

Assessment of the Global Rating of Knee Function in Patients Following Anterior Cruciate Ligament Reconstruction

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Objective: The purpose of this study was to assess the validity of the global rating of knee function as a measure of participation restrictions experienced during activities of daily living and sports by patients with a history of anterior cruciate ligament reconstruction (ACLR).

Design: Cross-sectional study.

Methods: Forty-three subjects (33 males, 10 females, age = 20.3 ± 1.3 years), at a mean of 31.2 ± 14.4 months following ACLR, participated in this study. During testing, subjects were first asked to provide a global rating of function by assessing their level of knee function on a 0 to 100 scale, with 0 points representing complete loss of function due to their knee injury and 100 points representing their level of function prior to their knee injury. After providing a global rating of function, subjects completed the Knee Outcome Survey (KOS) Activities of Daily Living Scale (ADLS) and Sports Activity Scale (SAS), which served as the measure of participation restrictions in this study.

Results: Pearson product correlations revealed moderate relationships between the global rating of function and the ADLS ($r = 0.66$, $p < 0.0001$) and SAS ($r = 0.69$, $p < 0.0001$).

Conclusions: The global rating of knee function provides a valid measure of participation restrictions experienced during activities of daily living and sports by patients with a history of ACLR.

Key Words: Disability, Knee surgery, Anterior cruciate ligament, Rehabilitation, Global rating of knee function, Outcome

Introduction

According to the International Classification of Functioning, Disability and Health, participation refers to involvement in life situations and participation restrictions refer to problems an individual may experience with involvement in life situations [1]. When evaluating patients with a history of anterior cruciate ligament reconstruction (ACLR), it is common for clinicians to determine the patient's level of participation restriction [2]. This is usually done by assessing patient perceived levels of function during activities of daily living or sporting activities through patient self-report measures, such as the Knee Outcome Survey (KOS) [3], the

Cincinnati Knee Scoring System [4], the International Knee Documentation Committee Subjective Knee Form [5], or the Lysholm Knee Scale [6].

In addition to assessing patient perceived levels of knee function through a patient self-report measure, several authors have also assessed patient perceived levels of knee function with a global rating of knee function by asking patients to rate their level of knee function on a scale of 0 to 100, with 0 points representing complete loss of function due to their knee injury and 100 points representing their level of function prior to their knee injury. Worrell et al [7] used the Functional Limitations with Activities of Daily Living Scale, a modified component of the KOS, and the global rating of knee function to

Received: Jul 23, 2021 Revised: Nov 18, 2021 Accepted: Dec 8, 2021

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determine the health status of patients with patellofemoral pain following physical therapy and surgical interventions. Fitzgerald et al [8] used the KOS and the global rating of knee function to determine the efficacy of augmenting a standard nonoperative anterior cruciate ligament rehabilitation program with a perturbation training program. Snyder-Mackler et al [9] used the Lysholm Knee Scale, the KOS, and the global rating of knee function to assess functional outcome after anterior cruciate ligament injury. Goodstadt et al [10] used the global rating of knee function as part of criterion-based guidelines to determine if athletes who had undergone an ACLR functioned better with or without their functional brace, one year after surgery. Sonesson et al assessed the impact of early knee status through the global rating of knee function and the International Knee Documentation Committee Subjective Knee Form on self-reported knee function at 3 and 12 months and on quadriceps strength at 12 months after non-surgically treated ACL injury [11].

Despite the prevalent use of the global rating of knee function, we have been unable to locate any studies that have reported its validity in assessing the level of participation restrictions experienced during activities of daily living or sports by patients with a history of ACLR. Understanding how well the global rating of knee function estimates participation restrictions experienced during activities of daily living and sports could potentially assist clinicians, especially those who use the global rating of knee function in isolation, in accurately assessing outcome in patients with a history of ACLR. Therefore, the purpose of this study was to assess the validity of the global rating of knee function as a measure of participation restrictions experienced during activities of daily living and sports by patients with a history of ACLR. More specifically, we assessed the relationship between global ratings of function and scores and KOS Activities of Daily Living Scale (ADLS) and Sports Activity Scale (SAS). We hypothesized that there would be moderate positive correlations between the global rating of knee function and scores on the KOS ADLS and SAS.

