

Comparison of Knee Function and Activity Level Between Bilateral and Unilateral ACL Reconstruction

A Matched-Group Analysis With Minimum 5-Year Follow-up

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Background: There is a lack of knowledge regarding knee function and activity level after bilateral anterior cruciate ligament reconstruction (ACLR) at midterm follow-up.

Purpose: To compare activity level, patient-reported knee function, and quality of life in patients with bilateral ACLR and matched controls with unilateral ACLR at a minimum 5-year follow-up.

Study Design: Cohort study; Level of evidence, 3.

Methods: Patients with bilateral ACLR who were aged ≤ 40 years and had a second ACLR performed between 2010 and 2015 were identified in the authors' local database. Surgical data and preoperative Knee injury and Osteoarthritis Outcome Score (KOOS) were extracted. The patients were sent a letter with questionnaires including the KOOS, EuroQol 5-Dimensions (EQ-5D), and EuroQol visual analog scale (EQ-VAS) and were asked study-specific questions by telephone regarding activity level and knee function at a minimum 5-year follow-up. For every patient with bilateral ACLR, a control matched for age ± 2 years, sex, year ACLR was performed, and preinjury activity level or sport at the time of injury were identified in the database.

Results: A total of 98 patients (mean age \pm SD, 33.3 ± 7.3 years) with bilateral ACLR and 98 patients with unilateral ACLR (mean age \pm SD, 33.1 ± 7.7 years) were included. The mean postoperative follow-up was 7.6 ± 1.8 years (from the second ACLR) for patients with bilateral ACLR and 7.8 ± 1.7 years for patients with unilateral ACLR. Patients with bilateral ACLR reported lower scores on all KOOS subscales, the EQ-5D, and the EQ-VAS at follow-up ($P < .05$). There was no difference in activity level between the groups at follow-up, but patients with bilateral ACLR were less satisfied with their activity level and knee function ($P < .05$).

Conclusion: Patient-reported knee function and health-related quality of life were inferior in patients with bilateral ACLR compared with patients with unilateral ACLR. Patients with bilateral ACLR cannot expect the same knee function and quality of life as patients with unilateral ACLR.

Keywords: contralateral; ipsilateral; patient-reported outcome measurements; KOOS; EQ-5D; Tegner activity scale

Return to sport (RTS) is ultimately characterized by returning to the same sport as before an injury. The RTS is a multistep process from return to participation, which includes unrestricted training, followed by full participation, to return to full performance.¹⁵ Patients' expectations after an anterior cruciate ligament (ACL) reconstruction (ACLR) are high regarding RTS. It has been reported that 91% of the patients undergoing ACLR expect to RTS at the same level as before their injury.⁵ For patients who had undergone a previous

ACLR, the expectations were lower.^{5,26} Among high-level competitive athletes, the RTS rates are between 60% and 80% after primary ACLR, but only 40% after bilateral ACLR.^{26,27} The RTS rate after ACLR also depends on preinjury activity level, age, and sex, where elite, younger, and male athletes RTS to a higher degree.¹

Patients who RTS after an ACLR run a high risk of a second ACL injury to the same or the contralateral knee compared with athletes with healthy knees.⁸ Studies have shown that among young athletes who underwent ACLR and returned to pivoting activities, as many as 23% to 25% of the patients sustained a new ACL injury, and 55% to 75% of the new ACL ruptures were to the contralateral knee.^{6,18}

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There are some inconsistent findings when comparing patient-reported knee function, quality of life, and activity level between patients with bilateral ACL injuries and patients with a unilateral ACL injury. Fältström et al⁷ reported that patients with bilateral ACL injury reported lower knee function compared with patients with a unilateral ACL injury. In contrast, Goddard et al⁹ reported no difference in subjective knee function when comparing patients with bilateral ACLR with those with unilateral ACLR. However, the patient groups were small in both studies; patients with bilateral ACLR were not matched to patients with unilateral ACLR regarding preinjury activity level, age, and sex; and in the study by Fältström, not all patients underwent ACLR.^{7,9} Another study by Cristiani et al³ did not reveal any significant difference in functional knee outcome between the primary and the contralateral ACLR in the same cohort of patients. There is a lack of midterm follow-up studies of patient-reported knee function and activity level after bilateral ACLR in comparison with unilateral ACLR. Patients undergoing bilateral ACLR need thorough counseling regarding their expectations after surgery. A study comparing patients with bilateral ACLR with patients with unilateral ACLR matched by age, sex, year ACLR was performed, and preinjury activity level or sport at the time of injury activity would be helpful to obtain a better understanding of the impact of the second ACLR on knee function, activity level, and quality of life and help surgeons to inform and set realistic expectations for patients undergoing bilateral ACLR.

