Knee Surg Sports Traumatol Arthrosc (2013) 21:2405–2411
DOI 10.1007/s00167-013-2409-z

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The unhappy total knee arthroplasty (TKA) patient: higher WOMAC and lower KSS in depressed patients prior and after TKA

Michael T. Hirschmann · Enrique Testa · Felix Amsler · Niklaus F. Friederich

Received: 15 October 2012 / Accepted: 14 January 2013 / Published online: 29 January 2013
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Abstract
Purpose Patient-based and psychological factors do influence outcome in patients undergoing total knee arthroplasty (TKA). The purpose was to investigate if preoperative psychological factors influence the subjective and objective outcomes 6 weeks, 4 months and 1 year after TKA. Our hypothesis was that there is a significant influence of psychological factors on clinical outcome scores before and after TKA.
Methods A prospective, longitudinal, single-cohort study investigating the correlation of depression, control beliefs, anxiety and a variety of other psychological factors with outcomes of patients undergoing TKA was performed. A total of 104 consecutive patients were investigated preoperatively using the Beck's depression inventory, the State-Trait Anxiety Index, the questionnaire for assessment of control beliefs and the SCL-90R inventory. The Knee Society Clinical Rating System (KSS) and the WOMAC were used. Analysis of TKA position was performed on radiographs according to Ewald et al. Correlation of psychological variables with outcomes was performed ($p < .05$).
Results Self-efficacy did not influence clinical scores. More depressed patients showed higher pre- and postoperative WOMAC scores, but no difference in amelioration. KSS scores were not influenced. Patients with higher State and Trait Anxiety Indexes had higher WOMAC and lower KSS scores before and after the operation, but most significant correlations were <0.3. Several SCL-90 dimensions had significant correlations with pre- and postoperative clinical scores, but not with their amelioration. The SCL-90 subscore for somatization and the overall SCL-90 significantly correlated with the WOMAC, KSS before and after TKA.
Conclusions Depression, anxiety, a tendency to somatize and psychological distress were identified as significant predictors for poorer clinical outcomes before and/or after TKA. Standardized preoperative screening and subsequent treatment should become part of the preoperative work-up in orthopaedic practice.
Level of evidence Prognostic prospective, Level I.

Keywords Knee · Total knee arthroplasty · Pain · Depression · Anxiety · Self-efficacy · Control beliefs · Somatization · WOMAC · KSS · Outcome

M. T. Hirschmann (✉) · E. Testa · N. F. Friederich
Department of Orthopaedic Surgery and Traumatology, Kantonsspital Baselland/Bruderholz, 4101 Bruderholz, Switzerland
e-mail: Michael.Hirschmann@ksbh.ch; Michael.Hirschmann@unibas.ch

F. Amsler
Amsler Consulting, Basel, Switzerland

Introduction

Although total knee arthroplasty (TKA) is considered to be a very successful treatment for end-stage osteoarthritis, a considerable number of patients after TKA continue to complain about persistent or recurrent pain and express dissatisfaction [9, 12, 17, 19, 33]. A variety of different causes, which can be differentiated in intra- or extraarticular causes, have been identified. Most common intraarticular causes are aseptic loosening, malposition, infection, instability and extensor mechanism problems such as unresurfaced patella, under- or oversizing of the patella button or patellar maltracking [1, 14, 17, 19, 30]. The most common 'extraarticular' problems are neurological or

vascular disorders, pathologies of the hip or spine, stress fractures or periprosthetic fractures [1, 14, 30].

There is a significant percentage of patients, in which the pain could not be explained by somatic reasons after a comprehensive clinical, serological, microbiological and radiological work-up. In some of these patients, the good clinical outcome contrasts the bad feeling and dissatisfaction of the patient [5, 15]. Wylde et al. [33] reported that 44 % of patients after TKA experience persistent pain of any severity and 15 % complain about severe-extreme persistent pain after TKA. Persistent pain after TKA clearly represents an under-acknowledged problem in TKA. In an effort to better understand, the pain generator and factors that lead to higher levels of experienced pain psychological factors such as anxiety, depression or control beliefs are increasingly identified as important field of research [7, 9, 10, 22, 24, 30, 32].

