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Satisfaction with playing pre-injury sports one year after anterior cruciate ligament reconstruction using a hamstring autograft

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21 **Abstract**

22 **Background:** Few studies have examined patient satisfaction with playing pre-injury sports after
23 anterior cruciate ligament (ACL) reconstruction. The purpose of this study was to investigate
24 patient satisfaction with playing pre-injury sport and identify factors associated with satisfaction.
25 **Methods:** A total of 97 patients underwent unilateral ACL reconstruction using a hamstring
26 autograft and returned to pre-injury sports one year after surgery. Patient satisfaction with
27 playing pre-injury sport was assessed by a visual analog scale (VAS) and an ordinal 4-grade
28 scale. Problems related to the operated knee were also assessed. Knee muscle strength, single leg
29 hop distance, knee laxity, subjective knee pain, and fear of movement/reinjury using Tampa
30 Scale for Kinesiophobia-11 (TSK-11) were measured. Multivariate linear regression analysis was
31 performed to determine the factors associated with patient satisfaction with playing pre-injury
32 sport one year after surgery.
33 **Results:** The average VAS score for patient satisfaction with playing pre-injury sports one year
34 after surgery was 77.8 ± 20.2. Of the 97 patients, 87 patients (89.7%) answered “satisfied” or
35 “mostly satisfied”, whereas 51 patients (52.6%) had one or more problems. Multivariate linear
36 regression analysis identified that the TSK-11 score was associated with patient satisfaction with
37 playing a pre-injury sport one year after surgery.

Conclusion: Most of the patients who returned to pre-injury sports were satisfied with their outcomes. In contrast, approximately half of the patients had one or more problems after returning to play pre-injury sports. In particular, fear of movement/reinjury was significantly associated with patient satisfaction with playing pre-injury sport one year after surgery.

Keywords: ACL reconstruction; fear of movement/re-injury; patient satisfaction; return to sport.

1. Introduction

Anterior cruciate ligament (ACL) reconstruction is performed to restore knee stability and function for patients with ACL injuries. Outcomes after ACL reconstruction are often evaluated by objective measurements such as instrumented knee laxity, knee muscle strength, and functional tests. Additionally, a patient's subjective post-surgical outcomes are also essential assessments. Patient-reported outcomes such as the International Knee Documentation Committee (IKDC) score, the Lysholm score, and the Knee Injury and Osteoarthritis Outcome Score have been widely used [1-3]. Although these scores are useful to evaluate pain and basic knee function in daily living activities, the results of these questionnaires may not fully reflect patient satisfaction, especially in patients who play sports because of expectations and high demands [4].

An increasing number of studies reported patient satisfaction in orthopedic surgeries [5-7]. To assess patient satisfaction with ACL reconstruction, a visual analog scale (VAS), a binary scale (yes/no), and ordinal scales (e.g. very satisfied, satisfied, dissatisfied, very dissatisfied) were used in previous studies [8-12]. In the treatment of patients with ACL injuries, returning to a pre-injury sport is an ideal goal after ACL reconstruction. Previous studies have focused on identifying factors associated with the return to a sport after ACL reconstruction. Furthermore, returning to pre-injury sports after surgery is not the final goal for athletes and playing the sport at a satisfactory performance level is an optimal goal [13]. Therefore, it is important to assess whether patients are

indeed satisfied with playing pre-injury sports after ACL reconstruction. However, few studies have examined patient satisfaction with playing pre-injury sports after ACL reconstruction. In addition, factors associated with satisfaction in playing pre-injury sports have not been thoroughly investigated.

The primary purpose of this study was to investigate patient satisfaction with playing pre-injury sport one year after ACL reconstruction using hamstrings autograft. The secondary purpose of this study was to identify factors associated with patient satisfaction with playing pre-injury sports after an ACL reconstruction using a hamstring autograft.

