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Patient satisfaction with health is substantially improved following ACL reconstruction

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Abstract
Purpose To prospectively monitor health-related quality of life and return to work after arthroscopic anterior cruciate ligament (ACL) reconstruction in patients with isolated ACL tears.
Methods Sixty consecutive patients with isolated ACL tears who underwent arthroscopic ACL reconstruction were prospectively monitored using the "Questions on Life Satisfaction Modules" (FLZ^M) and "Short-Form 12 (SF-12)" quality-of-life outcome measures. The Lysholm score and Tegner activity index were used as functional outcome measures. Additionally, return to work (months) together with level of physical workload was analysed. Outcome measures were assessed the day before surgery and at 6, 12 weeks and 6, 12, and 24 months post-operatively. Quality-of-life outcomes were correlated with functional outcome scores.
Results Satisfaction with health (FLZ^M) significantly improved within the first 2 years ($p < 0.05$), and the physical component scale (SF12) showed a significantly higher score after 3, 6, 12 and 24 months as compared with preoperative values ($p < 0.05$). "General life satisfaction (FLZ^M)" was initially decreased at 6 weeks ($p < 0.05$) but increased during the further follow-up period, reaching a score not significantly different from preoperative values. Mean Lysholm score improved from 66 preoperatively to 89 post-operatively ($p < 0.05$) and the median Tegner activity index improved from four to six points ($p < 0.05$) at final follow-up. Mean time to return to work was 7 weeks (range 1–34 weeks), and it strongly depended on physical workload. A positive correlation between quality of life and functional outcome (Lysholm score) was observed.
Conclusion General life satisfaction is impaired during the early post-operative course, but returns to preoperative values after 2 years. Satisfaction with health reaches higher values after 6, 12 and 24 months post-operatively, and the SF-12 physical component scale was seen to improve during the follow-up period. Improved functional outcomes were observed to correlate with quality-of-life measurements. Thus, patients can preoperatively be informed that they will benefit from ACL reconstruction in terms of an improved knee function and satisfaction with health. Heavy physical workload must be considered as a risk factor for prolonged time lost to return to work. These patients have to be identified and informed about realistic expectations.
Level of evidence II.

Keywords Anterior cruciate ligament · ACL tear · ACL reconstruction · Arthroscopy · Quality of life · Return to work

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Introduction

Anterior cruciate ligament (ACL) ruptures are treated operatively in 50–75% of cases in order to restore knee stability, improve knee function, and relieve discomfort [20]. Giving way, thigh muscle strength symmetry, patient-reported function, and return to sport achieve consensus among orthopaedic surgeons as key criteria for evaluating successful anterior cruciate ligament reconstruction [12] as has been reported in a number of clinical follow-up studies [2, 4, 7–9]. Given the high demands on knee function during both occupational and recreational aspects of daily living, however, standardized functional knee scores and/or imaging follow-up examinations may not be suitable alone to characterize the outcome of such a procedure. Particularly, given the importance of the patients' perceptions of benefits gained from surgical interventions, there has been a more recent shift in the orthopaedic field towards the use of patient-reported quality-of-life outcome measures to judge the success of interventions [13]. This approach allows measuring the effectiveness of a specific intervention by identifying individual priorities and problems, developing realistic goals, and assessing progress.

The purpose of this prospective case series was to monitor longitudinal changes in health-related quality-of-life measures following isolated arthroscopic ACL reconstruction. As a secondary outcome measure, time to return to work in relation to physical workload was monitored.

The primary hypothesis was that arthroscopic ACL reconstruction significantly improves health-related quality of life. The secondary hypothesis was that there is a positive correlation between quality of life and functional outcome scores. The tertiary hypothesis was that a higher physical workload significantly prolongs time to return to work.

This study was conducted to improve the understanding of patient satisfaction following ACL reconstruction and to identify a potential risk factor for prolonged incapacity to work.

