Original Article

Return to sport and knee functional scores after anterior cruciate ligament reconstruction: 2 to 10 years' follow-up

Sukrom Cheecharern*

Department of Orthopedics, Rajavithi Hospital, College of Medicine, Rangsit University, Bangkok, Thailand

A B S T R A C T

Background: Anterior cruciate ligament (ACL) reconstruction is one of the most common knee ligament reconstruction sustained by sports players. Previous studies have revealed different rates of returning to play sports depending on study sites, subjects, and time to follow-up; however, this subject has not been adequately investigated in Thailand.
Objectives: This study aimed to assess the percentage of ACL reconstruction patients who successfully returned to sport activities. Factors associated with being able to return to sport were also determined.
Materials and methods: A cross-sectional study was conducted to assess the rates of return to sport of patients who underwent ACL reconstruction between 2005 and 2015. All potential patients were initially contacted via letter or mobile phone and asked to report their long-term follow-up outcomes. Collected data from the interview, including return to sport status, performance following ACL, and reasons for not returning to play (if applicable) were then combined with the initial surgical findings and enrollment/follow-up cohort data for analysis. This study was reviewed and approved by the ethics committee of Rajavithi Hospital.
Results: A total of 110 participants were recruited, with a mean age of 35.05 ± 9.16 years. Most of the patients were male, single, with bachelor degree education, engaged in "other" occupations, had income up to 10,000 baht/month, were in the social security scheme (54.5%), and had no underlying diseases (85.5%). The mean $\pm$ SD of BMI was 25.58 ± 4.30 kg/m^2. When classified by whether or not they returned to sports, it was found that sex, education, income and underlying disease of those who returned to sport were significantly different from those of subjects who did not ($p < 0.05$). At follow-up, 36.4% had returned to sport. The main reasons stated for not returning to sport following ACL were fear of injury, concern about possible long-term effects, and worry about the possibility of re-injury. Overall, total IKDC scores of patients who returned to sport were significantly higher than those of subjects who did not. However, some points such as ability to kneel, ride and bend the knee were not different in the two groups. Bachelor degree education, monthly income lower than 10,000 Thai baht and IKDC score were the factors associated with returning to sport.
Conclusions: The rates of return to sport after ACL reconstruction were low compared to those of other reports in the literature. Education, low income and IKDC score were predictive factors of sport re-participation. Further studies should be carried out to assess the impact on treatment indications and rehabilitation.

© 2018 Asia Pacific Knee, Arthroscopy and Sports Medicine Society. Published by Elsevier (Singapore) Pte Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Introduction

Anterior cruciate ligament (ACL) is the most common ligamentous injury sustained by professional athletes at all levels of play, and its occurrence in the United States ranges from between 60,000 and 175,000 cases yearly.[1] In athletes, successful operations involving anterior cruciate ligament reconstruction techniques and rehabilitation have led to improved surgical outcomes and increased desire to return to play sports.[2] ACL reconstruction aims to get rid of functional instability, thereby decreasing the incidence of subsequent injuries.[3] Previous studies have revealed that the

---

* Corresponding author. Department of Orthopedics, 2, Rajavithi Hospital, Phyathai Road, Rajathewi District, Bangkok, 10400, Thailand.
   E-mail address: sukrom@gmail.com.

difference remains between expectation and actual return to sport with the latter ranging from 60% to 80% in various sports types.[4–7] A systematic review and meta-analysis which assessed 48 studies and 5770 patients with regard to return to sport after ACL found that while eighty-two percent of patients returned to sport, only 63% and 44% resumed their pre-injury and competitive sports respectively.[5] Although the outcomes after ACL reconstruction have been well-documented, athletes also require standard counseling especially on the timing of their return to sport and their levels of sports performance. Different sports types may influence the results and could also be affected after surgery.[8] For example, athletes who play American football experience a wide variety of aspects of the game involving size, speed and position.[9] ACL injury has been shown to vary depending on the position played,[10] some of which, such as running backs or wide receivers, require high-speed cutting and pivoting movement, while a lineman is more often subjected to direct blows to the knee.[11] Consequently, there are different predictive indicators for returning to sport following ACL reconstruction as a function of positional plays. It is crucial that patients be informed about these variations in order for them to be able to understand their chances of returning to their previous level of sports performance.[12] Additionally, sport-specific differences in outcomes following ACL reconstruction could help to optimize rehabilitation and expedite return to specific sports. In Thailand, there are few professional athletes, the majority being amateurs. Most patients who undergo ACL reconstruction surgery are students and others who exercise for recreational purposes. After ACL reconstruction, rehabilitation is needed to improve the ability and function of the knee; however, people who are not sports players may lack physical endurance, and this may be the reason for their not returning to sports after surgery. Socioeconomic factors are also associated with returning to sport.[4,5] Health attitudes may also differ among those who have different educational levels and income; therefore, these socioeconomic factors were included in the present study. The purpose of this research was to identify the percentage of ACL reconstruction patients who successfully returned to playing sport activities. Factors associated with being able to return to sport were also evaluated.