2. METHODS

2.1. Patients

In this cross-sectional study (level IV evidence), patients who underwent primary unilateral ACL reconstruction using a hamstring autograft from March 2014 to January 2019 with a minimum of one year follow up were examined. Patients who had the following conditions were excluded: (1) history of an ipsilateral or contralateral ACL reconstruction; (2) previous knee surgeries in the same knee (3) combined surgeries except concomitant meniscectomy and meniscus repair at the time of ACL reconstruction; (4) multi-ligament reconstruction; (5) ACL reconstruction using bone-patellar-tendon-bone autograft; (6) patients who did not regularly participate in sports

before injury; (7) patients who did not intend to play their pre-injury sport after the surgery (8) missing demographic or measurement data; and (9) patients who did not play their pre-injury sport at one year after surgery. Informed consent was obtained from all participants. Institutional review board approval was obtained from the ethics committee in our hospital (Approval No. B190055).

2.2. Surgical methods

For ACL reconstruction, single-bundle (SB) and double-bundle (DB) ACL reconstructions were performed using a hamstring autograft (the semitendinosus tendon alone or both the semitendinosus and gracilis tendons). During the SB ACL reconstruction, a single femoral tunnel and a single tibial tunnel were created at a central position between the original insertion of the anteromedial and posterolateral bundles. During the DB ACL reconstruction, the anteromedial and posterolateral bundles were reconstructed as previously described [14].

2.3. Postoperative rehabilitation

A unified rehabilitation protocol consisting of time-based menus was used for postoperative rehabilitation. All patients were given a copy of the protocol and treated with identical rehabilitation protocols for the first six months after surgery. A progressive range of motion exercises and partial weight-bearing with crutches were started as tolerated the day after

surgery. Full knee extension and full weight-bearing were allowed with a functional knee brace starting two weeks after surgery. If a concomitant meniscal repair was performed for an incomplete or complete tear, the weight-bearing and range of motion exercises were delayed for one or two weeks, respectively. Jogging was permitted approximately three months after surgery. After three months, the rehabilitation protocol focused on increasing lower muscle strength, endurance, neuromuscular control, and agility for the dynamic sport-specific program. If there was no impairment in the knee joint (full range of motion, symmetrical quadriceps, and hamstrings strength, no effusion, and pain), patients were allowed to participate in a sport-specific practice around nine months after surgery (average time from surgery to return to a sport: 8.7 ± 1.8 months).

2.4. Demographic data

The demographic data such as age at the time of operation, sex, body mass index (BMI), pre-injury Tegner activity scale (TAS), type of pre-injury sport (contact or non-contact), level of the pre-injury sport (athlete or recreation), waiting periods (time from injury to surgery), surgical technique (SB or DB), meniscus injury, and cartilage injury were obtained from medical records and patient interviews. Meniscus injury was defined as requiring surgical treatments such as meniscectomy or repair. BMI was calculated as follows: weight (kg) / (height (cm)/100).^{2}

2.5. Measurements

Objective and subjective measurements were performed one year (average 12.2 ± 1.0 months, range from 11 to 16 months) after the surgery.

2.5.1 Objective measurements

The maximum isokinetic quadriceps and hamstrings strengths at 60°/s were assessed using an isokinetic dynamometer (Genu PLUS, Inter Reha Co., Ltd, Tokyo, Japan). The strength test was first performed with the healthy limb. Each subject performed two practice contractions followed by five maximal effort contractions, and the peak extension and flexion torque were measured. The test was then repeated on the operated limb. The limb symmetry indexes for quadriceps strength (LSI-Q) and hamstrings strength (LSI-H) were calculated by normalizing the operated leg's peak torque with the uninvolved leg and multiplying it by 100.

The single leg hop test was used as a performance measurement [15]. Participants performed one practice and two measurement trials on each limb with the uninvolved limb first followed by the operated limb. We recorded the maximal distance of the two trials for the operated and uninvolved limbs. We calculated the limb symmetry index for the single leg hop distance (LSI-S) by normalizing the maximal distance of the involved leg with the uninvolved leg and multiplying it by 100.

Anterior knee laxity was measured using the KT-1000 knee arthrometer (MEDmetric Corp., San Diego, CA, USA) with maximum manual force. The side-to-side difference (millimeter) in the anteroposterior tibial displacement between the operated knee and the uninvolved knee was measured to assess anterior knee laxity.

2.5.2. Subjective assessments

For the assessment of subjective knee pain, the sub-item in the IKDC subjective score was used: “If you have pain, how severe is it?” The score of this question ranges from 0 to 10, with higher scores indicating no pain [16, 17].