The purpose of this study was to investigate activity level, patient-reported knee function, and health-related quality of life in patients with bilateral ACLR compared with a matched control group of patients with unilateral ACLR at a minimum 5-year follow-up. We hypothesized that patients who underwent bilateral ACLR would have a lower activity level and poorer patient-reported knee function.

METHODS

Ethical approval for this study was obtained from the regional ethics committee, and informed consent was obtained from all patients. The study was conducted in accordance with STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.²⁵

Study Design and Patients

Our local database at Capio Arthro Clinic, Stockholm, Sweden, was used to identify patients. The database contains detailed information about patient characteristics, surgical data, and patient-reported outcome measures (PROMs) before the

primary and contralateral ACLR (Knee injury and Osteoarthritis Outcome Score [KOOS],²² EuroQol 5-Dimensions [EQ-5D],¹⁹ and Tegner activity scale⁷). Patients aged ≤ 40 years at the second ACL injury who underwent contralateral ACLR between 2010 and 2015 after a previous unilateral ACLR were identified (bilateral ACLR group), thus having a minimum 5 years of follow-up. Patients who underwent concomitant ligament reconstruction (medial or lateral collateral ligament, or posterior cruciate ligament reconstruction) at the time of the first or second ACLR were excluded, as were patients not participating in sports at the time of injury.

The identified patients were sent a letter containing the PROM forms. One week after receiving the letter, the patients were contacted by phone and asked to answer a custom questionnaire containing study-specific questions (see Appendix Figure A1), and they were reminded to complete the PROM forms. An additional reminder was sent after 8 weeks to nonresponders. The results collected from PROMs at follow-up were compared with preoperative PROMs registered in the database.

The patients answering the telephone questionnaire were matched with patients who underwent unilateral ACLR (control group). The bilateral ACLR group and the control group were matched by age (± 2 years), sex, year of surgery (year of second surgery for the bilateral ACLR group), and level/type of activity (Tegner activity scale) at the time of the first ACL injury. For example, a female soccer player born in 1995 who underwent contralateral ACLR in 2012 was matched with a female soccer player born between 1993 and 1997 who underwent primary ACLR in 2012. In cases where a female soccer player was not available, a woman participating in a sport with the same Tegner activity scale and a similar degree of pivoting activity, such as handball, basketball, or floorball, was found.

The matched controls received the same letter with the same questionnaire, except that the study-specific questions were adapted to unilateral ACLR by excluding questions that were related to the second ACLR; for example, questions regarding the activity level after the second ACLR and activity performed at the second ACL injury were eliminated. If the matched control did not answer within 2 weeks, that patient was excluded and a new matched control was found. The data were collected from June 2020 to November 2020, reaching a minimum 5-year follow-up.

PROMs and Study-Specific Questionnaires

The KOOS is divided into 5 subscales: Symptoms, Pain, Activities of Daily Living (ADL), Sports/Recreation, and Knee-related Quality of Life (QOL). The scores are transformed to a 0 to 100 scale, with 0 representing extreme knee problems and 100 representing no knee problems.²² The achievement

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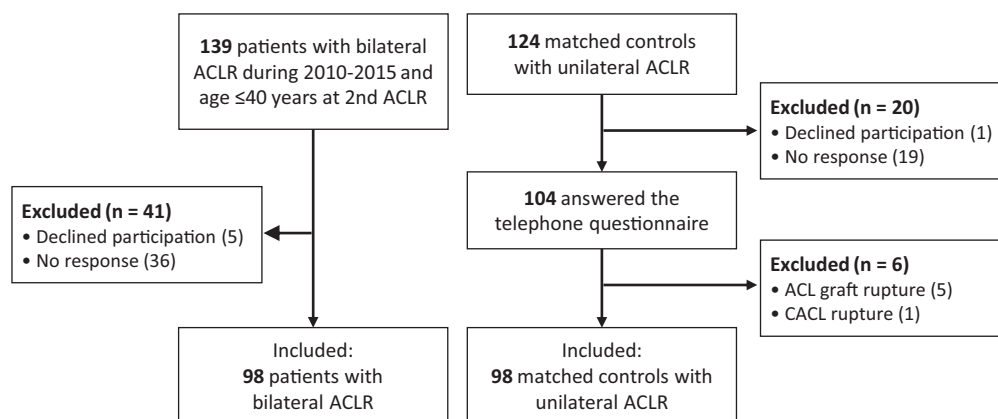


Figure 1. Patient flowchart. ACL, anterior cruciate ligament; ACLR, anterior cruciate ligament reconstruction; CACL, contralateral anterior cruciate ligament.

of a patient-acceptable symptom state (PASS) on the KOOS subscales was assessed based on the threshold values identified by Roos et al²⁰ (Pain, 89; Symptoms, 83; ADL, 95, Sports/Recreation, 72; and QOL, 73).

