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Single-level lumbar fusion in chronic discogenic low-back pain: psychological and emotional status as a predictor of outcome measured using the 36-item Short Form

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Object. The authors examined the effect of psychological and emotional status on the outcome in patients with suspected chronic discogenic low-back pain (LBP) who have undergone lumbar fusion.

Methods. The authors retrospectively analyzed the medical records, including the results of the 36-item Short Form (SF-36), of 57 consecutive patients (mean age 42.7 years) who underwent single-level lumbar reconstructive surgery between 1994 and 2000. The SF-36 physical-component summary (PCS) and mental component summary (MCS) domains were evaluated. Data were sorted into the following categories: excellent, good, fair, same, and worse. Scores greater than 40 for MCS and PCS were defined as "normal" according to US general population data provided by the Medical Outcomes Trust.

Of 57 patients, 47 completed postoperative SF-36 surveys at 1 year and 36 completed the 2-year follow-up surveys. Analysis showed that preoperative MCS scores exhibited a significant, direct correlation with PCS score improvements at 1 ($r = 0.584$, $p = 0.000$) and 2 ($r = 0.623$, $p = 0.000$) years after surgery. In patients in whom preoperative MCS scores reflected normal status, outcomes were excellent or good in 60% at 1-year (18 of 30 cases) and 2-year (15 of 25 cases) follow-up intervals. Patients in whom MCS scores represented abnormal status had less satisfactory outcomes, with excellent or good outcome in only two (18.2%) of all patients at the 2-year follow-up study.

Conclusions. Analysis of the data suggests that psychological and emotional distress may negatively affect postoperative outcome in patients with chronic discogenic LBP. The SF-36 may be easily and effectively used to measure both preoperative psychosocial distress and postoperative outcome.

KEY WORDS • **lumbar spine** • **discogenic low-back pain** • **36-item Short Form** • **mental component summary** • **physical component summary**

SINCE intervertebral disc fusion was first performed in 1911, spine surgery has increasingly been undertaken.[19] Despite substantial progress, the success of lumbar fusion in patients with chronic discogenic LBP has varied. One source of outcome variance in this group may be the relatively broad, varied indications for fusion surgery. Although general indications for fusion in patients with discogenic LBP may include chronic, incapacitating LBP failing conservative treatment and positive one- to two-level discography,[8] specific indications vary among countries, regions within countries, and even within a single institution.

Psychosocial factors, such as depression, somatization, personality disorders, and employment status, may affect diagnosis, patient selection, and treatment-related outcome. In the treatment of chronic LBP, involvement of these factors may be seriously problematic because the various available diagnostic tools may not unambiguously establish the origin of pain. Whereas provocative discography may be performed to determine pain generators, a self-reported pain response is required.[3] Psychological and emotional factors, secondary gain, and chronic pain are known to contribute to one's overall experience of pain.[4] Pain responses may be amplified, increasing false-positive rates. Postoperative symptoms may be amplified as well, leading to treatment failure. Although it has been suggested in a few reports that psychological factors may negatively affect outcome, the clinical feasibility of eval-

Abbreviations used in this paper: IDET = intradiscal electrothermal therapy; LBP = low-back pain; MCS = mental component summary; PCS = physical component summary; rhBMP-2 = recombinant human bone morphogenetic protein–2; SD = standard deviation; SF-36 = 36-item Short Form.

uating psychological and emotional status in patients with chronic discogenic LBP remains controversial.[9,10,14]

The SF-36 questionnaire was designed to allow for broad health assessment. It has been recommended as a dependent measure for assessing the effect of spine-related problems on quality of life. When used without condition-specific instruments, the SF-36 can reduce respondent burden, redundancy, data collection, and analysis burden.[15] The SF-36 has undergone more extensive development, use, and psychometric research than any other spine-specific scale;[16] however, in no previous study has the SF-36 been used to evaluate the effect of psychosocial distress on outcome after fusion.

