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REVIEW ARTICLES

Pretreatment Psychosocial Variables as Predictors of Outcomes Following Lumbar Surgery and Spinal Cord Stimulation: A Systematic Review and Literature Synthesis

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ABSTRACT

Background. In the multimodal treatment approach to chronic back pain, interventional back procedures are often reserved for those who do not improve after more conservative management. Psychological screening prior to lumbar surgery or spinal cord stimulation (SCS) has been widely recommended to help identify suitable candidates and to predict possible complications or poor outcome from treatment. However, it remains unclear which, if any, variables are most predictive of pain-related treatment outcomes.

Objective. The intent of this article is to perform a systematic review to examine the relationship between presurgical predictor variables and treatment outcomes, to review the existing evidence for the benefit of psychological screening prior to lumbar surgery or SCS, and to make treatment recommendations for the use of psychological screening.

Results. Out of 753 study titles, 25 studies were identified, of which none were randomized controlled trials and only four SCS studies met inclusion criteria. The methodological quality of the studies varied and some important shortcomings were identified. A positive relationship was found between one or more psychological factors and poor treatment outcome in 92.0% of the studies reviewed. In particular, presurgical somatization, depression, anxiety, and poor coping were most useful in helping to predict poor response (i.e., less treatment-related benefit) to lumbar surgery and SCS. Older age and longer pain duration were also predictive of poorer outcome in some studies, while pretreatment physical findings, activity interference, and presurgical pain intensity were minimally predictive.

Conclusions. At present, while there is insufficient empirical evidence that psychological screening before surgery or device implantation helps to improve treatment outcomes, the current literature suggests that psychological factors such as somatization, depression, anxiety, and poor coping, are important predictors of poor outcome. More research is needed to show if early identification and treatment of these factors through psychological screening will enhance treatment outcome.

Key Words. Psychological Variables; Lumbar Surgery; Spinal Cord Stimulation; Outcome; Review

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Introduction

Chronic pain is a widespread, costly condition that in"uences every aspect of normal functioning [1 4]; collectively, pain imposes a greater

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economic burden than any other disease, with estimates of annual costs near $100 billion [5 8]. Among the most prevalent and disabling of chronic pain syndromes is low back pain [9,10], which affects nearly 60 million Americans [11], and which accounts for a significant portion of pain-related disability in the Unites States [9,10]. While the majority who experience acute low back pain will benefit from a multimodal treatment approach and recover without need for surgery, recent estimates suggest that annual U.S. rates of interventional techniques for chronic spinal pain are in the range of 15 million, with hundreds of thousands of lumbar surgeries performed each year in the United States [10,12].

Implantation of a spinal cord stimulator is substantially less common than spinal surgery, and can often be indicated after a failed back surgery, yet its applications are rapidly expanding for those who do not benefit from more conservative management [13]. At present, roughly 20,000 spinal cord stimulators are implanted annually [14,15], with some recent research documenting their efficacy and cost-effectiveness in managing pain syndromes such as chronic low back pain [16,17]. Although studies suggest that roughly half of patients receive substantial benefits from spinal cord stimulation (SCS) treatment [13], outcome research to identify predictive variables remains in its infancy.

These findings suggest that lumbar surgery and SCS for chronic back pain are prevalent and growing interventional techniques, particularly for those who fail less invasive treatments. Given the significant inter-patient variability in treatment outcomes, it would be of tremendous value, from both a societal and patient perspective, to identify in advance who is most and least likely to benefit from such interventions. The identification of such predictors would have important potential implications for patient selection, for the information provided to patients as they choose among various treatment options, and for the design and evaluation of adjunctive interventions for patients considered at higher risk for failure.

In general, some risk factors have been identified that correlate with greater risk for pain or poor outcomes from treatment for pain. These include variables such as pain chronicity, psychological distress, a history of abuse or trauma, poor social support, and significant cognitive deficits [18 21]. In particular, psychopathology and/or extreme emotionality have been seen as contraindications for certain therapies [22 24]. Outcome studies highlight the poor response of patients with psychiatric co-morbidity (which is quite prevalent in the context of chronic pain) [25,26] to many treatments [27 30]. For example, spinal pain patients with both anxiety and depression have a 62% worse return-to-work rate than those with no psychopathology [19]. Similarly, cognitive processes such as maladaptive beliefs and pessimistic expectations are associated with poorer functional outcomes among chronic low back pain patients [31]. In one of the first reports on the use of psychological testing in predicting success from chymopapain injection therapy [27], it was found that two scales (Hysteria and Hypochondriasis) from the Minnesota Multiphasic Personality Inventory (MMPI) could predict who would benefit from treatment for low back pain. Since its publication in 1975, there have been several studies that have published similar results [18,19].

Overall, numerous factors are likely to play a role in shaping back pain outcomes following surgical interventions. However, there does not seem to be a consensus on what factors are the strongest and most consistently predictive of outcomes, and there is certainly no accepted gold standard approach for screening surgical candidates, although a presurgical psychological evaluation is often recommended. The aim of this article is to carry out a systematic review of the current literature, using critical appraisal and strategies to limit bias, to assess the strength of the evidence for the assumption that psychological variables are important predictors of pain-related and functional outcomes from lumbar surgery or SCS, and to identify which psychological factors are most likely to be predictive of outcomes.