The Japanese version of the Tampa Scale for Kinesiophobia-11 (TSK-11) was used to measure pain-related fear of movement/reinjury as a psychological factor. The TSK-11 consists of 11 questionnaires with a 4-point Likert scale. The score of the TSK-11 ranges from 11 to 44, with higher scores indicating greater fear of movement/re-injury [18]. The TSK was originally developed to evaluate the psychological characteristics in patients with lower back pain in the Japanese population [19]. In contrast, this scale was also used in patients who underwent ACL reconstructions [20, 21].

2.5.3. Return to play pre-injury sport and patient satisfaction

An original self-administered questionnaire was used to investigate return to sport and patient satisfaction while playing the sport one year after surgery. First, the questionnaire asked whether the patients returned to pre-injury sport (Figure 1). Participating in a match or a practice game for the same pre-injury sport was defined as a return to the sport based on the 2016 consensus statement [13]. Patients who answered "Yes" were next asked about time from the surgery to return to the sport-specific practice and their satisfaction with playing the sport with the following questions: "How satisfied are you with playing pre-injury sports?" Satisfaction was scored using the VAS (score of satisfaction ranges from 0 to 100, with higher scores indicating higher satisfaction) and scaled using an ordinal 4-grade scale (satisfied, mostly satisfied, mostly dissatisfied, and dissatisfied). Patients were further asked about the reason why they choose that satisfaction level using the multiple-answer question: problems related to the operated knee (pain, swelling, subjective range of motion restriction, thigh muscle weakness, giving way, or catching), problems in other part or conditions, other than in the operated limb (muscle weakness of the whole body or endurance reduction), fear/anxiety for exercise, and other reasons.

2.6. Statistical analysis

Statistical analysis was performed using EZR for Windows Ver 1.37 [22]. The sample size to achieve an alpha-level of 0.05 and a beta of 80% with a medium effect size of 0.15 was

calculated by G*power. The result of the calculation, considering the number of independent variables in multiple linear regression analysis, was 92 patients. Participant demographic and measurement data are shown in Table 1. The Shapiro-Wilk test was used to confirm the normality for continuous variables.

A univariate analysis (Pearson or Spearman correlation coefficients and Mann-Whitney *U* test) was performed to examine the association of the demographic and measurement data (independent variables) with the VAS score for the patient satisfaction with playing pre-injury sport (dependent variable) and one year after the surgery. A multiple linear regression analysis was performed to determine the factors affecting patient satisfaction with playing a pre-injury sport one year after the surgery. The VAS score for patient satisfaction with playing a pre-injury sport was set as the dependent variable. The outcomes with p-values of less than 0.05 in the univariate analysis and potential confounding factors including age at the time of operation, sex, pre-injury TAS, and time from operation to measurement were set as the independent variables. Finally, the univariate analysis between the identified significant factor and other demographic and measurement variables was performed again to investigate the interrelationship among the variables. Significance levels were set at a $p < 0.05$.

3. Results

A total of 97 patients were eligible for this study (Figure 2).

3.1 Subjective assessments and patient satisfaction

The average VAS score for patient satisfaction with playing a pre-injury sport was 77.8 ± 20.2. In the ordinal 4-grade scale question, 42 patients (43.3%) answered “satisfied,” 45 patients (46.4%) answered “mostly satisfied”, 9 patients (9.3%) answered “mostly dissatisfied”, and 1 patient (1.0%) answered “dissatisfied.” The results of questions about satisfaction and reasons for satisfaction were summarized in Table 2. Forty-six patients (47.4%) chose “no problem” for their sports activities. Thirty-eight patients (39.2%) answered as having a “knee-related impairment.” Twenty-nine patients (29.9%) answered that they have “Impairment other than the operated limb” (Table 2). Patients who answered "mostly dissatisfied" or "dissatisfied" had more impairments than those who answered "satisfied" or "mostly satisfied" (average number of impairments; dissatisfied & mostly dissatisfied: 2.9 ± 1.6, mostly satisfied: 1.4 ± 1.1, satisfied: 0.1 ± 0.3).