Methods

Study design

A cross-sectional study was conducted to examine the rates of return to sport of patients who had previously undergone ACL reconstruction. This study was reviewed and approved by the ethics committee of Rajavithi Hospital before database access and patient contact prior to performing data collection (EC 084/2560).

Participants

All patients who underwent ACL reconstruction surgery between 2005 and 2015 were enrolled. The exclusion criteria were patients with multiple ligaments which could not be repaired, medial meniscectomy of up to 30%, or had mental illness that prevented them from providing information during the study. Sample size calculation based on proportion was used to determine the sample size in the present study. The proportion of return to sport, taken from that of a study by Ardern et al.[5] (82%), was calculated, and 30% was added to the calculated number to allow for some possible errors; hence, all 110 patients were selected. A consent form was obtained from all participants.

Data collection

Data were collected using a questionnaire which was divided into two parts. Part I included baseline characteristics such as sex, age, education level, income level, occupation, marital status, and underlying diseases. Part II sought to obtain information on subjects' return to sport and their ability to perform using the IKDC Subjective Knee Evaluation Form. The rate of return to sport mainly focuses on only sport activities.

All potential patients were initially contacted via letter or mobile phone and asked a series of structured questions from a non-validated study-specific questionnaire regarding their participation in sports around the time of injury as well as the highest activity level attained following ACL reconstruction. Collected data from the interview, including return-to-play status, performance following ACL reconstruction, and reasons for not returning to play (if applicable) were then combined with the initial surgical and enrollment/follow-up cohort data for analysis. With regard to sports participation, the subjects were asked about their attempts to play sport since their surgery and whether they had attempted to play their pre-injury sports; they were also asked about their participation in competitive sports. Participants who changed their level of sports participation or did not return to sport were asked to indicate their reasons.

Research tools

The 2000 IKDC Subjective Knee Evaluation Form (IKDC-Thai version)[13–15] was employed to record information regarding knee function in daily life activities. The IKDC was initially developed as a ligament scoring system in 1987 by a group of American and European knee surgeons. The current modified form is divided into documentation, qualification and evaluation sections, and it examines four areas (subjective assessment, symptoms, range of movement and ligament examination). Knee symptoms were evaluated using questions with a 5-point Likert scale. Subjects were asked to indicate the highest level of activities that they could participate in on a regular basis. These included very strenuous activities like jumping or pivoting as in basketball or soccer, strenuous activities like heavy physical work, skiing or tennis; moderate activities such as undemanding physical work, running or jogging; light activities like walking, housework or yard work; and inability to perform any of the activities due to giving way of the knee. Daily knee ability in activities such as going up and down stairs, squatting, and sitting with knees bent were rated using a 5-point Linkert scale as not difficult at all, minimally difficult, moderately difficult, extremely difficult and too difficult to do. The responses to each question were scored with 0 given to responses that represent the lowest level of function or highest level of symptoms. For example, item 1, which is related to the highest level of activity without significant pain is scored by assigning a score of 0 to the response "Unable to perform any of the above activities due to knee pain" and a score of 4 to the response "Very strenuous activities like jumping or pivoting as in basketball or soccer". For item 2, which is related to the frequency of pain over the past 4 weeks, the responses are reverse-scored such that "Constant" is assigned a score of 0 and "Never" is assigned a score of 10. Similarly, for item 3, the responses are reversed-scored such that "Worst pain imaginable" is assigned a score of 0 and "No pain" is assigned a score of 10. Note: previous versions of the form had a minimum item score of 1 (for example, ranging from 1 to 11). In the most recent version, all items now have a minimum score of 0 (for example, 0 to 10).[15] This 2000 IKDC subjective knee evaluation form is scored by summing the scores for the individual items and then transforming the score to a ranged scale from 0 to 100. The

interpretation of transformed score is as a measure of function, with higher scores representing higher levels of function and lower levels of symptoms. A score of 100 is interpreted to mean no limitation with activities of daily living or sports activities and the absence of symptoms.[15]

Statistical analysis

Data were analyzed using SPSS version 17.0 (SPSS Inc., Chicago, Illinois, USA). Baseline characteristics were analyzed using descriptive statistics such as number, percentage, mean and standard deviation, minimum and maximum. Chi-square or Fisher Exact test were used to compare categorical variables and frequency differences. Student's t-test/Mann-Whitney U-teat were used to compare continuous variables. ANOVA with repeated measures was used to compare three or more group means where the participants were the same in each group. Binary logistic regression was used to identify the OR of the associated factors, and a p-value less than 0.05 was considered as statistically significant.