Materials and methods

Inclusion criteria were isolated and symptomatic ACL tears in patients aged 18–60 years treated with arthroscopic anatomic single-bundle reconstruction between 2011 and 2013 in a specialized orthopaedic sports medicine unit. Patients with partial ACL tears, concomitant lesions of the medial collateral ligament, the posterolateral complex or multi-ligament injuries were excluded. Furthermore, patients were excluded if concomitant procedures such as meniscal repair, cartilage therapy (e.g. microfracturing, osteochondral transfer, chondrocyte implantation) or osteotomies were performed. Patients were only included if they were working on a regular basis before the injury, did not receive income from Workers' Compensation and were not planning to apply for Workers' Compensation.

Data acquisition was conducted by two independent investigators and took place the day before surgery (baseline) and 6, 12 weeks and 6, 12, and 24 months after surgery.

Demographics

ACL reconstruction was performed in 97 consecutive patients within the study period. 37 were excluded on ground of: age ($n = 10$), not working on a regular basis ($n = 2$), meniscal repair ($n = 12$), concomitant high tibial osteotomy ($n = 1$), and multi-ligament injury ($n = 3$). In total, 69 patients met the criterion for initial inclusion in this study. Six patients were lost to follow-up; two patients suffered a traumatic re-rupture and underwent revision surgery, and one patient required removal of a meniscus ganglion 3 months post-operatively. Thus, a total of 60 patients were available at final follow-up (follow-up rate 87%). The mean patient age at surgery was 35 years [range 18–6; Standard Deviation (SD) 10.7], 26 patients (43%) were female and 34 male (57%). All patients took part in regular recreational sporting activity prior to their knee injuries. None of the included patients were professional athletes. Time from injury to surgery was at least 6 weeks. Key criteria for scheduling surgery were a completely reabsorbed knee effusion and a range of motion of at least flexion/extension 90–0–0.

Operative technique and rehabilitation

An anatomic single-bundle technique with autologous hamstring grafts was performed in all patients. The femoral tunnel was drilled via an anteromedial portal. For femoral graft fixation a cortical suspension device (ACL tight-rope, Arthrex Naples USA) was used and tibial fixation was performed using a bio-absorbable interference screw (Arthrex Naples USA).

The post-operative protocol consisted of 2 weeks partial weight-bearing on crutches without limitation of range of motion. Physical therapy twice a week was recommended and a brace (Medi M4, Medi Bayreuth Germany) provided for a period of 6 months. Patients were permitted to start swimming and running on a treadmill from 8 weeks

post-operatively and outdoor jogging after 12 weeks. Return to sport-specific training was allowed at 6 months and full return to contact/pivoting activities from 9 months post-operatively.

Assessment of health-related quality of life, functional outcome, and return to work

Health-related quality of life was assessed using "Questions on Life Satisfaction Modules" ("Fragen zur Lebenszufriedenheit^{Module}", FLZ^{M}) [6] and Short-Form-12 Health Survey [18] as primary patient-reported outcome measures. FLZ^{M} is a standardized self-assessment test using two modules with eight items each. It evaluates individual weighting of the items and therefore deals adequately with the problem of relative importance of individual aspects of quality of life. The modules and items comprise: (1) General life satisfaction (GLS): "Friends/acquaintances", "leisure time/hobbies", "health", "income/financial security", "occupation/work", "housing/living conditions", "family life/children", and "partner relationship/sexuality". (2) Satisfaction with health (SwH): "Physical condition/fitness", "ability to relax/stay on an even keel", "energy/zest for life", "mobility (e.g. walking, driving)", "vision and hearing", "freedom from anxiety", "freedom from aches and pains", and "independence from help/care". On 0–100 scale (with 100 representing maximal satisfaction) as a reference, mean normative weighted and age-adjusted reference for GLS module is 65, and 90 for SwH module [6]. SF-12 is a multi-dimensional generic quality-of-life measure derived from 12 items selected from the SF-36 health survey across eight dimensions of health: "Physical functioning", "role limitations—physical", "bodily pain", "general health", "vitality", "social functioning", "role limitations—emotional", and "mental health". It produces two summary scores: (1) physical component scale (PCS) and mental component scale (MCS) which were transformed linearly to 0–100 scales, with 0 and 100 assigned to the lowest and highest possible scores, respectively.