The EQ-5D is a standardized instrument that measures health-related quality of life.¹⁹ It consists of 2 parts: the EQ-5D and the EuroQol visual analog scale (EQ-VAS). The EQ-5D consists of 5 dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. The scores are presented as different index values ranging from <0 (worst) to 1 (best) and are elicited from a general population. The EQ-VAS measures self-rated health on a vertical VAS (0-100), where the endpoints are “worst imaginable health state” (0) and “best imaginable health state” (100).¹⁹

The study-specific questionnaire included information on occupation, whether patients had to change profession because of the ACL injury, family history of ACL injuries, and the type of activity and activity level before their first ACL injury and after the first and second ACLR. Time to RTS was registered, and more detailed questions about any reason for not returning to sport were asked. The patients were also asked about their current activity level and whether they were satisfied with this. Current global knee function and satisfaction with their knees on a 10-point scale, where 1 corresponded to “not satisfied at all” and 10 corresponded to “very satisfied,” were evaluated.⁷ There were also questions about any new injury after their first ACLR in both knees and whether the new injuries required surgery (see Appendix Figure A1). The activity level was graded using an updated Tegner activity scale.⁷

Statistical Analysis

All the variables were summarized with standard descriptive statistics such as frequency, mean, and standard deviation. The Tegner activity scale and the patients’ estimations on a 10-point scale in the study-specific questionnaire were reported as the median and interquartile range (IQR). Comparisons between the patients with bilateral ACLR and patients with unilateral ACLR regarding the KOOS,

EQ-5D, and EQ-VAS were made using a paired-sample *t* test. Comparisons of Tegner activity scale, knee function, satisfaction with knee function, “I feel limited when exercising,” and satisfaction with activity level were made using the Wilcoxon signed-rank test. Comparisons of the proportion of patients achieving a PASS, RTS, and return to the same level were made using Pearson chi-square test. The level of significance was set at $P < .05$ for all analyses. Statistical Package for the Social Sciences (SPSS) version 27.0 (IBM Corp) was used for all statistical analyses.

RESULTS

Patients

A total of 139 patients with bilateral ACLR who matched the inclusion criteria were identified. Five patients declined to participate (Figure 1). Among the 134 patients enrolled in the bilateral ACLR group, 98 patients (71%) responded to the telephone questionnaire and 92 patients (66%) responded to the KOOS, EQ-5D, and EQ-VAS. The mean time between the primary and the contralateral ACLR was 39 months (IQR, 25-62 months). The mean time from the second (contralateral) ACLR to follow-up was 7.6 ± 1.8 years.

A matched control group of 98 patients with unilateral ACLR was found in the database. If a patient declined participation, another matched control was found in the database. In all, a letter was sent to 124 patients. Among them, a total of 104 responded and gave their informed consent, but 6 of them were excluded since they suffered a rupture of the ACL graft or a rupture of the contralateral ACL that was registered at another clinic and we lacked data about that injury (Figure 1). The mean follow-up from the ACLR was 7.8 ± 1.7 years for patients with unilateral ACLR.

The characteristics of patients in the study groups are shown in Table 1, and injury and surgery characteristics are shown in Table 2. Women were significantly younger than men at the time of their first ACLR in the bilateral ACLR group (20.0 vs 23.4 years, respectively; $P = .005$). Patients in the bilateral ACLR group changed their plans for

occupation more often than patients in the unilateral ACLR group (10% vs 2%; $P = .017$). There were 48 (49%) patients in the bilateral ACLR group and 32 (33%) patients in the unilateral ACLR group who had concomitant injuries at the time of their first and second ACLRs. The 4 most common activities at ACL injury for both the first and the second ACL injury were soccer, downhill skiing, floorball, and handball.