3.2 Association of demographic and measurement data with patient satisfaction

None of the demographic data were significantly associated with patient satisfaction with playing a pre-injury sport one year after the surgery. In the measurement data, subjective knee pain was positively correlated ($p = 0.004$, correlation coefficient [r] = 0.29) and the TSK-11 was

205 negatively correlated ($p = 0.001$, $r = -0.32$) with patient satisfaction while playing a pre-injury
206 sport. None of the knee functional tests were significantly associated with patient satisfaction while
207 playing a pre-injury sport (LSI-Q; $p = 0.09$, $r = 0.17$, LSI-H; $p = 0.73$, $r = 0.04$, LSI-S; $p = 0.28$, r
208 $= 0.28$, knee laxity; $p = 0.17$, $r = 0.14$). Subjective knee pain and the TSK-11 were selected as
209 independent variables for the multiple linear regression analysis. The multiple linear regression
210 analysis, adjusted by age at the time of operation, sex, pre-injury TAS, and time from operation to
211 measurement, showed that the TSK-11 ($\beta = -1.37$, $p = 0.005$) was significantly associated with
212 patient satisfaction when playing a pre-injury sport one year after surgery (Table 3).
213 The univariate analysis for determining the interrelationship between the TSK-11 and the
214 demographic and measurement variables showed that the LSI-S ($p = 0.04$) and knee pain ($p <$
215 0.001) were significantly associated with the TSK-11 score.
216

217 **4. Discussion**

218 The significant findings in this study were that 89.7% of the patients who returned to pre-
219 injury sports after ACL reconstruction were satisfied during the sports activities. In contrast,
220 approximately half of the patients had one or more problems one year after surgery. In addition,
221 the scores of the TSK-11 were significantly associated with patient satisfaction with playing pre-
222 injury sport. Further, LSI of single leg hop distance and knee pain were significantly associated

223 with the TSK-11 score.

224 Returning to a pre-injury sport is one of the important parameters to assess the outcomes
225 after ACL reconstruction. It has been reported that the overall rate of return to play some kind of
226 sport was 82% and the rate of return to the pre-injury sport after ACL reconstruction was 63% in
227 the systematic review [23]. In the present study, patient satisfaction with playing pre-injury sport
228 was investigated. Eighty-seven (89.7%) of 97 patients answered “satisfied” or “mostly satisfied”
229 with the outcome. Nwachukwu et al. [11] examined return to play and patient satisfaction after
230 ACL reconstruction in athletes and reported that 89% of the athletes returned to the same level and
231 85.4% were very satisfied with the outcome at a mean of 3.7 years after ACL reconstruction.
232 Although there are some differences in the timing of the investigation and patient cohort between
233 our study and theirs, our study seemed to be satisfactory after ACL reconstruction.

234 On the other hand, 10 (10.3%) of 97 patients answered “mostly dissatisfied” or
235 “dissatisfied,” and 51 patients (52.6%) had one or more problems even though they had returned
236 pre-injury sports one year after ACL reconstruction. To determine the reasons for the
237 dissatisfaction and problems, a multiple-answer question was performed. Thirty-nine percent of
238 the answers selected impairments in the operated knees and pain, limitation of range of motion,
239 and thigh muscle weakness were the main reasons. In addition, patients who answered “dissatisfied”
240 or “mostly dissatisfied” tended to have more impairments than patients who answered “satisfied”.

241 Meanwhile, approximately 30% of the patients had some problems not only in the operated knee
242 but also in other conditions and endurance (18.6%) and fear/anxiety for exercise (11.3%). This
243 result suggested that a more comprehensive approach is also necessary to improve patient
244 satisfaction during sports activities after ACL reconstruction.

245 To further examine the patient satisfaction with playing pre-injury sports one year after
246 ACL reconstruction, satisfaction was quantified with VAS and factors correlated with satisfaction.
247 Subjective knee pain and the TSK-11 were selected as independent variables in the univariate
248 analysis. The multiple linear regression analysis showed that the TSK-11 score was negatively
249 correlated with patient satisfaction with playing a pre-injury sport one year after ACL
250 reconstruction. The results suggested that fear remained one year after surgery in some patients
251 while they had already returned to play and fear affected their satisfaction. The importance of fear
252 of re-injury and psychological readiness in return to a pre-injury sport after ACL reconstruction
253 has been indicated in previous reports [24, 25]. Flanigan et al. [26] reported that 54% of the 135
254 patients did not return to sports after ACL reconstruction, and persistent knee symptoms and
255 kinesiophobia are the most common reasons for not returning. Webster et al. [27] reported that
256 61% of the patients who underwent primary ACL reconstruction returned to a pre-injury sport one
257 year after surgery and that return to play a pre-injury sport was associated with higher
258 psychological readiness, higher symmetry in the hop test performance between the injured and