Methods

Data Sources

We searched electronic databases including PubMed (1966 2008), The Cochrane Library, EMBASE (1974 2008), PsycINFO (EBSCOhost) (1872 2008), and Science Citation Index Expanded (ISI Web of Science) (1945 2008). All searches were performed up to August 1, 2008. To ensure that we did not exclude any relevant studies, we adopted a sensitive search strategy using the following combination of keywords: SCS *and* outcomes, spinal cord stimulator *and* outcomes, SCS *and* screen, spinal cord stimulator and screen, lumbar surgery *and* outcomes, spine surgery *and* outcomes, lumbar surgery

and screen, spine surgery *and* screen, psychological *and* SCS, psychological *and* spinal cord stimulator, psychological *and* spine surgery, psychological *and* lumbar surgery, SCS *and* predict, spinal cord stimulator *and* predict, lumbar surgery *and* predict, spinal surgery *and* predict, SCS *and* risk factor, spinal cord stimulator *and* risk factor, lumbar surgery *and* risk factor, and spinal surgery *and* risk factor. Relevant articles were also identified by manual search of references from retrieved articles and available files.

Selection of Studies

Inclusion Criteria

The titles and abstracts of potentially relevant articles were screened and were included if they addressed psychological assessment and outcome from lumbar surgery or SCS. The final selection of studies was based on the following inclusion criteria: 1) the study used a prospective design; 2) the aim of the study was to identify pretreatment variables to predict treatment outcome; 3) the publication was a full report; 4) the subjects all had back pain as their primary complaint; 5) the subjects had undergone lumbar spine surgery (e.g., discectomy, laminectomy, and fusion) or implantation of a spinal cord stimulator; 6) follow-up after treatment was 3 weeks or longer; and 7) there was adequate description of the study design. An additional inclusion criterion for the SCS studies was that the patients received permanent implants after a trial of stimulation.

Exclusion Criteria

Studies were excluded if 1) specific predictors for the outcome after spine surgery or spinal cord stimulator implantation were not statistically tested; 2) articles were not translated into English; 3) the articles were redundant (i.e., report of identical data); or 4) the articles were letters or descriptive summaries from conference proceedings. In order to avoid missing relevant articles, the references of all selected articles were screened for additional potentially eligible publications.

Because the studies reviewed were clinically heterogeneous in terms of treatment, prognostic factors, and outcome measures, use of formal meta-analytic methods was not possible. Therefore, this is a synthesis of relevant published research integrating the available published literature. To ensure the basic methodological quality of the studies, a predetermined selection criterion was used. Also, in order to make some determination about both the prevalence of a variable and a variable s potential predictive value, we assessed the frequency with which a variable was measured in different studies, and whether a significant association between this variable and outcome was established. Although not an optimal index of predictive power, this strategy allowed for a general assessment of a variable s likely importance as a potential vulnerability for poor outcomes.

Data Extraction and Management

Each citation was reviewed to determine whether it might meet our criteria for inclusion in the review. If so, two of the authors independently read the entire article to make a final inclusion decision. All disagreements between reviewers were subsequently discussed during a consensus meeting. The quality and design of included studies was independently assessed by the reviewers in consideration of factors important for a systematic review [32]. We classified the methodological strength of each study using a scheme previously used by other reviewers [33]. The design of the studies were rated as follows: 1) prospective, randomized controlled trials (RCTs); 2) nonrandomized comparative studies with standardized measures, inclusion/exclusion criteria and follow-up; 3) uncontrolled before-after studies with follow-up; and 4) descriptive time-series studies.

Predictor variables were examined for psychometric properties and statistical significance (*P* value, correlations) described in the text. Preoperative predictor variables were grouped into categories labeled 1) PAIN, 2) PSYCH, 3) FUNCTION, and 4) OTHER. PAIN predictors included pain intensity (least, worst, average, now), pain descriptors, and pain location (pain drawings). PSYCH predictors consisted of fear of pain, pain coping, depression, anxiety, hypochondriasis, and somatization, as measured on preoperative questionnaires and scales. FUNCTION predictor variables included activity interference, level of activity, strength measures, disability, and exercise level. OTHER predictors included demographic information (e.g., age, gender), physical examination findings, pain duration, worker s compensation status, previous surgery, cigarette smoking, job satisfaction, litigation, and abuse history.

Data Synthesis

To compare the results of the studies, we collectively analyzed the pretreatment predictors for

