

How Athletic Swiss Patients Experience Their Return to Sports After Anterior Cruciate Ligament Reconstruction: Results from a Retrospective Self-Assessment

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Introduction: Anterior cruciate ligament (ACL) ruptures are frequent injuries, especially in athletes. Return to sports after reconstruction of the ligament is a frequently debated topic and of high relevance for these patients. It is mostly achieved at 9–12 months post-surgery. However, the risk of subsequent knee injuries is high and psychological factors play an important role in the process and success of returning to sports. Little is known about patients' perception of their journey returning to sports. This study aims to fill the gap.

Material and Methods: The study aimed to include patients treated surgically for an ACL injury over 5 years at a specialized sports-medicine clinic. Patients were surveyed on the impact of the injury on their lives, their return to sports experience, and medical history.

Results: In total, 100 (of 474) patients aged 35.9 years responded. Within 5 years, 19% experienced a reoperation and 23% a new knee injury. Overall, 83% of patients returned to their main sport, 72% reached their pre-injury level. However, 45% reported at least one distinct or severe consequence of their ACL injury. The ability to return to sports had more impact on the perception of the course of treatment than the experience of new injuries or surgery.

Conclusion: The rate of successful return to sports was comparable to previous reports despite a higher average age in this cohort. A successful return to sports seems to be a major determinant for the perception of impact from the injury and may be more important than the avoidance of repeat trauma.

Keywords: knee injury, patient journey, psychological impact of injury, quality of life, treatment perception

Introduction

Injuries of the anterior cruciate ligament (ACL) are a frequent pathology, often treated with surgical reconstruction. Overall, the rate of ACL-reconstructions has increased in recent years.^{1,2} The annual incidence of ACL-reconstruction in the Nordics has been reported between 32 and 38 per 100,000 citizens overall and between 71 and 91 per 100,000 in patients younger than 40 years.^{3–5} In other countries, it varies between 8 and 52 per 100,000 citizens with a median annual incidence of 30 per 100,000 citizens, whereas this reflects mainly studies from the western world.⁶ The annual incidence in professional athletes reaches on average about 1,235 per 100,000, which is four times the average observed in amateur athletes.⁶ However, it has to be mentioned that studies are often small evaluating high-risk sports and young athletes. National ligament registries report that 86% of sports-related ACL injuries are associated with high pivoting risk sports such as soccer, alpine skiing, or rugby.^{7,8} In Switzerland 10,000–12,000 cruciate ligament injuries are reported each year with most injuries occurring during athletic activities, mainly alpine skiing (36.4%) and soccer (21.8%).^{9,10} In principle, ACL rupture can be treated conservatively as well as surgically. Indication is primarily dependent on the patient's activity level in order to improve knee stability and support return to the previous levels of activity.¹¹ The

treatment approach has no consistent impact on the later development of osteoarthritis.¹² In Switzerland, ACL-reconstructions in an in-patient setting were documented with 6,308–7,667 per year (2015–2020, Swiss Federal Office for statistics).¹³

As most ACL injuries affect athletes, return to sports (RTS) is a highly relevant aspect for patients. Return rates between 13% and 69% to the pre-injury levels have been reported in the literature, with higher return rates if any athletic level is considered (56%–100%).¹⁴ Overall, the rate of return to competitive sports has been reported with 55%, and 83% in professional athletes, respectively.^{15,16} Physical restrictions and psychological aspects can limit engagement in sports after ACL-reconstruction.¹⁷

The question of when and how to return to sport is a crucial one in the individual management of patients and one basic topic of the communication between patients and surgeons during follow-up. One typical concern is the risk of secondary surgery or repeat injury, especially since rates of RTS and return to usual sport are lower after repeat injury than after primary ACL-reconstruction.^{18,19} Danish registry data report a re-operation rate of 4.1% within 5 years after primary ACL-reconstruction in the overall patient population.²⁰ Other studies show higher rates of reoperations within the first 2 years up to 23.6%.^{21,22} Within 4–5 years ACL re-injury rates have been reported to occur in 1.8–10.4% of patients, while 5.3–16.0% of patients sustained an injury on the contralateral side.^{23–26} In athletes, the incidence tends to be slightly higher with re-rupture rates around 8% and contralateral injuries in approximately 12%.²⁷ Risk factors for repeat injury after return to sports have been widely studied to develop recommendations on when and under which circumstances a return to sports should optimally be contemplated. A short abstinence from sports after surgery, younger age and return to high-risk sports have been identified as essential predictors for secondary ACL injuries.^{23,28,29}

In addition to physical conditions, psychological aspects are a crucial component for return to sports after ACL-reconstruction. Readiness and its role for predicting a successful return to sports has been investigated.³⁰ A recent systematic review evaluating 700 patients for depression and anxiety after ACL injury and/or ACL-reconstruction showed overall low rates of depression and anxiety; the authors describe, however, a higher incidence early after the trauma and in professional athletes.³¹ Negative affect has also been observed to play a relevant (long-term) role and psychological aspects are known to be of high relevance in sport rehabilitation.^{32–39}

This study aimed at analysing the patient journey during return to sports after ACL-reconstruction with a specific focus on the individual patient perception.

Materials and Methods

Study Design

The study was approved by the competent ethics committee (Ethikkommission Nordwest- und Zentralschweiz, EKNZ, Reference No. 2020–02939) and registered with ClinicalTrials.gov Identifier: NCT04862013. Patients gave informed consent in the use of their health-related routine and survey data. The study followed good clinical practice (GCP) as well as the tenets of the Declaration of Helsinki.

The retrospective study was based on a cohort of adult patients after primary treatment for an ACL-rupture at a single Swiss orthopaedic centre between 1.1.2013 and 31.12.2018 with a follow-up of up to 8 years. Patients were selected based on digitalized medical records and contacted by letter and/or email with an automatic reminder after 2 weeks and a second wave of contact after 3 months.