Results

Baseline characteristics of the subjects are shown in Table 1. One hundred and ten ACL reconstruction patients were included for analysis, with a mean age ($\pm$SD) of 35.05 ± 9.16 years old. The majority of the patients were male (83.6%), single (53.6%), had bachelor degree education (51.8%), were in "other" occupations (26.4%), earned up to 10,000 baht/month (73.6%), were in the social security scheme (54.5%), had no underlying diseases (85.5%), and had mean $\pm$ SD BMI of 25.58 ± 4.30 kg/m^2. When categorized

regarding their return to sport, it was found that sex, education, income and underlying disease of those who returned to sport were significantly different from those of subjects who did not ($p < 0.05$). Other baseline characteristics such as age, marital status, occupation, health care scheme and BMI were similar.

Of the 110 participant surveyed, about 36.4% (n = 40) returned to sport and the other 70 did not, as seen in Fig. 1. The top three reasons for not returning to sport following ACL were fear of pain (41.4%), concerns about possible long-term effects (32.9%), and worries about the possibility of repeated injury (18.6%) as shown in Table 2.

Responses to symptoms and IKDC scores are displayed in Table 3. Overall, total IKDC scores of patients who returned to sport were significantly higher than those of participants who did not. However, some points such as ability to kneel, ride and bend the knee were similar in the two groups.

The mean IKDC scores based on an assessment of the maximum activity levels that could be achieved without knee pain among pre-injury, post operation and current use of knee in patients who returned and did not return to sport following ACL are shown in Table 4. Comparison of the mean IKDC scores of those who returned and those who did not return to sport showed that the IKDC scores for post-operation and current knee use were significantly different in the two groups, while no difference was found at pre-injury (Fig. 2). Within the group who returned to sport, there were significant differences in the mean IKDC score between the pre-injury and post-operation ($p < 0.001$), pre-injury and current knee use ($p < 0.001$), and post-operation and current knee use ($p < 0.001$). These results were similar for those who did not return to sport.

The mean IKDC scores based on the levels of use of the knees

Table 1
Baseline characteristics and divided by return to sport.

|	Total (n = 110)		Return to sport				p-value
			yes (n = 40)		No (n = 70)		
	n	%	n	%	n	%	
Sex							0.003*
Female	18	16.4	1	2.5	17	24.3	
Male	92	83.6	39	97.5	53	75.7	
Age (years) mean ± SD	35.05 ± 9.16		32.87 ± 9.056		36.26 ± 9.07		0.064
Marital status							0.159
Single	59	53.6	25	62.5	34	48.6	
Married	51	46.4	15	37.5	36	51.4	
Education							<0.001*
Primary school	7	6.4	6	15.0	1	1.4	
Secondary school	27	24.5	3	7.5	24	34.3	
Diploma	11	10.0	2	5.0	9	12.9	
Bachelor	57	51.8	24	60.0	33	47.1	
Above bachelor	8	7.3	5	12.5	3	4.3	
Occupation							0.077
Civil servant	13	11.8	5	12.5	8	11.4	
Public Enterprise	28	25.5	7	17.5	21	30.0	
Labor	27	24.5	13	32.5	14	20.0	
Owner	12	10.9	1	2.5	11	15.7	
Others	29	26.4	13	32.5	16	22.9	
Income							0.014*
<10,000 baht/month	29	26.4	16	40.0	13	18.6	
>10,000 baht/month	81	73.6	14	60.0	57	81.4	
Health care scheme							0.237
Paid	4	3.6	0	0.0	4	5.7	
Social Security Scheme	60	54.5	22	55.0	38	54.3	
government-sponsored forms of insurance	17	15.5	6	15.0	11	15.7	
Health Card Scheme	25	22.7	12	30.0	13	18.6	
Company health scheme	4	3.6	0	0.0	4	5.7	
Underlying diseases							0.032*
No	94	85.5	38	95.0	56	80.0	
Yes	16	14.5	2	5.0	14	20.0	
BMI (Kg/m2) mean ± SD	25.58 ± 4.30		25.79 ± 4.69		25.46 ± 4.10		0.698
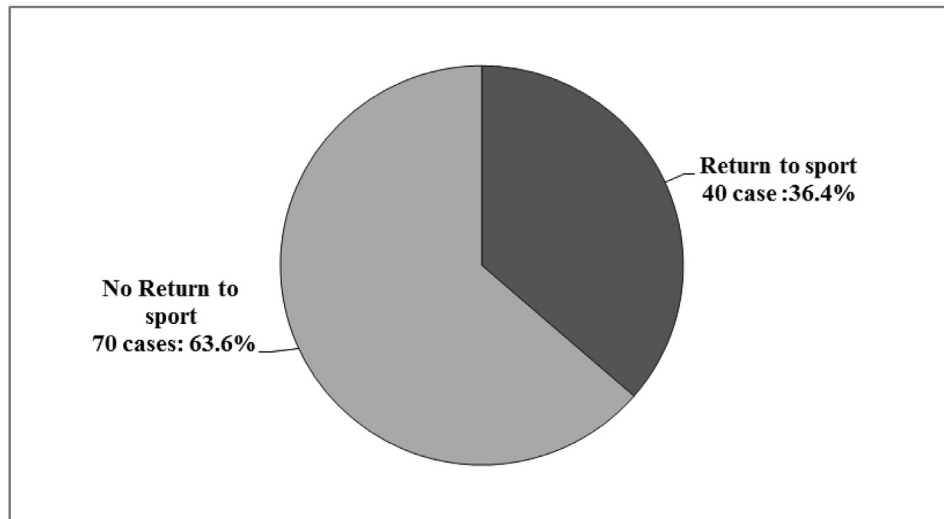
Fig. 1. Number and percent of patients who return to sport following ACL.