TABLE 1
Characteristics of Patients With Bilateral and Unilateral ACLR^a

	Bilateral ACLR (n = 98)	Unilateral ACLR (n = 98)
Sex, male/female	44/54 (45/55)	44/54 (45/55)
Age at follow-up, y, mean ± SD	33.3 ± 7.3	33.1 ± 7.7
Male	35.5 ± 6.4	35.6 ± 6.2
Female	31.5 ± 7.5	31.0 ± 8.2
Educational level		
Low: 0-9 y	3 (3.0)	1 (1.0)
Medium: 10-14 y	32 (32.7)	34 (34.7)
High: ≥15 y	63 (64.3)	63 (64.3)
Occupation		
Changed occupation	10 (10.2)	2 (2.0)
Worker, mainly sedentary	49 (50.0)	57 (58.2)
Worker, mainly physical	34 (34.7)	23 (23.5)
Student	13 (13.3)	17 (17.3)
Unemployed	2 (2.0)	1 (1.0)
Family history of ACL injury	21 (21.4)	19 (19.4)

^aData are reported as n (%) unless otherwise indicated. ACL, anterior cruciate ligament; ACLR, anterior cruciate ligament reconstruction.

TABLE 2
Injury and Surgery Characteristics of Patients With Bilateral and Unilateral ACLR^a

	Bilateral ACLR		Unilateral ACLR
	Primary	Contralateral	
Time between ACLRs, mo, median (IQR)	39 (25-62)		—
Concomitant injuries			
Medial meniscal tear	21 (21.4)	13 (13.3)	12 (12.2)
Lateral meniscal tear	13 (13.3)	22 (22.4)	15 (15.3)
Medial and lateral meniscal tears	5 (5.1)	2 (2.0)	2 (2.0)
Chondral lesion	5 (5.1)	11 (11.2)	3 (3.1)
Age at ACLR, y, mean ± SD	21.6 ± 6.1	25.7 ± 7.0	25.5 ± 7.0
Male	23.4 ± 5.7	27.7 ± 6.3	27.7 ± 6.3
Female	20.0 ± 6.0	24.1 ± 7.0	23.7 ± 7.1
Time from ACLR to follow-up, y, mean ± SD	11.7 ± 3.1	7.6 ± 1.8	7.8 ± 1.7
Graft type, HT/BPTB autograft	88 (90)/10 (10)	87 (89)/11 (11)	92 (94)/6 (6)
Activity performed at injury			
Soccer	56 (57.1)	53 (54.1)	67 (68.4)
Downhill skiing	9 (9.2)	14 (14.3)	13 (13.3)
Floorball	9 (9.2)	10 (10.2)	4 (4.1)
Handball	6 (6.1)	5 (5.1)	4 (4.1)
Motor sport	3 (3.1)	2 (2.0)	2 (2.0)
Freestyle skiing	2 (2.0)	2 (2.0)	2 (2.0)
Other	13 (13.3)	12 (12.2)	6 (6.1)

^aData are reported as n (%) unless otherwise indicated. ACLR, anterior cruciate ligament reconstruction; BPTB, bone–patellar tendon–bone; HT, hamstring tendon; IQR, interquartile range.

Subjective Knee Function

For the question “How would you rate your knee function on a 10-point scale?” the patients who underwent bilateral ACLR scored significantly lower compared with the unilateral ACLR group (median [IQR], 7 [5-8] vs 8 [7-9], respectively; $P < .001$). Within the bilateral ACLR group, there were no significant differences regarding knee satisfaction between the first and contralateral ACL-reconstructed knee (Table 3). Regarding the statement “I feel limited when exercising,” patients with bilateral ACLR felt more limited compared with patients with unilateral ACLR (median [IQR], 3 [2-5] vs 3 [2-4], respectively; $P = .014$) (Table 3).

PROM Scores

Patients with bilateral ACLR obtained a lower mean score on the EQ-5D (mean [95% CI], 0.82 [0.78-0.86] vs 0.90 [0.88-0.93], respectively; $P = .002$) and EQ-VAS (mean [95% CI], 76.7 [72.6-81.0] vs 84.6 [81.3-87.8], respectively; $P = .001$) compared with patients with unilateral ACLR (Table 3).