Not only recently, it has been discovered that there are patient based and psychological factors, which could influence outcome in patients undergoing orthopaedic surgery [5, 7–10, 15, 22, 32]. Fisher et al. [15] found that younger patient age, female gender, comorbidities such as diabetes mellitus, chronic lung disease, depression, previous knee surgery and a higher BMI was correlated with inferior clinical outcome in patients undergoing TKA. Valdes et al. [31] reported that lower preoperative radiographic osteoarthritis is associated with higher pain levels postTKA. Numerous authors have shown a significant influence of anxiety and depression on the pain level in patients before and after TKA [7–10, 15, 32]. Brander et al. [9, 10] reported that preoperative depression, anxiety and pain were associated with greater pain and worse clinical outcome 1 year after TKA. However, the importance of other psychosocial factors such as control beliefs, patient expectations, control beliefs (the belief that someone has the ability to control pain), somatization, interpersonal sensitivity and personality was not particularly assessed here.

Only when the exact psychological factors which contribute to poorer outcome in patients undergoing TKA are identified, psychological therapeutic interventions could be specifically targeted.

The purpose of the present study was to investigate if preoperative psychological factors such as anxiety, depression, control beliefs or other psychological factors do have a major influence on the subjective as well as objective outcomes 6 weeks, 4 months and 1 year after TKA. Our hypothesis was that there is a significant influence of psychological factors on clinical outcome scores before and after TKA.

Materials and methods

A prospective, longitudinal, single-cohort study investigating the correlation of psychological factors such as depression, control beliefs, anxiety and a variety of other psychological factors with clinical and radiological outcomes of patients undergoing TKA was performed. From January 2009 to September 2011, all patients with knee osteoarthritis undergoing primary TKA for osteoarthritis were considered for enrolment ($n = 452$). For inclusion in the study, the patients had to meet the following enrolment criteria: diagnosis of primary osteoarthritis of the knee, age older than 50 years, no previous diagnosis and/or treatment of depression or other psychological disorders, adequate cognitive function to fill out the assessment forms and availability for clinical and radiological follow-up.

A total of 110 consecutive patients were consented and included in this study. A total of 104 patients (95 %) had a clinical and radiological follow-up (mean age 70 ± 11 years, m:f = 46:58, mean body mass index 29 ± 6).

For TKA, femoral fixation was press-fit and tibial component was cemented. The patella was not resurfaced, but denervated using electrocautery. To compensate for rotational alignment, a mobile bearing polyethylene was used.

For postoperative pain management, epidural anaesthesia using local anaesthetics such as ropivacaine or intravenous patient controlled analgesia was used for the first postoperative day followed by oral analgesics (paracetamol and/or diclofenac and/or metamizole) on subsequent days. Postoperatively all patients underwent a standardized rehabilitation programme. Active assisted physiotherapeutic exercises starting on the first day with unrestricted active motion and weight bearing were encouraged. Continuous passive motion machine was used for the first 6 weeks after surgery. While in hospital patients received inpatient physical therapy, which was then continued in a 2–3 weeks rehabilitation programme at a rehab centre and/or by outpatient physical therapy.

The patients were investigated preoperatively using the following psychological instruments. The Beck‘s depression inventory (BDI) in the German version is a self-reported instrument with 21 items used to assess the severity of depression [3, 4]. Higher scores indicate worse depression levels [3, 4].

The State-Trait Anxiety Index [STAI] was used to measure two types of anxiety, state anxiety and trait anxiety [21, 27]. The index is based on a 40 items on a 4-point Likert scale. Higher scores indicate increased anxiety levels [21, 27].

The questionnaire for assessment of control beliefs in relation to illness and health was used evaluate the control beliefs (self-efficacy) of patients using a 21-items self-reported questionnaire [23]. Control belief is the degree to which individuals believe that their health is controlled by internal versus external factors. Three different total scores, namely the internal locus of control, external locus of

control (social) and external locus of control (fatalism) were calculated.