Table 2
Reasons of patients who did not return to sport following ACL (n = 70).

Reasons	n	%
Fear of injury	29	41.4
Fear of long term effect	23	32.9
Fear to re-injury	13	18.6
No time	11	15.7
The pain remain	7	10.0
Heavy weight	5	7.1
Old age	2	2.9
Physician suggestion	2	2.9
Rehabilitation	1	1.4

among pre-injury, post operation and current use of knee between patients who returned and did not return to sport following ACL are presented in Table 5. Comparison of the mean IKDC scores of those who returned and did not return to sport showed that the IKDC scores for post-operation (p < 0.017) and current knee use (p = 0.001) were significantly different between groups, while no difference was found at pre-injury (Fig. 3). Within the group who returned to sport, there was a significant difference in the mean IKDC scores between the post-operation and current knee use results (p = 0.043). For those who did not return to sport, there were significant differences between pre-injury and post-operation (p < 0.001), and pre-injury and current knee use results (p = 0.002). Bachelor degree level of education, monthly income of less than 10,000 Thai baht and IKDC score were the factors associated with returning to sport. Factors associated with return to sport following Anterior Cruciate Ligament reconstruction are shown in Table 6.

Table 3
Comparison of mean IKDC scores based on activities between patients who returned and did not return to sport following ACL.

Activities	Total (n = 110)		Return to sport				p-value
			Yes (n = 40)		No (n = 70)		
	Mean	SD	Mean	SD	Mean	SD	
1. The highest activity level can be performed without significant knee pain	60.00	24.93	81.88	24.67	47.50	14.21	<0.001*
2. Frequency of pain in the last 4 weeks or since injury	68.39	30.23	85.00	17.80	60.48	32.01	0.011*
3. Pain severity	70.65	27.32	84.00	17.76	64.29	29.08	0.028*
4. Stiff or swollen knee in the last 4 weeks or since injury	87.10	24.04	95.00	10.54	83.33	27.76	0.103
5. Highest activity level without significant swelling in knee	69.35	25.58	100.00	.00	54.76	16.99	<0.001*
6. Knee lock or catch in the past 4 weeks or since injury	87.10	34.08	80.00	42.16	90.48	30.08	0.433
7. Highest activity level can be performed without significant giving way	73.39	24.95	100.00	.00	60.71	20.27	<0.001*
8. Activities can be participated on a regular basis	63.71	24.87	95.00	15.81	48.81	9.61	<0.001*
9. Knee effect on ability							
9.1 Go up stairs	91.36	18.06	97.50	7.60	87.86	21.17	0.001*
9.2 Go down stairs	90.91	18.15	99.38	3.95	86.07	21.13	0.001*
9.3 Kneel on the front of your knee	68.06	35.82	67.76	35.79	68.21	36.10	0.951
9.4 Squat	75.68	32.39	81.88	27.14	72.14	34.72	0.130
9.5 Sit with your knee bent	85.68	23.08	88.75	21.89	83.93	23.71	0.294
9.6 Rise from a chair	95.91	13.34	99.38	3.95	93.93	16.17	0.009*
9.7 Run straight ahead	87.05	25.51	98.75	5.52	80.36	29.76	<0.001*
9.8 Jump and land on your involved leg	71.80	36.14	90.44	18.48	59.62	39.65	<0.001*
9.9 Stop and start quickly	77.67	33.19	92.50	14.10	68.25	38.15	<0.001*
10.1 Pre-injury use of the knee	94.52	14.10	99.00	3.16	92.38	16.70	0.093
10.2 The current use of the knee	79.03	19.21	94.00	10.75	71.90	18.34	<0.001*
Total IKDC SCORE	78.32	17.19	88.13	8.92	72.72	18.29	<0.001*

p-value from Student t-test, *Significant at p < 0.05.

