altman plotting method was used to evaluate within-subject variation and limits of agreement [6].

Validity Construct validity was assessed by correlating ACL-RSI scores with KOOS, Lysholm and IKDC scores. Pearson's correlation coefficients of SC-ACL-RSI scores were calculated, and the results are expressed as 'excellent' ($r > 0.8$), 'very good' ($r = 0.61$–0.80), 'moderate' ($r = 0.41$–0.60), 'fair' ($r = 0.21$–0.40), and 'poor' ($r < 0.20$) [15]. We hypothesized that the ACL-RSI was correlated with KOOS, Lysholm and IKDC subjective knee form scores. Discriminant validity was tested via Student's t test between patients who returned to the previous level of sport and those who could not return to the same level.

Results

Translation

No major linguistic problems occurred during translation and back translation. Only small revisions were made. For example, "give way" was a common expression in English, but there was no similar Chinese expression to convey the original meaning. After a discussion, this phrase was translated as "daruantui" and an explanation "anterior translation, slipping, or a sense of looseness within your knee" was added. Participants completed the Pilot-ACL-RSI without questions and doubt.

Descriptive data

All 122 patients who met the inclusion/exclusion criteria were enrolled in the study. Related demographic data are reported in Table 1.

Score distribution

The SC-ACL-RSI score was well distributed with ceiling and floor effects less than 15% in total and for each item. Moreover, none of the items had a poor corrected item-total correlation, indicating that all items should be included in the SC-ACL-RSI (Table 2).

Internal consistency

When any one of the items was deleted, each Cronbach α coefficient was greater than 0.75 and less than 0.95, indicating a strong correlation between items (Table 2). Each item was correlated with the total scale according to the good item-total correlation for each item (Table 2).

Table 1 Demographic and clinical characteristics of participants

Characteristic	Sample ($N = 122$)
Age	
Range	17–68
Mean (SD)	34.0 (13.0)
Gender	
Male *n* (%)	71 (58.2)
Female *n* (%)	51 (41.8)
Time from injury to operation (mo) (%)	
< 3	23 (18.9)
3–12	78 (63.9)
> 12	21 (17.2)
Tegner score mean (SD)	5.5 (1.4)
Returned to the same activity *n* (%)	
Yes	49 (40.2)
No	73 (59.8)
Graft type *n* (%)	
Hamstring tendon	92 (75.4)
LARS artificial ligament	30 (24.6)

SD standard deviation, *mo* month, *LARS* the ligament advanced reinforcement system

Table 2 Score distribution and internal consistency of the SC-ACL-RSI

Question	Mean ± SD	Corrected item-total correlation	Alpha if item removed	Ceiling effect (%)	Floor effect (%)	Cronbach's alpha
SC-ACL-RSI						0.939
Emotions						0.875
3	57.4 ± 23.6	0.856	0.928	4.1	2.5	
6	50.0 ± 25.4	0.747	0.933	2.5	4.1	
12	62.5 ± 18.0	0.599	0.938	3.3	0	
7	46.2 ± 26.5	0.740	0.934	2.5	5.7	
9	49.4 ± 25.1	0.746	0.933	1.6	4.1	
Confidence in performance						0.891
4	62.1 ± 19.8	0.842	0.929	3.3	0.8	
5	58.8 ± 18.6	0.679	0.935	1.6	0	
8	59.8 ± 18.9	0.698	0.934	0.8	0	
1	47.9 ± 18.7	0.670	0.935	1.6	3.3	
11	60.3 ± 18.6	0.744	0.933	3.3	0.8	
Risk appraisal						0.792
2	50.9 ± 22.1	0.778	0.931	3.3	0.8	
10	69.7 ± 17.8	0.643	0.936	6.6	0	

SC-ACL-RSI simplified Chinese version of the anterior cruciate ligament-return to sport after injury, *SD* standard deviation

Test–retest reliability

Test–retest reliability was calculated by the ICC between the test and retest with a 1-week interval. All 122 participants were included in the test. The ICCs exceeded 0.9 for the total and three aspects of the SC-ACL-RSI, indicating that the test–retest reliability of the SC-ACL-RSI was excellent (Table 3). Moreover, the Bland–Altman plots of the two tests showed no systematic bias between the test and retest, indicating excellent test–retest reliability of the three parts and total scale (Fig. 1a–d).

Validity

The Pearson correlation coefficients related to the SC-ACL-RSI are shown in Table 4. The SC-ACL-RSI score was strongly correlated with the KOOS subscale "QoL". The SC-ACL-RSI was also moderately correlated with the KOOS subscales ("pain" and "sports"), IKDC subjective knee form score and Lysholm score (Table 4). By contrast, the SC-ACL-RSI was fairly correlated with the KOOS subscales "symptoms" and "ADL". All the above data indicated that the SC-ACL-RSI had good construct validity.

The SC-ACL-RSI scores were significantly different between patients who returned to the same preinjury level of sport and those who could not return to the same level ($p < 0.001$). The scores of patients who returned to the same level (65.1 ± 14.3) were noticeably higher than those of patients who could not return to the same level (51.0 ± 15.0). Thus, the discriminant validity of SC-ACL-RSI was demonstrated to be good.