We have analyzed outcome data by using the SF-36 questionnaire in cases of suspected chronic discogenic LBP in patients who underwent single-level lumbar fusion. This study was designed to determine if preoperative psychological or emotional status affects clinical improvement rate. We discuss the results of the SF-36 in relation to patients with chronic discogenic LBP.

Clinical Material and Methods

Patient Population

All data were obtained retrospectively from a prospectively collected database. The patients were provided with oral and written information about the treatment. Patients with chronic discogenic LBP consecutively referred from primary care physicians and other clinicians between January 1994 and August 2000 were considered for inclusion. Eligibility criteria included a 6-month or greater duration of unsuccessful conservative treatment, no history of spinal surgery, positive single-level discography with negative adjacent control discs, and pain more pronounced in the back than leg. Failure of conservative treatment was defined as an absence of significant pain intensity improvement despite the provision of various conservative treatments including epidural steroid agent injection. The level included in the fusion was determined preoperatively by independent correlative testing for back pain symptoms—that is, provocative pressure-controlled discography. Symptoms referable to lower-extremity pain were evaluated by making selective foraminal epidural injections. All patients underwent the same surgical procedure including circumferential reconstruction of the lumbar spine via the posterior approach. Surgery included posterior decompression to relieve documented neural compression, interbody arthrodesis at the selected level, placement of posterior segmental spinal instrumentation, and posterolateral fusion. The two surgeons (J.J.L. and T.A.K.) performed all surgeries.

Outcome Measures

Initial-Visit Questionnaire. Data were collected through an initial visit questionnaire administered by a person not associated with the study. Patients answered questions concerning spinal symptoms, demographics, and work, and responded to the standardized SF-36. Most patients completed the entire questionnaire in less than 20 minutes.

The SF-36 Health Status Questionnaire. The functional status of patients was measured using the SF-36 preoperatively (baseline) and at 1 and 2 years postoperatively. Physical functional status conveys how patients perceive their level of physical dysfunction and its effects on their everyday lives. The eight subscales of the SF-36 are general health perceptions, physical function, general mental health, role–function as limited by physical problems, role–function as limited by emotional problems, bodily pain, vitality, and social function. Data generated by these subscales were then used to compute PCS and MCS scores (the equation was provided by the Medical Outcomes Trust[17]).

Data were sorted into the following categories to reflect outcome: excellent, good, fair, same, and worse. A postoperative PCS score increase of 100% or more was categorized as an excellent outcome; between 50 and 99% as good; between 10 and 49% as fair; an increase or decrease of 10% as the same; and a decrement less than 10% as worse. If PCS and MCS scores were greater than 40, outcome, according to US general population data (mean 50 ±10 [SD]) provided by the Medical Outcomes Trust, was defined as normal.

Statistical Analysis

Preoperative and postoperative SF-36 scores were compared using a paired t-test. The correlation between preoperative MCS score and PCS score improvements was analyzed using Pearson correlation and linear regression statistics. All data analysis was performed using SPSS software (Version 10; SPSS, Inc., Chicago, IL) by an independent researcher. Values are presented as the means ± SDs.

Results

Population Characteristics

Data obtained in 57 patients (mean age 42.7 years) who underwent single-level lumbar reconstructive surgery were retrospectively analyzed. Smokers composed 30.8% of the population. The incidence of patients receiving Workers' Compensation or involved in litigation was 64.1%. Of the 57 patients, 47 completed postoperative SF-36 surveys at 1 year and 36 completed the forms at 2 years. No significant perioperative complications were documented and pseudarthrosis did not occur. A postoperative wound infection, which resolved without obvious long-term sequelae, was observed in only one case.

The SF-36 Results

The mean PCS baseline score was significantly low (26.24 ± 7.18, range 13.96–44.26). The mean baseline MCS score was 43.77 ± 12.72. The mean postoperative PCS score increased to 35.72 ± 9.93 at 1 year and to 37.40 ± 10.47 at 2 years. The mean 1-year MCS score was 47.95 ± 13.86, whereas that at 2 years was 46.56 ± 13.33.