Data Collection

Data were collected using a patient questionnaire covering both baseline and follow-up. (Table 1). The baseline part included sections on patient characteristics, type, and intensity of athletic activities before the injury and questions about the injury. The follow-up part included the duration of work incapacity, the number of physiotherapy series and return to sports-information ie, reasons for not continuing sports, not returning to the original level, or for starting new sports and time to events as well as consequences on different aspect of life, subsequent knee injuries and surgeries we well as the KOOS-12 (Knee Injury and Osteoarthritis Outcome Score-12).⁴⁰

Table I Data Collection

Patient characteristics	
Based on questionnaire:	Based on clinical records:
BMI	Age at surgery
Physical activity at work	Gender
Educational level (according to categories of the Swiss Census) ⁴¹	
Accident and injury related characteristics	
Accident type (classified as football, skiing, other sport, not sport related)	
Pivoting risk of accident (classified according to Grindem et al). ⁴²	
Meniscal injury (no, lateral, medial, both)	
Side of injury	
Type of operated injury (ACL alone vs ACL + other)	
Additional injuries (meniscus medial, meniscus lateral, meniscus bilateral, medial collateral ligament (MCL), other)	
Previous injuries same side (yes/no)	
Previous injuries opposite side (ACL, ACL + other, other, none)	
Surgery related variables	
Lag time between accident and surgery	
Type of fixation femoral (RIGIDFIX Pin, RIGIDLOOP adjustable, other, unknown, none)	
Type of fixation tibial (MILAGRO Advance, Poller-screw, RIGIDFIX Pin, none)	
Treatment meniscus (partial meniscectomy, partial meniscectomy + suture, suture, none)	
Treatment type (ACL-reconstruction, ACL healing response)	
Sport activities at time of injury	
Number of sports	
Type of sports	
Maximal number of years in sport	
Maximal level (hobby athlete, ambitious hobby athlete, competitive athlete)	
Overall number of training hours per week	
Professional status (amateur, semi-professional, professional) ^a	
Course of treatment after surgery^b	
Duration of 100% incapacity	
Duration of at least 50% incapacity	
Duration of any degree of incapacity	
Number of physiotherapy series	

(Continued)

Table 1 (Continued).

Patient characteristics
Return to sport
Return to main sport ^c
Return to the original level ^c
Achievement of the desired level
Continuation of original sports (no, partially, yes)
Starting of new sports
Reasons for stopping some sports (knee pain, swelling of the knee, knee stiffness, other injury, failure to reach the desired level, fear of a second injury, insecurity, no motivation, no time, change of job, change of residence, social life change, other)
Reasons for not returning to original level (decreased strength, lack of trust in the knee, feeling of instability in the knee, knee pain, movement limitation in the knee, lack of desire, other, reason unknown)
Intercurrent health events^d
New injury
Any surgery (reoperation)
Revision surgery (for the initially treated knee)
Subsequent intervention (for new injury)
Patient reported outcomes
KOOS-12
Patient experience of the knee injury (see Table 2)
Treatment satisfaction
Open questions on return to sports experience and on the course of treatment
Final comment at the end of the questionnaire

Notes: ^aThe participant could specify the contribution of all sports to the personal income at the time of accident as a percentage. The professional status was derived as described in [Appendix 2](#). ^bDuration of work incapacity was derived both from clinical records (weeks) and the self-reports (months). ^cFor these two events, the patients also reported the date. The time to return to main sport was analysed in all patients. The time to return to the original level was analysed in all patients and in patients who returned to their main sport. In the latter, both the time from return to main sport as well as the time from surgery were considered. ^dFor each event, the time from surgery as well as the time from return to main sport was considered.

Study data were collected and managed using REDCap.^{43,44} The report form is available under <https://fxdb.usb.ch/surveys/?s=FDNFXY8HKHHH4DLJ> (last accessed 22.10.2022). An English version is also available in [Appendix 1](#). In addition, information was extracted from the patient records. The data extraction form is available under <https://fxdb.usb.ch/surveys/?s=DY9C9MLF33D7EPCA> (last accessed 22.10.2022).

The questionnaire also included questions to evaluate the subjective impact of the injury with a free text prompt as well as an evaluation of satisfaction at 1 year. The same systematic was used for the assessment of all free text reports.

For each of the items shown in [Table 2](#) the participants were asked to give short explanations in a free-text field. A further question about treatment satisfaction at 1 year (with response options dissatisfied, not really satisfied, satisfied, completely satisfied) was regarded as a further self-assessed experience. The patients had the opportunity to give additional comments on their return to sports experience in general, the course of treatment, or a final comment at the end of the questionnaire.

In order to identify topics of common interest for this patient population, all these text fields were screened for topics voiced by several participants. A list of topics was created, and for each participant it was decided whether a specific topic was touched upon in their statements covered in the free-text field or not. For some topics representing an aspect, which can be reported as present or absent (eg, I have pain vs I have no pain), a corresponding distinction was additionally made.

Table 2 Items About Experience During Postoperative Rehabilitation and Return to Sports Process

Item name	Wording	Response Options
Consequences on occupation	How would you describe the impact of the knee injury on your professional situation?	None, minor, significant, severe
Change in occupation ^a	Did you have to change your occupation after the injury?	Yes/no
Consequences on enjoyment of sports	How would you describe the impact of the knee injury on your desire to do sports? ^b	None, minor, significant, severe
Consequences on private life	How would you describe the impact of the knee injury on your private life?	None, minor, significant, severe
Consequences on sport activities	How would you summarize the impact of the knee injury on your overall athletic activities?	None, minor, significant, severe
Fear of a new injury	How strong was the fear of a second knee injury during your rehabilitation?	Non-existent, moderate, medium, strong
Overall psychological impact	Overall, how much did the original injury affect you psychologically?	Not at all, slightly, significantly, severely

Notes: ^aSince only 3 participants indicated a change in occupation only the remaining items are included in the analysis. ^bHow the joy of sports has changed due to the injury.