Table 3 Test–retest reliability and distribution of the SC-ACL-RSI

Scale	First test[a] (Mean ± SD)	Second test[a] (Mean ± SD)	ICC (CI range)
SC-ACL-RSI total	56.2 ± 16.5	57.0 ± 17.1	0.978 (0.969–0.985)
Emotions	22.1 ± 8.1	22.0 ± 8.2	0.941 (0.924–0.955)
Confidence in performance	24.0 ± 6.6	24.8 ± 7.2	0.947 (0.925–0.963)
Risk appraisal	10.1 ± 3.0	10.3 ± 3.4	0.921 (0.888–0.944)

SC-ACL-RSI simplified Chinese version of the anterior cruciate ligament-return to sport after injury, *SD* standard deviation, *ICC* intraclass correlation coefficient, *CI* confidence interval

[a]The first test was conducted at the beginning of this research (122 patients), the second test was conducted 1 week later to calculate the test–retest reliability (ICC) of the SC-ACL-RSI (122 patients)

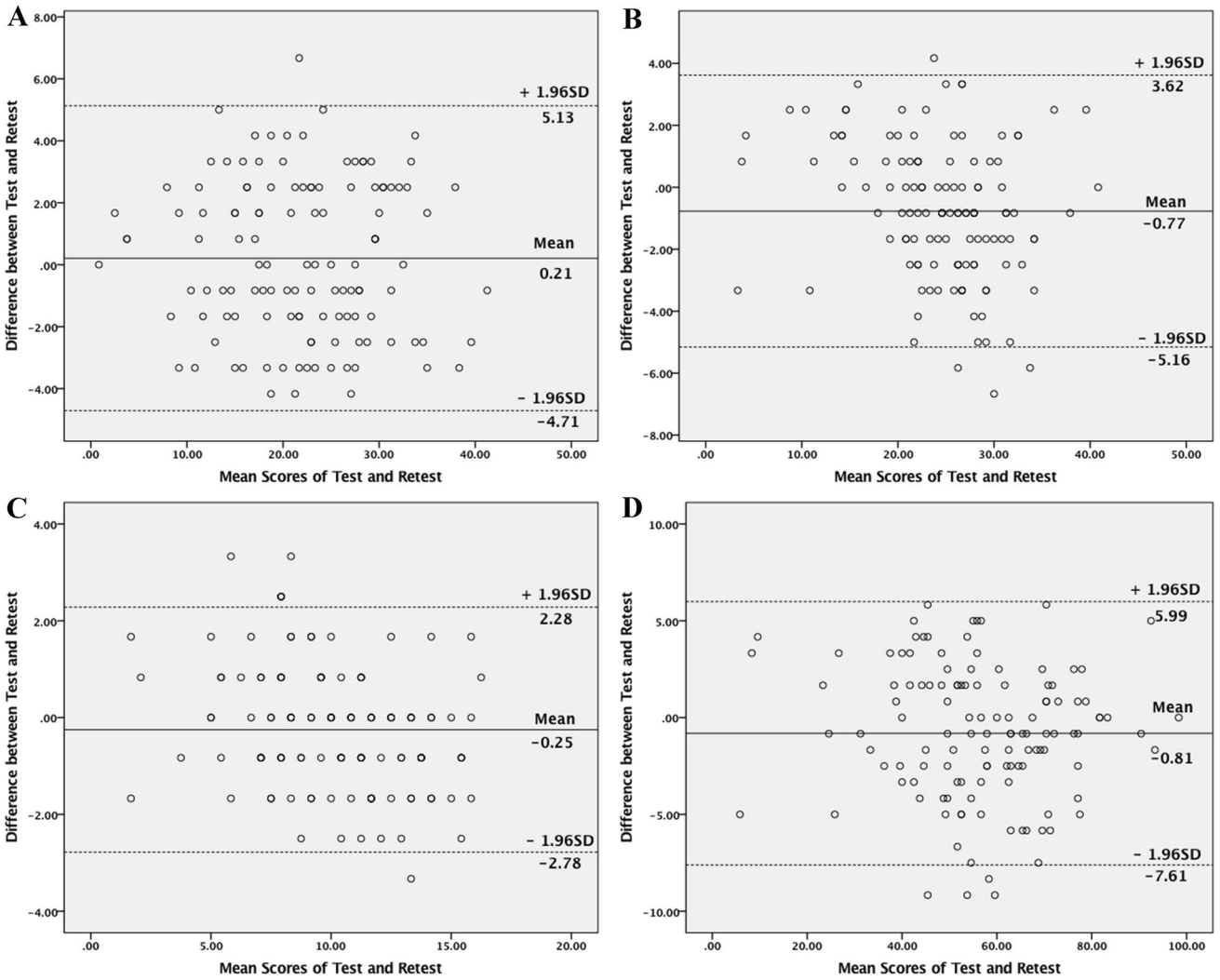

Fig. 1 Bland–Altman diagrams of the SC-ACL-RSI for test–retest reliability. Each diagram is for **a** emotions, **b** confidence in performance, **c** risk appraisal, and **d** the total scale. The dashed line shows the 95% (±1.96 SD) limits of agreement. (*SC-ACL-RSI* simplified Chinese version of the anterior cruciate ligament-return to sport after injury, *SD* standard deviation)