Table 4
Comparison of mean IKDC scores in Item 1 (Assessment the maximum activity levels that can be achieved without knee pain) among pre-injury, post operation and current use of knee between patients who returned and did not return to sport following ACL.

Assessment the maximum activity levels that can be achieved without knee pain	Total (n = 110)	Return to sport		p-value
		Yes (n = 40)	NO (n = 70)	
Pre-injury	87.95 ± 23.40	90.00 ± 19.45	86.79 ± 25.44	0.491
Post operation	51.82 ± 24.12	68.75 ± 27.59	42.14 ± 15.07	<0.001*
Current	60.00 ± 24.93	81.88 ± 24.67	47.50 ± 14.21	<0.001*
p-value within group				
Pre-injury vs Post-operation	<0.001*	<0.001*	<0.001*	
Pre-injury vs Current	<0.001*	<0.001*	<0.001*	
Post-operation vs Current	<0.001*	<0.001*	<0.001*	

p-value from repeated measure ANOVA, *Significant at p < 0.05.
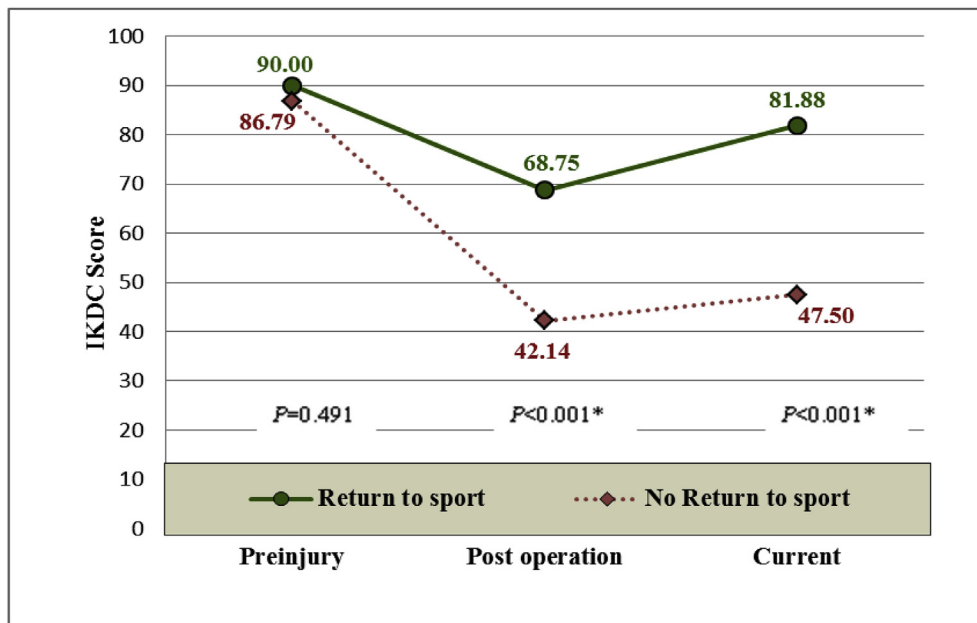
Fig. 2. Comparison of the mean IKDC scores based on assessment of the maximum activity levels that can be achieved without knee pain between those who returned and did not return to sport at pre-injury, post-operation and current knee use.