non-injured sides, higher IKDC subjective knee scores, and higher activity level. In particular, psychological readiness was reported as the strongest factor contributing to return to play. Thus, it was suggested that some patients could not overcome the fear during movement and failed to return to sports or returned to sports in psychologically unready conditions. Therefore, psychological treatment approaches may also be necessary.

In the concurrent study, potential interrelations between the TSK-11 and other parameters were further investigated and revealed that the TSK-11 was associated with LSI of single leg hop distance and knee pain. Although these factors were not identified as directly affecting factors related to patient satisfaction, these factors could be involved in fear during sports and consequently affected patient satisfaction. Therefore, improving knee function, such as single leg hop performance and knee pain, may reduce pain-related fear of movement/reinjury, and eventually improve patient satisfaction with playing pre-injury sports.

Our study had some limitations. First, patients who did not perform the functional test one year after the surgery were not investigated. Therefore, this study may over/underestimate the satisfaction with playing a pre-injury sport after ACL reconstruction. Second, preoperative patient expectations were not examined and patient expectations may affect patient satisfaction [28]. Third, questions regarding a patient's intentions to return to sport before surgery were retrospectively asked. Thus, the answers were based on patient memory and had a risk of recall bias at the time of

277 measurement. Fourth, although VAS was used to evaluate patient satisfaction, it has not been
278 validated for the evaluation of patient satisfaction. Some studies suggested that assessing the
279 validity of satisfaction outcomes is difficult because of the lack of instruments of validated patient
280 satisfaction [8, 10, 11]. Fifth, we did not measure patient's sport specific performance. Therefore,
281 it should be noted that satisfaction is a different concept from return to their pre-injury performance.
282 Finally, although the same postoperative rehabilitation protocol was used in all the patients, the
283 details of actual rehabilitation were not assessed in this study. Despite these limitations, the present
284 study provided useful information to improve patient satisfaction after ACL reconstruction,
285 especially in patients who play sports.

5. Conclusion

Most of the patients who returned to pre-injury sports were satisfied with their outcomes. Conversely, approximately half of the patients had one or more problems after returning to pre-injury sports. Reducing fear of movement/reinjury and improving knee function may improve patient satisfaction when playing pre-injury sports.

Declaration of Competing Interest: None

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410 **TABLE**

Table 1. Patients demographic and measurement data.

	Value
Age at the time of operation, mean (SD), y	21.7 (8.5)
Male, No. (%)	51 (52.6)
BMI, mean (SD), kg/m^2	22.2 (2.9)
Waiting periods, mean (SD), mo	2.7 (4.7)
Pre-injury Tegner activity scale, mean (SD)	7.8 (1.4)
Type of pre-injury sport, No. (%), contact	65 (67.0)
Level of pre-injury sport, No. (%), athlete	65 (67.0)
Surgical technique, No. (%), Double bundle	71 (83.5)
Meniscus injury, No. (%), yes	32 (37.7)
Cartilage injury, No. (%), yes	6 (6.2)
LSI of quadriceps strength, mean (SD), %	89.2 (17.0)
LSI of hamstrings strength, mean (SD), %	92.7 (13.2)
LSI of single leg hop distance, mean (SD), %	95.0 (7.9)
Knee laxity, mean (SD), mm	1.2 (2.5)
Subjective knee pain, mean (SD)	8.7 (1.8)
TSK-11, mean (SD)	17.2 (4.4)
Time from operation to return to sport, mean (SD), mo	8.7 (1.8)
Time from operation to measurement, mean (SD), mo	12.2 (1.0)

Abbreviation: BMI, Body Mass Index; LSI, Limb Symmetry Index;

TSK-11, Tampa Scale for Kinesiophobia-11.