There were significant differences between the groups regarding the preoperative KOOS-Pain and KOOS-Symptoms subscales at primary ACLR (Figure 2). The bilateral ACLR group reported higher scores on the KOOS-Pain but lower scores on the KOOS-Symptoms. At follow-up, the bilateral ACLR group reported a significantly lower score on all KOOS subscales (Figure 3). The unilateral ACLR group showed a greater improvement than the bilateral ACLR group on all KOOS subscales. The difference in improvement between the groups was

TABLE 3
Responses to PROMs and Questionnaire:
EQ-5D and EQ-VAS for the Bilateral (n = 98) and Unilateral ACLR (n = 98) Groups at Follow-up^a

	Bilateral ACLR ^b	Unilateral ACLR ^c	P
Knee function: 0-10	7 (5-8)	8 (7-9)	<.001
Satisfaction with knee function: 1-10			
First injured knee	8 (6-9)	8 (7-9)	.051
Second injured knee	8 (6-9)		
I feel limited when exercising: 1-10	3 (2-5)	3 (2-4)	.014
Satisfaction with activity level: 1-10	7 (4-9)	8 (6-10)	.047
Tegner activity level			
Before first injury	9 (1-10; 7-9)	9 (3-10; 7-9)	.703
After first ACLR	8 (1-10; 7-9)	6 (1-9; 6-8)	<.001
After second ACLR	7 (1-10; 4-9)		
At follow-up	4 (1-9; 2-7)	4 (1-9; 2-6)	.641
EQ-5D: 0-1 ^d	0.82 ± 0.21 (0.78-0.86)	0.90 ± 0.11 (0.88-0.93)	.002
EQ-VAS: 0-100 ^d	76.7 ± 20.2 (72.6-81.0)	84.6 ± 15.9 (81.3-87.8)	.001

^aData are presented as mean ± SD (95% CI) or median (range; interquartile range [IQR]). Bold P values indicate a statistically significant difference between groups (P < .05). ACLR, anterior cruciate ligament reconstruction; EQ-5D, EuroQol 5-Dimension; PROM, patient-reported outcome measure; VAS, visual analog scale.

^bTime from injury to follow-up, median (IQR): first injury, 11.3 years (9.5-13.8 years); second injury, 7.5 years (5.9-9.4 years).

^cTime from injury to follow-up, median (IQR), 7.7 years (6.2-9.5 years).

^dResponses were missing from 6 patients in the bilateral group and 4 patients in the unilateral group.

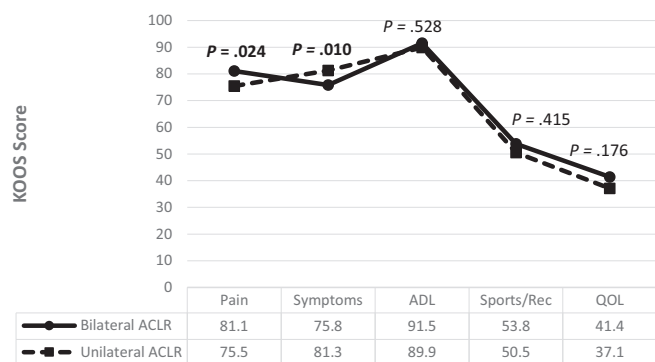


Figure 2. The mean preoperative Knee injury and Osteoarthritis Outcome Scores (KOOSs) at primary anterior cruciate ligament reconstruction (ACLR) for the bilateral ACLR group (n = 95) and the unilateral ACLR group (n = 98). Bold P values indicate a statistically significant difference between the groups (P < .05). ADL, Activities of Daily Living; QOL, Quality of Life; Sports/Rec, Sports/Recreation.

significant for all the subscales except for the KOOS-Symptoms subscale (Figure 4).

Patients in the bilateral ACLR group achieved a PASS on the KOOS-Symptoms and KOOS-QOL subscales to a lesser extent than patients in the unilateral ACLR group at follow-up (Figure 5).

Activity Level

After the first ACLR, the bilateral ACLR group reported a higher return to the same sport (88% vs 54%; P < .001) and preinjury activity level (66% vs 45%; P = .003) compared

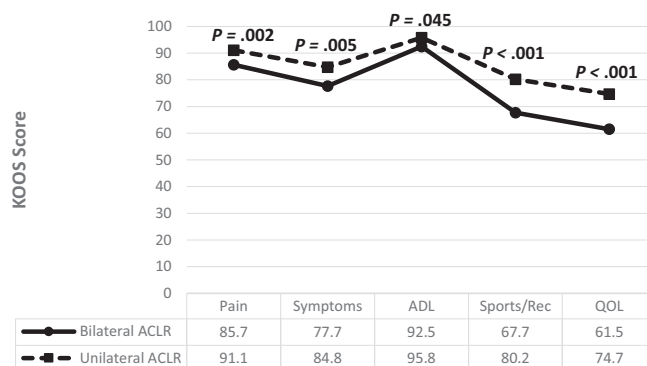


Figure 3. The mean Knee injury and Osteoarthritis Outcome Scores (KOOSs) at follow-up for the bilateral anterior cruciate ligament reconstruction (ACLR) group (n = 92) and the unilateral ACLR group (n = 94). Bold P values indicate a statistically significant difference between the groups (P < .05). ADL, Activities of Daily Living; QOL, Quality of Life; Sports/Rec, Sports/Recreation.