Methods

Participants

An a priori power analysis was conducted to determine

the minimum sample size required to find significance with a desired level of power set at 0.80, an α -level at 0.05, and a moderate strength of correlation ($r=0.50$). Based on the analysis, it was determined that a minimum of 29 subjects were required to ensure adequate power. Overall, 43 subjects (33 males, 10 females) participated in this study from the nonintercollegiate cadet population at the U.S. Air Force Academy, CO (age= 20.3 ± 1.4 years, height= 179.5 ± 8.6 cm, weight= 80.9 ± 12.3 kg). Prior to participation in this study, all subjects read and signed an informed consent document approved by the Institutional Review Board at the U.S. Air Force Academy.

All subjects had undergone ACLR in which their ipsilateral central third of the patellar tendon was used in a bone-tendon-bone graft. Following ACLR, all subjects completed a rehabilitation program that focused on an early return of full range of motion, early full weightbearing, lower extremity strengthening, and a full return to military and athletic activities. At the time of testing, all subjects had resumed performing all required U.S. Air Force Academy military and athletic activities. The mean time from injury to ACLR for subjects in this study was 37.8 ± 30.5 days (range=10 to 175 days). Subjects were assessed at a mean of 31.2 ± 14.4 months (range=12 to 65 months) following their ACLR. Six subjects underwent additional knee surgery at a mean of 17.2 ± 11.8 months (range=3 to 37 months) following ACLR, including partial meniscectomy ($n=5$) and diagnostic arthroscopy ($n=1$). Subjects were assessed at a mean of 29.5 ± 14.9 months (range=12 to 69 months) following their most recent knee surgery.

Patient Self-Report Measures

Global Rating of Function.

Subjects were first asked to provide a global rating of function by assessing their level of knee function on a 0 to 100 scale, with 0 points representing complete loss of function due to their knee injury and 100 points representing their level of function prior to their knee injury.

Knee Outcome Survey.

After providing a global rating of function, subjects completed the KOS ADLS and SAS [2,12], which served

as the measure of participation restrictions in this study. Items on the ADLS relate to symptoms (i.e., pain, crepitus, stiffness, swelling, instability, weakness) and functional limitations (i.e., walking, stairclimbing, standing, kneeling, squatting, sitting, rising from sitting) patients may experience during activities of daily living. With regard to symptoms, possible patient responses are graduated in terms of the functional limitations that are placed on patients during activities of daily living. With regard to functional limitations, possible patient responses are graduated from no limitation to the inability to perform the specific activity.

Items on the SAS assess symptoms (i.e., pain, crepitus, stiffness, swelling, instability) that patients may experience while playing sports. With regard to symptoms, possible patient responses on the SAS are graduated in terms of the amount of disability that is placed on patients during sport activities. Functional limitations that patients may experience during sport activities (running, stopping, starting, jumping, landing, cutting, pivoting) are also included on the SAS, with possible patient responses graduated from no limitation to the inability to perform the specific activities.

Both components of the KOS are numerically graded on a scale of 0 to 100, with a score of 0 indicating an inability to perform the activity, and a score of 100 indicating no limitation. The KOS has been shown to provide a reliable and valid measure of disability in patients with knee impairments [2,12].

Reliability Study

In order to estimate the test-retest reliability for the global ratings of function and the KOS ADLS and SAS, 10 subjects with a history of ACLR (7 males, 3 females, mean age = 21.4 ± 1.4 years, mean time from ACLR to testing = 26.7 ± 13.3 months) were assessed as previously described prior to collecting data for the descriptive study. All subjects in the reliability study reported that their knee had reached a plateau. Subjects were tested 5 days apart. For the second test session, subjects were required to report that the status of their knee had not changed since the first test session.

Data Analysis

Intraclass correlation coefficients (formula 2,1) were used to assess test-retest reliability [13]. The standard error of measurement ($SD\sqrt{1-ICC}$) was also calculated to assess the amount of error associated with repeated measurements.

Pearson product moment correlation coefficients were used to assess the relationship between global ratings of function and scores and KOS ADLS and SAS. The probability level was set at $p \leq 0.05$.

Results

The intraclass correlation coefficients and standard errors of measurement for the global rating of function and the KOS ADLS and SAS are presented in Table 1. Means, standard deviations, and ranges for the global rating of function and the KOS ADLS and SAS are presented Table 2. Pearson product correlations revealed significant relationships between the global rating of function and the ADLS [$r=0.66$ (95% confidence interval: 0.45–0.80), $r^2=0.44$, $p<0.0001$] and SAS [$r=0.69$ (95% confidence interval: 0.49–0.82), $r^2=0.48$, $p<0.0001$].