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Table 2. Result of a multiple answers question

	All patients (N = 97)	Satisfied (n = 42)	Mostly satisfied (n = 45)	Dissatisfied & mostly dissatisfied (n = 10)
No problem	46 (47.4)	39 (92.9)	7 (15.6)	0 (0.0)
Knee-related impairment	38 (39.2)	3 (7.1)	26 (57.8)	9 (90.0)
Pain	15 (15.5)	1 (2.4)	10 (22.2)	4 (40.0)
Swelling	5 (5.2)	0 (0.0)	3 (6.7)	2 (20.0)
Limitation of range of motion	11 (11.3)	0 (0.0)	5 (11.1)	6 (60.0)
Thigh muscle weakness	19 (19.6)	2 (4.8)	11 (24.4)	6 (60.0)
Giving way	3 (3.1)	0 (0.0)	2 (4.4)	1 (10.0)
Catching or locking	6 (6.2)	0 (0.0)	4 (8.9)	2 (20.0)
Impairment other than the operated limb	29 (29.9)	0 (0.0)	23 (51.1)	6 (60.0)
Muscle weakness of the whole body	5 (5.1)	0 (0.0)	3 (6.7)	2 (20.0)
Endurance reduction	18 (18.6)	0 (0.0)	15 (33.3)	3 (30.0)
Fear/anxiety for exercise	11 (11.3)	0 (0.0)	8 (17.8)	3 (30.0)
Other reasons	3 (3.1)	0 (0.0)	3 (6.7)	0 (0.0)

Values was shown as No. (%).

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Table 3. The result of the multiple linear regression analysis for satisfaction with playing pre-injury sport at 1 year after ACL reconstruction using hamstrings autograft

	β	(95% CI)	p value
Subjective knee pain	1.30	(-1.11 to 3.70)	.29
TSK-11	-1.37	(-2.32 to -0.43)	.005*

Abbreviations: ACL, Anterior cruciate ligament; CI, Confidence Interval;

TSK-11, Tampa Scale for Kinesiophobia-11. *; $p < 0.05$

Adjusted for age at the time of operation, sex, pre-injury Tegner activity scale, and time from operation to return to sport.

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Figure legend

FIGURE 1. The questionnaire about returning to sport after the knee surgery.

FIGURE 2. Flow diagram showing included and excluded patients in this study. ACL, anterior cruciate ligament; BPTB, bone patella tendon bone.

Questionnaire about return to sport after the knee surgery

Name _____ Date _____

Q1. Did you play sports before injury?

1. No ➡ Finished
2. Yes ➡ kind of sport _____ Frequency _____

Q2. Have you been able to "return to sports" you had playing before the injury?

"Returne to sport" is defined as the participating a match or a practice of game form of pre-injury sport.

1. No ➡ Finished
2. Yes

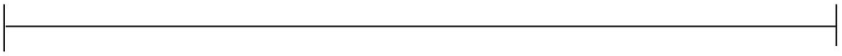
Please answer people who only answered "Yes" in Q2

Q2, 1. When you resume a sport-specific practice? Date _____

Q2, 2. How satisfied are you playing its pre-injury sports?

Please draw a line to the applicable part

Dissatisfied Satisfied



Please choose one from the options below

1. Dissatisfied 2. Mostly dissatisfied 3. Mostly satisfied 4. Satisfied

Q3. Please circle all items that apply to the following (multiple answers allowed)