Furthermore, we evaluated the answers to all open questions and classified the respondents with respect to their overall satisfaction into four categories comprised: complete satisfied (no negative aspects at all); satisfied, if the overall tenor was positive but limitations mentioned; dissatisfied (focus rather on limitations than positive experience); completely dissatisfied, if only limitations and concerns were reported. A similar approach has previously been used by Arvidsson.⁴⁵ This score is also regarded as a self-assessed experience.

Since no population norms for the KOOS-12 are available, the population norms for the long form of the KOOS were taken as starting point and transformed as described in [Appendix 3](#).⁴⁶ These norms were used to translate the observed raw scores into z-scores, expressing the deviation of a patient from the mean in age- and gender-matched subjects from the general populations. Z-scores between -2 and 2 represent the normal range.

Analytical Strategy, Analytical Variables, and Statistical Analysis

Patient self-reporting tends to raise questions about the validity of data. As some items were collected both based on the clinical records and questionnaires, we start with a comparison between the two sources.

In a second step, we describe patient and treatment characteristics based on the medical records as well as the self-reported athletic activities at the time of injury. Next, the return to sports data and clinical follow-up with respect to postoperative treatment and health-related events is depicted. The self-assessed experience and the knee status assessed at follow-up are evaluated in a fourth step, including an analysis of the association among all variables in this context. In step five, these variables are related to the medical and return to sports history in order to identify potential determinants of self-assessed experience and knee status. Finally, we look at the topics specifically mentioned by the patients in response to open questions.

Many steps only contain a description of the distribution of variables. The variables themselves are partially already the result of a pre-processing of original variables. These pre-processing steps are described in [Appendix 2](#).

The distributions of categorical variables are described by absolute and relative frequencies, the distributions of continuous variables by mean, standard deviation, 5% and 95% percentile. In addition, the distribution after a categorization is shown. The number of available observations is reported as (n= ...). The distribution of the time until a certain event is analysed using Kaplan–Meier curves. The date the first attempt of patient-contact was used for censoring. To allow comparison with published studies, for new injuries and surgeries estimates for the rates after 2 years are reported. Due to the rather long follow-up of about 5 years, also 5-years rates are reported, which have not been surveyed as often as the 2-year rates in the literature. The distribution of ordinal variables is visualised by stacked bar charts.

Correlations are assessed using the Spearman correlation coefficient. The correlations are visualized as heat maps. Correlation between -0.15 and 0.15 are shown as grey in these heat map. The further colours refer to a spacing by 0.1 .

Results

Recruitment and Response Rates

In total, 474 patients were identified and contacted by letter. Two hundred ninety-eight were additionally contacted by e-mail. A flow-chart is provided in [Figure 1](#).

Agreement Between Recorded and Self-Reported Data

We observed a good agreement between self-reports and information from the medical records ([Appendix 4](#)). Agreement was only limited for the number of physiotherapy sessions, probably due to prescription by other health care providers or out-of-pocket coverage.

Baseline Characteristics

[Table 3](#) shows patient and trauma characteristics. The mean age at surgery was 35.9 years, the majority of patients were male, most had primarily sedentary occupations and high educational status. Accidents predominantly occurred during athletic activities, such as skiing and soccer, typically associated with pivoting risk activities.

The study included 10.3% competitive athletes, 34% ambitious hobby athletes and 55.7% hobby athletes as shown in [Table 4](#). The average lifetime engagement in athletic activity was 21.5 years. Patients reported a mean training time of 7.8h/week. Hobby athletes had a mean weekly training time of 6.8 hours, ambitious hobby athletes reported 7.6 hours and competitive athletes 13.1 hours. Hobby athletes participated in mean 2.6 different kinds of sport, ambitious athletes in 2.3 and competitive athletes in 1.7.

Details on the surgical intervention and time to surgery are described in [Appendix 5](#). The median time to surgery was 49 days with lower intervals in competitive athletes and athletes with more than 6 training hours per week.

Return to Sports

In total, 15% of the patients did not continue with their original sport and one-quarter only partially. Overall, 65% of the patients returned to their main sport within 12 months after surgery, a return to the main sport later than 24 months was a rare event (see [Figure 2](#)). Among the patients returning to sports, 39% reached the original level within 6 months, 59% within 12 months, overall, 72% reached their original level. Three out of five patients succeeded in returning to the

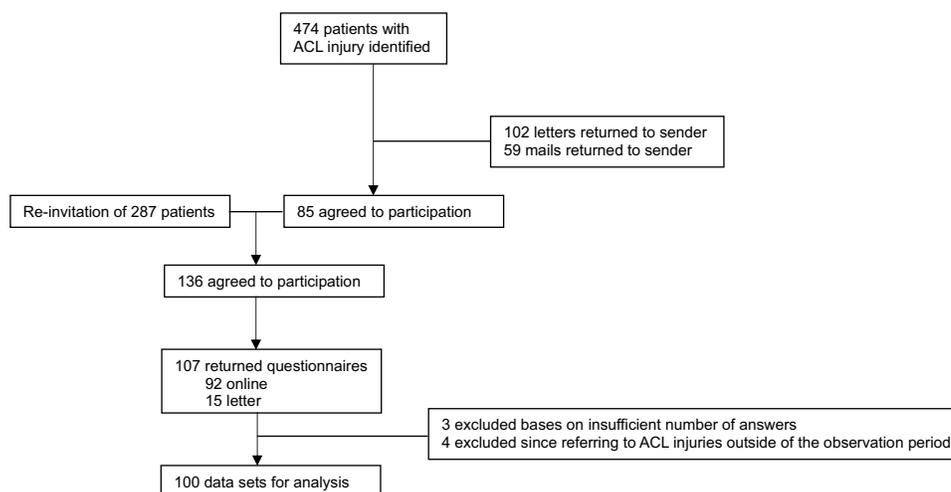


Figure 1 Patient flow chart.