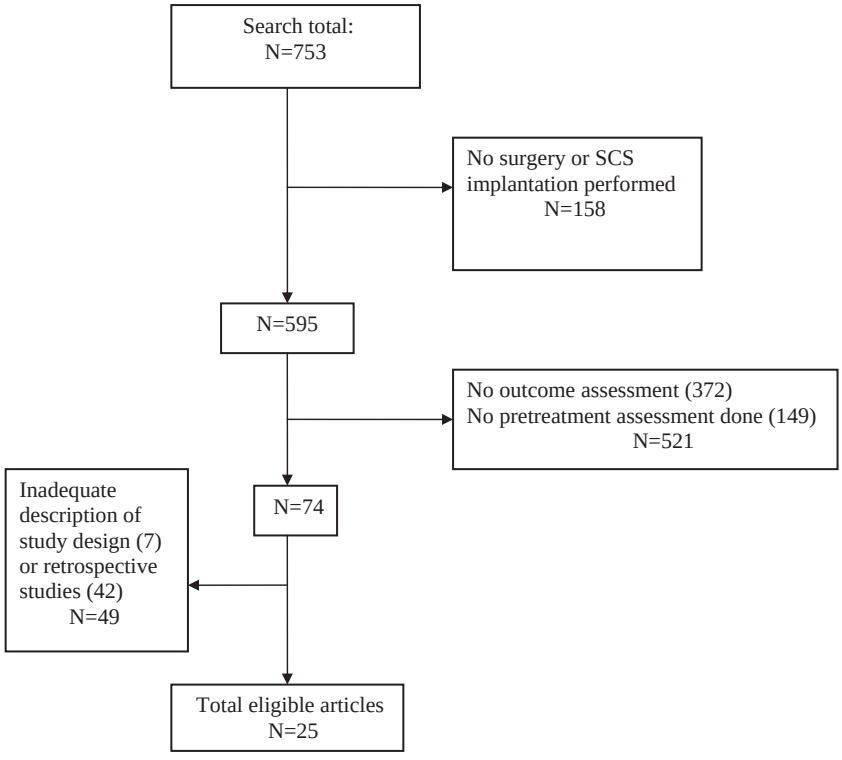

Figure 1 Screening process for articles found in systematic review.

all outcomes (PAIN, PSYCH, FUNCTION, OTHER). Then, we separately examined the degree to which the pretreatment variables were able to predict different outcomes. Because numerous scales were used, results of specific variables were only included in the summary if the authors of the studies used the same name of the construct being assessed (e.g., depression). When more than one outcome assessment was performed, data from the final assessment period was used. Finally, in order to compare the results of studies by intervention (SCS vs lumbar surgery), we used the above categorization scheme to separately analyze the studies that assessed SCS implantation and studies that assessed various lumbar surgeries.

Results

The search strategy identified 753 study titles, of which 158 were omitted because they were not related to either spinal surgery or SCS. An additional 372 articles were omitted because they were either not full articles (e.g., abstracts of meetings), did not assess treatment outcome, or were redundant (the same data had been presented more than once). Also, 149 articles were excluded because they did not employ any type of pretreatment standardized assessment. Of the remaining 75 articles, 49 were omitted because they were not prospective studies or they lacked adequate description of the study design. Thus, most studies were eliminated from the review because they were not prospective outcome-based studies, no surgery or SCS implantation was performed, or no valid and reliable pretreatment assessment was conducted. A diagram of the study exclusion process is presented in Figure 1. The included studies were independently read in full by at least two reviewers in order to resolve the eligibility criteria. A total of 25 studies met the inclusion criteria for review. There was no disagreement among the authors about the ratings of the methodological strength of the studies. Of the 25 articles reviewed, none of the studies were RCTs and none met all of the quality criteria. The topic of this review, however, unlike an intervention or drug study, was mostly concerned with prospective comparison trials in order to establish the relationship between pre-intervention factors that would likely predict post-intervention outcome. Twelve studies analyzed the outcome using multivariate regression analyses, while 14 studies performed univariate analyses. In general, successful outcome was defined as decreased pain, increased function, return to work, and reduced medical treatment.

Lumbar Surgery

A summary of 21 studies for low back surgery, listed alphabetically by author, including number of subjects, patient diagnoses, type of treatment, baseline measures, outcome measures, length of follow-up, study design, and additional study information, is presented in Table 1. Most studies (13/21) included more than 100 patients. All studies except two [34,36] followed patients for up to 6 months, with 13 studies including patients who had received follow-up evaluation 1 year or more after treatment. In addition, six studies had more than one follow-up assessment. One study did not give information on length of follow-up [37].

An overview of the predictors for all outcome measures for lumbar surgeries is presented in Table 2. The level of evidence for these categories in predicting outcome is also presented (+ = positive relationship, ± = mixed relationship; − = no relationship; 0 = not examined). When considering all studies combined, preoperative pain ratings predicted outcome in only a half of the studies where they was assessed (7/14). In general, higher pain intensity tended to be related to poorer outcome, while multiple pain locations correlated with poorer outcome in two of six studies (33.3%) where it was assessed. In those studies, when significance was reached between baseline variables and outcome, greater pain intensity and more pain locations were related to poorer outcome. In the PSYCH category, a positive relationship was found between general psychological factors and poorer outcome in 14 of 21 studies where it was measured (70.0%) and mixed findings in four other studies. When specifically assessed, higher levels of depression predicted poorer outcome in 13 of 16 studies (81.3%), while higher levels of anxiety predicted poorer outcomes in seven of eight studies (87.5%). Somatization and hypochondriasis predicted poor outcome in six of six studies (100.0%) and poor coping was also related to poor outcome in three of three studies (100.0%) in which it was assessed. Even with different assessment measures, the majority of the studies that attempted to evaluate the impact of depression, anxiety, somatization, and coping found that these pretreatment variables positively predicted poorer outcomes.

In the FUNCTION category, 7 of 14 studies (50.0%) in which self-reported activity interference and disability at baseline was assessed reported a significant relationship with treatment outcome. In the minority of studies in which a significant relationship was found, greater pretreatment disability predicted poor outcome. In the OTHER category, most studies found mixed results in predicting demographic information with outcome (8/14) when this data was assessed. Older age was found to be predictive of poorer outcome in four of seven studies (57.1%) while in two of four studies, being female was found to be a poorer predictor of outcome. In five studies (100%), pain duration was also negatively associated with outcome in agreement with past reports [38,39]. No other variables from the OTHER category were consistently found to predict treatment outcome.

