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ORIGINAL ARTICLE

Psychological predictors of quality of life and functional outcome in patients undergoing elective surgery for degenerative lumbar spine disease

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Abstract

Objective To quantify the correlation between patients' psychopathological predisposition, disability and health-related quality of life (QOL) after surgery for degenerative lumbar spine disease.

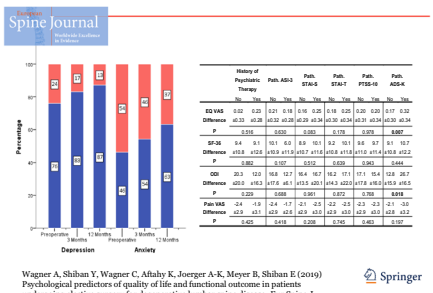
Methods We prospectively included patients undergoing decompression for degenerative lumbar spinal stenosis, spondylolisthesis or disc herniation with additional fusion of up to two segments. Patients completed a structured psychological assessment including the Center for Epidemiological Studies Depression Scale (ADS-K), Post-Traumatic Stress Scale–10 (PTSS-10), State Trait Anxiety Inventory–State Anxiety and State Trait Anxiety Inventory–Trait Anxiety (STAI-S and STAI-T) and Anxiety Sensitivity Index–3 (ASI-3) before surgery, after 3 and 12 months. Outcome measures included EuroQol 5D (EQ), Short Form-36 (SF-36) and Oswestry Disability Index (ODI) scores.

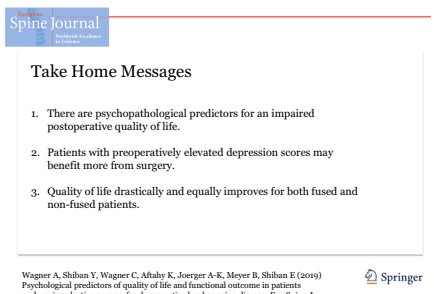
Results In total, 245 patients between March 2013 and November 2017 received surgery, of which 180 (73.5%) fully completed follow-up after 3 months and 12 months. QOL scores significantly increased by 3 months (EQ: +0.2; $p < 0.001$; SF-36 PCS: +7.0; $p < 0.001$; SF-36 MCS: +3.3; $p = 0.018$), a benefit which was retained at 12 months, without statistically significant difference between fused and non-fused patients. Depressed patients exhibited impaired mean scores of EQ (0.58 vs. 0.36; $p < 0.001$) and ODI mean scores (35.5 vs. 51.9; $p < 0.001$) at baseline, which significantly improved and converged with scores of non-depressed patients after 12 months. Linear regression analysis identified statistically significant predictors in age, STAI-T and SF-36 MCS for post-operative QOL and disability.

Conclusion Despite exhibiting pronounced psychological distress preoperatively, patients may significantly benefit from surgery with an outcome equal to psychologically healthy patients after 12 months.

Graphic abstract

These slides can be retrieved under Electronic Supplementary Material.





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Extended author information available on the last page of the article

Keywords Degenerative spine disease · Depression · Anxiety · Quality of life

Introduction

Surgery for degenerative lumbar spine disease offers the potential for pain relief, functional recovery and improved health-related quality of life (QOL) [1, 2]. Owing to well-known demographic developments, procedural rates of elective lumbar spine surgeries continue to gain significance in health economics, particularly for fusion procedures [3]. In light of the comparably high cost, it is crucial to recognize and select appropriate candidates for a foreseeable significant surgical success, which in itself is a complex multifactorial construct of subjective and objective variables. International guidelines so far remain cautionary to recommend decompressive and fusion surgery for degenerative lumbar spine disease on a broad scale and advocate careful selection of surgical candidates only after exhaustion of conservative therapy [4]. An additional layer, aside from a diagnosis-based indication, is founded in the psychopathological profile of patients. A number of authors saw statistically meaningful interactions of preoperative functional predictors with satisfactory post-operative QOL [5–9]. Only few of these studies have, to our knowledge, specifically addressed psychopathological dimensions via specialized instruments pertaining to depression in the perioperative setting of degenerative lumbar spine disease, and none has correlated perioperative anxiety scores with post-operative disability and QOL [8, 9]. In our investigation, we sought to identify predictors from the individual psychopathological profile of patients undergoing elective lumbar spine surgery, explore the correlation with various denominators of post-operative QOL and therefore conceive a predictive model on the basis of a standardized psychopathological screening environment.

