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**Does movement quality 6 months post ACL reconstructive surgery indicate
the perceived functional abilities 2 years later?**

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Abstract

Background: Anterior cruciate ligament (ACL) injuries are common, especially among athletes. The injury often leaves the patient with consequences, such as affected postural orientation, impaired functional performance, and muscle weakness, even after rehabilitation is completed. In addition to performance-based tests, patient-reported outcome measures (PROMS) may be used to measure the patient's perceived functional abilities. A correlation worth evaluating is the potential association between postural orientation errors (POE) and future PROMs.

Aim: The aim of this study was to investigate the association between the POEs seen in functional tests 6 months after reconstructive ACL-surgery (ACLR), and the perceived functional abilities 2 years later.

Study Design: The study is a longitudinal, observational study.

Methods: The study included 21 participants, 7 women and 14 men, who had undergone an ACL-reconstruction. POEs were visually evaluated while the participants performed 5 functional tasks approximately 6 months post-surgery. The tasks were scored segment-specifically from 0-3, where 0 indicates no postural orientation errors and 3 higher level of POE. The tasks were divided into subscale Activity of Daily Living (ADL) and subscale Sport, and POE was calculated for each subscale, as well as total score for all tasks. PROM-questionnaires were sent out 2 years later. Spearman's rank coefficient (r_s) was used to determine any association.

Result: The strongest association was observed between the POE subscale Sport and the PROM ACL-Quality of Life subscale Sport ($r_s = -0.576$, $p = 0.006$). In addition, significant moderate associations were observed in 6 of the other correlations between the different POE scores and PROMs ($r_s = -0.435$ to -0.490 , $p < 0.05$).

Conclusion: Assessment of POEs after ACLR may be used to indicate future perceived functional abilities, as this study shows associations between POEs after 6 months and future PROMs (2 years). This suggests that assessment of POEs might be useful during later stages of rehabilitation to get an indication of future perceived functional abilities.

Key Words: Anterior Cruciate Ligament, Anterior Cruciate Ligament Reconstruction, Postural Orientation, Postural Orientation Errors, Patient Reported Outcome Measures, Rehabilitation

Sammanfattning

Bakgrund: främre korsbandsskador (ACL) är vanliga, speciellt bland idrottare. Skadan leder ofta till konsekvenser för patienten, så som påverkad postural orientering (PO), nedsatt funktionell förmåga samt muskelsvaghet, även efter att rehabiliteringen är slutförd. Förutom prestationsbaserade tester kan patientrapporterade utfallsmått (PROMS) användas för att mäta patientens upplevda funktionella förmåga. En korrelation värd att undersöka är det potentiella sambandet mellan posturala orienteringsavvikelser (POE) och framtida PROMs.

Syfte: syftet med denna studie var att undersöka sambandet mellan POEs vid funktionella test 6 månader efter främre korsbandsrekonstruktion (ACLR) och upplevd funktionell förmåga 2 år senare.

Studiedesign: denna studie är en longitudinell observationsstudie.

Metod: studien inkluderade 21 deltagare, 7 kvinnor och 14 män, som hade genomgått en ACLR. POEs bedömdes visuellt när deltagarna genomförde 5 funktionella tester, ungefär 6 månader efter operation. Testen var poängsatta segmentspecifikt från 0-3, där 0 indikerade inga POE och 3 en högre grad av POE. Testen delades upp i subskalan Activity of Daily Living (ADL) och subskalan Sport, och POE räknades ut för respektive subskala samt som en totalpoäng för alla test. PROMs-enkäter skickades ut 2 år senare. Spearmans rangkorrelation (r_s) användes för att avgöra graden av sambandet.

Resultat: det starkaste sambandet kunde ses mellan POE subskala Sport och PROM ACL-Quality of Life subscale Sport ($r_s = -0.576$, $p = 0.006$). Utöver det, sågs signifikanta måttliga samband mellan POE-poäng och 6 andra PROMs ($r_s = -0.435$ to -0.490 , $p < 0.05$).