The mean scores for the eight SF-36 scales generally increased over time. The greatest increases were seen in the following domains: physical function, role–function as limited by physical problems, bodily pain, vitality, and social function ($p = 0.000$; Table 1).

TABLE 1
*Summary of SF-36 results stratified by domain**

SF-36 Subscale‡	Mean SF-36 Score (SD)† Preop	1-Yr FU	2-Yr FU
physical function			
investigational	27.2 (20.3)	52.0 (24.6)	55.1 (25.5)
normative	84.2 (23.3)		
role–physical			
investigational	1.6 (8.1)	28.7 (40.7)	41.7 (42.7)
normative	81.0 (34)		
bodily pain			
investigational	18.4 (11.4)	48.3 (24.8)	44.5 (25.8)
normative	75.2 (23.7)		
general health perception			
investigational	69.1 (17.0)	64.7 (23.1)	64.5 (22.0)
normative	72.0 (20.3)		
vitality			
investigational	36.6 (21.8)	51.7 (24.8)	48.4 (22.4)
normative	60.9 (21.0)		
social function			
investigational	30.1 (18.9)	56.4 (29.8)	57.5 (32.3)
normative	83.3 (22.7)		
role–emotional			
investigational	50.4 (43.9)	64.5 (43.1)	64.8 (42.9)
normative	81.3 (33.0)		
mental health			
investigational	62.0 (22.8)	67.8 (24.3)	66.1 (23.8)
normative	74.7 (18.1)		

* FU = follow up.
† The number of patients assessed preoperatively, 1 year postoperatively, and 2 years postoperatively were 57, 47, and 36, respectively.
‡ Normative data were reported by Ware, et al., 2002, from a US sample population of 2474 individuals.

Comparison of physical health–related SF-36 subscales (PCS, physical function, physical problems, and bodily pain) based on preoperative MCS scores revealed significant increases in cases in which MCS scores reflected normal status. The mean PCS score obtained in patients in whom the MCS score reflected normal status increased significantly: 13.9 at 1-year and 16.1 at 2-year follow up. In contrast, the PCS score increase in patients in whom the MCS score represented abnormal status was 1.7 at 1-year and 1.8 at 2-year follow up ($p < 0.005$; Fig. 1). Values in other scales showed a great increase in cases in which the MCS score reflected normal status compared with cases in which it reflected abnormal status ($p < 0.05$).

Individual Outcome Based on PCS Score Improvement

At 1 year after surgery, an excellent outcome was demonstrated in 21.3% of patients and a same or worse outcome was documented in 40.4%. At 2 years, an excellent outcome was observed in 16.7% and a same or worse in 30.6% (Table 2).

In 18 (60%) of 30 patients with a normal preoperative MCS score, the 1-year follow-up outcome was an excellent or good; in 15 (60%) of 25 the 2-year outcome was excellent or good. In only 16% of patients with an MCS score–documented normal status was 2-year outcome the same or worse. Only 11.8% of patients in whom MCS scores had reflected abnormal status experienced excellent or good outcomes at 1 year and 18.2% (two of 11) at 2 years. Among patients with preoperative MCS scores indicating abnormal status, the same or worse outcome was documented in 64.4% at 2 years after surgery (Table 3).

Correlation of Preoperative MCS and Postoperative PCS Scores

Preoperative MCS scores correlated directly and significantly with increases in 1- and 2-year PCS scores ($r = 0.584$, $p = 0.000$ and $r = 0.623$, $p = 0.000$, respectively; Fig. 2). These findings support the hypothesis that preoperative psychological or emotional status can significantly affect the rate of clinical improvement.

Using linear regression analysis, the regression coefficient was 3.049 ($p = 0.000$) at 1 year postoperatively. The 95% confidence interval for coefficient changes was approximately 1.776 to 4.323. At 2 years, the regression coefficient was 3.043 ($p = 0.000$) with a 95% confidence interval of 1.711 to 4.374. Based on these data it is possible to generate a regression equation to predict postoperative outcome for candidates undergoing a single-level lumbar fusion based on the preoperative MCS score. The 1-year follow-up equation is PCS improvement rate (%) = 3.049 [preoperative MCS] – 85.752, and the 2-year follow-up equation is PCS improvement rate (%) = 3.043 [preoperative MCS] – 82.144.