Patients and methods

Patients scheduled for elective lumbar spine surgery with a diagnosis of degenerative spinal stenosis with and without concomitant spondylolisthesis, degenerative spinal instability or a lumbar disc herniation were asked to participate in this prospective observational single-centre study, and informed consent was obtained from all participants. The analysis included patients aged over 18 years, with a planned procedure addressing up to two adjacent segments for the corresponding degenerative pathology and a minimum duration of symptoms of 6 weeks despite conservative treatment. Symptoms included low back pain (LBP), sciatica corresponding to disc herniation on imaging or neurogenic claudication with predominant impairment of walking distance as assessed and reported on examination. Severe neurological motor deficit defined as Medical Research Council grade 3 and below, vegetative symptoms, clinical findings suggestive of spondylodiscitis or complications secondary to a prior procedure precluded study inclusion. Magnetic resonance images (MRI) or computed tomography (CT) scanning with adjunct myelography of the lumbar spine were used for assessment of lumbar spine pathologies, any findings of neoplastic lesion, inflammatory changes indicative of spondylodiscitis, multiple level pathologies necessitating surgery of more than two-segment fusion or decompression precluded study participation. Preoperative diagnostics beyond MRI and CT of the lumbar spine were complemented according to the operating surgeon's preferences and included dynamic radiographs, long-standing radiographs and bone densitometry. Patient demographics and socioeconomic factors were recorded at baseline in addition to a standardized screening via an assortment of common and validated psychopathological instruments including the German versions of the *Center for Epidemiological Studies Depression Scale* (*Allgemeine Depressionsskala*; ADS-K), *Post-Traumatic Stress Scale–10* (PTSS-10), *State Trait Anxiety Inventory–State Anxiety and State Trait Anxiety Inventory–Trait Anxiety* (STAI-S and STAI-T) and *Anxiety Sensitivity Index–3* (ASI-3). These instruments have proved to be reliable and valid assessors of their respective psychopathological dimensions and have thus been chosen by our neuropsychologists [10–13]. The aforementioned scales are concordant with the majority of the pertinent literature, although there are several further psychosocial dimensions to potentially consider. Research has shown kinesiophobia and dysfunctional catastrophizing of thoughts to be significant predictors for disability and increased pain after lumbar spine surgery [14–16]. We deliberately chose to omit these rather specific factors in favour of a more concise and practical assortment of questionnaires, so as to not overburden patients with too many items and retain practicability and generalizability of the test battery. For more information on the psychopathological scales, see Table 1.

The screening was conducted with the assistance of a study assistant neuropsychologist as were all assessments on follow-up sessions at 3 and 12 months after surgery. Cut-offs for pathological scores were predetermined in accordance with the pertinent literature [10, 12, 17–20]. Additionally, patients completed the German versions of QOL questionnaires *EuroQol 5D* (EQ), *Short Form 36* (SF-36), which is further classified into the Physical and Mental Component Scores (PCS and MCS), as well as functional disability scale *Oswestry Disability Index* (ODI) at all sittings, constituting

Table 1 Overview of the standardized questionnaires used in the study

Questionnaire	Description	Cut-off
General Depression Scale (Allgemeine Depressionsskala; ADS-K)	This index is based on the *Center for Epidemiological Studies Depression Scale* (Radloff 1977) and was devised to determine depression levels for outpatients. The 15 items are sensitive to dysthymic disorders, not only to major depression	≥ 18
State Trait Anxiety Inventory (STAI-T and STAI-S)	This two-part questionnaire was conceived to measure the two different dimensions of anxiety with 20 items each: a stable character trait and personal disposition and a transient state as a function of current influences	> 40
Post-Traumatic Stress Scale (PTSS-10)	The scale consists of 10 items that check for pathognomonic symptoms of post-traumatic stress disorder	≥ 18
Anxiety Sensitivity Index (ASI-3)	This index is a measure of susceptibility to states of anxiety and perception of potentially hazardous symptoms, 18 items	> 30
European Quality of Life Questionnaire (EuroQol)	The concept of quality of life leans on five dimensions of everyday life including *mobility, self-care, usual activities, pain/discomfort* and *anxiety/depression*. The respective scores are summarized into a single index on the *visual analogue scale* (VAS). Higher scores on the VAS indicate better quality of life	Score 0–1
Short Form Health Survey (SF-36)	With its 36 items, the SF-36 gauges eight aspects of health-related quality of life of a patient. The aspects may be summarized in the *Physical Health Component Summary Score* (PCS) and *Mental Health Component Summary Score* (MCS), higher values signal favourable physical and mental capacity	Score 0–100
Oswestry Disability Index (ODI)	The ODI has been a reliable tool for the assessment of functional impairment in patients with degenerative spine disease. Each of the 10 items addresses certain domains of everyday life and autonomy. A score of 0–5 is assigned to each answer and multiplied by 2, with higher scores representing higher disability	Score 0–100

the primary clinical outcome. For the secondary outcome measures, perception of pain was assessed through the visual analogue scale (VAS) at all sittings, referring to the patients' respective localization of pain, i.e. VAS leg pain for subjects with a herniated disc. A history of psychiatric treatment was taken and defined as any consultation of a psychiatrist in the recent 12 months not necessitating inpatient treatment. Finally, patients were asked to rate their individually perceived surgical success after 12 months on a Likert scale from 1, designated "no improvement", to 10, designated "full resolution of complaints".