Table 3 Patient and Trauma Characteristics

Age at Surgery (n=100)		Type of Accident (n=96)	
Mean (SD)	35.9 (12.1)	Soccer	26 (27.1%)
5th – 95th percentile	17.0–51.0	Skiing	35 (36.5%)
<25	23 (23%)	Other sport	30 (31.2%)
25 – <40	35 (35%)	Not sport related	5 (5.2%)
40 - <50	26 (26%)	Pivoting risk of accident (n=91)	
≥50	16 (26%)	Level I (handball, soccer, basketball)	31 (34.1%)
BMI at time of injury (n=100)		Level II (volleyball, tennis, skiing)	43 (47.3%)
Mean (SD)	24.8 (4)	Level III (running, cycling, swimming)	2 (2.2%)
5th – 95th percentile	19.3–31.2	Unknown	15 (16.5%)
<20	8 (8%)	Side (n=100)	
20 - <25	56 (56%)	Left	59 (59.0%)
25 - <30	27 (27%)	Right	41 (41.0%)
≥30	9 (9%)	Additional injuries (n=104)^a	
Gender (n=100)		Meniscus medial	27 (26.0%)
Male	54 (54%)	Meniscus lateral	12 (11.5%)
Female	46 (46%)	Meniscus bilateral	35 (33.7%)
Physical activity at work (n=99)		MCL	24 (23.1%)
Sedentary	58 (58.6%)	Other	6 (5.8%)
Mixed	29 (29.3%)	Previous injuries same knee (n=100)	
Mainly active	8 (8.1%)	Yes	5 (5.0%)
No occupation	4 (4.0%)	Previous injuries opposite knee (n=100)	
Education (n=100)		None	87 (87.0%)
Low	24 (24%)	Only ACL	6 (6.0%)
Middle	22 (22.0%)	ACL + other	2 (2.0%)
High	54 (54.0%)	Other	5 (5.0%)

original level and two thirds to the desired level. Starting new sports was reported by 46% of the patients. Only 9 patients neither started a new sport or at least partially continued their original one.

Within the 39 patients reporting reasons for stopping some sports, the main reasons were fear of a second injury (19 patients, 48.7%), insecurity (12 patients, 30.8%) and/or knee pain (11 patients, 28.2%). Similar reasons were stated for not reaching the original level of athleticism. Psychological reasons were the most frequent ones for starting a new sport like reducing risk of injury or increasing pleasure. Another frequently stated reason was building muscles and gaining stability (see [Table 5](#)).

Patients reported 100% work incapacity for approximately 1 month, and at least a partial incapacity for approximately 2.6 months in total ([Appendix 6](#)). Work incapacity showed an association with the physical demands at work (cf. [Appendix 4](#)).

On average, patients received 3.1 physiotherapy series (SD 1.3, 5th to 95th percentile 1.0–5.2).

Table 4 Characteristics and Types of Sport Activities at Time of Injury

Years in Sport (n=95)		Sport	Frequency
Mean (SD)	21.5 (12.4)	Ski	35
5th – 95th percentile	4.0–46.0	Soccer	27
<10	19 (20%)	Jogging	22
10 - <20	25 (26.3%)	Fitness	20
20 - <30	25 (26.3%)	Cycling	16
≥30	26 (27.4%)	Hiking	12
		Swimming	10
Numbers of different sports (n=97)		Volleyball	9
1	28 (28.9%)	Mountainbike	9
2	32 (33.0%)	Running	8
3	17 (17.5%)	Badminton	7
≥4	20 (20.6%)	Climbing	7
		Weight training	5
Training time (hours per week) (n=90)		Snowboard	3
Mean (SD)	7.8 (6.1)	Walking	3
5th – 95th percentile	2.0–20.0	Dancing	3
<3	12 (13.3%)	Horse riding	3
3 - <6	31 (34.4%)	Yoga	3
6 - <12	28 (31.1%)	Golf	3
≥12	19 (21.1%)	Squash	3
		Tennis	3
Sports level (n=97)		Professional status prior to injury (n=82)	
Hobby athlete	54 (55.7%)	Amateur	57 (69.5%)
Ambitious hobby athlete	33 (34.0%)	Semi-professional	15 (18.3%)
Competitive athlete	10 (10.3%)	Professional	10 (12.2%)

During follow-up, 25/100 patients reported a new knee injury, seven patients were injured twice. Among these 32 events (with potentially multiple pathologies), the most frequently reported injuries were ruptures of the ACL (27.3%), injuries of the medial meniscus (22.7%), and injuries of the lateral meniscus (13.6%).

Within 5 years after surgery 19% of patients underwent revision surgery. Revision surgery was indicated for arthrolysis, cartilage debridement, plica resection, cyclops resection and removal of painful hardware. Figure 3 depicts the distribution of the time to a new injury, time to subsequent intervention, time to revision surgery, and time to any surgery (reoperation).

Self-Assessed Experience and Knee Status

Patients performed their self-assessment on average 5.3 years after surgery (range of 2.5 to 8.3 years). The distribution of response options is shown in Figure 4. In general, the majority of patients choose one of the two most favourable