with the unilateral ACLR group. Patients in the bilateral ACLR group had a significantly higher Tegner score after the first ACLR (median [IQR], 8 [7-9] vs 6 [6-8] for the unilateral group; P < .001). After the second ACLR (in the bilateral ACLR group), 61% of the patients returned to the same sport and 41% returned to their preinjury activity level.

At follow-up, both groups had a reduced activity level, but there were no significant differences between the groups. However, patients in the bilateral ACLR group were significantly less satisfied (median [IQR], 7 [4-9] vs

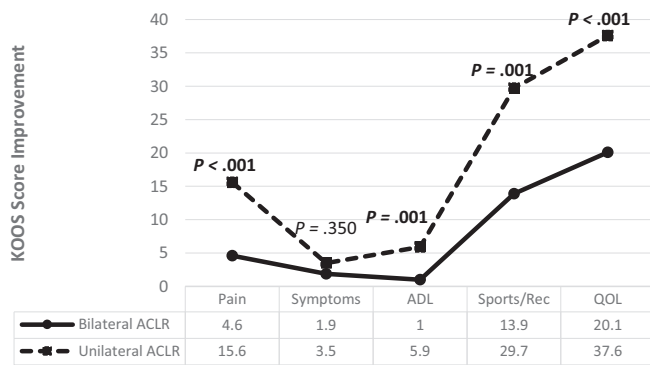


Figure 4. The mean improvement in Knee injury and Osteoarthritis Outcome Score (KOOS) from preoperative primary anterior cruciate ligament reconstruction (ACLR) to follow-up for the bilateral ACLR group (n = 89) and the unilateral ACLR group (n = 94). Bold values indicate a statistically significant difference between the groups ($P < .05$). ADL, Activities of Daily Living; QOL, Quality of Life; Sports/Rec, Sports/Recreation.

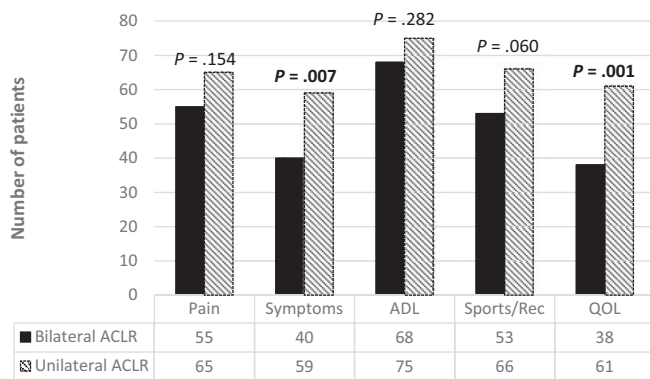


Figure 5. Number of patients achieving a patient-acceptable symptom state on the Knee injury and Osteoarthritis Outcome Score subscales at follow-up in the bilateral anterior cruciate ligament reconstruction (ACLR) group (n = 92) and unilateral ACLR group (n = 94). Bold values indicate a statistically significant difference between the groups ($P < .05$). ADL, Activities of Daily Living; QOL, Quality of Life; Sports/Rec, Sports/Recreation.

8 [6-10] for the unilateral group; $P = .047$) with their activity level (Table 3). Fear of suffering another injury was the most common reason in both groups for not returning to their preinjury activity level (Table 4).

DISCUSSION

The most important finding in this study was that the bilateral ACLR group had a poorer self-reported knee function and quality of life in the KOOS and EQ-5D compared with the matched unilateral ACLR group after a minimum follow-up of 5 years. Both groups had a reduced activity

TABLE 4
The Most Common Reasons for Not Returning to the Preinjury Activity Level^a

	Bilateral ACLR (n = 42)	Unilateral ACLR (n = 45)
Poor knee function	3 (7.1)	7 (15.6)
I do not trust my knee	5 (11.9)	2 (4.4)
Fear of suffering another injury	21 (50.0)	16 (35.6)
My team has changed	1 (2.4)	3 (6.7)
Do not have time because of family situation	4 (9.5)	3 (6.7)
Do not have time because of work situation	2 (4.8)	2 (4.4)
Dissuaded by doctor/physical therapist	3 (7.1)	1 (2.2)
Other	3 (7.1)	11 (24.4)

^aValues are reported as the number of patients (% of the group that did not return to their preinjury activity level). ACLR, anterior cruciate ligament reconstruction.

level at follow-up compared with the preinjury state, but there was no significant difference between the groups. Moreover, this study showed that patients with bilateral ACLR are less satisfied with their current activity level compared with unilateral ACLR.