Konklusion: bedömning av POEs efter ACLR kan möjligtvis användas för att indikera framtida upplevda funktionella förmågor, då denna studie visar på associationer mellan POEs efter 6 månader och framtida PROMs (2 år). Detta antyder att bedömning av POEs skulle kunna vara användbart i de senare skedena av rehabilitering för att få en indikation av framtida upplevda funktionella förmågor.

Nyckelord: Anterior Cruciate Ligament, Anterior Cruciate Ligament Reconstruction, Postural Orientation, Postural Orientation Errors, Patient Reported Outcome Measures, Rehabilitation

Abbreviations

- ACL: Anterior Cruciate Ligament
- ACLR: Anterior Cruciate Ligament Reconstruction
- ACL-QoL: Anterior Cruciate Ligament-Quality of Life
- ADL: Activity of Daily Living
- FL: Forward Lunge
- KOOS: Knee injury and Osteoarthritis Outcome Score
- KMFP: Knee-Medial-to-Foot-Position
- K-SES: Knee Self-Efficacy Scale
- OA: Osteoarthritis
- PO: Postural Orientation
- POEs: Postural Orientation Errors
- PROs: Patient-Reported Outcomes
- PROMs: Patient-Reported Outcome Measures
- SD: Stair Descending
- SF-36: 36 Item Short-Form Health Survey
- SH: Side Hop
- SLHD: Single-Leg Hop for Distance
- SLS: Single-Leg mini Squat

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1 Background

1.1 Introduction

The anterior cruciate ligament (ACL) is a dense band of tissues, creating an intra-articular and extra-synovial connection in the knee joint. The attachment points are on the edge of the lateral femoral condyle and the intercondylar fossa of the tibial plateau. This gives the ligament a stabilizing functioning role in the joint. It primarily prevents excessive anterior tibial translation and internal rotation of the tibia, and keeps the knee stable through the entire range of motion (1). ACL injuries are common, especially among athletes participating in contact sports (2). Among people in general, a study shows that ACL injuries are sustained by 0.81 persons per 1000 inhabitants per year (3).

Common movements causing the ACL to rupture are hyperextension combined with rotation (4), which can occur from external forces or abrupt stops and changes of directions (3). The treatment of an ACL injury can be either surgical or conservative, often depending on the patient's age and activity level, as younger and more physically active people may be more likely to be offered surgery. Regardless of method, rehabilitation is necessary, and a systematic review by Smith et al. suggests that the end result often is equally good with either treatment process (5).

As summarized in the dissertation by Nae et. al (6), some of the consequences of an ACL injury include pain, swelling, and limited range of motion can be seen immediately, whereas weakness and affected functional performance can be seen as long-term problems. Lasting weakness in quadriceps and reduced function are common consequences often resulting in problems such as reduced jump performance (6). Another common problem is persistently affected postural control, which can be seen even after the rehabilitation is completed (7). Postural control is defined as a combination of different sensorimotor aspects. The primary aspects are postural orientation (PO) and postural stability, where postural orientation involves the active alignment of the individual's body segments in relation to each other as well as to external factors (8). It is further suggested that there is a higher risk for people with altered PO to re-rupture the ACL or sustain other lower extremity injuries (9).

To assess the results of the treatment is key in order to examine the patients' development. This is needed to monitor the advancement of rehabilitation through its different phases, for example in the later phases as well as before the return-to-play/activity. To get the patient back to full physical function is one of the central aims of the treatment. Examples of physical functions are muscle strength and hop performance. Evaluation of this, with the help of performance-based tests, where strength and single-leg hop performance is evaluated, has generally been used (10). It has also been shown that assessing PO is of importance to obtain a better understanding of the patient's physical functions in multiple aspects (11) and in

research performed by Nae et al., a test battery has been evaluated and optimized to accurately assess PO (6).