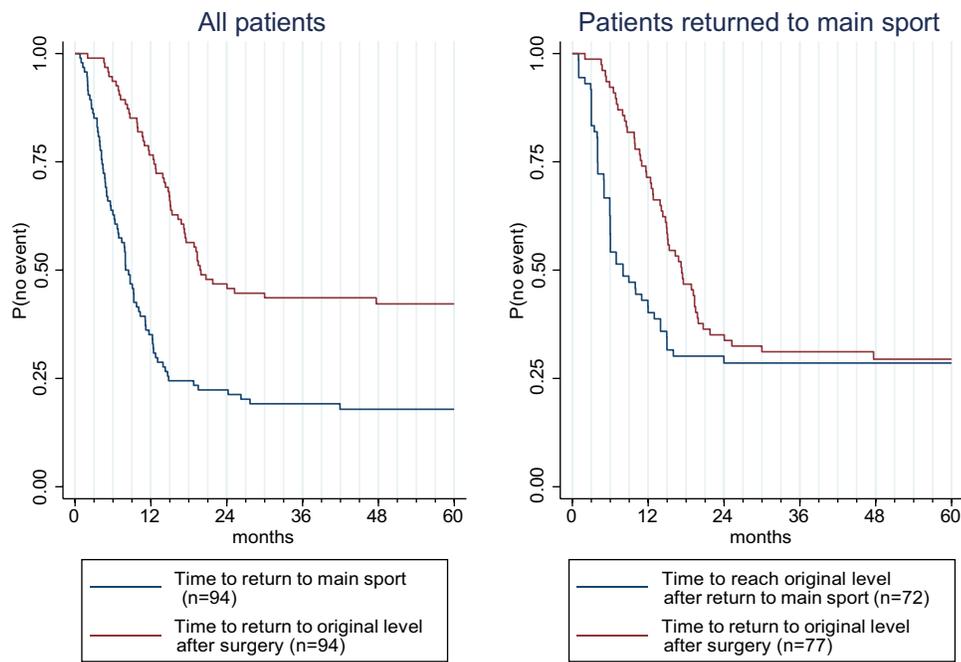


Figure 2 Time to return to sports in general and to the original main sport. The distribution of the time to return to main sport or the original level in all patients (left side) and the distribution of the time to return to the original level in patients returned to main sport (right side) visualized by Kaplan–Meier curves. The curves are truncated at 60 months as no events happened later than 60 months.

response options; the most unfavourable one was rarely checked, except in the context of fear of a new injury. With respect to the overall psychological impact, three-quarters of the patients reported at least some impact. The satisfaction score showed a similar distribution as the other variables. Across all eight items 45% of patients reported at least one distinct or severe consequence and only 20% choose always the most favourable option.

Table 5 Frequency of Events and Obstacles Related to Return to Sports

Continuation of Original Sports (n=99) ^a	Yes	No	Partially
		61 (61.6%)	15 (15.2%)
Events			
Return to main sport (n=100)			83 (83.0%)
Return to original level (n=100)			60 (60.0%)
Return to original level (if returned to main sport (n=83))			60 (72.3%)
Achievement of desired level (n=100)			67 (67.0%)
Achievement of desired level (if returned to main sport) (n=83)			67 (80.7%)
Start of new sports (n=100)			46 (46.0%)
Reasons for stopping some sports (n=39)		Reasons for not returning to original level (n=23)	
Fear of a second injury	19 (48.7%)	Lack of trust in the knee	14 (60.9%)
Insecurity	12 (30.8%)	Decreased strength	9 (39.1%)
Knee pain	11 (28.2%)	Feeling of instability in the knee	5 (21.7%)
Other injury	7 (17.9%)	Knee pain	5 (21.7%)

(Continued)

Table 5 (Continued).

No time	6 (15.4%)	Movement limitation in the knee	4 (17.4%)
Social life change	6 (15.4%)	Lack of desire	2 (8.7%)
Failure to reach the desired level	4 (10.3%)	Other	5 (21.7%)
Swelling of the knee	(5.1%)	Reason unknown	1 (4.3%)
Change of residence	2 (5.1%)		
Change of job	1 (2.6%)		
Knee stiffness	1 (2.6%)		
No motivation	1 (2.6%)		
Other	11 (28.2%)		

Figure 5 depicts the distribution of the three KOOS-12 sub-scores expressed as z-scores (the distribution of the raw scores is shown in Appendix 7). For each score in particular, the function score, the median values are above 0, ie, above the median in an age and sex-matched normal population. However, a relevant number of patients score lower than -2 on the pain or quality of life scale, indicating levels clearly beyond the normal range, even several years after surgery.

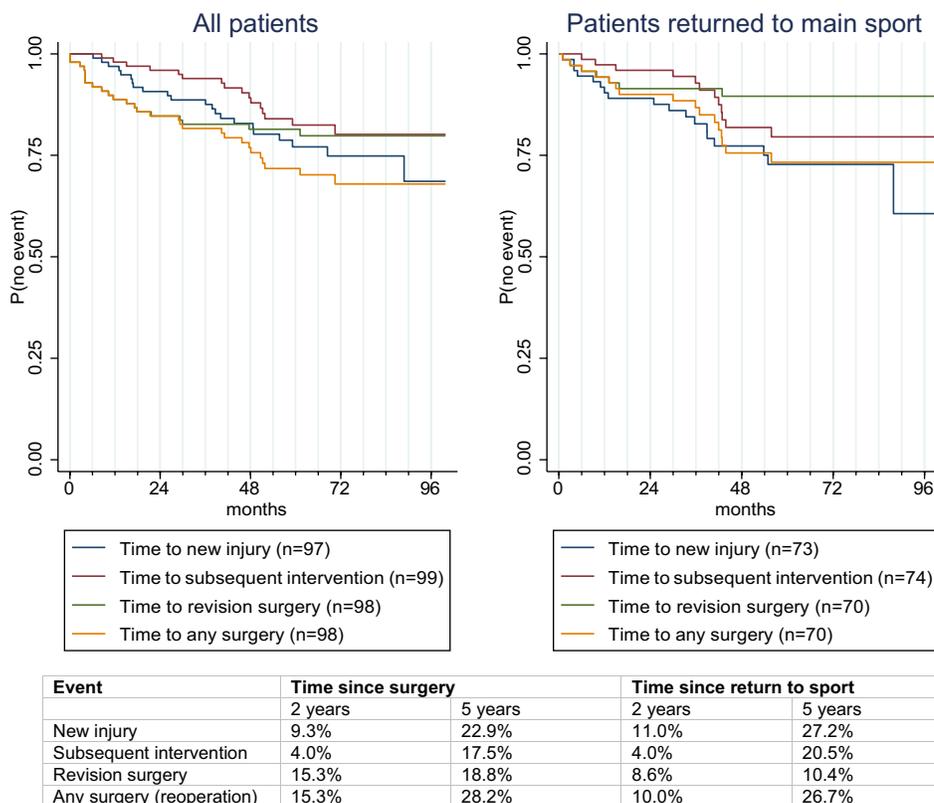


Figure 3 The distribution of the time to four health-related events in all patients (left side) and in patients returned to main sport (right side) visualized by Kaplan–Meier curves. Note: After 2 years the rates of revision surgery and any surgery are identical, as all patients with a subsequent intervention within the first 2 years had also a revision surgery within the first 2 years. The curves on the left side refer to the time since surgery. The curves on the right side to the time since return to main sport.