For example, given a patient with a preoperative MCS score of 40, the likely 1-year PCS improvement rate would be approximately 36.2% following fusion surgery. The 2-year PCS improvement rate would be approximately 39.6%.

Effect of Smoking, Worker's Compensation, or Litigation on PCS Score

Analysis of the mean baseline PCS scores between smokers and nonsmokers (28.59 and 27.99, respectively) did not yield a significant intergroup difference ($p = 0.815$). The respective intergroup 1-year (38.2 and 32.5, $p = 0.578$) and 2-year (41.07 and 37.34, $p = 0.785$) PCS scores were also not significantly different. Comparison of the mean baseline PCS scores between patients receiving Workers' Compensation or involved in litigation and patients without these factors (27.34 and 30.59, respectively) did not show significant intergroup differences ($p = 0.278$). The respective intergroup 1-year (35.17 and 31.1, $p = 0.292$) and 2-year (39.04 and 35.13, $p = 0.482$) PCS scores were also not significantly different.

Effect of Incomplete Follow-Up Data

To support the validity of these results, we compared the baseline and 1-year follow-up data between patients who completed 1- and 2-year follow-up surveys and patients who did not. No significant differences were found ($p > 0.05$; Table 4).

Discussion

Analysis of the present study's results reveals a direct correlation between preoperative mental health status and physical health improvement in patients with chronic discogenic LBP who will undergo fusion. Although the correlation coefficient was less than 0.7, a high–moderate

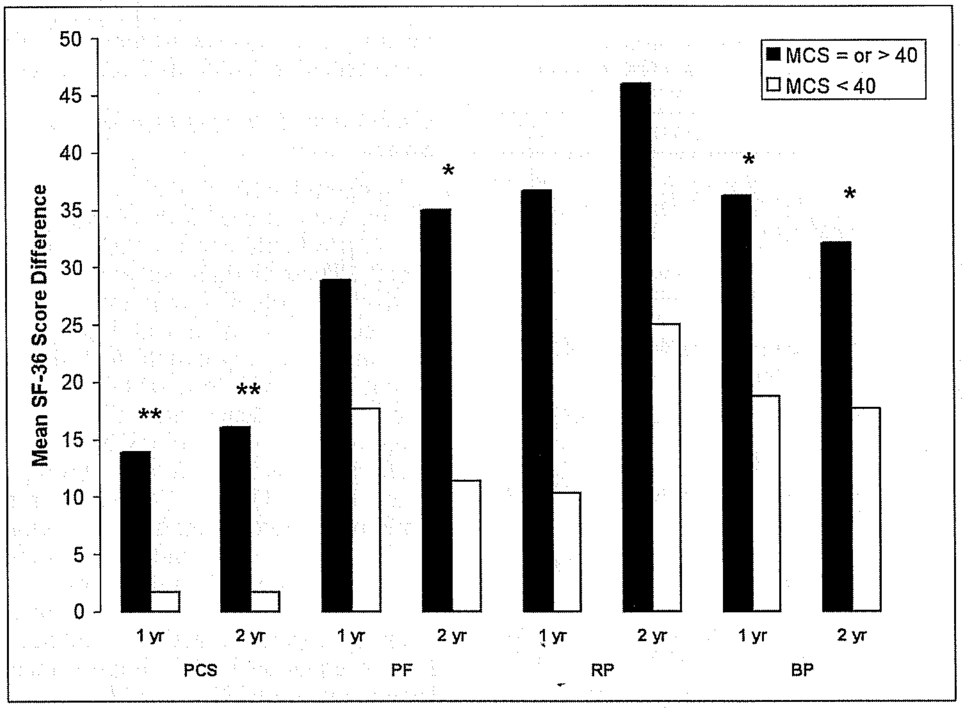

FIG. 1. Bar graph showing differences in mean SF-36 scores when comparing preoperative scores with 1- and 2-year postoperative scores in patients in whom MCS scores reflected normal (≥ 40) and abnormal (< 40) preoperative status. BP = bodily pain; PF = physical functioning; RP = role–physical. * $p < 0.05$; ** $p < 0.005$.