There is not a clear correlation between the patient's performance, as assessed by strength and hop symmetry, and PO, as concluded in two cross-sectional studies (12,13). The research, thus, suggests that PO evaluations could be a good complement to performance-based tests, such as strength and hop performance tests (10, 11). Another fundamental aim of the treatment is to enhance long-term quality of life (10). Patient reported outcomes (PROs) are a direct way to determine the patient's own perception of different aspects of their life, including quality of life, physical function, and health. PROs can be assessed by using Patient-Reported Outcome Measurements (PROMs) (14).

Findings in previous studies regarding a possible association between PO and self-perceived abilities have been inconsistent. A study by Nae et al, cross-sectionally investigated the correlation between visual assessment of postural orientation errors (POEs) and four PROMs 6 months after ACL surgery. The study did not show any indicators that POEs would associate with the patients' self-perceived knee function or knee-related quality of life (6). In a longitudinal study by Flosadottir et al., PO, and functional tests, were evaluated and correlated to the PROM called Knee Injury Osteoarthritis Outcome Score (KOOS) and a moderate association between PO and KOOS score was found. This study included, however, one PROM only (KOOS) at 3 and 5 years post injury (15). Further studies are, thus, needed to evaluate the correlation between POEs in the early rehab stages and different long-term PROMs. Assessments of POE may be useful since the PO might play an important role in the patients' rehabilitation and future abilities.

1.2 Problem Statement

The process of returning to sport or daily activities after an ACL injury is long. An aspect that could be important to evaluate is if there is a correlation between the PO during rehabilitation and the perceived functional abilities, not only short term but also after a longer period of time. Early evaluations of PO could potentially be an indication of what the patient's perceived abilities will be long term.

1.3 Aim of Study

The aim of this study is to investigate the association between the POEs visually assessed in functional tests 6 months after reconstructive ACL-surgery, and the perceived functional abilities 2 years later.

2 Methods

Study design: longitudinal observational study.

2.1 Data collection

The data for evaluating the POEs was collected by Nae et al. and it was used for a previous cross-sectional study. That study was evaluating the reliability and validity of the POE assessment with visual observations during functional tests 4-8 months after reconstructive ACL surgery (ACLR), and this was the original reason for collecting the data that will be used for the present study. The baseline data was collected during the period of February to August 2016 (16). Baseline data used in the current study includes age, BMI, number of weeks since surgery, sex, Tegner Activity Scale, and POE (16). Tegner Activity Scale is an 11 graded scale, where 0 indicates very low activity level and 10 indicates high competitive level in sports (17).

2.1.1 Participants

For the original study, 165 patients who had undergone ACLR at the Department of Orthopedics, Skåne University Hospital between June 1, 2015 and March 15, 2016, were invited to participate. 68 patients agreed to partake in the study, 15 patients were excluded due to below mentioned inclusion criterias, leaving 53 patients to participate in the study. Patients were excluded if they did not meet following criteria (16):

- Participants should be aged >18 and <40
- Surgery should have been done at least 16 weeks ago
- Rehabilitation should not be finalized
- Participants should have initiated jumping
- Participants should not be using crutches
- Participants should not have a medial collateral ligament injury (MCL) grade 3 injury
- Participants should not have other diseases or injuries overshadowing the knee injury

Among the final participants, there were 29 men and 24 women. 2 years later (2018), the same 53 participants received the request to partake in the follow up study to evaluate the perceived functional abilities. All descriptive data of the participants was collected at baseline (16).

2.2 Ethical Stance

The Regional Ethical Review Board in Lund, Sweden, approved the studies (2015/8 and 2015/581) and gave approval to identify patients through the orthopedics department. All participants gave written consent prior to participating (16). In this current study, all participants were anonymous as only the raw numeric data was provided.

2.3 Assessment

2.3.1 Postural Orientation Errors

To assess the PO, by rating POEs, a test battery consisting of 5 functional tasks was performed on average 6 months after ACLR. The test battery consisted of: single-leg mini squats (SLS), stair descending (SD), forward lunge (FL), single leg hop for distance (SLHD) and side-hop (SH). This test battery was developed, evaluated, and used for data collection by Nae et al. and it showed good validity and reliability for visually assessing POEs in patients with ACLR (16, 18). According to the study where the test-battery was extended with one added task (SH), it is also applicable in the later and more advanced stage of the rehabilitation (16).