Decompressive surgery and sequestrectomy were done in a standard microsurgical set-up, with a subperiosteal interlaminar preparation from the side of predominant stenosis or hernia or the surgeon's preference otherwise and undercutting to the contralateral side when indicated as per clinical and radiographic findings. For fusion, we performed navigation-assisted posterior instrumentation with additional decompression by laminectomy of stenotic and unstable segments. All procedures were indicated and conducted in compliance with our department's standards and the Declaration of Helsinki, and operating surgeons and ward personnel were blinded to study participation. A positive vote by the local ethics committee was acquired beforehand (registration no. 409/13).

For the primary outcome correlation, we took to recent works with similar set-outs to determine the sample size [8, 21]. Assuming a fairly low correlation coefficient of $r = 0.300$ with an $\alpha < 0.05$ and $\beta = 0.80$, the sample size is calculated as $n = 85$. Since there are only scarce data to base these calculations on and in accounting for a heterogenous cohort, we decided to increase the planned sample size to 200.

Statistical analysis focussed on repeated measures analysis of variance (rANOVA) and multiple mixed linear regression analysis of primary outcome, i.e. the primary objective of the study was to correlate preoperative psychopathological scores with QOL and functional primary and secondary outcome variables after 12 months. Secondary comparisons addressed the improvement in preoperative pain and disability across the entire cohort, the differences in post-operative QOL and functional outcome between surgical subgroups as well as a correlation analysis between independent variables. We also provided a simple stratification of the cohort by pathological scores and a comparison of QOL and disability of these subgroups. Further, Student's *t* test and Chi-square testing were employed for parametric and nonparametric comparisons, respectively. We used IBM SPSS in its 21st version for statistics, and the level of significance was defined a priori as $\alpha = 0.05$.

Results

Epidemiology

We prospectively included 245 patients between March 2013 and November 2017, of which 180 (73.5%) fully completed follow-up after 3 months and 12 months. Baseline characteristics of the cohort are listed in Table 2, and independent variables of age ($p=0.879$), gender ($p=0.105$) marital status ($p=0.629$) and level of education ($p=0.588$) were adjusted between subgroups undergoing decompressive surgery with and without fusion. Degenerative spondylolisthesis and degenerative instability among patients receiving fusion were significantly higher ($p<0.001$), and single-segment procedures were also significantly more common (77.0% vs. 49.1%; $p<0.001$) in the decompression only subgroup. None of the patients underwent reoperation for surgical complications during follow-up and no patient who was not lost to follow-up deceased.

Psychopathological assessment

Overall, 18.3% of patients reported having received psychiatric treatment before, which was distributed to 16.9% in the decompression and 21.6% in the fusion subgroups ($p=0.444$). A significant reduction in the proportion of subjects with pathological anxiety ($p=0.004$) and depression ($p=0.003$) scores was noted over the course of follow-up (Fig. 1). For the decompression subgroup, proportions of pathological anxiety scores were reduced by 8.4 ($p=0.005$) and depression scores by 10.0 ($p=0.001$). For the fusion subgroup, proportions of pathological anxiety were reduced by 22.6 ($p=0.016$) and depression by 11.9 ($p<0.001$). Changes in psychopathological mean scores are listed in Table 3, with a comparison between the decompression and fusion subgroups, which did not reveal any significant differences of mean scores.

Pain, function and quality of life

At baseline, mean pain intensity was 7.1 and 28.4 as graded by the VAS and SF-36 bodily pain scale for the decompression subgroup as opposed to 6.6 and 26.4 for patients undergoing fusion, respectively. There was no significant difference in baseline pain intensity (Table 4). For the entire cohort, respective improvement was significant by 3.1 (VAS; $p<0.001$) and 23.4 (SF-36; $p<0.001$) after 3 months. The pain relief was maintained for both measures after 12 months without significant change (VAS: −0.1;

Table 2 Baseline characteristics of cohort stratified by subgroups of patients undergoing decompression alone or decompression with fusion

	Fusion	No fusion	*p*
	106	74	
Age in years (range)	63 (20–87)	63 (26–83)	0.879
Gender			
Female	66.0%	54.1%	0.105
Relationship status			
Single	7.8%	13.5%	0.629
Married	73.5%	66.2%	
In a relationship	9.8%	10.8%	
Widowed	8.8%	9.5%	
Education level			
Secondary school	59.2%	54.4%	0.588
High school	40.8%	45.6%	
Pathology			
Stenosis	32.1%	40.5%	< 0.001
Disc herniation	15.1%	56.8%	
Instability	31.1%	1.4%	
Spondylolisthesis	21.7%	1.4%	
Segments			
1	49.1%	77.0%	< 0.001
2	50.9%	23.0%	