correlation was observed. The regression coefficient values (3.043 and 3.049, respectively) indicate that the PCS scores improved approximately 3% when preoperative MCS scores increased by approximately one point.

Table 3 provides a summary of individual outcomes based on preoperative MCS scores. Patients with MCS scores less than 40 exhibited substantial outcome differences. Among 20 patients with good or excellent 1-year outcomes, an MCS score of less than 40 was observed in only two. Among 19 patients with worse or same outcomes, an MCS score of less than 40 was demonstrated in 12. These results suggest that preoperative mental health may be a strong predictive factor for the outcome of successful lumbar fusion surgery in patients with chronic discogenic LBP.

Psychosocial factors may mediate, modulate, or maintain symptoms (for example, LBP).[4] They may also influence a patient's self-reported improvement after treatment. The influence of these factors may vary over time and depend on situational variables.[6] Growing evidence suggests that psychosocial factors may significantly affect the outcome of various therapies. Numerous psychometric scales (for example, Minnesota Multiphasic Personality Inventory) may predict back surgery outcome;[5,11,14] however, the clinical utility of psychometric testing remains problematic because of the time required and low rates of patient completion. Trief, et al.,[14] evaluated the effect of psychological distress on postoperative outcome; they used numerous tools including the Spielberger Trait Anxiety Inventory, Zung Depression Scale, Modified Somatic Perception Questionnaire, and Cook–Medley Hostility Scale which they administered 1 to 2 weeks before surgery. Analysis of the results suggested that screening for presurgical distress is likely to identify patients at risk of poor outcome. The investigators of the Swedish Lumbar Study Group recently demonstrated that depressive symptoms were not significantly associated with fusion outcome in patients with chronic LBP, although personality traits related to neuroticism were significant predictors of unfavorable outcome after fusion.[10] Although the aforementioned groups showed that psychological distress or personality factors may be associated with fusion outcome, only specific aspects of mental health (that is, personality, anxiety, depression, and hostility) were observed.

TABLE 2

*Summary of 1- and 2-year outcomes**

Outcome	No. of Patients (%) 1-Yr FU	2-Yr FU
worse	8 (17.0)	6 (16.7)
same	11 (23.4)	5 (13.9)
fair	8 (17.0)	8 (22.2)
good	10 (21.3)	6 (16.7)
excellent	10 (21.3)	11 (30.6)

* See text for a definition of outcome categories.

TABLE 3

*Outcomes determined at 1 and 2 years postoperatively stratified MCS score–based status**

	1-Yr FU (%)		2-Yr FU (%)	
Outcome†	Normal MCS (30 cases)	Abnormal MCS (17 cases)	Normal MCS (25 cases)	Abnormal MCS (11 cases)
worse	4 (13.3)	4 (23.5)	1 (4)	5 (45.5)
same	3 (10.0)	8 (47.1)	3 (12)	2 (18.9)
fair	5 (16.7)	3 (17.6)	6 (24)	2 (18.9)
good	9 (30)	1 (5.9)	5 (20)	1 (9.1)
excellent	9 (30)	1 (5.9)	10 (40)	1 (9.1)

* A PCS score greater than 40 was defined as reflecting normal status according to US general population data (mean 50 ± 10) provided by the Medical Outcomes Trust.

† An increase in PCS greater than or equal to 100% over preoperative status was categorized as an excellent outcome, an increment of 50 to 99% as good, an increase to 49% as fair, an increase or decrease of less than 10% as the same, and a decrease of greater than or equal to 10% as worse.