SCS

A summary of four studies for SCS, listed alphabetically by author, including number of subjects, patient diagnoses, baseline measures, outcome measures, length of follow-up, study design, and additional study information, is presented in Table 3. No study included more than 100 patients. All studies followed patients for ≥6 months, with two studies including patients who had received follow-up evaluation 1 year or more after treatment.

In the four studies reviewed examining the benefit of SCS, psychological factors were most predictive of treatment outcome (3/4), while pain (0/2) and disability (0/1) were not found to be predictive of outcome (Table 4). Age was found to be predictive of outcome in two studies, with older patients doing less well than younger patients. In general, our findings seem to suggest that psychological factors are particularly important in predicting outcome in SCS implantation, perhaps more so than for other interventional spinal procedures and surgeries. However, in one of the studies, psychological factors were only useful in predicting a successful temporary SCS implantation trial, but did not show any effect in determining long-term outcomes once the SCS were left in place [40]. In addition, with so few outcome studies available in the literature examining the benefit of SCS, a review of available study results are difficult to evaluate. Yet, the current review is different from and expands on previous reviews in that it attempts to include specific inclusion and exclusion study criteria to review the role of psychosocial factors in determining outcomes in SCS implantations.

Table 1 Description of outcome studies for low back surgery

Study†	N	Diagnosis	Surgery Type	Baseline Measures	Outcome measures	Follow-up	Study Type	Study Information
[41]	566	CLBP	Fusion	DPQ, DEMO	DPQ, DRAM	1 year+	III	Patients classified as 1) slight disability, 2) intermediate disability, 3) major disability, 4) major disability and emotional distress. Low disability = collapsed groups 1 and 2, high disability = collapses groups 3 and 4. Incomplete responders omitted.
[42]	73	Disc herniation	DISC	VAS, ZDS, DEMO, phys exam findings	VAS	3 and 12 months	III	Focused on role of pain and depression in predicting unfavorable outcome from surgery
[43]	204	CLBP	LAM/DISC, fusion	VAS, MMPI, ODI, worker's comp status	ODI,VAS	6 months	III	Subjects grouped as high/low med and psych risk based on specific indicators with classification of good, fair, or poor prognosis.
[34]	182	CLBP	DISC	VAS, TKS-AV, PCI, NOE, RDQ, DEMO, medications	RDQ, VAS	6 weeks to 6 months	III	Prospective cohort study examining a number preoperative and postop descriptive and cognitive factors as predictors of long-term disability and pain.
[44]	116	CLBP secondary to industrial injury	DISC, and fusion	MPQ, Pain drawing, MMPI, DEMO	Orthopedic surgeon interview and work status	12 months	II	Surgery vs no surgery; Grouped as poor, fair, moderate, and good outcome by surgeon
[45]	275	Sciatica	DISC	SF-36, RDQ, worker's comp status	SF-36, RDQ	Up to 3 years	III	Prospective study of outcomes following surgical and nonsurgical treatment of sciatica
[46]	48	Herniated lumbar disk	DISC	CSQ, BDI, DMQ	Frequent MD visits, opioid usage, inability to return to work	6 months	III	Subjects classified into 2 groups: 1) Good outcomes (<3 outcome criteria) and 2) Bad outcomes (meeting all three outcome criteria)
[47]	122	Lumbar herniated disk	DISC	VAS, HADS, MSPQ, phys exam findings, ODI, COS, DEMO	Repeat surg, satisfaction of surg, return to work	1 year and 7 years	III	Clinical Overall Score determined by repeat tests and interview with study author
[36]	50	herniated disk	LAM/DISC	VAS, CSQ, STAI, sleep	VAS, activity level, anxiety/depression, meds, surgical outcome	Range of 22–69 days after discharge	III	Ss were interviewed 5 days after surgery and about 6 weeks after discharge. The study controlled for presurgery pain. Data were analyzed using regression analyses
[48]	264	CLBP	Fusion w/ or w/out instrument-Ation	VAS, ZDS, SCID, KSP, ODI, GFS, DEMO, exam findings	VAS, ODI, GFS, ZDS, return to work	2 years	I	Randomized to lumbar fusion (with or without instrumentation) or nonsurgical control as part of the Swedish Lumbar Spine Study. Ss with psychiatric illness and previous spine surgery were excluded. Patients grouped into 1) much better, 2) better, 3) unchanged, 4) worse.
[49]	69	CLBP and lower extremity pain	LAM, DISC, LAM w/ fusion	Pain drawings, MMPI, DEMO	Pain drawing, MMPI, return to work, pain	1–11 years	III	Collected pre and post-op MMPIs. Outcome ratings of good, fair, and poor.