p level of significance

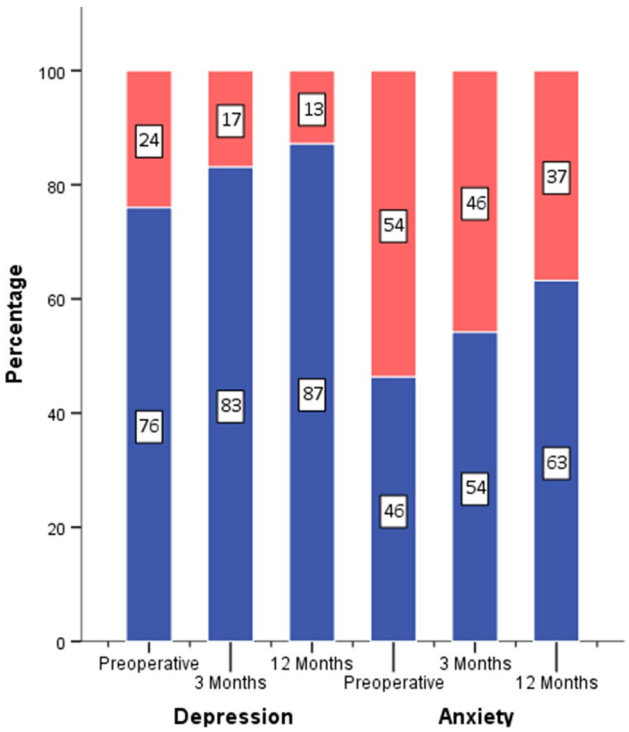

Fig. 1 Proportion of patients with pathological depression and anxiety scores over follow-up. Normal scores in blue stacks; pathological scores in red stacks. Numbers in stacks represent percentages of entire cohort

Table 3 Psychopathological scores at baseline, after 3 and 12 months, stratified by surgical subgroups

	Fusion	No fusion	*p*
ADS-K			
Preop.	12.5	12.1	0.746
Month 3	9.9	9.8	
Month 12	9.7	8.5	
ASI-3			
Preop.	15.8	17.1	0.543
Month 3	14.8	16.6	
Month 12	14.0	15.9	
STAI-S			
Preop.	42.3	41.9	0.214
Month 3	38.5	37.5	
Month 12	36.6	36.7	
STAI-T			
Preop.	37.5	37.9	0.241
Month 3	35.7	35.5	
Month 12	35.4	36.4	
PTSS-10			
Preop.	12.3	11.2	0.281
Month 3	8.0	6.7	
Month 12	7.9	6.5	

Preop. preoperative

Table 4 Pain intensity as measured by the SF-36 bodily pain subscale and the VAS at baseline, after 3 and 12 months, stratified by subgroups of fusion and decompression only

	Fusion	No fusion	*p*
SF-36 bodily pain preoperative	26.4 (0–51)	28.43 (0–62)	0.486
SF-36 bodily pain at 3 months	46.44 (12–100)	56.12 (12–100)	0.370
SF-36 bodily pain at 12 months	50.75 (10–100)	56.86 (22–100)	0.140
VAS preoperative	6.6 (4.0–9.0)	7.1 (2.0–9.0)	0.594
VAS at 3 months	4.0 (0–8.0)	3.4 (0–8.0)	0.170
VAS at 12 months	4.1 (0–9.0)	3.9 (0–8.0)	0.529
Changes after 12 months			
SF-36 bodily pain	24.4	28.4	0.440
VAS	−2.5	−3.2	0.425

95% confidence interval in parentheses

$p = 1.0$; SF-36: +3.3; $p = 0.177$). No difference in mean changes was found between subgroups of decompression and additional fusion (Table 4). Further subgroup analysis resulted in statistically significant improvement in EQ and ODI developments in patients with pathological preoperative ADS-K scores (Table 5). This finding has to be viewed in light of the preoperatively significantly decreased EQ (0.58

Table 5 Changes in QOL, functional and pain scores with a 95% confidence interval after 12 months, stratified by subgroups of normal and pathological psychological scores at baseline

	History of psychiatric therapy		Baseline path. ASI-3		Baseline path. STAI-S		Baseline path. STAI-T		Baseline path. PTSS-10		Baseline path. ADS-K	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
EQ VAS increase	0.20 ± 0.33	0.23 ± 0.28	0.21 ± 0.32	0.18 ± 0.28	0.16 ± 0.29	0.25 ± 0.34	0.18 ± 0.30	0.25 ± 0.34	0.20 ± 0.31	0.20 ± 0.34	0.17 ± 0.30	0.32 ± 0.34
p	0.516		0.630		0.083		0.178		0.978		**0.007**	
SF-36 increase	9.4 ± 10.8	9.1 ± 12.6	10.1 ± 10.9	6.0 ± 11.9	8.9 ± 10.7	10.1 ± 11.6	9.2 ± 10.8	10.1 ± 11.8	9.6 ± 11.0	9.7 ± 11.4	9.1 ± 10.8	10.7 ± 12.2
p	0.882		0.107		0.512		0.639		0.943		0.444	
ODI decrease	− 20.3 ± 20.0	− 12.0 ± 16.3	− 16.8 ± 17.6	− 12.7 ± 6.1	− 16.4 ± 13.5	− 16.7 ± 20.1	− 16.2 ± 14.3	− 17.1 ± 22.0	− 17.1 ± 17.8	− 15.4 ± 16.0	− 12.8 ± 15.9	− 26.7 ± 16.5
p	0.229		0.688		0.961		0.872		0.768		**0.018**	
Pain VAS decrease	− 2.4 ± 2.9	− 1.9 ± 3.1	− 2.4 ± 2.9	− 1.7 ± 2.6	− 2.1 ± 2.9	− 2.5 ± 3.0	− 2.2 ± 2.9	− 2.5 ± 3.0	− 2.3 ± 2.9	− 2.3 ± 3.0	− 2.1 ± 2.8	− 3.0 ± 3.2
p	0.425		0.418		0.208		0.745		0.463		0.197	

