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Relationships between epidural fibrosis, pain, disability, and psychological factors after lumbar disc surgery

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Abstract Failed back surgery syndrome (FBSS) is an important complication of lumbar disc surgery. Epidural fibrosis is one of the major causes of FBSS. However, most patients with epidural fibrosis do not develop symptomatic complaints from scarring. The purpose of this prospective study was to evaluate the relationships among the severity of epidural fibrosis, psychological factors, back pain and disability after lumbar disc surgery. Twenty-nine surgically managed patients (13 women, 16 men) were included in this study. In all patients, the presence and severity of epidural fibrosis was determined with contrast-enhanced magnetic resonance imaging (MRI). A pain visual analog scale (VAS) and Oswestry Disability Questionnaire (ODQ) were completed before and after surgery. Subjects were grouped by their type of herniation (protrusion, free fragment), MRI findings and results of the mini form of the Minnesota Multiphasic Personality Inventory (MMPI), and the groups were compared for their VAS and ODQ scores. Our results disclosed that neither the postoperative VAS scores nor the postoperative ODQ scores differed significantly among the epidural fibrosis severity groups. Moreover, postoperative VAS scores were positively correlated with the scores of the mini MMPI. These findings indicate that epidural fibrosis may be considered as a radiological entity independent of patients' complaints. Furthermore, the mini MMPI should be included in the assessment and planning of the reoperations in FBSS patients, because of the importance of psychological factors in postoperative pain and disability.

Key words Visual analog scale (VAS) · Oswestry Disability Questionnaire (ODQ) · Minnesota Multiphasic Personality Inventory (MMPI) · Epidural fibrosis · Failed back surgery syndrome (FBSS)

Introduction

Failed back surgery syndrome (FBSS) presents a difficult diagnostic problem. Fifteen percent of all patients who undergo an initial surgical procedure will have significant discomfort and disability [13, 28, 33]. Although FBSS is usually due to improper diagnosis and surgery, other important causes are epidural fibrosis and recurrent disc prolapse [33]. The role played by epidural fibrosis as a cause of failed back surgery syndrome is the subject of continuing debate among spinal surgeons, mainly because of the multiple factors involved in the pathogenesis of this condition. The diagnosis of epidural fibrosis can be made radiologically. Unfortunately, the correlation between the radiological and clinical findings has sometimes been poor. There is as yet no explanation for why epidural fibrosis of the same neuroradiologic appearance and localization is associated with incapacitating pain in some patients and not in others. There are a few studies about

epidural fibrosis alone and about its relationship to recurrence of symptoms; however, the diagnostic and prognostic value of epidural fibrosis is not proven and studies including asymptomatic patients are necessary [2, 7, 12, 19, 33].

Chronic low back pain (LBP) may be associated with psychological disturbance with or without an organic disease such as epidural fibrosis or recurrent disc herniation. Psychological factors affect the patients' perception and assessment of physical stimuli. Hence, psychological testing, particularly with the Minnesota Multiphasic Personality Inventory (MMPI), which continues to be widely used by psychologists working with the pain population to estimate the outcome of various medical, surgical and psychological treatments, is used in the assessment of personality characteristics in LBP patients [11, 14, 16, 17, 22, 23, 26, 27, 39, 40]. The studies have generally found the hypochondriasis (Hs) and hysteria (Hy) scales, and frequently the depression (D) scale to be the most predictive of surgical outcome [17, 39, 40]. The Turkish version of the mini form of the MMPI, comprising the scales of this "neurotic triad", was derived from the Turkish version of the MMPI, which has been found to be valid and reliable [37]. We preferred to use it because it is less time consuming and more commonly practised [16, 27].

The visual analog scale (VAS) is the most commonly used measurement in many pain evaluation centers for pain intensity assessment. The Oswestry Low Back Pain Disability Questionnaire (ODQ) was introduced in 1984 as an adjunct to decision-making in surgical treatment of the degenerate lumbar spine. Initial disability is a predictor of outcome after lumbar spinal surgery [9, 21]. Both VAS and ODQ are useful tests for effective monitoring of changes in pain and functional capacity after spinal surgery [5, 13, 21, 22, 26].