[50]	54	CLBP	DISC	ZDS, MSPQ, DRAM, ODI	ODI, ZDS, MSPQ	6 months	III	Subjects were grouped preoperatively as 1) no psych disturbance, 2) at risk, or 3) distressed.
[51]	220	Disk herniation	DISC	Pain Index, SCL-90, ADL index, DEMO, sick leave	Pain Index, Activities of Daily Living	1 and 6 months	III	Patient evaluations were used to classify into 1) much better, 2) better, 3) no change, or 4) worse outcome
[52]	381	CLBP	DISC	VAS, BDI, HMQ, DEMO	VAS, return to work, MD/hosp visits	6 and 12 months	III	Ss classified as good, moderate, and bad outcome based on pain rating, return to work, and healthcare visits.
[53]	46	CLBP	DISC	VAS, MPQ, BDI, RDQ, MRI findings, DEMO	VAS, RDQ, return to work, pain meds	2 years	III	Included subjects who were employed at time of surgery who failed other treatments. Study controlled for preoperative pain and disability and used multiple regression analyses.
[54]	57	CLBP—herniated disk	DISC	MMPI	VAS, health status, work status	Mailed questionnaires at 6 and 24 months	III	Subject reported health status of very good, fair, or bad. Poor outcome based on >5 VAS, bad health status, and not working. Correlated MMPI scales with outcome.
[55]	130	CLBP	Lumbar decompression surgery	PVQ, work status	Post-op interviews of pain: absent, less, unchange, worse	6 months	III	Patients grouped based on high/low psychological vulnerability.
[56]	102	CLBP	Fusion, LAM	STAI, DRAM, ZDS, CMHS, DPQ, litigation and work status	DPQ, work status, pain questions	6 and 12 months	III	Patients were classified based on follow-up pain rated as worse, a little worse, same, a little better, much better
[57]	106	CLBP	LAM	PAI, MMPI	Interviewed for pain, return to work, med use and, activity restriction	12 months	III	The Pain Assessment Index was derived from the MMPI. Ss categorized as having good, fair, poor outcome by surgeon.
[58]	53	CLBP	Fusion	VAS, NPL, ODI	VAS, ODI	12 months	III	Subjects categorized as organic, uncertain, or psychogenic based on a psychogenic back pain test.
[37]	110	CLBP	Decompression	VAS, MPQ, Pain drawings, litigation status	VAS,	NR	III	Outcome determined based on change in VAS, surgeon's rating, and pt classifications of level of work and pain. Patients grouped as good/excellent or fair/poor.

† First author and year.

ADL = activities of daily living; BDI = Beck Depression Inventory; CLBP = chronic low back pain; CMHS = Cook-Medley Hostility Scale; COS = Clinical Overall Score; CPI = California Personality Inventory; CSQ = Coping Strategies Questionnaire; DABS = Derogatis Affects Balance Scale; DEMO = demographic information; DISC = disectomy; DPQ = Dallas Pain Questionnaire; DRAM = Distress and Risk Assessment Method; GFS = General Function Score; HADS = Hospital Anxiety and Depression Scale; HMQ; Hannover Mobility Questionnaire; KSP = Karolinska Scales of Personality; LAM = laminectomy; MMPI = Minnesota Multiphasic Personality Inventory; MPQ = McGill Pain Questionnaire; MSPQ = Modified Somatic Perception Questionnaire; NR = Not reported; NOE = Negative Outcome Expectancies; NPL = Dutch version of psychogenic back pain scale; ODI = Oswestry Disability Index; PAI = Personality Assessment Index (derived from MMPI); PCI = Pain Coping Inventory; PVQ = Psychological Vulnerability Questionnaire; RDQ = Roland Disability Questionnaire; SCID = Structured Clinical Interview for DSM-III-R; SCL-90 = Symptom Checklist 90; SCS = spinal cord stimulation; SF-36 = Short Form Health Survey; SIP = Sickness Impact Profile; STAI = State Trait Anxiety Inventory; TKS-AV = Tampa Scale of Kinesiophobia; VAS = visual analog scale; ZDS = Zung Depression Scale.

Table 2 Comparison of baseline measures of pain (PAIN), mood (PSYCH), disability/function (FUNCTION), and demographic variables (OTHER) with outcome from lumbar surgery

Study†	Baseline Pain Measrues	Pain Predictors	Baseline Psych Measures	Psych Predictors	Baseline Function Measures	Fuction Predictors	Baseline Other Measures	Other Predictors	Outcome Summary
[41]	NR	0	DPQ—anxiety/ depression	+	DPQ—activity interfere.	–	Age, gender, work status, pain duration	±	Patients classified as distressed pre-op had higher disability post-op.
[42]	0–10 VAS	+	ZDS	+	NR	0	Age, gender, level of disc hern.	–	Depression predicted poor outcome from surgery
[43]	0–10 VAS	–	MMPI, Poor coping	+	ODI	+	Worker's comp, heavy job, abuse history, previous surgeries	±	Psychological risk factors were significantly related to poor outcome
[34]	VAS	+	TKS-AV, PCI, NOE	+	RDQ	+	Age, lower education, pain meds	±	Fear of movement, passive coping, and negative outcome expectances correlated most with poor outcome.
[44]	MPQ, Pain drawings	±	MMPI	±	Hendler Screening Test	+	Older age, lower edu, nonEnglish speaking	±	Poor outcomes were predicted by hypochondriasis, lack of proficiency in English, and older age
[45]	SF-36 pain	+	SF-36 mental health	+	RDQ, SF-36 physical function	+	Worker's comp	–	Greater pain and disability over time were predicted by worse mood, and greater previous pain and disability
[46]	NR	0	CSQ, BDI, DMQ	±	NR	0	NR	0	Poor outcome Ss used defense mechanisms and had poor coping. Depression was not predictive of outcome.
[47]	0–100 VAS	–	HADS, MSPQ	+	Phys exam, ODI, COS	–	Gender, meds, weight, smoking, older age	±	Preoperative psychological distress and being female correlated with poor outcome after 7 years.
[36]	VAS	+	CSQ, STAI	±	Activity interfere, Sleep disturb	+	NR	0	High self-reliance, loss of control, and active coping predicted less post-op pain.
[48]	VAS	–	ZDS, SCID, KSP	+	ODI,GFS	–	Socio-demographics, clinical findings	–	No differences in pain or disability between surg vs no surg.; neurotic personality related to unfavorable surgery outcome
[49]	Pain drawing	–	MMPI	+	NR	0	Longer pain duration, unemployed, age, gender, obesity	±	Hypochondriasis and Hysteria were modestly predictive of outcome.