The Lysholm score and Tegner activity index were used to evaluate the functional outcome [21]. Time (weeks) lost to return to work was recorded and type of occupation were assessed as "non-/mild-physical" or "heavy physical workload" using the German classification system according to the REFA Association of occupational medicine and social medicine [15, 16].

The study protocol was approved by the institutional review board (IRB number: 415/15). All patients provided written informed consent to participate in this investigation.

Statistical analysis

Statistical analysis was performed using SPSS software version 20.0 (IBM-SPSS, New York, USA). All data were tested for normal distribution using the Kolmogorov–Smirnov test.

Longitudinal dependent samples were computed by the paired *t* test for parametric and the paired Wilcoxon test for nonparametric data. Characteristics between groups were compared using the Mann–Whitney *U* test.

Correlation was calculated using Spearman's correlation coefficient. A nominal *p* value of less than 0.05 was considered to indicate statistical significance.

Results

Longitudinal changes in health-related quality of life

Changes over time of FLZ^{M} and SF-12 are described in detail in Tables 1, 2, 3, 4 and 5. FLZ^{M} summary scale "general life satisfaction" (GLS) significantly decreased initially ($p < 0.05$), but increased within the further follow-up time period. There was no difference observed between the preoperative sum score and the score 24 months post-operatively. Its subscale "health" was significantly higher at 12 and 24 months as compared to preoperatively ($p < 0.05$), in contrast "family life/children" was lower at 2 years.

FLZ^{M} summary scale "satisfaction with health" (SwH) significantly decreased initially ($p < 0.05$). Subsequently the score improved continuously. Other than "ability to relax/stay on an even keel", "vision and hearing" and

Table 1 FLZ^{M} summary scale general life satisfaction (GLS)

	Preoperative	6 weeks post-operative	12 weeks post-operative	6 months post-operative	12 months post-operative	24 months post-operative
FLZ summary scale general life satisfaction (GLS)						
Mean	70.9	54.6	62.0	67.5	70.6	73.0
95% CI	63.1–78.7	46.0–63.1	53.3–70.8	60.0–75.0	62.4–78.8	64.9–81.1
p value		0.00	0.01	n.s.	n.s.	n.s.

Table 2 FLZ^{M} weighted satisfaction with general life (GLS)

FLZ (weighted satisfaction with general life)	preoperative		6 weeks post-operative		12 weeks post-operative		6 months post-operative		12 months post-operative		24 months post-operative	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Friends/acquaintances	12.1	5.9	10.5*	6.8	10.1*	6.5	10.7	5.4	10.1*	6.1	10.7	6.6
Leisure time/hobbies	8.1	7.3	2.4*	7.6	5.3*	6.2	6.9	6.2	7.2	6.3	8.2	6.0
Health	5.7	8.0	3.7*	7.2	6.6	5.6	6.8	5.6	8.6**	6.5	9.7**	6.8
Income/financial security	6.9	5.9	5.9	5.0	6.7	5.8	6.6	6.1	7.6	5.7	7.8	5.2
Occupation/work	7.5	5.7	6.1	6.9	6.4	5.9	7.5	5.8	7.3	5.2	7.3	5.0
Housing/living conditions	9.4	5.6	8.5	5.3	8.9	5.5	10.2	5.4	9.3	6.0	9.4	5.7
Family life/children	11.6	8.3	10.2	7.6	10.0	7.5	10.7	8.3	11.1	7.7	10.3*	7.5
Partner relationship/sexuality	10.2	6.8	7.6*	7.3	8.1*	7.2	8.2*	7.6	9.9	7.3	9.7	7.5

* Significant lower values than preoperative ($p < 0.05$); ** significant higher values than preoperative ($p < 0.05$)