Table 5
Comparison mean IKDC scores in Item 10 (The level of use of the knee) among pre-injury, post operation and current use of knee between patients who return and not return to sport following ACL.
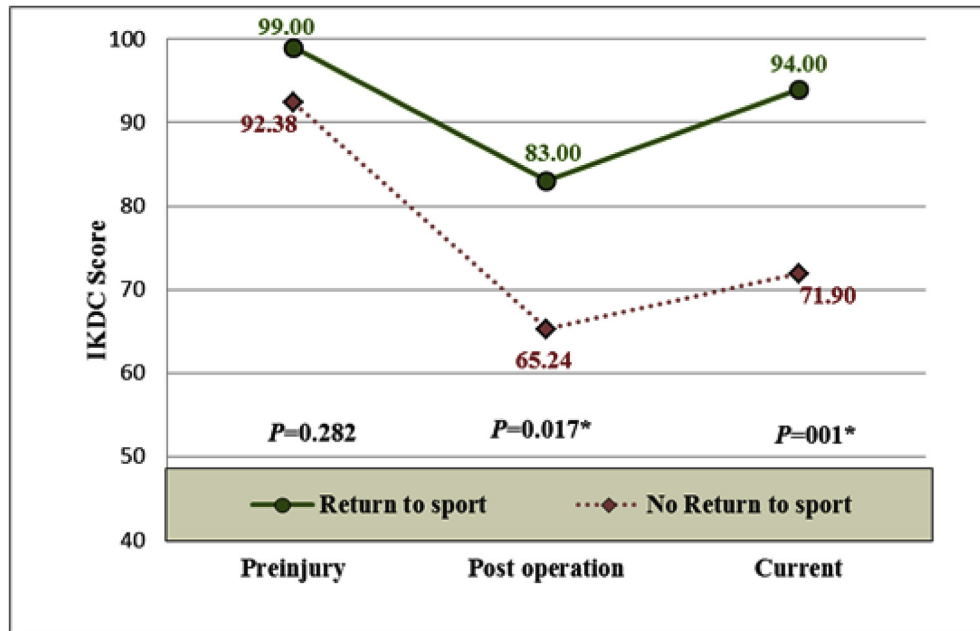
The level of use of the knee	Total (n = 110)	Return to sport		p-value
		Yes (n = 40)	NO(n = 70)	
Pre-injury	94.52 ± 14.10	99.00 ± 3.16	92.38 ± 16.71	0.228
Post operation	70.97 ± 19.89	83.00 ± 19.47	65.24 ± 17.78	0.017*
Current	79.03 ± 19.21	94.00 ± 10.75	71.90 ± 18.34	0.001*
p-value within group				
Pre-injury vs Post-operation	<0.001*	0.223	<0.001*	
Pre-injury vs Current	0.005*	1.00	0.002*	
Post-operation vs Current	0.006*	0.043*	0.088	

p-value from repeated measure ANOVA, *Significant at p < 0.05.

Discussion

Individuals who returned to sport had different baseline characteristics from those who did not in terms of sex, educational levels, income and underlying diseases. These findings revealed that 36.4% of individuals returned to playing sport, which is not consistent with the results of other recent similar studies evaluating return-to-sport following ACL, in which higher rates of return to sport were found, such as in a systematic review by Ardern et al.[5]

of 48 studies and 5770 patients which found that 82% of patients returned to sport, 63% were participating in their pre-injury sport and 44% had returned to competitive sport. In professional athletes, the rate of return to sport has been reported to be as high as 97% in hockey players, 86% in basketball exponents, and 77% in soccer players.[16–18] In most sports, however, there are many different playing positions, each of which requires a unique skill set and places a different amount of stress on the knee; consequently, it is crucial to assess the impact of ACL reconstruction on each

Fig. 3. Comparison of the mean IKDC scores based on the level of use of the knee between those who returned and did not return to sport at pre-injury, post-operation and current knee use.

Table 6
Associated factors of return to sport following Anterior Cruciate Ligament reconstruction (n = 70).

	Crude OR (95%CI)	p-value	Adjusted OR (95%CI)	p-value
Age	0.96 (0.91–1.003)	0.067	1.03 (0.96–1.10)	0.406
Male	12.51 (1.60–98.01)	0.016*	7.60 (0.64–9.94)	0.108
Bachelor degree+	2.49 (1.08–5.75)	0.033*	4.23 (1.33–13.48)	0.015*
Income <10,000 Thai baht	2.92 (1.22–7.00)	0.016*	5.97 (1.59–22.47)	0.008*
No underlying diseases	4.75 (1.02–22.11)	0.047*	5.50 (0.57–53.19)	0.141
IKDC score	1.11 (1.05–1.16)	<0.001*	1.09 (1.03–1.15)	0.002*

OR(**95%CI**) = Odds Ratio (95% Confidence) from Binary Logistics Regression, *Significant at p < 0.05.

individual player position. The overall rate of return to sport from the present study was low, and this may be due to sample size and some errors in patient reporting. In view of the low prevalence of returning to sport found in this study, a larger population size should be examined in future research.

The main reasons stated by participants for not returning to sport following ACL were fear of injury and long-term effects, and this is consistent with a study by Bjordal JM[19] of patients who had participated in organized soccer in the Hordaland region of Norway; nearly one-third of the injured athletes gave up soccer because of poor knee function and fear of new injury. In addition, knee pain during physical activity was an independent negative predictor for returning to football after ACL reconstruction in female football players in Sweden.[20]

The IKDC scores of patients who returned to sport were significantly higher than those of subjects who did not return to sport; consequently, these patients had the highest activity achieved without obvious knee pain among pre-injury, post operation and current use of knee following ACL reconstruction. This operation is common and, if the ACL is not reconstructed and rehabilitated appropriately, it can signal the end of an individual's sports career.[21] Currently, with advances in surgical techniques and technology, a greater number of athletes are recovering from, and playing well after, ACL reconstruction and surgical treatment.[21] The current study sought to determine the proportion of patients who were are able to return to playing sport and how well they could

perform after their ACL reconstruction in comparison with their pre-injury level, post-operation and current knee use. The results based on IKDC scores showed a significant difference in performance among pre-injury level, post-operation and current knee use. First, the IKDC scores were high pre-injury and slightly lower after operation; however, this score increased again for current knee use but was not as high as pre-injury. One possible explanation is that patients are aware of their knee function and fear long-term effects if they play harder. From the orthopedic surgeon's perspective, this study demonstrated that the overall rate of return-to-sport at medium-term follow-up appeared to be relatively low (<40%).