In the present study, we used the SF-36 to assess preoperative psychosocial status and postoperative outcome. The SF-36 survey comprises eight domains representing specific aspects of physical and mental health and two summary scales providing a measure of overall physical and mental health.[16] The two summary scales, PCS and MCS, are adjusted by the population mean and SD to produce normative data based scores in which the common mean is 50 and SD is 10. Scores less than 50 represent a decrement from "normal" health and functioning. The MCS is an aggregate score quantifying how patients perceive psychological or emotional stresses in their daily lives; the PCS is a score quantifying how patients perceive the impact of their condition on physical aspects of their daily lives, a measure of each patient's physical morbidity. This survey has been recommended as a dependent measure for the outcome of spine-related treatments.[15] It can reduce respondent burden, redundancy, and data collection and analysis burdens without missing clinical differences.

Some investigators have reported variable results when using the SF-36 for chronic discogenic pain. In a randomized, placebo-controlled trial study of IDET for discogenic LBP, bodily pain and physical functioning showed increments of 17 (an increase from 36–53) and 15 (an increase from 56–71), respectively;[13] however, these results were not significantly different from those obtained in a sham group. We observed significant improvements in the scores obtained in our patients, such as a 29.9 increment for bodily pain (from 18.4–48.3) and 24.8 increment for physical functioning (from 27.2–52). Although direct comparison with the IDET study is impossible, analysis of our results demonstrates a higher increment of SF-36 survey scores than that for IDET when treating chronic discogenic LBP. In other studies of fusion outcome authors have reported similar results.[1,2] In an efficacy study comparing the use of rhBMP-2 and autogenous iliac crest bone graft after single-level lumbar interbody fusion, mean PCS scores increased approximately 15 (from 30–45) and 10 at the 2-year follow-up evaluation, respectively.[2] The mean increase in the PCS score (+ 11.7) for the entire patient population enrolled in our study is comparable with the aforementioned result when we consider the high rate of Workers' Compensation (64.1% compared with 21% in the rhBMP-2–treated group) and nonstrict participants selection for good outcome (no criteria compared with an Oswestry Disability Index score > 35 in the rhBMP-2–treated group) in our study group. The authors of a study of fusion outcome in adult patients with isthmic spondylolisthesis[12] showed a greater than 30-point improvement in physical function, role physical, and bodily pain at the 2-year follow-up examination. We observed similar improvement in our cases: increases of 27.8 for physical function, 39.6 for physical problems, and 27.7 for bodily pain at