Table 3 FLZ^{M} summary scale satisfaction with health (SwH)

	Preoperative	6 weeks post-operative	12 weeks post-operative	6 months post-operative	12 months post-operative	24 months post-operative
FLZ summary scale satisfaction with health (SwH)						
Mean	66.9	52.8	67.9	79.5	83.1	87.2
95% CI	57.6–76.1	43.4–62.2	60.0–75.8	70.9–88.1	74.5–91.7	77.6–96.7
p value		0.00	n.s.	0.01	0.00	0.00

Table 4 FLZ^{M} weighted satisfaction with health (SwH)

FLZ (weighted satisfaction with health)	preoperative		6 weeks post-operative		12 weeks post-operative		6 months post-operative		12 months post-operative		24 months post-operative	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Physical condition/fitness	5.1	7.0	.93*	6.4	2.9	5.4	5.9	5.9	7.3**	6.4	8.3**	6.7
Ability to relax/stay on an even keel	5.2	5.6	4.4	5.9	5.1	6.2	6.9	5.9	7.2	5.8	6.5	5.6
Energy/zest for life	7.6	7.2	5.9*	6.6	6.9*	5.9	8.6	5.8	8.2	6.1	8.4	7.6
Mobility	8.5	8.7	3.7*	8.5	9.5	6.5	11.3**	6.3	12.5**	5.7	13.4**	5.9
vision and hearing	12.8	6.2	12.8	6.2	12.3	6.2	12.3	6.5	12.2	6.1	12.4	6.7
Freedom from anxiety	8.5	6.4	10.0	6.9	10.3**	6.0	11.1**	6.1	11.0**	5.1	11.5**	6.2
Freedom from aches and pain	6.4	6.4	4.9*	5.8	7.1	5.5	8.0	7.4	8.9**	6.7	9.7**	7.3
Independence from help/care	13.2	7.7	10.3*	8.1	13.8	5.4	15.7**	5.3	16.0**	4.8	17.0**	4.6

* Significant lower values than preoperative ($p < 0.05$); ** significant higher values than preoperative ($p < 0.05$)

Table 5 Longitudinal course of short form (SF-12) physical component scale (PCS) and mental component scale (MCS) after arthroscopic ACL reconstruction (*$p < 0.05$)

	Preoperative	6 weeks post-operative	12 weeks post-operative	6 months post-operative	12 months post-operative	24 months post-operative
PCS/MCS						
Mean	39.7/51.5	34.8/49.3	43.5*/54.5	49.2*/51.7	52.5*/50.4	53.4*/51.2
95% CI	37.1–42.3/48.4–54.6	32.7–36.9/46.5–52.0	40.9–46.0/52.2–56.8	47.1–51.3/49.4–54.1	50.6–54.4/47.9–52.1	51.4–55.3/48.7–53.7

* Significant higher values than preoperative ($p < 0.05$)

"energy/zest for life", all items significantly improved within the first two post-operative years ($p < 0.05$).

Physical component scale (SF-12) showed a significantly higher score at 3, 6, 12 and 24 months compared to preoperatively ($p < 0.05$). The outcome of mental component scale (MCS) was constant from baseline to final follow-up with no difference observed. For details, see Table 5.

Longitudinal functional outcome and return to work

Changes over time of Lysholm score and Tegner activity index are presented in detail in Tables 6 and 7. Lysholm score decreased initially, but showed higher values at 12 weeks and 6, 12 and 24 months. From 12 to 24 months' follow-up, no significant improvement was observed (n.s.). The median Tegner activity index improved from four to six points from preoperatively to 2 years post-operatively.

Preoperatively, all patients were in regular employment. Mean time to return to work was 7 weeks (1–34, SD 6). Forty patients (66.7%) worked in desk jobs, and 20 patients (23.3%) had occupations involving a heavy physical workload. With 5 weeks (1–18, SD 3.1) versus 10 weeks (1–34, SD 5.55), a significant difference in time to return to work was observed between the two groups ($p < 0.05$).