Psychological distress was assessed using the SCL-90R inventory, which is a self-report psychometric instrument designed to evaluate a variety of psychological problems and symptoms of psychopathology [16]. It is one of the most commonly used instruments to assess psychological distress in clinical practice and research. The patient rated their symptoms in the last 7 days using 90 items with 5-grades Likert scales [16]. Primary symptom dimensions are somatization (a tendency to experience and communicate somatic distress in response to psychosocial stress), obsessive–compulsive, interpersonal sensitivity (appropriateness of perceptions with respect other persons), depression, anxiety, hostility (form of angry internal rejection or denial), phobic anxiety, paranoid ideation, psychoticism (personality pattern typified by aggressiveness and interpersonal hostility) and 'additional items' such as poor appetite [16]. Higher values in the global severity index (GSI) summarizing the SCL-90 subscores represent more psychological distress [16].

The subjective clinical outcome was assessed preoperatively, 6 weeks, 4 months and 12 months postoperatively using a visual analogue scale for knee pain (0 = no pain to 10 = intolerable pain). Patients marked the level of their knee pain on a 10-cm horizontal line. Similar VAS scales were assessed for satisfaction (0 = no satisfaction to 10 = perfect satisfaction).

For clinical scoring, the Knee Society Clinical Rating System (KSS) and the Western Ontario and McMasters Universities Osteoarthritis Index (WOMAC) score were used [6, 20]. The KSS can be subdivided into a knee score (KSS A) that rates only the knee joint itself and a functional score (KSS B) that rates the patient's ability to walk and climb stairs. The WOMAC score is a self-administered questionnaire developed to study patients with hip and knee osteoarthritis.

Analysis of femoral and tibial TKA component position was assessed on long-leg anteroposterior standing, lateral and patellar sunrise radiographs using the knee society total knee arthroplasty roentgenographic evaluation and scoring system (TKA-RESS) [13]. At 4 months follow-up, mechanical alignment was recorded on long-leg radiographs. Adverse events were recorded at each clinical follow-up. The study was approved by the local ethics committee.

Statistical analysis

A sample size calculation indicated a minimum of 82 patients to find correlations >0.3 between psychological factors and clinical scores with a power of 80 %.

Data were analysed using SPSS 17.0 (SPSS, Chicago, USA). Continuous variables were noted as mean ± SD and median, categorial variables as absolute and relative frequencies. Due to the nonnormal distribution of most of the scores, nonparametric statistics were used to test for the changes in time (Friedman-test for the overall change and Wilcoxon test between each point in time) and for the correlation between the psychological variables with the subjective and objective outcomes (Spearman's rho). The level of significance was defined as $p < .05$. Correlation coefficients rho <0.3 are interpreted to be of low clinical interest, those >0.3 as clinically relevant.

Results

The results of the preoperative psychological instruments are presented in Table 1. The objective and subjective clinical outcomes at 6 weeks, 4 months and 1 year follow-up are shown in Table 2. Over the 1 year course, a steady improvement of the clinical outcome instruments (WOMAC, KSS) was observed. The WOMAC pain score significantly decreased from 52 ± 24 to 13 ± 17, the WOMAC stiffness from 54 ± 26 to 20 ± 20, the WOMAC function 48 ± 20 to 16 ± 18. There was a continuous amelioration until 4 months and then stayed stable up to 1 year. The total KSS increased from 118 ± 32 to 186 ± 26 ($p < .001$). In contrast to the WOMAC, the

Table 1 Preoperative psychological scoring using the Beck's depression inventory, the State-Trait Anxiety Index, the questionnaire for assessment of control beliefs in relation to illness and health *and the* SCL-90 inventory

Preoperative scoring	Mean ± standard deviation	Median
Self-efficacy - internal locus of control	28 ± 6	29
Self-efficacy- external locus of control (social)	22 ± 5	23
Self-efficacy- external locus of control (fatalism)	22 ± 7	17
Becks depression inventory	7.0 ± 5.0	7
State-Trait Anxiety Index (State)	36 ± 10	35
State-Trait Anxiety Index (Trait)	33 ± 9	31
SCL-90 somatization	5.5 ± 5.2	4
SCL-90 obsessiveness-compulsiveness	4.2 ± 4.9	3
SCL-90 interpersonal sensitivity	2.8 ± 3.1	2
SCL-90 depression	4.9 ± 7.0	3
SCL-90 anxiety	2.9 ± 4.2	1
SCL-90 hostility	1.1 ± 2.0	1
SCL-90 phobic anxiety	1.3 ± 2.4	0
SCL-90 paranoid ideation	1.9 ± 2.8	1
SCL-90 psychoticism	1.9 ± 3.0	1
SCL-90 additional	3.5 ± 3.1	3
SCL-90 GSI (total)	30 ± 32	20