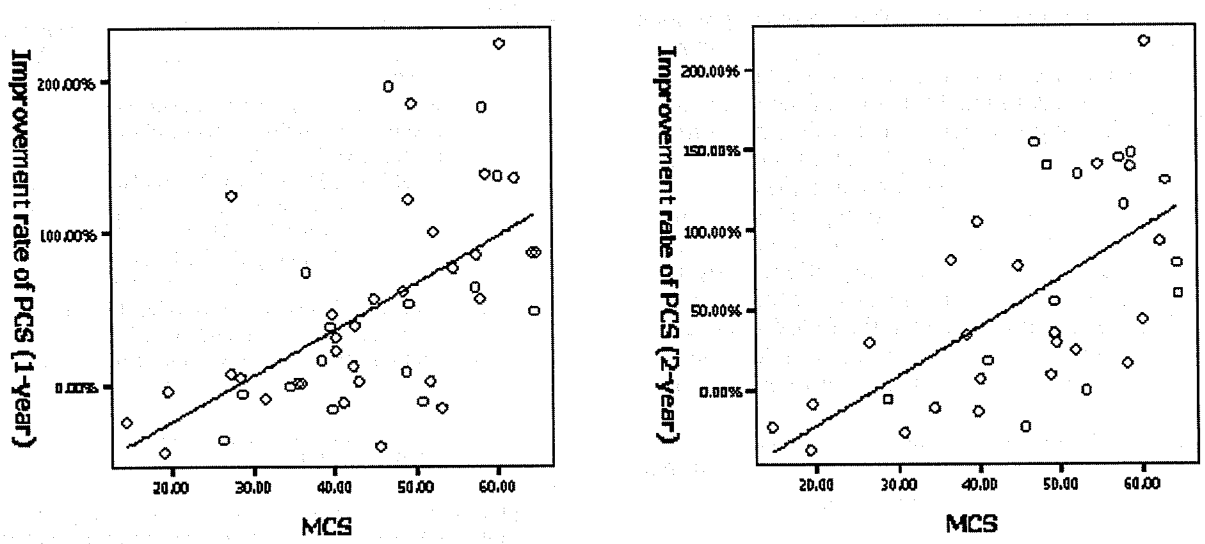

FIG. 2. Scatterplots showing 1-year *(left)* and 2-year *(right)* PCS score improvement rate as a function of preoperative MCS score. Preoperative MCS scores correlated directly and significantly with the PCS score improvement rate at 1- and 2-year follow up.

TABLE 4

*Comparison of previous mean MCS and PCS scores in patients completing and not completing follow up**

SF-36 Item	Basal MCS & PCS Score (57)			1-Yr MCS & PCS Score (47)		
	1-Yr FU (47)	No 1-Yr FU (10)	p Value	2-Yr FU (36)	No 2-Yr FU (11)	p Value
PCS	26.24 ± 7.34	27.71 ± 6.51	0.578	36.6 ± 10.66	33.65 ± 12.96	0.359
MCS	44.33 ± 12.85	40.80 ± 12.31	0.451	48.70 ± 14.34	46.15 ± 12.95	0.570

* Values in parentheses indicate the numbers of patients. Tabular data are presented as the means ± SDs. Statistical analysis was performed using the independent t-test.

2 years postoperatively. In the isthmic spondylolisthesis outcome study we might expect more dramatic improvement, because all cases involved a single clearly defined disease; however, the outcome results were similar. In addition, we found a substantial increase in physical health–related scores (16.1 for PCS, 35 for physical function, 46 for physical problems, and 32.1 for bodily pain) in patients in whom MCS scores reflected normal status (Fig. 1). Comparison with values reported in the literature supports that our results are comparable with those of other studies and that preoperative mental health can significantly affect clinical outcome of patients undergoing fusion surgery.

Although the use of a single scale has several advantages, it can be seen as a limitation of this study. Analysis that included several psychiatric scales might permit additional insights; however, the MCS correlates highly with the mental health, role–emotional, and social functioning scales of the SF-36.[16] The MCS measure has been shown to be useful in screening for psychiatric disorders, and it correlates highly with anxiety and depression scales.[7,17] Ware, et al.,[17] showed that the MCS had a sensitivity of 74% and a specificity of 81% for detecting patients in whom a depressive disorder was diagnosed. Another possible shortcoming of the present study involves the interrelation between PCS and MCS scores. Because both scores arė computed using the same eight scales, the scores can influence to each other. The authors of previous studies, however, have validated that changes in physical and mental health were reflected in PCS and MCS scores, respectively.[18] One additional limitation of our study is the incomplete follow-up data and a relatively small sample size. Although patients enrolled in the study were tracked, some patients were unavailable after a period of 1 or 2 years to complete the final follow-up requirements. These missing data, however, corresponded to a random loss of data points and did not systematically affect study outcome. Comparison of baseline and 1-year follow-up data obtained in patients who completed the follow-up interval with those obtained in patients did not complete the follow-up interval showed no significant differences (Table 4). Because of the relatively small sample size, however, the suggested formula for predicting postoperative outcome may not be completely generalizable, and further study involving a larger population is required.

Conclusions

Psychological and emotional distress negatively affected fusion surgery outcome in patients with chronic discogenic LBP. Low MCS scores may indicate the need for more extensive assessment, and psychological intervention before surgery may be warranted. The SF-36 can be easily and effectively used as a dependent measure tool for preoperative psychosocial distress and as a predictive tool for postoperative outcome.

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