The functional tasks were standardized and each task was filmed from a frontal view with a video camera (1920 × 1080 pixels; 30 Hz; Qualisys motion capture system, Gothenburg, Sweden). All assessments of POEs were visually performed by one physical therapist (JN) who evaluated the video recordings. Six segment-specific POEs were specifically graded: foot pronation, knee medial-to-foot position (KMFP), femur medial to shank, femoral valgus, deviation of pelvis in any plane, and deviation of trunk in any plane. Each segment-specific PO was rated from 0 (good) to 2 (poor), in line with a valid and reliable scoring system. A 3 was given if the participant could not perform the exercise as expected, representing very poor postural orientation. The functional tasks and POEs were divided into two subscales: POE subscale Activity of Daily Living (ADL), including SLS, SD, and FL, and POE subscale Sport, including SLHD and SH. Each subscale was calculated to a minimum score of 0 and a maximum score of 100 per subscale. A Total POE score was also calculated with a minimum value of 0 and maximum score of 100. For a more detailed description of the scoring-system, and which segment-specific POEs that were rated for each of the 6 tasks, see Appendix A, Figure 1 (16). Permission to re-use this table was given by the author.

2.3.2 Patient Reported Outcome Measures

To follow-up on self-perceived functional abilities, quantitative data was gathered 2 years after baseline using the following PROMS: Knee Self-Efficacy Scale (K-SES), the Anterior Cruciate Ligament-Quality of Life (ACL-QoL), the KOOS, Global Knee Function, and Anterior Cruciate Ligament–Return to Sport after Injury (ACL-RSI). These forms were sent electronically to invited participants (6).

K-SES is a validated and reliable self-efficacy questionnaire that consists of 22 items. Each item is scored on a 11 grade likert scale from 0-10, where 10 indicates strong self-efficacy and 0 indicates poor self-efficacy (19). It is specific to ACL injuries and can be used to evaluate the expectations of the prognosis. This test has been evaluated as valid against Short Form-36 (SF-36) (20). SF-36 is designed to evaluate the health status of the general population (21).

ACL-QoL is a questionnaire developed to evaluate the quality of life, experienced by people with ACL injuries. The test is divided into 5 domains: symptoms and physical complaints, work-related concerns, recreation and sport concerns, lifestyle concerns, and social and emotional concerns. A total of 32 items are included and graded on a visual analogue scale (VAS) 0-100, where 100 is representing no problems and 0 is representing maximum problems. The results are summarized on a 100-grade scale where each question weights equally (22). In this study the domains recreation and sport, lifestyle, and total score was used in the analysis. These were chosen to better correspond to the functional task subscales.

KOOS is a PROM specifically designed for patients with knee injuries and knee osteoarthritis (OA). It was developed over 20 years ago and has been used both clinically and for research purposes. KOOS is valid against SF-36 (23). The questionnaire has 5 subscales: Pain, Symptom, ADL, Sport/Rec and QoL, with a total of 23 items. Answers are given on a 0-4 graded scale, which are converted into a 1-100 scale for each category where 100 indicates no problems and 0 indicates maximum problems (19). The subscales ADL, Sport, and QoL were used in the present study. These were also chosen to better correspond to the functional task subscales.

Global Knee Function is utilising a VAS to determine the patients' perceived overall knee function from 1-100. The VAS can be used for various perspectives on the knee function, including both pain and function (24).

ACL-RSI is a graded scale from 1-10 quantifying psychological factors associated with the process of returning to sport after the injury. The scale is covering emotions, confidence in performance, and risk appraisal, on a form consisting of 12 items (25). The scale has been validated through Webster's study (25) to measure the psychological impacts after an ACLR in regard to returning sports.