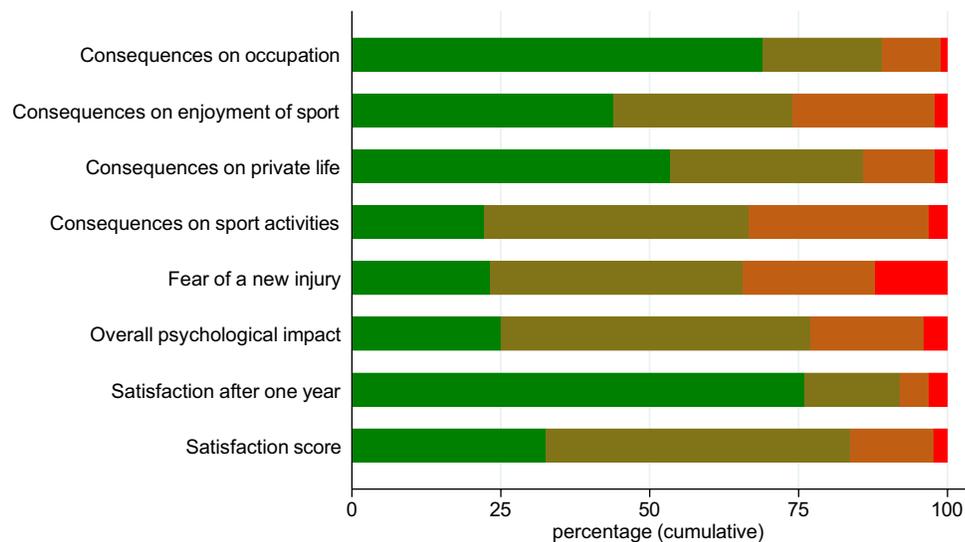


Figure 4 The distribution of the eight variables reflecting self-assessed experience. The most favourite response options are coloured in green, the least favourable in red.

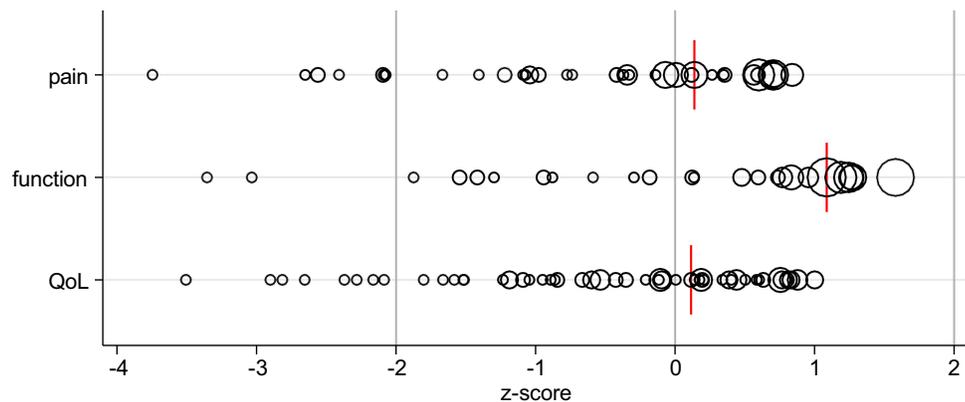


Figure 5 The distribution of the three sub-scores of KOOS-12. The red lines indicate the median values.

Association Analysis

Distinct correlations were observable among the three KOOS-12 dimensions (Figure 6A). Some correlations were also observed for consequences of the injury. Consequences on private life and sports activity were correlated, so were consequences on occupation with consequences on private life, satisfaction at 1 year and KOOS-12 pain and QoL.

Fear of new injury seems to reflect a completely different dimension, as there are no distinct correlations. Similarly, the overall psychological impact correlates only moderately with consequences on private life, consequences on sport activities, and the fear of a new injury. Treatment satisfaction at 1 year correlates distinctly with the satisfaction score based on the open questions, both correlate with KOOS-12, pain and QoL more so than function.

Sports-related achievements were mostly negatively correlated with the other (negatively connotated) self-assessed consequences; starting of a new sport was correlated with fear of injury, but not with other self-assessed variables. Experiencing health-related events such as injury or surgery was positively correlated in particular for the KOOS Quality of life subscale but also some self-assessed consequences. A distinct correlation was observed between revision surgery and satisfaction at 1 year.

It is noteworthy that the association of the self-assessed experience with achieving (positive) events related to return to sports was often more pronounced than the association with health-related events. Exceptions were the impact of surgery on treatment satisfaction after 1 year, quality of life, and on consequences on sport activities.