Table 2 Clinical outcome scoring preoperatively, 6 weeks, 4 months and 1 year after surgery: mean ± standard deviation (M ± SD), Median (Md), p between measuring points (Wilcoxon test) and overall *p* (Friedman test))

Clinical scoring	Preoperative		*p*	6 weeks p. o.		*p*	4 months p. o.		*p*	1 year p. o.		Overall
	M ± SD	Md		M ± SD	Md		M ± SD	Md		M ± SD	Md	*p*
WOMAC pain	52 ± 24	49	***	25 ± 14	22	***	14 ± 16	9	n.s.	13 ± 17	6	***
WOMAC stiffness	54 ± 26	50	***	36 ± 20	30	***	22 ± 20	15	n.s.	20 ± 20	15	***
WOMAC function	48 ± 20	44	***	27 ± 15	22	***	16 ± 15	12	n.s.	16 ± 18	9	***
Knee Society Score A	55 ± 20	56	***	84 ± 12	88	**	88 ± 14	93	**	92 ± 12	96	***
Knee Society Score B	64 ± 20	60	**	73 ± 21	70	***	89 ± 16	100	*	94 ± 16	100	***
Total Knee Society Score	118 ± 32	117	***	157 ± 28	159	***	176 ± 26	185	***	186 ± 26	195	***

n.s. $p > .05$; * $p < .05$; ** $p < .01$; *** $p < .001$

Table 3 Spearman correlations of preoperative psychological instruments and clinical outcome scoring before TKA

	WOMAC pain	WOMAC stiffness	WOMAC function	KSS A	KSS B	Total KSS
Internal locus of control	0.06	−0.03	−0.03	0.21*	0.06	−0.19
External locus of control (social)	0.06	0.04	0.12	0.04	−0.18	−0.05
External locus of control (fatalism)	0.15	0.06	0.05	−0.05	−0.23*	−0.17
Becks depression inventory	0.26**	0.33**	0.33**	−0.13	0.13	−0.14
Anxiety index: state	0.19	0.27**	0.30**	−0.11	0.18	−0.17
Anxiety index: trait	0.06	0.18	0.21*	−0.09	−0.28**	−0.20*
SCL-90 somatization	0.31**	0.44***	0.39***	−0.15	−0.37***	−0.30**
SCL-90 obsessiveness-compulsiveness	0.05	0.24*	0.26*	0.03	−0.11	−0.03
SCL-90 interpersonal sensitivity	0.12	0.21*	0.23*	0.02	−0.07	−0.02
SCL-90 depression	0.17	0.29**	0.31**	0.01	−0.16	−0.06
SCL-90 anxiety	0.15	0.23*	0.29**	−0.07	−0.17	−0.15
SCL-90 hostility	0.05	0.17	0.13	0.07	−0.12	−0.03
SCL-90 phobic anxiety	−0.04	0.12	0.22*	−0.01	−0.14	−0.07
SCL-90 paranoid ideation	0.19	0.14	0.23*	−0.03	−0.09	−0.06
SCL-90 psychoticism	0.01	0.12	0.03	0.11	−0.15	−0.02
SCL-90 additional	0.18	0.30**	0.14	−0.03	−0.11	−0.09
SCL-90 GSI (total)	0.18	0.33**	0.30**	−0.01	−0.20	−0.11

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

KSS continued to ameliorate in the last phase of the study between 4 months and 1 year.

The preoperatively measured psychological scores were correlated with the preoperative clinical scores, the outcome after 1 year and the delta between the two measures (Tables 3, 4 and 5).

Self-efficacy (locus of control) did not influence clinical scores or their amelioration.

More depressed patients (BDI) showed higher pre- and postoperative WOMAC scores, but no difference in amelioration. KSS scores were not influenced.

Patients with higher State and Trait Anxiety Indexes had higher WOMAC and lower KSS scores before and after the operation, but most significant correlations were <0.3.

Several SCL-90 dimensions have significant correlations with pre- and postoperative clinical scores, but not with their amelioration. The SCL-90 subscore for somatization also significantly correlated with the WOMAC, KSS before and after TKA. The overall SCL-90 GSI score representing psychological distress showed a significant correlation with WOMAC and KSS before and after surgery.