[50]	NR	0	ZDS, MSPQ, DRAM	–	ODI	–	NR	0	Preoperative psychological disturbance was unrelated to surgery outcome
[51]	Pain Index yes/no questions	–	SCL-90	+	ADL Index; “no difficulty” to “does not manage”	–	Age, pain duration, sick leave		Somatic nonspecific symptoms correlated with poor outcome.
[52]	0–10 VAS number of pain locations	–	BDI	+	HMQ	+	Lower edu, pain duration	+	Weak relationship between depression/ psychological factors and outcome.
[53]	0–100 VAS, MPQ	–	BDI, Psych well-being	+	RDQ	–	MRI findings, job satisfaction, phys exam, soc. support	±	Return to work was best predicted by depression and occupational stress. Social support by the spouse had a sign. negative influence on outcome.
[54]	NR	0	MMPI	+	NR	0	NR	0	High MMPI subscales predict poor outcome with Hysteria most predictive.
[55]	NR	0	PVQ	+	NR	0	Work status	–	Psychological impairment and neurotic symptoms predicted poor outcome.
[56]	NR	0	STAI, DRAM, ZDS, CMHS	±	DPQ	–	Pain duration, litigation, presurg work status	±	Anxiety, depression and presurgical distress predicted poor outcome. Hostility was unrelated to outcome.
[57]	NR	0	PAI, MMPI	±	NR	0	NR	0	MMPI Hypochondriasis scale was best at predicting poor surgical outcome.
[58]	VAS	+	Psychogenic back pain test—NPL	+	ODI	+	NR	0	Psychological distress and psychogenic pain is related to poor outcome.
[37]	VAS, MPQ, Pain drawings	+	Prolo—mood	–	Prolo-work status	–	Litigation	–	Neither psychiatric factors nor litigation predicted outcome. High MPQ ratings were negatively associated with outcome.

† First author and year.
+ = positive evidence; – = no evidence; ± = mixed evidence; 0 = not examined.
ADL = activities of daily living; BDI = Beck Depression Inventory; CLBP = chronic low back pain; CMHS = Cook-Medley Hostility Scale; COS = Clinical Overall Score; CPI = California Personality Inventory; CSQ = Coping Strategies Questionnaire; DABS = Derogatis Affects Balance Scale; DEMO = demographic information; DISC = disectomy; DPQ = Dallas Pain Questionnaire; DRAM = Distress and Risk Assessment Method; GFS = General Function Score; HADS = Hospital Anxiety and Depression Scale; HMQ = Hannover Mobility Questionnaire; KSP = Karolinska Scales of Personality; LAM = laminectomy; MMPI = Minnesota Multiphasic Personality Inventory; MPQ = McGill Pain Questionnaire; MSPQ = Modified Somatic Perception Questionnaire; NR = Not reported; NOE = Negative Outcome Expectancies; NPL = Dutch version of psychogenic back pain scale; ODI = Oswestry Disability Index; PAI = Personality Assessment Index (derived from MMPI); PCI = Pain Coping Inventory; PVQ = Psychological Vulnerability Questionnaire; RDQ = Roland Disability Questionnaire; SCID = Structured Clinical Interview for DSM-III-R; SCL-90 = Symptom Checklist 90; SCS = spinal cord stimulation; SF-36 = Short Form Health Survey; SIP = Sickness Impact Profile; STAI = State Trait Anxiety Inventory; TKS-AV,Tampa Scale of Kinesiophobia; VAS = visual analog scale; ZDS = Zung Depression Scale.

Table 3 Description of outcome studies for spinal cord stimulation (SCS)

Study†	N	Diagnosis	Baseline Measures	Outcome Measures	Follow-Up	Study Type	Study Information
[35]	40	CLBP/or leg pain	VAS, MPQ, MMPI, ODI, worker's comp status, DEMO	% pain relief, change in VAS	3–6 months	III	88% of outcomes correctly predicted by age, depression, and MPQ scores
[59]	40	Failed back	24 psycho-dynamic items	Nurse evaluation	6 months	IV	Evaluated relation between 24-item "psychogenic functioning" measure and 6-month outcome
[60]	30	Mixed	MPQ, CPI	Satisfaction with pain relief	Up to 7 years	IV	At long-term follow-up, 73% of SCS patients were satisfied with their degree of pain relief
[40]	58	CLBP	DABS, MMPI, age, phys exam	Successful trial,long-term pain relief	2 years	III	Ss screened out for psych issues

† First author and year.
CLBP = chronic low back pain; CPI = California Personality Inventory; DABS = Derogatis Affects Balance Scale; DEMO = demographic information; MMPI = Minnesota Multiphasic Personality Inventory; MPQ = McGill Pain Questionnaire; ODI = Oswestry Disability Index; SCS = spinal cord stimulation; VAS = visual analog scale.