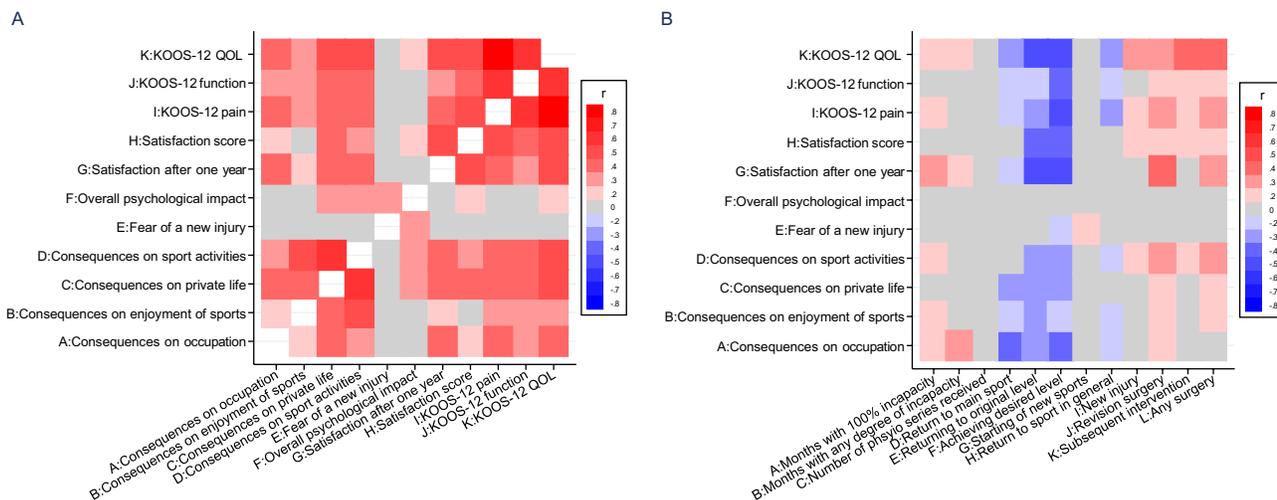


Figure 6 Spearman correlations between all pairs of self-assessed experience and knee status variables (A) and with variables depicting the course after surgery (B). Red shows a positive correlation, blue a negative correlation and grey indicates a correlation close to 0.

Aspects Collected from Free-Text Sections

In total, 79 patients gave at least one free-text comment as part of the self-assessment and 63 made use of at least one of the three comment fields. On average 4.5 free-text answers were available per patient.

Table 6 shows the topics and their frequency. Pain was the most frequently mentioned topic followed by awareness of risks.

Table 6 Frequency of Topics Mentioned in the Free Text Sections

Topics	Frequency of Mention		
	Overall	+	-
Pain	42	30	12
Increased caution during sports or everyday life, awareness of risks	32	30	2
Changes in sport (type of sport, doing less sport)	30	28	2
Restrictions during sport	29	16	13
Impact on occupation / workload	27	12	15
Fear of repeat injury / reoperation	26	19	7
Previous / subsequent surgeries and injuries	20	20	0
Improvement experience	18	7	11
Movement limitations	17	11	6
Psychological effects (depression, general anxiety, ...)	17	16	1
Praise for surgeon / clinic / treating institution	16	-	-
Benefit from physiotherapy	14	11	3
Restrictions in general	14	7	7
Effect on muscle building	13	7	6

(Continued)

Table 6 (Continued).

Topics	Frequency of Mention		
	Overall	+	-
Positive effects on sport and motivation (more, more regularly, more consciously)	11	9	2
Stability	11	4	7
Different perception of the knee	11	11	0
Impact on family / friends / social life	10	8	2
Concern about long-term prognosis	5	-	-
Other health problems	4	4	0
Interest in the results of the study	3	-	-
Waiting for normalization	3	3	0
Criticism of previously consulted specialists	2	-	-
Criticism of surgeon / clinic / treating institution	2	-	-

Discussion

This study evaluated the journey of a group of athletic patients after ACL-injury and -reconstruction both with respect to their return to sports and medical history and the patient's perception of the impact of their knee injury. At the time of injury about 80% of the patients had been participating in athletic activities for more than 10 years, 70% had been practising more than one sport, 50% were training at least 6 hours per week, and 30% considered themselves as semi-professional or professional.

After surgery 83% of patients returned to their main sport, which is comparable to the results in other athletic populations at 2 years.^{14,47-49} In our cohort, a return to sports was rarely seen at later time points. Furthermore, 60% of all patients and 72% of the patients who returned to their main sport succeeded in returning to the original level. These rates in principle match the existing literature and are rather in the high range but not as high as those observed in professional athletes.^{14,16} The evaluated cohort, though, is approximately 10 years older than most of the previously reported ones. The high return rates to the main sport and to the previous level are hence in contrast to the literature, which indicates that younger age is associated with a higher RTS rate.¹⁴ This may reflect the high level of ambition in the cohort studied and the relevance of sports for patients' lives.

The observed rate of reoperations of 15.4% at 2 years is overall comparable with rates from individual studies, while the Danish ACL-reconstruction registry found a 2-year reoperation rate of 4.1% in the general patient population.²⁰⁻²² Besides differences in the patient populations, registries may suffer from a higher risk for a loss to follow-up than smaller cohorts emerging from single clinics, which are typically characterized by a close patient–surgeon relationship. Different definitions of reoperations/revision surgeries/subsequent interventions make it even more difficult to compare the data.

A new injury occurred in 9.3% of the patients within 2 years after treatment. This is lower than the previously reported rates of 13.9–18%.^{23,27,50} The lower rate of reinjury in our population may be due to their athleticism and training awareness, that was emphasized by several patients in their survey responses. In our cohort, reinjury rate increased from 9.3% after 2 years to 22.9% after 5 years, which fits to previous literature.²⁶ After RTS, 11% of the patients experienced a new injury within 2 years. This is distinctly lower than the rate of 29% reported previously.⁵¹ However, the latter study is only based on 78 patients.

When considering the eight items directly asking about the patients' perception, 45% of the patients reported at least one distinct or severe consequence. A higher rate of distinct or severe consequences with respect to enjoyment of sports and athletic activities compared to occupation and private life indicates a high relevance of sports in this population. This

is also emphasized by the association between the various aspect of returning to sports and the reported consequences, which was much more pronounced than the association with new injuries or surgery. The relevance of return to sports for this patient population is finally underlined by the result that three of the four most frequently mentioned free-text topics were related to return to sports (with frequencies around 30%) and that 13% of the patients explicitly mentioned the absence of sport-related restrictions when giving open comments.