Table 1. Subject demographics.

Characteristic	
Male/Female (n)	33/10
Age (mean \pm SD)	20.3 \pm 1.4 years
Height (mean \pm SD)	179.5 \pm 8.6 cm
Weight (mean \pm SD)	80.8 \pm 12.3 kg
Time from ACLR (mean \pm SD)	31.2 \pm 14.4 months

Note. SD=standard deviation, ACLR=anterior cruciate ligament reconstruction.

Table 2. Reliability data.

	ICC	SEM
Global Rating of Function	0.86	3.58
KOS Activities of Daily Living Scale	0.93	3.98
KOS Sports Activity Scale	0.95	4.70

Note. ICC=intraclass correlation coefficient, SEM=standard error of measurement, KOS=knee outcome survey.

Table 3. Means, standard deviations, and ranges for the global ratings of function and the Knee Outcome Survey Activities of Daily Living Scale and Sports Activity Scale.

	Mean \pm SD	Range
Global Rating of Function	92.21 \pm 7.76	70 to 100
KOS Activities of Daily Living Scale	92.10 \pm 7.59	71.25 to 100
KOS Sports Activity Scale	88.65 \pm 11.35	60 to 100

Note. KOS =Knee Outcome Survey.

Table 4. Pearson product correlations between the global rating of function and the Knee Outcome Survey Activities of Daily Living Scale and Sports Activity Scale.

	Global Rating of Knee Function
KOS Activities of Daily Living Scale	0.66 (95% CI: 0.45 –0.80)
KOS Sports Activity Scale	0.69 (95% CI: 0.49 –0.82)

Note. KOS =Knee Outcome Survey, CI=confidence interval.

Discussion

Good to high test-retest reliability was demonstrated for the global rating of knee function, ADLS, and SAS, as all of the intraclass correlation coefficients were greater than 0.80 [12] (Table 1). Furthermore, relatively small standard errors of measurement were noted for each of the three measures (Table 1). Although we were unable to locate any reports of test-retest reliability for the global rating of knee function or the SAS, the reliability results for the ADLS seen in this study are in general agreement with Irrgang et al [3], who reported a test-retest reliability ICC of 0.97 for the ADLS.

The results of this study revealed that the global rating of knee function was moderately correlated with the KOS ADLS and SAS, although the global rating of knee function had a slightly higher correlation with the SAS than the ADLS. This indicates that while the global rating of knee function provides a valid measure of participation restrictions experienced during activities of daily living and sports by patients with a history of ACLR, the global rating of knee function may be more closely related to the SAS than the ADLS.

Although global ratings of knee function are commonly used in physical therapy to assess levels of participation restrictions, few reports exist that have examined its reliability and validity. In order to assess the validity

of the global rating of knee function, it was necessary to compare the global rating of knee function with a “gold standard” for assessing participation restrictions following ACLR. Since participation restrictions refer to problems an individual may experience with involvement in life situations, participation restrictions should be assessed through measures of patient perceived levels of function in these life situations (i.e., activities of daily living, sports). Our use of the KOS ADLS and SAS as the “gold standard” for assessing participation restrictions in this study reflects this need.

The moderate correlation seen in this study between the global rating of knee function and scores on the KOS ADLS ($r=0.66$) is in general agreement with previous research by Irrgang et al [3] who examined the relationship between global ratings of function and the KOS in patients seen in physical therapy for a variety of knee conditions ($n=397$) and operative procedures ($n=225$) over the course of the first eight weeks of rehabilitation. Irrgang et al [3] determined that Pearson correlation coefficients between the global rating of knee function and the KOS ADLS ranged from 0.66 to 0.75 during the first eight weeks of rehabilitation.