Discussion

The most clinically relevant contributions of the present study are that patients with inferior preoperative psychological characteristics showed inferior WOMAC scores, KSS scores and VAS pain and satisfaction at 6 weeks, 4 months and 1 year after TKA. However, a similar finding was found already for the preoperative outcome scores. Patients with inferior psychological scores, in particular for depression, anxiety and somatization as well as control beliefs showed poorer outcome scores. Identification and

Table 4 Spearman correlations of preoperative psychological instruments and clinical outcome scoring 1 year after TKA

	WOMAC pain	WOMAC stiffness	WOMAC function	KSS A	KSS B	Total KSS
Internal locus of control	−0.11	0.03	−0.04	−0.02	−0.01	−0.01
External locus of control (social)	0.13	0.08	0.13	−0.10	−0.08	−0.11
External locus of control (fatalism)	−0.08	0.15	0.01	0.05	−0.04	0.01
Becks depression inventory	0.29*	0.34**	0.37***	−0.09	0.02	−0.04
Anxiety index: state	0.15	0.21	0.15	−0.22	−0.05	−0.19
Anxiety index: trait	0.25*	0.26*	0.25*	−0.24*	−0.06	−0.20
SCL-90 somatization	0.35**	0.36**	0.43***	−0.12	−0.04	−0.10
SCL-90 obsessiveness-compulsiveness	0.40***	0.40***	0.47***	−0.13	−0.09	−0.12
SCL-90 interpersonal sensitivity	0.29*	0.38***	0.28*	−0.17	−0.09	−0.15
SCL-90 depression	0.36**	0.34**	0.41***	−0.16	−0.07	−0.15
SCL-90 anxiety	0.09	0.26*	0.20	−0.25*	−0.01	−0.19
SCL-90 hostility	0.21	0.37**	0.28*	−0.19	−0.03	−0.15
SCL-90 phobic anxiety	0.08	0.24*	0.20	−0.15	−0.12	−0.20
SCL-90 paranoid ideation	0.34**	0.38***	0.36**	−0.21*	−0.13	−0.21
SCL-90 psychoticism	0.24*	0.32**	0.22	−0.04	0.00	−0.02
SCL-90 additional	0.24*	0.40***	0.33**	−0.10	−0.08	−0.10
SCL-90 GSI (total)	0.33**	0.41***	0.41***	−0.17	−0.05	−0.14

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 5 Spearman correlations of preoperative psychological instruments and the delta of preoperative and 1 year postoperative clinical outcome scoring

	WOMAC pain	WOMAC stiffness	WOMAC function	KSS A	KSS B	Total KSS
Internal locus of control	−0.05	0.03	−0.04	−0.21*	−0.06	−0.12
External locus of control (social)	0.02	0.09	−0.01	−0.02	0.15	−0.08
External locus of control (fatalism)	−0.24*	0.00	−0.10	0.09	0.17	0.18
Becks depression inventory	−0.01	−0.10	−0.06	0.11	0.19	0.14
Anxiety index: state	−0.07	−0.07	−0.13	−0.01	0.21	0.10
Anxiety index: trait	0.13	0.00	0.03	−0.04	0.29**	0.12
SCL-90 somatization	0.02	−0.19	0.01	0.08	0.36***	0.22*
SCL-90 obsessiveness-compulsiveness	0.21	−0.02	0.09	−0.10	0.10	−0.05
SCL-90 interpersonal sensitivity	0.21	0.03	0.04	−0.16	0.05	−0.09
SCL-90 depression	0.13	−0.11	−0.03	−0.10	0.17	−0.01
SCL-90 anxiety	−0.04	−0.02	−0.12	−0.09	0.14	0.03
SCL-90 hostility	0.04	−0.01	−0.01	−0.12	0.13	−0.01
SCL-90 phobic anxiety	0.14	−0.04	−0.12	−0.08	0.10	−0.03
SCL-90 paranoid ideation	0.14	0.04	0.07	−0.10	0.11	−0.03
SCL-90 psychoticism	0.10	0.01	0.08	−0.13	0.18	0.04
SCL-90 additional	0.05	−0.08	0.10	0.01	0.10	0.05
SCL-90 GSI (total)	0.12	−0.09	0.02	−0.09	0.21*	0.04

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

subsequent treatment of these psychological traits and states before surgery could lead to improvement of subjective and objective outcomes after TKA. Our findings are consistent with other previous reports showing that higher levels of depression and anxiety before TKA predict poorer clinical outcome and higher pain levels after surgery [7, 25, 28, 32]. To our knowledge, there is no study investigating the SCL-90 psychological domains, Beck's depression inventory, control beliefs in health (self-efficacy) and State and Trait Anxiety Index at one-year follow-up after TKA.