Table 4 Construct validity of the SC-ACL-RSI

Scale	Mean ± SD	SC-ACL-RSI	
		Pearson's correlation coefficient (*r*)	*p* value
IKDC	76.3 ± 11.6	0.459	< 0.001
KOOS-symptoms	78.5 ± 13.0	0.352	< 0.001
KOOS-pain	84.5 ± 7.9	0.464	< 0.001
KOOS-ADL	93.3 ± 5.7	0.297	< 0.001
KOOS-sport	65.5 ± 15.6	0.413	< 0.001
KOOS-QoL	63.1 ± 15.8	0.691	< 0.001
Lysholm	87.8 ± 9.4	0.564	< 0.001

SC-ACL-RSI simplified Chinese version of the anterior cruciate ligament-return to sport after injury, *SD* standard deviation, *IKDC* the International Knee Documentation Committee (IKDC) subjective knee form, *KOOS* the Knee injury and Osteoarthritis Outcome Score, *ADL* activities of daily living, *QoL* quality of life

Discussion

The most important finding of this study was that the SC-ACL-RSI instrument exhibited a good score distribution, high internal consistency, excellent test–retest reliability, and notable construct and discriminant validity.

Recently, interest in the psychological implications after ACLR has grown [3]. Psychological implications were documented as an important factor for returning to sports in addition to surgery and rehabilitation [10, 26]. Previous studies have demonstrated that fear of reinjury, self-esteem levels, motivation and locus of control are associated with the ability to return to preinjury sport [9, 26]. The original version of the ACL-RSI scale was used to evaluate three aspects of psychological implications, including emotions, confidence in performance, and risk appraisal. As seen in

previous studies, the Cronbach α coefficient among the 12 items of the SC-ACL-RSI scale was high [13, 17]. Furthermore, the corrected item-total correlation and item-deleted Cronbach *α* coefficient were also high for each item, indicating that none of the items could be separated and that they were strongly correlated with each other. Thus, although the scale contains three aspects, they should be calculated as one total score. Good test–retest reliability demonstrated that the SC-ACL-RSI could remain stable over time. Both the results of the ICC and Bland–Altman plots were consistent with other versions of the ACL-RSI [7, 13, 17, 24].

Various instruments, including the IKDC subjective knee form, KOOS subscales and Lysholm score, were chosen to evaluate the construct validity of the SC-ACL-RSI. All of these instruments were developed to monitor patients with knee disorders and are commonly used. Moreover, all of them are valid and reliable in China. These instruments focus on the functions and symptoms after a knee injury. Only the KOOS subscale "QoL" has two items related to psychological implications. The ACL-RSI is a common scale to specifically assess the psychological implications of returning to sport after ACLR, and there is no suitable questionnaire for testing construct validity in China. Thus, these three questionnaires were chosen for comparison. The correlation between the SC-ACL-RSI and the KOOS subscale "ADL" was the lowest, and the correlation between the SC-ACL-RSI and the KOOS subscale "QoL" was the strongest. The weak relationship between the SC-ACL-RSI and the KOOS subscale "ADL" might be due to most patients returning to normal activities in daily life after ACLR, which is different from returning to sport. The strongest relationship with the KOOS subscale "QoL" was likely due to the two "QoL" items related to psychological impact. The correlation between the SC-ACl-RSI and other included questionnaires was significant, and similar results were also found in the Swedish, French and Turkish versions [7, 13, 17].

The discriminant validity of the SC-ACL-RSI was confirmed by comparing patients who were able to return the preinjury sport level and those who were not. Individuals without an ACL injury were not included as a control group because four items (No. 1, 2, 7, and 10) of the SC-ACL-RSI were not suitable for non-injured individuals. The SC-ACL-RSI could distinguish patients who could not return to a preinjury sport level from those who could.

This study has two major limitations. First, this research was a single-centre study and most of participants were from the east of China. Thus, the sample cannot fully represent the entirety of the Chinese-speaking people. Second, the follow-up duration was short for ACLR, and the percentage of patients who returned to a preinjury level of sport was unstable.

It is important to evaluate patients' ability to return to sport after an ACL injury. The information provided by the SC-ACL-RSI could influence decisions for treatment and rehabilitation plans, which are more likely to influence clinical outcomes. The SC-ACL-RSI can now be used to assess the ability to return to sport after an ACL injury and assist clinicians in optimizing rehabilitation plans for patients with an ACL injury.

Conclusions

The SC-ACL-RSI is a reliable and valid instrument that can be employed to evaluate the psychological impact of returning to sport after ACLR.

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Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval Ethical approval was obtained from clinical research ethics committee of Changhai hospital (No. CHEC2015-041).

Informed consent Informed consent was obtained from all individual participants included in this study.

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