Path. pathological

Bold type indicates statistically significant values

vs. 0.36; $p < 0.001$) and elevated ODI mean scores (35.5 vs 51.9; $p < 0.001$) in depressed patients, resulting in a significant improvement in disability and equalization of QOL and functional outcome for both depressed and non-depressed patients after 12 months (EQ: 0.74 vs. 0.67; $p = 0.107$ and ODI: 21.8 vs. 20.9; $p = 0.890$).

Mean scores of the EQ VAS and SF-36 scale improved significantly for the entire cohort over the course of follow-up (Fig. 2a–f). Pairwise comparison demonstrates most distinct improvements between preoperative status and at 3 months after surgery (EQ: + 0.2; $p < 0.001$; SF-36 PCS: + 7.0; $p < 0.001$; SF-36 MCS: + 3.3; $p = 0.018$), which at 12 months further improved non-significantly for the EQ and SF-36 MCS, but significantly for the SF-36 PCS (+ 2.99; $p = 0.003$). Developments of neither scale were significantly influenced by type of surgery and at no time were mean scores significantly different (Fig. 3).

Similarly, functional disability significantly improved with ODI scores decreasing by 15.3 after 3 months ($p < 0.001$) and further by 6.1 after 12 months ($p = 0.005$) without significant differences between subgroups (Fig. 3).

When asked about subjective surgical success on the last follow-up, 60.8% in the decompression subgroup versus 58.5% in the fusion subgroup reported substantial improvement from preoperative complaints, defined as 8–10 points on Likert scale item. A proportion of 13.5% in the decompression subgroup versus 13.2% in the fusion subgroup reported minor to no improvement at all, defined as 0–2 points on the same item, the proportions were statistically equal between subgroups ($p = 0.926$). According to this item, a mean VAS improvement of 2.48 was required for a rating of at least 8 on the Likert scale. Thus, 44.3% in the decompression subgroup and 46.2% in the fusion subgroups achieved this estimated minimally clinical important difference (MCID), which is conform to other calculations [22]. Similarly, mean ODI decreased by 9 at the predisposed Likert scale cut-off of 8 for patient satisfaction; hence, 53.3% in the decompression subgroup and 70.4% in the fusion subgroup ($p = 0.270$) achieved the estimated MCID, which is also reciprocated by other studies [22, 23].

Regression analysis of outcome predictors

A multiple linear mixed regression model resulted in select independent variables adding statistically significantly to the equation of primary and secondary outcome-dependent variables. Specifically, preoperatively elevated STAI-T scores negatively affected improvements in EQ, PCS and patient satisfaction, whereas high preoperative MCS correlated with higher EQ, ODI and patient satisfaction. Patients of high age experienced impaired outcomes in EQ and PCS scales. The remaining variables had more vague associations. Interestingly, elevated preoperative ADS-K scores significantly and *positively* correlated with the EQ increase after surgery (Table 6).

Univariate correlation analysis between changes in QOL scores and pain relief after 12 months revealed strong correlations in each of the three pairs (EQ/pain: Pearson = 0.65; SF-36/pain: Pearson = 0.69; ODI/pain: Pearson = 0.66; $p < 0.001$, respectively). A significant correlation was also noted between pairs of pain relief and the respective instruments of anxiety and depression (pain/STAI-S; pain/STAI-T; pain/ADS-K; pain/PTSS-10: $p < 0.001$, respectively) with the exception of no correlation between decrease in ASI-3 scores and pain relief (pain/ASI-3: $p = 0.707$).

Discussion

Beneath the selection for surgical candidates presenting with degenerative disease of the lumbar spine lies a multifactorial decision-making. Favourable surgical, functional and QOL outcomes have been well documented, albeit most relevant studies so far have neglected the psychopathological predisposition of patients [1, 2]. Even in the studies specifically addressing the said psychological predisposition, a clinically meaningful correlation has yet to be pinpointed.