Table 4 Comparison of baseline measures of pain (PAIN), mood (PSYCH), disability/function (FUNCTION), and demographic variables (OTHER) with outcome from spinal cord stimulation

Study†	Baseline Pain Measures	Pain Predictors	Baseline Psych Measures	Psych Predictors	Baseline Function Measures	Function Predictors	Baseline Other Measures	Other Predictors	Outcome Summary
[35]	0–10 VAS and MPQ	–	MMPI	±	ODI	–	Worker's comp previous surg, pain duration, age	±	MMPI Depression scores, MPQ-evaluative scores, and age correlated with poor outcome.
[59]	NR	0	24 psycho-dynamic items	+	NR	0	NR	0	Psychological themes predicted outcome.
[60]	MPQ	–	CPI	+	NR	0	NR	0	Psych factors were "Most important reasons for failure".
[40]	NR	0	DABS, MMPI	+	NR	0	Age, physical exam	±	Younger age, some physical findings, and low DABS anxiety score predicted a successful trial. No predictors of long-term outcome were found.

† First author and year.
+ = positive evidence; – = no evidence; ± = mixed evidence; 0 = not examined.
CPI = California Personality Inventory; DABS = Derogatis Affects Balance Scale; MMPI = Minnesota Multiphasic Personality Inventory; MPQ = McGill Pain Questionnaire; NR = Not reported; ODI = Oswestry Disability Index; SCS = spinal cord stimulation; VAS = visual analog scale.

Discussion

The results of this review indicated that support for the notion that pretreatment psychological variables predict treatment outcome in patients undergoing spinal surgery and SCS cannot clearly be determined by the available evidence, though the findings do suggest the possibility of such an association. Specifically, self-reported levels of depression, anxiety, coping, somatization and hypochondriasis were found to be associated with greater risk for poor outcome in most studies (and in the expected direction: e.g., higher presurgical levels of distress, somatization, etc were generally associated with less treatment-related benefit), in agreement with past reviews [18]. Presurgical levels of variables within the categories of pain (PAIN) and activity limitation (FUNCTION) were less useful in predicting treatment outcome. In the majority of studies in which demographic variables were assessed, a significant relationship was found between older age and poorer outcome from spinal surgery and SCS. However, no consistent relationships were found between gender, workers compensation status, employment status, previous surgeries, or physical examination findings and treatment outcome.

Psychosocial in"uences have increasingly become accepted as potentially important determinants of response to spine surgery [18]. This, in part, has led to the almost ubiquitous recommendation of presurgical psychological evaluations. Moreover, psychological screening prior to surgery is often required in many states in the United States by insurance companies. The recommendations in favor of pretreatment psychological assessment are based on the assumption that these screenings will be useful in preventing those at high risk for poor outcomes from having invasive interventions performed. To date, there is little empirical support for this notion because no controlled trials of having vs not having psychological screening before back surgery or an implantable device have yet been published. Hence, recommendations are generally based on predictive cohort studies that assess factors that are prospectively associated with post-surgical outcomes. Our review of current psychological screening practices and their results (e.g., what proportion of screened patients are cleared for surgery, what factors and cutoffs are used to classify patients as poor candidates, do such screening procedures actually improve outcomes?) demonstrate that the evidence for the predictive power of psychological screening for invasive spinal procedures is unknown.

The methodological quality of the papers reviewed was highly variable. A review of the current literature identified a limited number of studies that met criteria for inclusion. We found many studies that documented outcomes of surgery, but only a minority was devoted to assessing predictors of outcomes, and fewer studies were dedicated to evaluating psychosocial predictors specifically. Most notably, of the 25 studies that met the inclusion criteria, only four of these studies were outcome studies of SCS. There was also a notable lack of controlled trials (level I or level II studies); despite the frequency of lumbar disk surgeries and SCS implantations, only two studies had control groups [44,61], and only one study incorporated randomization into their study design to attempt to objectively assess the relationship between outcome and psychological screening factors [61]. We acknowledge that RCTs may not be necessary or practical in understanding the relationship between pretreatment predictor variables and outcome; large cohort studies can be nearly as useful in evaluating such relationships. However, a controlled trial in which, for example, two patient groups (high anxiety vs low anxiety) were randomized to either receive spinal surgery or not and be followed for 1 year, would provide significant improvement in our understanding of the role of the predictor variable (e.g., anxiety) in shaping treatment outcomes. Unfortunately, as best as we can determine, such studies do not currently exist in the scientific literature. The follow-up time among studies was also variable, with most studies having a follow-up time averaging approximately 6 months after the intervention.