2.4 Data analysis

For the present study the data was analyzed using SPSS version 25 (IBM Corporation, New York, USA) to investigate the association between the POEs observed in functional tests 6 months after reconstructive ACL-surgery, and the perceived functional abilities 2 years later. Calculations for descriptive statistics for POE scores and participant characteristics were conducted. Comparisons of the characteristics between the responders and non-responders of the follow-up questionnaires were performed using the independent t-test (continuous data), Mann-Whitney U test (ordinal data) or chi-square test (nominal data) as appropriate.

The Spearman's rank correlation coefficient was used to determine any associations between the POEs and the PROMs, by examining monotonic relationships. Correlation coefficients close to ± 1 indicates a strong association while correlation coefficients close to 0 indicates no association. Thresholds for the coefficient are: ≥ 0.5 indicates strong correlations, 0.3-0.49

indicates a moderate correlation, and ≤ 0.29 indicates poor correlations. Statistical significance is determined by p-values < 0.05 (26).

3 Results

3.1 Descriptive data

Out of the 53 original participants, 21 (40%) answered the follow-up PROMS, out of those, there were 7 women (33%) and 14 men (67%). The characteristics of the participants are displayed in Table 1. No statistically significant differences in baseline characteristics or baseline POEs were observed between those who responded at follow-up and those who did not (Table 1).

Table 1. Baseline data and comparison between those who responded at the follow-up and those who did not respond at the follow-up

	Responded at follow-up (n=21)	Did not respond at follow-up (n=32)	p-value
Age (years) Mean (sd)	26 (6.9)	27 (6.3)	0.669*
BMI (kg/m ²) Mean (sd)	25 (3)	24.5 (3.4)	0.684*
Time since surgery (weeks)	28.6 (6.7)	27 (6.4)	0.439*
Women, n (%)	7 (33)	17 (53)	0.157***
Tegner before injury Median (Q1-Q3)	8 (7 – 9)	8 (5 – 9)	0.695**
Tegner at baseline Median (Q1-Q3)	4 (2.5 – 5)	3 (2 – 4)	0.338**
Total POE score Median (Q1-Q3)	24 (14 – 30)	25.5 (19 – 32.25)	0.338**
POE subscale ADL Median (Q1-Q3)	17 (11 – 23.5)	22 (11 – 31)	0.292**
POE subscale Sport Median (Q1-Q3)	31 (12.5 – 34.5)	31 (19 – 36)	0.687**

*Independent sample t-test, **Mann Whitney U-test, ***Chi-square test

3.2 Correlations between POEs at baseline and PROMs at two years

The correlation between the POEs and the PROMs are displayed in Table 2. Spearman's Rank Correlation Coefficient (r_s) showed that the strongest significant association was observed between the POE subscale Sport and the ACL-QoL subscale Sport ($r_s = -0.576$, $p = 0.006$). Moderate to strong associations between POE subscale Sport and ACL-QoL subscale Lifestyle and ACL-QoL Total Score ($r_s \geq -0.467$, $p < 0.05$) was also observed. Furthermore, moderate significant associations were observed between Total POE score and ACL-QoL subscale Sport, as well as between Total POE score and ACL-QoL Total score ($r_s \geq -0.462$, $p < 0.05$). Finally, moderate associations were also seen between Total POE score and K-SES, as well as between POE subscale Sport and K-SES ($r_s \geq -0.435$, $p < 0.05$).

No significant associations were observed between any POE scores and Global Knee Function, the KOOS subscales, or ACL-RSI (Table 2). There were no significant associations with POE subscale ADL and any of the PROMs either.

Table 2. Spearman's Rank Correlation Coefficient (r_s) between POE scores and PROMs

	Total POE score		POE subscale Sport		POE subscale ADL	
	r_s	p-value	r_s	p-value	r_s	p-value
KOOS - ADL	-0.349	0.121	-0.215	0.349	-0.360	0.109
KOOS - Sport	-0.280	0.218	-0.274	0.230	-0.247	0.280
KOOS - QoL	-0.412	0.063	-0.360	0.109	-0.346	0.124
ACL - QoL subscale Lifestyle	-0.395	0.076	-0.475	0.029*	-0.164	0.478
ACL - QoL subscale Sport	-0.462	0.035*	-0.576	0.006*	-0.174	0.450
ACL - QoL Total score	-0.467	0.038*	-0.467	0.038*	-0.334	0.150
Global Knee Function	0.245	0.297	0.166	0.485	0.238	0.312
K-SES	-0.490	0.024*	-0.435	0.049*	-0.369	0.100
ACL - RSI	-0.388	0.091	-0.395	0.085	-0.0245	0.299