Various efforts assessing post-operative QOL and disability substantiate a clear benefit after surgery for degenerative lumbar spine disease in general, the surgical strategies and particulars seemingly being of subordinate importance [24]. It appears plausible that with the projected pain relief, which often represents the driving force behind a patient's desire to undergo treatment, QOL measures post-operatively concur: DeVine et al. [25] published a systematic review of the literature with an emphasis on the correlations between pain relief and QOL outcome. The authors reason that despite there being moderate to strong positive correlation between these dimensions, assessment with only one QOL and pain measurement by itself may be an inadequate gauge of the individually perceived surgical success and misrepresent patient satisfaction after surgery. Another systematic review refers to 25 randomized controlled trials with marked benefit in SF-36 scores across all surgical groups compared to conservative treatment, which is in accordance with consensus in the abundant literature [26–28].

An additional dimension to the multifaceted constructs of surgical success derives from the psychopathological profile of patients. A matter of debate has far less frequently been investigated despite increasing implications of its presumably fundamental inference on the said success. Chaiana et al. and Lebow et al. [8, 9] reported some predictability of post-operative disability and pain relief by determining preoperative depression and somatization in patients undergoing lumbar microdiscectomy. Both studies find high success rates with marked improvement in leg pain

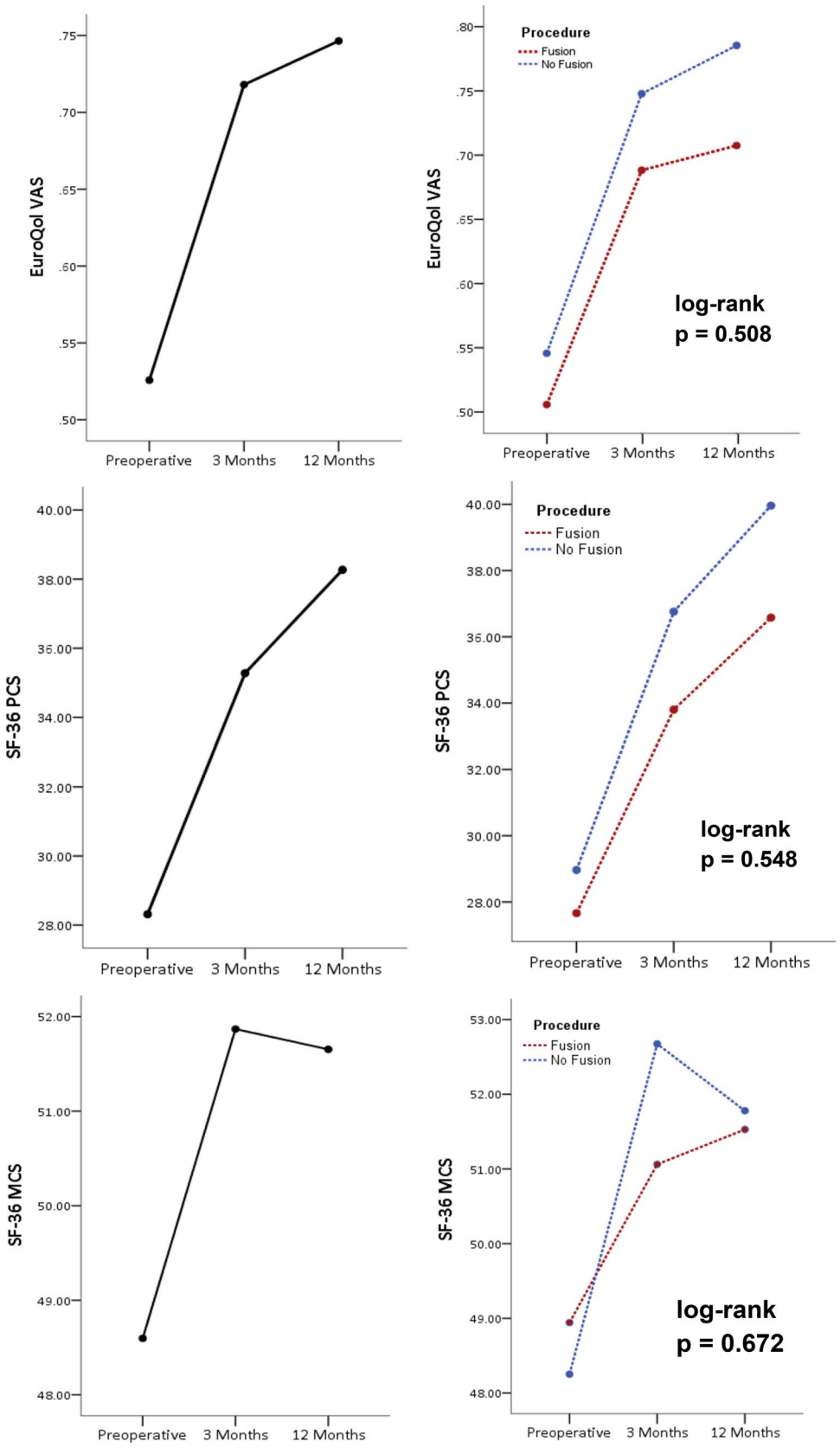

Fig. 2 Development of Euro-Qol, SF-36 PCS and MCS for the entire cohort (**a**, **c**, **e**) and stratified according to procedure (**b**, **d**, **f**)