In a systematic review, Vissers et al. [32] aimed to investigate which psychological factors influence the outcome in patients after TKA or total hip arthroplasty. Nineteen studies were included on TKA [32]. The most often evaluated psychological factors were depression, anxiety, patient expectations and the surrogate measure

mental health [32]. In 17 of these studies, the clinical follow-up was shorter than one year [32], which is rather short, as in clinical experience one could observe a decrease in the pain level till one to 2 years after TKA. A finding which could be due to real improvement or adaptation of the patient to the pain and then it is called response shift [2]. Vissers et al. [32] concluded that mental health measured with SF-12 or SF-36 and pain catastrophizing are the most important factors for increased postoperative pain after TKA.

Lopez-Olivo et al. [24] evaluated 241 consecutive patients undergoing TKA in a prospective cohort study before and 6 months after TKA. For clinical outcome assessment, the WOMAC and KSS were used [24]. Depression, coping style, social support and health control beliefs were identified as independent predictors of clinical outcomes [24]. In another study with 6 months follow-up, Riddle et al. [26] identified catastrophizing pain as predictor for a poorer WOMAC score.

To include such psychological instruments into the diagnostic algorithm of patients with pain after TKA, the optimal psychological screening tools have to be identified. In the present study, we decided to use mostly self-reported instruments, which generally show less observer bias. In addition, these instruments are feasible even in a busy orthopaedic clinic setting. Only when the psychological instruments proposed are reliable, time and cost-efficient, it will find it is way into clinical routine.

Screening for depression, anxiety, a tendency to somatize and psychological distress using the psychological instruments used in the present study could easily become part of the preoperative work-up in every orthopaedic practice. To date, many spine centres have already incorporated a psychological screening and subsequent treatment in their spine surgery programmes [11, 29]. In the case of a psychological state at risk for poorer clinical outcome, the patient could undergo a specific psychological preoperative treatment. Targeted and customized exercise and sport programmes could simultaneously help to improve the knee function, self-efficacy and mood of the patient.

Several limitations have to be considered when interpreting the present study results.

Firstly, the patients investigated in the present study were all patients being operated in a single knee centre. This could bear some regional (selection) bias. It could be speculated if the patients included represent the general orthopaedic patient population. However, when compared to previous study populations, it seems to be comparable.

Secondly, the position of femoral and tibial TKA components as well as the mechanical axis or radiolucent lines representing loosening was only assessed on radiographs. This is the current accepted method, but the method is prone to measurement errors [18]. In this study setting, we were not able to obtain 3D-CT for analysis of TKA component position, which has to be considered as the current gold standard [18]. Hence, it could not be excluded that some of these patients were in pain due to malposition of the TKA.

Thirdly, due to feasibility in clinical hospital routine, we could not include more questionnaires investigating patient expectations and other psychological factors such as pain catastrophizing in this present study. In our study, we choose the most relevant and validated psychological instruments which reflect the most important psychological factors. Furthermore, there is already good evidence that patient expectations and pain catastrophizing is an important predictor of the pain level after TKA [32].

Conclusion

Depression, anxiety, a tendency to somatize and psychological distress were identified as significant predictors for poorer clinical outcomes before and/or after TKA. Standardized preoperative screening and subsequent should become part of the preoperative work-up in orthopaedic practice. Further clinical studies should reveal if a supportive psychological treatment before TKA could improve the outcome in these patients with inferior psychological characteristics.

Acknowledgments We greatly thank the ENDO-Stiftung, Hamburg, Germany and the Swiss Society of Orthopaedic Surgery and Traumatology (Schweizerische Gesellschaft für Orthopädie und Traumatologie SGOT), Lucerne, Switzerland for financial support of the study. We are also grateful to Dr. phil. Daniela Heimberg for her help and advice in psychological scoring.

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