* = significant p-values

POE = Postural Orientation Error

PROM = Patient-Reported Outcome Measures

KOOS = Knee injury Osteoarthritis Outcome Score

ADL = Activity of Daily Living

QoL = Quality of Life

ACL-QoL = Anterior Cruciate Ligament Quality of Life

K-SES = Knee Self-Efficacy Scale

ACL - RSI = Anterior Cruciate Ligament Return to Sport

4 Discussion

The purpose of this study was to explore the association between the POEs seen in 5 different functional tests 6 months after ACLR, and the perceived functional abilities 2 years later, measured by 5 different questionnaires. The main result of the study suggests that examining POE Sports 6 months after ACL-R could give an indication of the self-perceived abilities 2 years later in regard to quality of life and function.

The findings in similar studies have in general been inconsistent, which is why further studies were needed (6, 15). Flosadottir et al. investigated postural orientation at 3 years as well as 5 years post-injury/ACLR and compared it with KOOS in longitudinal and cross-sectional analyses. The authors observed that worse PO was associated with worse KOOS-scores. In Flosadottir's study, the only PROM used was KOOS, and a completely different test battery and scoring system for PO was applied (15). In the current study there were no statistically significant associations between POEs and KOOS QoL which might be explained by the small sample size (27). However, the Spearman's coefficient correlation was similar ($r_s = -0.400$ and $r_s = -0.412$) in both studies, and showed significance in the study by Flosadottir et al (15), suggesting there may be an association between POEs and the KOOS QoL.

In the cross-sectional study by Nae et al, the correlation between POEs and PROMs, both at 6 months after surgery, was investigated, but no associations were found (6). The same test battery was used in both the current study and the previous research by Nae et al. To our knowledge, our study is the first to look at the associations between POEs in the late rehabilitation phase and various future PROMs, longitudinally. Interestingly, the current study showed more, and higher levels of associations compared to the previous study by Nae et al (6). A possible explanation for the observed associations could be that worse PO might affect the quality of the rehabilitation exercises and the following training. If the patient cannot fully utilize the rehabilitation, the long-term strength might be affected, causing altered future perceived functional abilities. Cronström et al. showed that worse PO in three-dimensional knee abduction was associated with lower knee muscle strength in patients with ACLR (28). In addition, previous studies have shown that thigh strength, especially quadriceps, is important for knee functions and return to previous activities (29, 30).

Perceived functional abilities play a significant role related to improved quality of life, which is a specific main goal of the rehabilitation process (10). Our study showed that there is a moderate to strong association between POE subscale Sport and the ACL-QoL subscales, and the POE subscale Sport and K-SES showed a moderate association. These associations suggest that POE subscale Sport might be an important aspect of future perceived abilities when measured with certain questionnaires and should be encouraged to focus on during rehabilitation. Regarding the aspects where no correlation was observed might indicate that not all POEs reflect all PROMs.

4.1 Strengths and Limitations

The greatest strength of this study is the well-developed and evaluated test-battery. Two previous studies have aimed to optimize and perfect a set of tasks to be relevant for the purpose of evaluating POEs. Using visual assessments to analyze POEs is relatively easy and economically feasible, which allows this method to be clinically manageable (16, 18).

When asked to answer follow-up questionnaires approximately 2 years later, 21 out of 53 participants chose to answer. This highly affected the sample size, and the individuals' reasons for dropping out are unknown. However, there was no significant difference in baseline characteristics between those who responded and those who did not respond to the follow-up PROMs.