In the present study, the bilateral ACLR group reported a significantly lower score on all KOOS subscales compared with the unilateral ACLR group at follow-up and also achieved a PASS on the KOOS-Symptoms and KOOS-QOL to a lesser extent. These results are consistent with the findings by Fältström et al,⁷ in which the bilateral ACLR group obtained significantly lower scores on the KOOS-Pain, -Sport/Recreation, and -QOL subscales. Interestingly, in our study, the bilateral ACLR group reported higher scores at follow-up on all KOOS subscales compared with the bilateral ACLR group in the study by Fältström et al.⁷ This difference might be explained by the fact that only 65% of the patients with bilateral ACL injuries in their study were treated with an ACLR, and it has been shown that an ACLR improves the KOOS.¹¹ Moreover, associated knee injuries were more common in the study by Fältström et al⁷ compared with our study, and it has been shown that associated injuries can reduce PROMs.¹⁶

The differences on the KOOS for all the subscales, EQ-5D, and EQ-VAS were statistically significant between the bilateral and unilateral ACLR at follow-up. However, the clinically important difference was most pronounced in the Sport/Recreation subscale. The minimal clinically important difference (MCID) for the KOOS has been suggested to be 8 to 10 points.²¹ A recent study by Ingelsrud et al¹² suggested different MCIDs for the KOOS subscale scores for patients undergoing ACLR. The authors suggested that only the Sport/Recreation and QOL subscales should be considered as primary outcomes after ACLR and that the MCIDs for those subscales would be 12.1 and 18.3, respectively. According to the MCID values suggested by Ingelsrud et al,¹² a clinically relevant difference between

the unilateral and bilateral ACLR group would therefore only be present for the Sport/Recreation subscale.

The differences between MCID values suggested by Ingelsrud et al¹² and Roos and Lohmander²¹ could be partly explained by the fact that the MCID was suggested for different patient groups. Roos and Lohmander²¹ suggested the MCID for the KOOS without regard to any specific diagnosis, whereas Ingelsrud et al¹² proposed an MCID specifically for patients undergoing ACLR. However, there are some weaknesses when it comes to the use of the MCID values since these might only help to identify patients who feel clinically improved, and that it is not equivalent to a condition of feeling well from the patient's perspective. How patients feel at the time of follow-up may be more important than how much they have improved from preoperatively to postoperatively. The PASS thresholds were therefore used to identify patients who feel well and not only improved.²⁰ By using the already established PASS thresholds, we found that patients with bilateral ACLR achieved a PASS to a lower extent on the KOOS-Symptoms and KOOS-QOL subscales compared with patients with unilateral ACLR.

The bilateral ACLR group reported a significantly higher activity level after their first ACLR compared with the unilateral ACLR group. They returned to sport to a greater extent, which may be one reason for incurring a contralateral ACL injury. It is known that a higher activity level is a risk factor for a second ACL injury.^{2,4,8,13,17} Another possible reason could be that the patients with bilateral ACLR were younger than patients with unilateral ACLR at the time of primary ACLR.^{2,4,13} The bilateral ACLR group reported a return to preinjury level rate of 66% after primary ACLR and 41% after the contralateral ACLR, while the unilateral ACLR group showed a return to preinjury level rate of 45% after primary ACLR.

Webster et al²⁷ reported a return to preinjury level rate of 83% after primary ACLR, which is higher than our findings, but the rate of return to preinjury level was 40% after contralateral ACLR, which is in line with our results. The patients in the Webster et al²⁷ study were similar to those of the current study regarding age and sex, but there was a different panorama of sports practiced among the patients. Soccer was only played by 1 in 6 patients in their study, whereas it was played by more than half of the patients in the present study. It could be hypothesized that the patients in the bilateral ACLR group had greater ambitions with their sports activities than patients in the unilateral ACLR group and managed to return to a more active lifestyle after their first ACLR, but when they suffered a second ACL injury, their activity level decreased to the same level as the unilateral ACLR group after a minimum follow-up of 5 years. Since patients in the bilateral ACLR group were unable to achieve their previous activity level, they were more dissatisfied with their knee function, and they also reported poorer scores on all KOOS subscales at follow-up.