People who answered "Yes" in Q3 ➡ Reason for choosing that satisfaction

0. No problem at all
1. Knee-related impairment

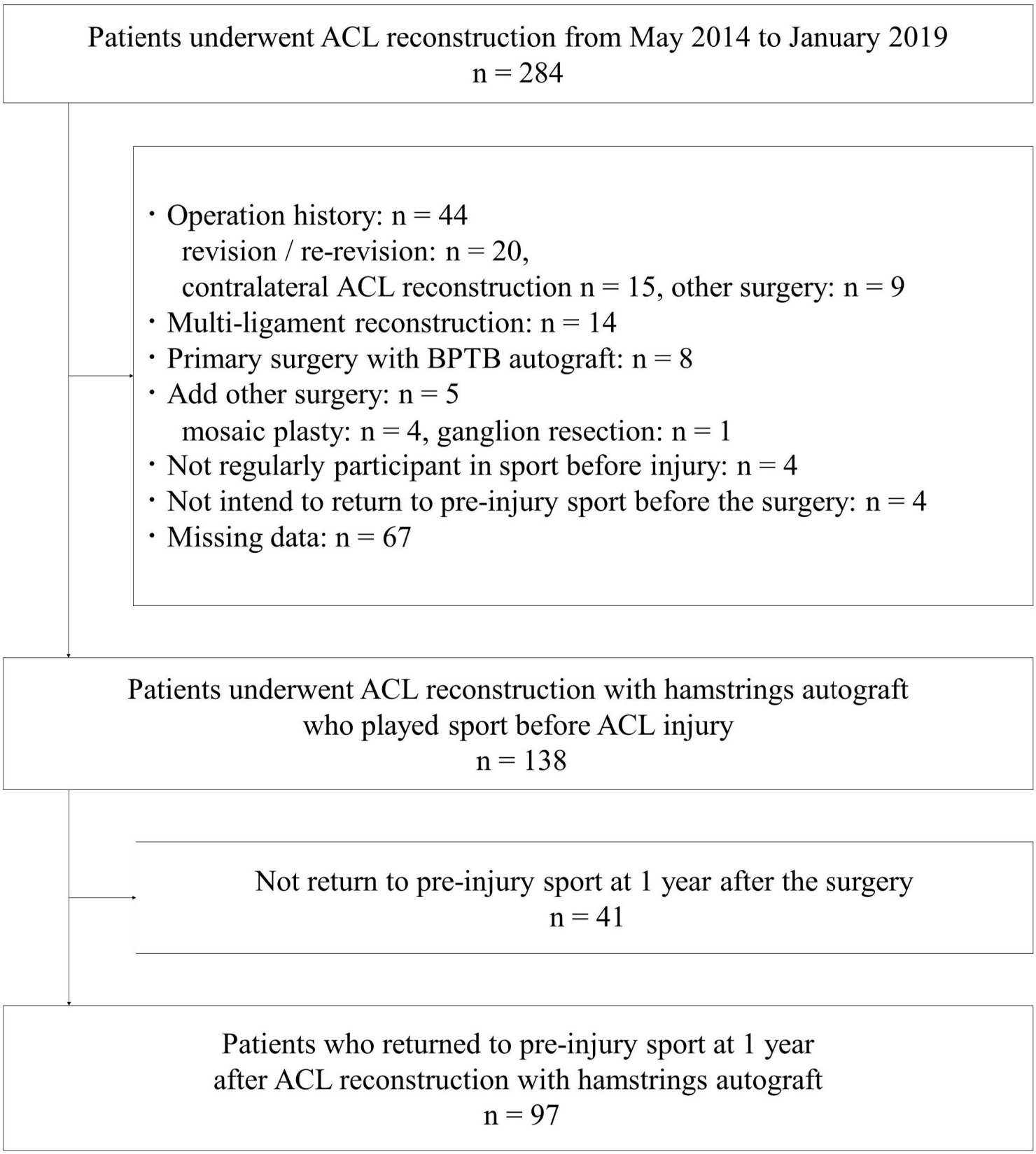
[Pain, Swelling, Range of motion restriction, Thigh muscle weakness, Giving way, Catching]

2. Impairment other than the operated limb

[Muscle weakness of the whole body, Endurance reduction, Fear/anxiety for exercise]

3. Other reasons

_____


Patients underwent ACL reconstruction from May 2014 to January 2019
n = 284
・Operation history: n = 44
revision / re-revision: n = 20,
contralateral ACL reconstruction n = 15, other surgery: n = 9
・Multi-ligament reconstruction: n = 14
・Primary surgery with BPTB autograft: n = 8
・Add other surgery: n = 5
mosaic plasty: n = 4, ganglion resection: n = 1
・Not regularly participant in sport before injury: n = 4
・Not intend to return to pre-injury sport before the surgery: n = 4
・Missing data: n = 67
Patients underwent ACL reconstruction with hamstrings autograft
who played sport before ACL injury
n = 138
Not return to pre-injury sport at 1 year after the surgery
n = 41
Patients who returned to pre-injury sport at 1 year
after ACL reconstruction with hamstrings autograft
n = 97