The small sample size can be seen as the study's major limitation. There were no significant associations observed between the POE subscale ADL and any of the PROMs, but several of the Spearman correlation values (r_s) showed moderate non-significant associations between the following POEs and PROMs: total POE score and KOOS-ADL ($r_s=-0.349$), KOOS-QoL ($r_s=-0.412$), ACL-QoL lifestyle ($r_s=-0.395$), ACL-RSI ($r_s=-0.388$); POE subscale Sport and KOOS-QoL ($r_s=-0.360$), ACL-RSI ($r_s=-0.395$); and POE subscale ADL and KOOS-ADL ($r_s=-0.360$), KOOS-QoL ($r_s=-0.346$), ACL-QoL Total score ($r_s=-0.334$), K-SES ($r_s=-0.369$).

The statistical insignificance might be associated with the small sample size (27). Further studies with a larger sample should, thus, be conducted. In the study by Nae et al., women had worse POE than men (6). Therefore, another aspect worth continuing to study is the longitudinal differences between men and women, as the sample in the current study was too small to provide a relevant comparison between sexes. As seen in the results, improved POE scores may result in improved PROMs in the future, thus further studies could also be conducted to develop and optimize rehabilitation programs to improve PO.

4.2 Clinical Relevance

Assessing POEs may provide information that could be of value in the rehabilitation process. It could be used as a systematic approach to measure movement quality to complement other more performance-based tests, such as strength and hop performance tests, recommended during rehabilitation (10, 11). The information provided by the POE assessment could help to focus on the correct interventions for the patient's main weaknesses to improve future self-perceived abilities and quality of life. The information could also be used to motivate the patient, by discussing the work required to improve POE scores for optimization of long-term results.

Evaluating the POEs is a rather extensive and time-consuming project, and it could potentially be used differently depending on where in the rehabilitation phase the patient is. In the study by Nae et al, it was discussed how the use of POE subscale ADL could be

relevant in the earlier stages of rehabilitation to determine the patient's advancements (6). Based on the results of the current study, POE subscale Sport could be beneficial to use during the later stages during rehabilitation.

5 Conclusion

The Total POE score and POE subscale Sport 6 months after ACLR seems to be moderately to strongly associated with the self-perceived functional abilities based on the PROMs ACL-QoL and K-SES conducted 2 years later. Better POE scores seem to be associated with better PROMs, regarding above mentioned variables. This suggests that assessing POEs during rehabilitation could be useful, as the results might indicate the long-term result in an important aspect of the rehabilitation, the patient's perceived functional abilities.

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Appendix A

Figure 1. The Final test battery of tasks and POEs assessed within each task, the calculations for the percentage scale and median (quartiles) for each task, POE sub scale scores and for the Total POE score.

Functional tasks	Ankle POE	Knee POEs		Thigh POE	Hip POEs	Trunk POEs	Within-task POE score	Median (quartiles)
	Foot pronation	Knee Medial-to-foot position	Femur medial to shank	Femoral valgus	Deviation of pelvis in any plane	Deviation of trunk in any plane		
Single-leg mini squat	X	X	X	X	X	X	$\frac{\text{sum score}}{18} \times 100$	17 (11-28)
Stair descending			X	X			$\frac{\text{sum score}}{6} \times 100$	25 (0-33)
Forward lunge		X	X	X	X		$\frac{\text{sum score}}{12} \times 100$	25 (8-33)
Single-leg hop for distance		X	X	X	X		$\frac{\text{sum score}}{12} \times 100$	33 (25-44)
Side-hop lateral landing		X	X	X			$\frac{\text{sum score}}{24} \times 100$	27 (17-33)
Side-hop medial landing		X	X	X	X	X		
Subscale ADL	(Sum score of single-leg mini squat, stair descending and forward lunge)						$\frac{\text{sum score}}{36} \times 100$	19 (11-28)
Subscale Sport	(Sum score of single-leg hop for distance and side hop)						$\frac{\text{sum score}}{36} \times 100$	31 (19-35)
Total POE score							$\frac{\text{sum score}}{72} \times 100$	25 (17-31)

ADL = Activity of Daily Living

POE = Postural Orientation Errors