More than 20 different screening questionnaires were used among all the studies reviewed. A significant minority of these screening tools appeared to lack any literature demonstrating their validity in assessing the construct of interest. Some of the screening tools were specifically devised by the research group conducting the study, and these were rarely validated. Yet, these studies often also used other screening tools that were more established in the literature. A substantial majority of the studies used one or more assessment measures that are well-established in the literature, such as the McGill Pain Questionnaire, Beck Depression Inventory (BDI), and the Zung Depression Scale (ZDS). Collectively, the Minnesota Multiphasic

Personality Inventory (MMPI) was the most common psychological screening tool used, with eight studies utilizing this questionnaire. In part, this may re"ect the rather broad distribution of study ages in this literature, with a number of studies published in the 1980s, when use of the MMPI as a screening tool was more prevalent than it is today. Not surprisingly, the assessment of complex, multidimensional constructs, such as depression, was variable. Globally, depression was often measured by instruments that evaluated a continuum of depressed mood or a number of depressive symptoms, as opposed to categorical entities corresponding to clinical diagnoses of depression. This included the second-most popular screening tool used, the modified ZDS, which was created specifically for back pain populations [62]. When combined with the Modified Somatic Perception Questionnaire, the ZDS forms the Distress and Risk Assessment Method (DRAM) [63], which has been shown to be a very good assessment tool in low back pain populations. The BDI was also used frequently to assess mood.

Other papers used generic instruments to assess psychological distress, a broad construct that generally includes symptoms of depression and anxiety. The Symptom Checklist (SCL-90-R) is one example of a commonly-used questionnaire that yields a global distress score [64]. It is important to note that there has been an as-yet-unresolved debate on whether generic instruments such as the SCL-90-R have adequate psychometric properties in pain populations, with some suggesting not [65 67], while other studies demonstrate the usefulness of such measures [68]. The measurement of pain-related coping strategies was also variable, included instruments such as the Pain Coping Inventory (PCI). Although this and similar questionnaires are used extensively in chronic pain research, interpretation of the resulting findings is often not straightforward [69]. In the present review, however, all of the studies that used the PCI found that it had significant predictive value in the context of both SCS implantation and lumbar surgeries.

As with any review of this nature, there are a number of limitations that need to be identified. First, we only included studies listed through the literature search engines, a manual search of bibliographies from the retrieved articles and other available articles. Hence, some studies may have been omitted. Also, it is well-known that many studies with negative results often go unpublished. Second, we found that different studies used different indications for spine surgery; this is hardly surprising, but it does suggest that the selection criteria vary across studies, sites, and practitioners, making the comparison of findings across studies very difficult. For example, if a prospective cohort study of patients undergoing discectomy excluded patients with high presurgical distress levels, and then found that presurgical distress scores did not predict outcomes, this would be misleadingly classified as a negative finding. Relatedly, some studies only included patients who had no prior spine surgery [61], while others had included a mix of both first-time and repeat surgery patients [47]. Also, outcome studies of response to SCS excluded subjects who failed a trial of SCS, and the numbers excluded from treatment went mostly unreported.

Third, we also found that some studies used unvalidated measures of predictor variables and outcome variables. In particular, surgeon categorization of global outcomes (in contrast to patient report of outcomes using standardized measures) was relatively common. Fourth, important demographic and clinical information, such as the duration of chronic pain experienced by participating patients, was often not assessed or reported. This kind of information may play an important role not only in determining outcome, but may also be related to level of psychological distress experienced by individual patients.

Fifth, studies varied tremendously in their analytic strategy and particularly in their selection of control variables. For example, many studies did not control for presurgical levels of pain and disability. Finally, because of the many variables and measures used among the studies, we could not perform quantitative analyses of the results for a more formal systematic evidence review. Thus, there remains a need for further prospective studies to elucidate which pretreatment factors are most useful in predicting outcome after invasive, expensive, and potentially risky spinal interventions. Such studies should be conducted on large sample sizes, with careful section of validated screening tools and concerted efforts to decrease loss to follow-up.

Despite the above limitations, the results of the present study suggest the importance of specific psychological factors that seem to be potential vulnerabilities for poor outcomes in the interventional treatment of chronic back pain. In particular, presurgical somatization, depression,

anxiety, and poor coping seem most prevalent in their association with poor outcomes. Even though a comprehensive picture of the role of psychosocial factors in identifying patients who may fare better or worse after spine surgeries or an implantable device is not clear based on the current literature, the use of psychological screening to identify these specific vulnerabilities early in the delivery of a multimodal and interdisciplinary plan may enhance overall patient satisfaction and treatment outcomes. Therefore, we would like to propose the following recommendations regarding the use of psychological screening for the treatment of chronic back pain. First, there is modest support for comprehensive psychological screening for persons with chronic pain who are seeking invasive treatment for their pain in order to identify those variables that are predictive of outcome. Second, patients who are identified as having significant somatization, depression, anxiety, and poor coping, should be offered treatment for these symptoms as part of the multimodal treatment plan. Third, repeat assessment of psychological vulnerabilities would be useful to document changes in these predictive variables to gain further understanding of the risk-benefit analysis of invasive treatments for any individual. Finally, this review points to the need for additional controlled trials to help understand the role of pretreatment psychosocial variables in predicting outcome from invasive surgical procedures. Indeed, the literature in this area would specifically benefit from trials such as the following: 1) a randomized, controlled trial of psychological screening s effects on long-term treatment outcomes (i.e., patients being considered for surgery are randomized to either receive or not receive presurgical psychological screening); 2) prospective cohort studies comparing the predictive value of various psychological factors in several relatively homogeneous treatment groups; 3) pre- or peri-surgical intervention studies in patients who are screened as high-risk; and 4) studies of tailored interventions based on screening results (e.g., high-risk patients with a predominance of depressive symptoms might receive one type of intervention, which those who primarily show elevations in somatization or poor pain coping might receive another). Collectively, definitive statements regarding the benefits (or lack of benefits) of presurgical psychological screening will have to await the emergence of studies such as these.

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