While the results of this study indicate that the global rating of knee function provides a valid measure of participation restrictions experienced during activities of daily living and sports by patients with a history of ACLR, it is not known if the global rating of knee

function is sensitive enough to detect clinically meaningful changes over time in patients with a history of ACLR who have completed a rehabilitation program. However, the global rating of knee function was sensitive enough to detect pre- to post-treatment changes in patients with a history of anterior cruciate ligament injury who completed either a standard rehabilitation program or standard rehabilitation program augmented with perturbation training [8]. Furthermore, at the time of the 6-month follow-up, subjects who completed the perturbation training maintained their global rating of knee function scores, while the scores of the subjects who completed the standard training program decreased (i.e., increased participation restrictions) [8]. This finding is consistent with the frequency of reported rehabilitation success or failure among subjects in both treatment groups, as subjects who received perturbation training were 4.88 times more likely to have a successful outcome with nonoperative treatment than subjects who completed the standard training program [8]. Further study is needed to determine if the global rating of knee function is sensitive enough to detect clinically meaningful changes over time in patients with a history of ACLR.

The scores on the global ratings of function explained 44% and 48% of the variance in scores on the ADLS and SAS, respectively. This suggests that although the global rating of knee function was significantly correlated with scores on the ADLS and SAS in this study, it may be indicated to use the global rating of knee function in conjunction with other measures (e.g., range of motion, graft integrity, lower extremity muscle strength, proprioception, patient subjective report of knee function) to gain the most effective estimate of participation restrictions and outcome in patients with a history of ACLR.

Following ACLR, the goal of surgery and rehabilitation is to return the patient to their preinjury functional levels [14-15]. To evaluate the effectiveness of surgical and rehabilitation outcomes, tools capable of assessing patient reported outcome in a reliable and valid fashion are necessary [16-18]. Unfortunately, despite the benefit of using patient reported outcomes, poor clinician adherence to the use of these measures has been previously reported [18-20]. Several factors have been identified as contributing to the limited use of patient reported outcomes including the administrative burden in terms of time constraints of the patient and clinician, lack of resources, and lack of training and knowledge regarding

the information gained from their use [18-20]. However, the global rating of knee function can provide clinicians with important insight regarding the patient's opinion of their knee function in a manner that is quicker and easier than distributing and scoring traditional measures of patient reported outcomes which overcomes many of the burdens and barriers that concern clinicians [18].

The global rating of knee function is a qualitative assessment of knee symptoms and function that takes into account work, sports, and daily living activities, while also accounting for psychological factors pertinent to patients [18, 21]. For the authors of this study, it is used to facilitate patient communication regarding the status of their knee since it gives us a quick sense of how much of a problem the knee symptoms are in limiting the patient's return to full function. For example, when a patient 9 months following ACLR reports a low score and has symptoms and physical examination findings that are consistent with significant impairments, the patient is likely not doing well and most likely would benefit from continued rehabilitation focused on addressing their impairments. In contrast, when a patient 9 months following ACLR reports a high score and has minimal symptoms and physical examination findings that are consistent with minimal impairments, the patient is likely doing well and is most likely ready to begin a return to sport program. It also has prognostic value if it is captured early in the course of care. Sonesson et al determined that global rating of knee function, when used in combination with knee joint stability, gait pattern and one-legged squat at a mean of 2 weeks following anterior cruciate ligament injury, had an impact on self-reported knee function at both 3 and 12 months [11].

While we believe the global rating of knee function has clinical merit, a limitation of this measure is that it cannot provide any specific information as to what specific aspect of knee function is affected. Thus, whenever possible, we recommend that the global rating of knee function be used as a supplement to validated patient reported outcome measures like the KOS ADLS and SAS, the International Knee Documentation Committee Subjective Knee Form, or the Lysholm Knee Scale, as these measures can provide specific information regarding what specific aspect of the patient's knee function is affected [3, 5-6]. However, for clinical practices that are not able to distribute patient reported outcome

measures, we believe that the global rating of knee function can be used as an easy and acceptable alternative as long as the clinician can determine the specific activity limitations and participation restrictions from the patient's history [18].

There are some limitations to this study. We used a relatively small sample size in this study. Repeating this study with a larger sample size would increase the confidence in our results. All of the subjects in this study were cadets enrolled at a collegiate military training academy who had undergone ACLR. Thus, caution should be used in generalizing the results of this study to other patient populations with disorders other than ACLR.

This study assessed the validity of the global rating of knee function as a measure of participation restrictions experienced during activities of daily living and sports by patients with a history of ACLR. The results suggest that the global rating of knee function provides a valid measure of participation restrictions experienced during activities of daily living and sports by patients with a history of ACLR.

Acknowledgements

We would like to thank all of the participants in this study who graciously participated in this study.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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