However, return to sports is not the only relevant aspect in this patient population. Pain was stated by 25% of patients as explanation for not returning to sports, which is in line with previous reports.^{52–55} Pain also was the most frequently mentioned single topic. These findings are in line with unfavourable KOOS-12 pain and quality of life scores in a substantial number of patients. Not only the presence of pain was mentioned (30 patients) but also the absence of pain (12 patients) implying fear of pain as a relevant factor to address in patient communication. A similar non-negligible aspect is the fear of a new injury. This was the most frequently reported reason for not continuing with any sport. About 30% of the patients reported a level of at least medium fear. Fear of a new injury was associated with reporting an overall psychological impact but not with reporting consequences or quality of life. Fear of injury seems to play a rather independent role. The fear of pain and injury seem to be central for patients' perception and may need to be addressed more specifically and systematically to improve the patient journey after ACL-reconstruction.

The use of the KOOS-12 allowed to evaluate patients' current knee status. Despite the large variability, the results indicate that more than half of the study population report a status better than the age-matched normal population.^{40,46} This is particularly visible with respect to function and may reflect the athletic ambition and rehabilitative efforts of the study population. These high values may also indicate a better prognosis with regard to osteoarthritis.⁵⁶ Some athletes mentioned building of musculature, improving joint stability and a more conscious approach to athletic activities in the open questions, which may as well give them a benefit with regard to symptomatic osteoarthritis.⁵⁷

The more pronounced association of the self-assessed experience with return to sports than with health-related events is an interesting finding suggesting that experiencing injuries and surgeries is regarded by many athletic patients as part of their normal life. This interpretation is supported by the rather low frequency of references to injuries and surgeries in the open questions. Indeed, when injuries and surgery were mentioned, they were often mentioned with no great emphasis. Nevertheless, the fear of a new injury was present in this population as mentioned above. However, it seems that the fear of the event is bigger than the impact if it actually occurred. Further, an evaluation of the comments categorized "Fear of a new injury" revealed that fear was often mentioned without great emphasis.

Despite post-operative issues such as pain, fear of a new injury, and the general challenge of returning to sports as soon as possible, it should be emphasized that the majority of patients were able to reach a satisfying symptomatic and functional status after surgical treatment of ACL and rarely reported severe consequences. Some patients mentioned even positive influences, such as increased muscle mass or a better feeling for the body. However, for many patients the time after surgical treatment of ACL has elements of a struggle, and they have to bring along a certain self-motivation and self-management in order to reach a successful rehabilitation process. This is, for example, illustrated by the high frequency of mentioning increased caution and change of sport as a topic in the comments.

Limitations

A principal limitation of the study is the low response rate. Only 136 of the 474 invited patients sent back the informed consent (28.7%) and 107 patients (22.6%) returned the questionnaire. Other studies reported higher response rates up to 70.1%.⁵⁵ Exact information about how many patients received any information about the study is not available to us. Due to a follow-up time of up to 8.3 years it is likely that some patients changed both the email and postal addresses. In accordance with Swiss legislation, it was not possible to use an online informed consent and patients had to give wet inked consent. This may have decreased the attractiveness of participation for some patients. We observed that many patients signed the consent immediately after receiving the letter but needed several weeks to put it into a mailbox. This multi-step process prior to accessing the study may therefore have been a barrier.

The results of this study cannot simply be applied to the general population of patients undergoing surgery for ACL rupture. They may not even be directly generalizable to all athlete populations, as our study population seems to consist mainly of highly motivated athletes with mostly non-physically demanding professions, and it was on average older than

athlete populations in previous studies. For less motivated patients with physically demanding occupations, corresponding investigations may lead to less favourable results. For clinical institutions similar to the clinic treating our population, however, these results may match and be informative.

In our study cohort, the fraction of highly educated subjects was 54%, which is much higher than the fraction of 29.6% (2021, in the group of 25 to 64 years old population) in the general Swiss population.⁵⁸ It remains unclear, whether this reflects already a property of the patient population treated at the clinic considered or a selection introduced by agreeing on participation.

Further, we have to note that the follow-up time of the participants varied between 2.5 and 8.3 years. This may have resulted in variation with respect to remembering the different aspects addressed in the questionnaire.

The patients' self-assessment of their experience was based on items designed for the purpose of this study, and hence does not represent a validated instrument. Similarly, the open questions have not been validated. However, the correlations among the items themselves and with potential predictors such as return to sports, KOOS-12 and health-related events suggest some degree of reliability and validity.

The studies on psychological issues mentioned in the introduction reported primarily psychological issues during the early phase of the rehabilitation and in particular the influence on the return to sports decision itself. These primarily early effects could not be assessed in this study.

Conclusion

In summary, a successful return to sports is important for athletic patients after surgical treatment of ACL injuries, possibly, even more important than the experience of new injuries or surgery. Returning to the main sport and to preinjury/desired level seems to be a major determinant for overall satisfaction. However, besides the wish to return to sport, pain and the fear for reinjury or negative consequences contribute to a demanding situation for many patients. A holistic approach and supportive communication are important so that patients can successfully return to sports.^{36,37}

Abbreviations

ACL, Anterior cruciate ligament; RTS, Return to sports; KOOS-12, Knee Injury and Osteoarthritis Outcome Score-12.

Data Sharing Statement

The dataset of the current study is not publicly available due to including very detailed personal information. However, aggregated data or extracts are available from the corresponding author on reasonable request.

Ethics Approval and Informed Consent

The study was approved by the competent ethics committee (Ethikkommission Nordwest- und Zentralschweiz, EKNZ, Reference No. 2020-02939) and registered with ClinicalTrials.gov Identifier: NCT04862013, date of registration: 27.04.2021.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Dr Franziska Saxer is an employee and share holder of Novartis and reports reimbursement for work in European Union Expert Panel on Medical Devices. The authors declare that they have no other competing interests in the context of this manuscript.

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