The current study identified the IKDC scores related to symptoms, sports activity and daily activity. Pain and the highest activity level that could be performed without significant knee pain were associated with returning to sport, while stiff or swollen knee, and knee lock or catch were not. In terms of sports activities, the patients who returned to sport had significantly higher IKDC scores than those who did not in terms of rising from a chair, running straight ahead, jumping and landing on an involved leg, and stopping and starting quickly, and this might be a direct outcome of returning to playing sport. There were significant differences in the IKDC scores of the two groups with regard to daily activities performed on a regular basis such as going up and down stairs, whereas other daily activities such as kneeling on the front of knee, squatting, and sitting with knees bent were not different in the two

groups.

It is also worth noting that, in the present study, the younger participants and those with lower income were more likely to return to sport. One explanation for this may be that younger people have more opportunities to participate in sport via teams linked to educational institutions/universities. This is in agreement with a study by Ardern et al.,[4] which indicated that the older participants have more interests competing for their time: lifestyle factors, employment, and family are an influence on the decision whether to continue playing sport at their pre-injury level after ACL reconstruction. In addition, patients with higher income and education were more likely to be concerned about their health, and to be aware of the danger of re-injuries and surgery.

During the decade of this study, the number of professional sports players was small in Thailand, with most people playing sports as recreational activities and for social reasons. The present study found that the main reason for not returning to sport was the fear of repeat injuries. In spite of having ACL reconstruction, some subjects believed that their loss of physical fitness was due to ACL reconstruction, and this may have resulted in fewer of them returning to sport.

A limitation of this study was its inability to assess physical examination, functional tests, and other structural measures to evaluate the post-ACL reconstruction knee performance. This would include KT-1000, Lachman, MRI, and/or pivot shift testing to help evaluate a functionally stable graft. Future studies should involve increased numbers of subjects and collect data prospectively with additional psychological and performance measurements to complement patient-reported outcome scores. In retrospective studies conducted many years post-injury, recall bias is a major concern. The primary outcome (return to sport) is a discrete event that our subjects were aware of when completed; as a result, the subjects may suffer reporting bias. In this current study, patients were more likely to return to activities such as cycling and jogging after ACL reconstruction than those to cutting and pivoting sports such as soccer and football. Few data are documented in the literature on sport-specific outcomes in athletes after ACL reconstruction; considering the impact that such information may have on treatment indications and rehabilitation strategies for athletes, additional studies are needed to address this question. Furthermore, no patient-reported or surgeon-measured outcomes were available. This included general health (e.g., Quality of Life-Short Form 36) and joint-specific (Knee Society Score) scores. Furthermore, it was not possible to evaluate patient satisfaction in terms of knee pain and function.

The present study may be useful for clinicians. First, it was conducted with patients who underwent ACL reconstruction who were asked to assess their current knee function. Few studies in Thailand have reported on the rates of return to playing sport for these patients, and little is known about their status after surgery. Second, this is one of only a small number of studies focusing on return to sport many years after ACL reconstruction. The present study succeeded in showing the overall rates of return to sport and factors related to not doing so.

In conclusion, this study demonstrated that 36.4% of participants attempted to return to sport after ACL reconstruction which was inconsistent with the return to pre-injury activity level percentages reported in other recent studies. The main reasons for not returning to sport were fear of pain, repeated injury and long-term effects. Younger participants with lower income were more likely to return to sports participation than older subjects, and this may reflect their lifestyle factors. IKDC score was a factor associated with return to sport. Future studies can be conducted to examine the rate of return-to-sport based on different types of sport and the re-injury rate after sport return. Moreover, research should be carried out to assess the impact on treatment indications and rehabilitation.

Potential conflicts of interest

None.

Acknowledgement

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.asmart.2018.01.003.