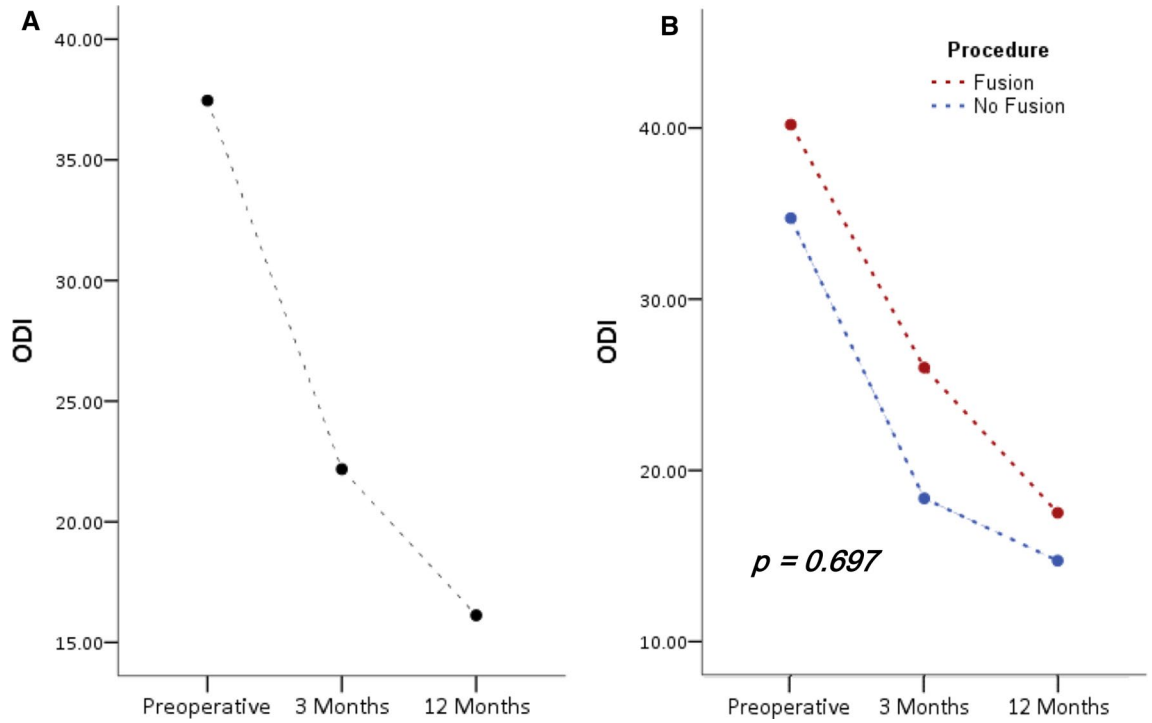

Fig. 3 Development of ODI scores for the entire cohort (**a**) and stratified according to procedure (**b**)

Table 6 Multiple linear regression analysis of correlation between changes in EQ VAS, SF-36 PCS, ODI as well as patient satisfaction scores and independent predictors

	EQ VAS increase	*p*	SF-36 PCS increase	*p*	ODI decrease	*p*	Patient satisfaction	*p*
Age	**−0.005**	**0.004**	**−0.131**	**0.013**	+0.055	0.288	−0.037	0.038
Gender	+0.064	0.176	+0.248	0.872	−0.403	0.781	−0.346	0.512
Relationship status	**+0.076**	**0.016**	+0.874	0.403	−0.438	0.652	−0.183	0.598
Psychiatric history	+0.030	0.637	−1.710	0.391	**−4.092**	**0.030**	0.716	0.293
Preop. STAI-S score	+0.003	0.324	−0.283	0.066	+0.045	0.634	−0.013	0.703
Preop. STAI-T score	**−0.007**	**0.025**	**−0.117**	**0.041**	−0.017	0.894	**−0.083**	**0.047**
Preop. ASI-3 score	−0.002	0.261	+0.114	0.383	−0.025	0.683	+0.037	0.091
Preop. PTSS-10 score	−0.008	0.156	−0.048	0.852	**−1.344**	**0.023**	−0.017	0.797
Preop. ADS-K score	**+0.009**	**0.031**	+0.039	0.858	−0.253	0.073	−0.050	0.360
Preop. SF-36 MCS	**+0.006**	**0.023**	−0.087	0.364	**+0.199**	**0.006**	**+0.058**	**0.043**
Fusion	+0.022	0.644	+2.045	0.214	+2.000	0.174	+0.077	0.886
Number of segments	+0.017	0.723	+0.966	0.564	+0.517	0.730	−0.356	0.514

Positive and negative correlations are denoted by plus and minus signs, respectively