Correlation of health-related quality of life with functional outcome

There was a strong positive correlation between quality-of-life outcomes (FLZ^M GLS, FLZ^M SwH, and SF-12) and functional outcome (Lysholm score). Correlation coefficients were 0.38, 0.53, and 0.38 at 2 years.

Discussion

The most significant finding of this study was significant increase in health-related quality of life, functional outcome, and level of sporting activity 2 years following arthroscopic ACL reconstruction. The FLZ^M summary scale "satisfaction with health" and the SF-12 physical component scale were seen to increase continuously from 3 months post-operatively up to final follow-up. Lysholm and Tegner score were significant higher than preoperatively at 2 years.

Quality of life measures the difference and gap at a particular period of time between the individual's hopes, expectations, and desires in the context of the individual`s present experiences and sense of reality [1]. It depends on individual current lifestyle, ambitions, experiences, and realistic priorities and goals. Improvement is related to the ability to identify and actively achieve these goals. "Good" quality of life therefore can be defined as the matching and fulfilled by experience of personal hopes. This is expressed by satisfaction, contentment, fulfilment, and the ability to cope. [1] The most widely used quality-of-life measure in orthopaedic research to date is the Short-Form health survey. It focusses on the lower extremity and is recognized as a good indicator for physical function [10]. Physical and mental well-being can also be monitored using the FLZ^M. More importantly, this score includes weighting for the relative importance of each dimension to the individual concerned. Consequently, the

Table 6 Longitudinal course of Lysholm score after arthroscopic ACL reconstruction

	Preoperative	6 weeks post-operative	12 weeks post-operative	6 months post-operative	12 months post-operative	24 months post-operative
Lysholm score						
Mean	66.0	55.4	75.6	79.9	87.1	89.2
95% CI	61.3–70.7	51.0–59.9	71.9–79.3	76.0–83.9	84.1–90.0	86.2–92.2
p value		0.00	0.00	0.00	0.00	n.s.

Table 7 Longitudinal course of Tegner activity index after arthroscopic ACL reconstruction

	Preoperative	6 weeks post-operative	12 weeks post-operative	6 months post-operative	12 months post-operative	24 months post-operative
Tegener score						
Median	4	2	3	4	5	6
95% CI	3.9–5.2	1.9–2.7	3.0–3.7	4.0–4.6	4.7–5.6	5.3–6.1
p value		0.00	0.00	n.s.	n.s.	0.00

rating in a dimension that is of little importance to an individual does not contribute the same amount to the overall score as the rating in a dimension that is considered particularly important to that person [6]. There are few studies investigating quality of life after arthroscopic ACL reconstruction [5]. To the knowledge of the authors, this is the first prospective case series to investigate patient satisfaction using a standardized health-related quality-of-life outcome scale that incorporates individually weighted importance of each dimension.

This study shows a significant increase in patient satisfaction with health (FLZ^M) in the first 2 years following arthroscopic ACL reconstruction. The subitems "physical condition/fitness" and "freedom from aches and pain" were significant higher at 12 and 24 months with only a slight difference between these two measurements, indicating that the rehabilitation programme is routinely completed within the first post-operative year. Patients were observed to be more active, as represented by a higher Tegner score, and had an increased knee function (Lysholm score), at 12 and 24 months. The patient satisfaction with health (FLZ^M) subscales "mobility" and "independence of help/care" were seen to be significantly lower at 6 weeks. Within this period, patients used crutches and did not fully weight-bear, resulting in restricted mobility and may explain the inability to return to work even among patients worked in desk jobs. After 6 months these subitems increased. At this point, post-operatively patients stopped wearing their knee-stabilizing brace, which may impair quality of life and is not recommended for routine use by some authors [14, 19]. "Freedom from anxiety" was significant higher after 12 weeks. Within this period, the risk of post-operative complications (e.g. infection, arthrofibrosis) decreases and patients usually begin to notice an improvement in knee function and step-wise progress in physiotherapy. Additionally, reduced fear of giving ways due to ACL insufficiency may help explain higher values during further follow-up which was seen to continue improving up to the final follow-up of the present study, at 2 years.