Fear of reinjury was the most common reason for not returning to sport in both the unilateral and the bilateral ACLR group. Additionally, fear of reinjury was more common in the bilateral ACLR group after the last surgery. Patients with bilateral ACLR underwent 2 ACLRs, and the fear of suffering a new ACL rupture can be expected to be

high.⁵ However, this difference was not seen in the study by Fältström et al,⁷ where the main reason for not returning to the previous activity level was self-reported reduced function in the knee or knees. One explanation may be that not all the patients with bilateral ACL injuries in the study by Fältström et al⁷ were treated with ACLR, which is accepted to be the treatment of choice for patients who wish to return to jumping, cutting, and pivoting sports.^{10,23,24} Fear of a new injury has been reported as the most common reason for not returning to sport in other studies as well.^{14,27} These data, combined with our findings, highlight the importance of empowering the patients both psychologically and physically.

One strength of this study was the relatively high response frequency (>70%). The groups that were analyzed and compared were homogeneous. All ACLRs were performed at the same clinic, and rehabilitation and the preoperative and postoperative assessments were standardized. Another strength was the midterm follow-up. To our knowledge, studies thoroughly comparing patients with bilateral ACLR with matched patients with unilateral ACLR, regarding RTS and knee function at a midterm follow-up, are lacking. Moreover, we collected separate data regarding RTS and return to preinjury activity level because all the patients who return to the same sport do not always achieve their preinjury level.¹ The main limitation that should be acknowledged is that the patients had to recall their activity and activity level retrospectively when asked about what happened during the first years after surgery. It can be assumed that it is difficult to recall exactly what happened 5 to 10 years ago, but we believe that these important events in life are seldom forgotten and that recall bias had a minor impact on our result. Another limitation was that not all the patients were able to be matched for the same sport. In the event that matching by sport was not possible, patients were matched by the same type of activity or similar degree of pivoting activity based on the Tegner activity scale. Finally, we have not matched the groups for associated injuries to meniscus and cartilage, which also could impact outcome.

CONCLUSION

Patient-reported knee function and health-related quality of life on the KOOS and EQ-5D were inferior in patients with bilateral ACLR compared with patients with unilateral ACLR. There was no significant difference in activity level between the groups after a minimum of 5 years of follow-up; however, patients with bilateral ACLR were less satisfied with their activity level and knee function. Patients with bilateral ACLR cannot expect the same functional knee outcome and quality of life as patients with unilateral ACLR.

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APPENDIX

Background

What is the highest level of education you have completed?

What is your main occupation?

Have you changed your profession because of your ACL injury?

Have any of your siblings or parents suffered an ACL injury?

Activity Level

Which activity were you active in before your first ACL injury? On which level? How often did you exercise, including competitions?

Which activity did you perform at your injury? First injury? Second injury?*

Which activity were you active in after your first ACLR? On which level? How often did you exercise, including competitions?

Which activity were you active in after your second ACLR? On which level? How often did you exercise, including competitions?*

Did you return to your previous sport or your previous activity level after your first ACLR? Second ACLR?
If yes, how many months did it take?
If not, for what reason?

Which activity do you currently perform? On which level? How often do you exercise, including competitions?

How much time did you spend during the previous week on everyday exercise?

How much time did you spend during the previous week on physical activity?

Knee Function and Satisfaction

Do you feel limited when exercising after your ACLR on a 10-point scale?
1 – Not limited at all. 10 – Very limited.

Are you satisfied with your current activity level on a 10-point scale?
1 – Not satisfied at all. 10 – Very satisfied.

How would you rate your knee function on a 10-point scale?
0 – Inability to cope with normal daily activities. 10 – Normal, excellent function

Are you satisfied with your knee function in your right knee?
1 – Not satisfied at all. 10 – Very satisfied

Are you satisfied with your knee function in your left knee?
1 – Not satisfied at all. 10 – Very satisfied

New Injuries

Have you sustained any new injuries in your knee after your ACLR in your right knee?
If yes, what type of injury? When? Did it require surgery?

Have you sustained any new injuries in your knee after your ACLR in your left knee?
If yes, what type of injury? When? Did it require surgery?

*Only to the bilateral group.

Figure A1. Custom questionnaire used during the telephone interview with patients.