References

1. Lyman S, Koulouvaris P, Sherman S, Do H, Mandl LA, Marx RG. Epidemiology of anterior cruciate ligament reconstruction: trends, readmissions, and subsequent knee surgery. J Bone Joint Surg Am. 2009;91:2321—2328.
2. Ellman MB, Sherman SL, Forsythe B, LaPrade RF, Cole BJ, Bach Jr BR. Return to play following anterior cruciate ligament reconstruction. J Am Acad Orthop Surg. 2015 May;23(5):283—296. https://doi.org/10.5435/JAAOS-D-13-00183.
3. Nebelung W, Wuschech H. Thirty-five years of follow-up of anterior cruciate ligament-deficient knees in high-level athletes. Arthroscopy. 2005;21(6): 696—702.
4. Ardern CL, Taylor NF, Feller JA, Webster KE. Return-to-sport outcomes at 2 to 7 years after anterior cruciate ligament reconstruction surgery. Am J Sports Med. 2012;40(1):41—48.
5. Ardern CL, Webster KE, Taylor NF, Feller JA. Return to sport following anterior cruciate ligament reconstruction surgery: a systematic review and meta-analysis of the state of play. Br J Sports Med. 2011;45(7):596—606.
6. Busfield BT, Kharrazi FD, Starkey C, Lombardo SJ, Seegmiller J. Performance outcomes of anterior cruciate ligament reconstruction in the National Basketball Association. Arthroscopy. 2009;25(8):825—830.
7. Carey JL, Huffman GR, Parekh SG, Sennett BJ. Outcomes of anterior cruciate ligament injuries to running backs and wide receivers in the National Football League. Am J Sports Med. 2006;34(12):1911—1917.
8. Warner SJ, Smith MV, Wright RW, Matava MJ, Brophy RH. Sport-specific outcomes after anterior cruciate ligament reconstruction. Arthroscopy. 2011 Aug;27(8):1129—1134. https://doi.org/10.1016/j.arthro.2011.02.022. Epub 2011 Jun 12.
9. Dick R, Ferrara MS, Agel J, et al. Descriptive epidemiology of collegiate men's football injuries: national collegiate athletic association injury surveillance system, 1988—1989 through 2003—2004. J Athl Train. Apr-Jun 2007;42(2): 221—233.
10. Dragoo JL, Braun HJ, Durham JL, Chen MR, Harris AH. Incidence and risk factors for injuries to the anterior cruciate ligament in national collegiate athletic association football: data from the 2004—2005 through 2008—2009 national collegiate athletic association injury surveillance system. Am J Sports Med. May 2012;40(5):990—995.
11. Bradley J, Honkamp NJ, Jost P, West R, Norwig J, Kaplan LD. Incidence and variance of knee injuries in elite college football players. Am J Orthop (Belle Mead NJ). Jun 2008;37(6):310—314.
12. McCullough KA, Phelps KD, Reinke EK. Return to high school and college level football following ACL reconstruction: a MOON cohort study. Am J Sports Med. 2012;40(11):2523—2529.
13. Hefti F, Muller W, Jakob RP, Staubli HU. Evaluation of knee ligament injuries with the IKDC form. Knee Surg Sports Traumatol Arthrfosc. 1993;1(3-4): 226—234.
14. Hambly K, Griva K. IKDC or KOOS? Which measures symptoms and disabilities most important to postoperative articular cartilage repair patients? Am J Sports Med. 2008;36—9:1695—1704.
15. The American Orthopaedic Society for Sports Medicine. 2000 IKDC Knee Forms [internet] [cited 10 May 2017]. Available from: http://www.sportsmed.org/aossmimis/Members/Research/IKDC_Forms/Members/Research/IKDC_Forms.aspx?hkey=4e0ca7a9—3a3c-49f9-b9b6-4e133de4ad22.
16. Erickson BJ, Harris JD, Cole BJ, et al. Performance and return to sport aAfter

nterior cruciate ligament reconstruction in National Hockey League players. *Orthop J Sports Med*. 2014 Sep 5;2(9), 2325967114548831. https://doi.org/10.1177/2325967114548831. eCollection 2014 Sep.

17. Erickson BJ, Harris JD, Cvetanovich GL, et al. Performance and return to sport after anterior cruciate ligament reconstruction in male Major League Soccer players. *Orthop J Sports Med*. 2013;1, 2325967113497189.

18. Harris JD, Erickson BJ, Bach BR Jr, et al. Return-to-sport and performance after anterior cruciate ligament reconstruction in National Basketball Association players. Sports Health. 2013;5:562—568.

19. Bjordal JM, Arnly F, Hannestad B, Strand T. Epidemiology of anterior cruciate ligament injuries in soccer. *Am J Sports Med*. 1997 May-Jun;25(3):341—345.

20. Sandon A, Werner S, Forssblad M. Factors associated with returning to football after anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc*. 2015 Sep;23(9):2514—2521. https://doi.org/10.1007/s00167-014-3023-4. Epub 2014 May 27.

21. Cheatham SA, Johnson DL. Anatomic revision ACL reconstruction. *Sports Med Arthroscopy Review*. 2010;18(1):33—39. https://doi.org/10.1097/JSA.0b013e3181c14998.