The FLZ^M summary scale "general life satisfaction" showed no difference after 2 years. Its subscales "friends/acquaintances", "leisure time/hobbies", and "partner relationship/sexuality" were significant lower at 6 and 12 weeks post-operatively. This may be as a result of restricted mobility and impaired activities within the early post-operative period following ACL reconstruction, however, all subitems improved and reached results comparable to preoperative values after 2 years. The subitem "health" was significantly higher at 12 and 24 months, which underlines the beneficial effect of this surgical procedure. The SF-12 mental component scale did not differ between follow-up time-points and was comparable to preoperative values at 2 years. The SF-12 physical component scale, however, was significantly higher at 3, 6, 12, and 24 months post-operatively. Longitudinally monitored, both SF-12 (PCS) and FLZ^M (SwH) showed comparable trends.

Arthroscopic ACL reconstruction is a well-established technique to address anterior cruciate ligament tears. Very positive short- to long-term functional outcomes for arthroscopic ACL reconstruction have been reported previously [3, 11, 22]. It is beyond the scope of the present study to comment on the ideal method for ACL reconstruction; however, functional outcomes observed in the present study are comparable with current literature and represent a significant clinical improvement [4, 9, 11].

While the FLZ^M has not been validated against knee specific functional outcome scores, Short-Form health survey has been previously validated against Lysholm score for patients with ACL insufficiency, with significant correlation observed [17]. In the present study, a positive correlation was observed between quality of life and functional outcome (Lysholm score), which would seem to indicate the importance of considering both when judging post-operative results, despite the differing nature of quality of life and functional scores.

Mean time to return to work was 7 weeks (1–34, SD 6) in this study, and it depended significantly on heavy physical workload.

Some limitations must, however, be considered in the present study, namely: (1) the study was performed at a tertiary care centre. Results may not reflect the characteristics of patients that present at different levels of institutions. (2) There is no control group for the reconstruction technique used in this study; however, it was beyond the scope of this study to investigate the relative merits of differing surgical techniques. Nevertheless, arthroscopic ACL reconstruction with the presented technique remains a mainstream and widely accepted treatment option. (3) The number of participants of this study is low when compared with other studies; however, these results do represent comparable outcomes. (4) Since improvement was seen to continue up to the 2-year follow-up period of this study, further longitudinal monitoring may have been necessary to identify further improvements and final, steady-state, outcomes. (5) Individuals that suffered from recurrent instability were excluded from further follow-up.

Since unrealistic patient expectations may cause dissatisfaction despite technical successful arthroscopic anatomic ACL reconstruction, surgeons should consider counselling their patients concerning realistic aims and goals. The present study adds valuable results to the existing literature, particularly given the nature of the patient cohort represented, with isolated ACL reconstructions without additional procedures performed. Following ACL reconstruction, patients can expect improved knee function, higher levels of sporting activity and an increased health-related

quality of life. This information is useful in daily clinical practice when patients are preoperatively informed about benefits from ACL reconstruction.

Conclusion

General life satisfaction is impaired during the early post-operative course, but returns to preoperative values after 2 years. Satisfaction with health reaches higher values after 6, 12 and 24 months post-operatively and the SF-12 physical component scale was seen to improve during the follow-up period. Improved functional outcomes were observed to correlate with quality-of-life measurements. Heavy physical workload must be considered as a risk factor for prolonged time lost to return to work.

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Compliance with ethical standards

Conflict of interest The authors have no conflict of interest related to this study.

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Ethical approval The study was approved by the Institutional Review Board of the Technical University of Munich (No. 415/15) and conducted according to the Declaration of Helsinki.

Informed consent Informed consent was obtained from all individual participants included in the study.

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