Bold type indicates statistically significant values

after microdiscectomy in addition to receding depression and somatization scores. The authors surmise a strong interaction between preoperatively impaired mental health status and patient-reported outcome after lumbar discectomy, although they conclude that the question of *what came first* remains unanswered and presumably necessitates conducting a far grander population study than our efforts can provide at this time; still, these studies address a limited patient sample that is distinguished by a relatively short duration of pain and therefore, possibly, lower risk of mental distress and burden. A different verdict can be made on the correlation of the preoperative psychiatric history and postoperative outcome. In our study, a proportion of 18.3% of patients reported having consulted a psychiatrist during the recent 12 months for any type of psychiatric comorbidity. Interestingly, with the exception of the ODI scale, none of

the functional measures were significantly affected by this denominator in the multiple regression analysis (Table 6). Despite this weak association, it seems that medium-term psychiatric burden does not play a role as important as one might assume for the post-operative course, a claim supported by equal improvements in quality of life, pain and functional status for both subgroups (Table 5).

Sinikallio et al. [29] provided evidence for depressed patients underperforming in conventional QOL and functional outcome scales on long-term follow-up after decompression, without assessment for anxiety scales. A literature search by Wilhelm et al. [30] found a limited number of studies evaluating the psychosomatic interaction with only two high-quality studies of which none assessed patients beyond the SF-36 MCS subscale and preoperative prevalence of depression. Two other studies examined anxiety and depression in the perioperative setting, with inconclusive results. Lee et al. [31] did not find a significant correlation between the degree of preoperative anxiety and depression levels and post-operative objective outcome measures in ODI and pain VAS, although they employed a retrospective cohort design. Netto et al. [32] report about decreased SF-36 scores in patients with anxiety symptoms. Their statistical validity is hampered by a small cohort of 32 and short follow-up time of 4 months. Further, the authors do not correlate preoperative screening results with post-operative courses of outcome, hence rendering prediction of the said outcomes difficult.

In our investigation, we applied an assortment of psychopathological screening tools for thorough assessment of different dimensions of anxiety and depression as was implemented priorly for similar studies by our institution. The set-up facilitated analysis of independent factors that constitute a patient's psychological profile and their predictive influence on long-term outcome and surgical success.

Over the follow-up, all QOL instruments significantly improved, whilst psychopathological scores promptly receded, irrespective of surgical strategy. These changes correlated strongly with the extent of pain relief, mirroring their close association that we set out to quantify. The prevalence of clinically significant depression in our cohort proved to match the prevalence in the general population when compared to the available literature, the majority of which lends credence to there being a strong association between symptomatic degenerative spine disease and psychiatric comorbidity [33]. Patients with pathological depression scores, defined as equal or above 18 on the ADS-K scale, exhibited a particularly accentuated benefit in the EQ and ODI scales after 12 months. On closer analysis, it is revealed that depressed patients show significantly low EQ and ODI scores at baseline, but experience such improvement that their scores align with those of non-depressed patients. More so, this observation is reinforced by the positive correlation of preoperative ADS-K scores with post-operative EQ increase in the multiple regression analysis. This result ought to come fairly unexpected, but in our mind might represent the depressed patients' inability to cope with somatic stressors such as pain and disability stemming from degenerative spine disease. Alleviating these stressors then would not only produce favourable somatic outcomes, but also reduce depressive symptoms as indicated in Fig. 1. This observation is further reinforced by the fair correlation between relief of pain and improvement in psychopathological scores.

Consequently, we encourage routine preoperative screening of patients with the aforementioned instruments as devised by our test battery, offering an accessible and validated aid for the preselection of surgical candidates. By no means should identification of patients at risk of an impaired outcome, however, disqualify from being considered for surgical treatment; rather, it permits adequate psychological support and tailored perioperative care for patients in need of surgical treatment for intractable pain, compromised quality of life and functional disability.

Study limitations

The study was designed without an observational control arm, which reduces the statistical power of our results. Further, pre-emptive clear definition of inclusion criteria and stratification allowed for comparability of a fairly heterogenous cohort, which, however, biases results and impedes generalizability.

This observational study merely depicts the characteristics of mental distress and emotional burden and their implications on outcome of patients undergoing surgery. The results suggest that a proposition for focused psychological perioperative support for select patients is not unwarranted.

Conclusion

There is a considerable psychological and emotional burden in patients undergoing treatment for degenerative lumbar spine disease and intractable pain. Despite exhibiting pronounced psychological distress preoperatively, patients may significantly benefit from surgery with an outcome equal to psychologically healthy patients after 12 months.

Compliance with ethical standards

Conflict of interest ES received research grants and is a consultant for Nevro (Redwood City, California, USA) and Icotec (Alstätten, Switzerland). BM received research grants and is a consultant for Brainlab AG (Munich, Germany). BM received honoraria, consulting fees, and research grants from Medtronic (Meerbusch, Germany), Icotec ag (Altstätten, Switzerland), and Relievant Medsystems Inc., (Sunnyvale,

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