The aim of this study was to determine the importance of the severity of epidural fibrosis and psychological factors in estimating the outcome of the patients after lumbar discectomy. VAS and ODQ scores were determined before and after surgery by a self-assessment questionnaire and the results were compared with MRI findings and mini MMPI results of the operated herniated discs.

Materials and methods

Twenty-nine patients (13 women, 16 men) with a single-level lumbar disc herniation, who were operated by same surgeon (E.C.) between 1995 and 1997, were included in this study. Patients with spinal canal stenosis, lateral recesses, infectious spondylitis and neoplastic diseases were excluded. Mean age was 47.5 ± 11 (range 20–53). Surgical approach was performed at the levels L5-S1 (n = 13), L4-L5 (n = 14) and L3-L4 (n = 2). Education levels of the patients were: primary school in 6, secondary school in 9, and university in 14 of the patients. Surgical pathologies were divided into two groups according to the radiological and operative findings: (1) disc protrusion, (2) extruded disc or free fragment. After a follow-up period ranging from 6 to 32 months (mean 18.7 ± 9.3 months), all of the patients were invited to the hospital for reassessment.

Table 1 Classification of the extent of mass effect of abnormal soft tissue in the spinal canal [2]

Stage	Classification
1	Replacing the epidural fat but not affecting the thecal sac
2	Minimal compression (< 25%) of the thecal sac
3	Moderate compression (25–50%) of the thecal sac
4	Severe compression (> 50%) of the thecal sac

Magnetic resonance imaging (MRI) was performed on a 0.5-T super-conductive MR MAX (General Electric, Milwaukee, Wisc., USA), using surface coils. Gradient echo (GE) T1-weighted sagittal [TR 480/TE 12 (repetition time ms/echo time ms) 1900 × 90 matrix], axial (TR 400/TE 14, 128 × 224) and spin echo (SE) T2-weighted sagittal plane (TR 1900/TE 90, 96 × 224 matrix) images were taken with 5 mm thickness and a 2-mm interslice gap. Gadolinium-diethylenetriaminepenta-acetic acid (Gd-DTPA) enhanced (0.1 mmol/kg body weight) postcontrast sequences were completed within 20 min. MR scans were performed to evaluate the effectiveness in differentiating recurrent disc prolapse from epidural fibrosis. The diagnosis of epidural fibrosis was made when there was an area of intermediate signal intensity on T1-weighted images in epidural space that obscured or obliterated the normal high signal of the epidural fat [35]. The amount of scar tissue was scored on a four-point scale, described by Annertz et al. [2] (type I = least severe, type IV = most severe), according to the mass effect of the structures in the spinal canal (Table 1). The images were examined for degeneration in the adjacent lumbar disc and postoperative changes in surgical field. All MR images were interpreted independently by a neuroradiologist and the surgeon (E.P., E.C.). When disagreement arose about pathologic findings, other neurosurgeons (T.S., K.T.) adjudicated.

Pain intensity and disability were assessed both preoperatively and postoperatively. Pain intensity was evaluated by the VAS. VAS is reliable, valid, simple for the patient to use and easy for reviewer to score [5, 23, 30]. It consists of a 10-cm line that represents the continuum of the pain experience. The descriptors are used only at the extremes, being 'no pain' at one end and 'severe pain' at the other, without any descriptors along the length of the line. The VAS scale depicted severity of present pain felt in the low back or leg. Disability was evaluated by the ODQ, which consists of ten questions, each rated on a 0–5 scale, evaluating daily activities. This disability questionnaire has a proven reliability and validity for low back pain patients [5, 9, 21, 32, 36]. The improvement rates in the VAS (ΔVAS) and ODQ (ΔODQ) were calculated simply [21] as:

$$\Delta VAS = preVAS–postVAS)/preVAS$$

and

$$ODQ = preODQ–postODQ/preODQ$$

The MMPI was administered at the postoperative follow-up examination. The short form of the MMPI consists of 172 affirmative statements, to which the patient responds either 'True' or 'False' [16, 27]. These items are then combined into two validity scales – lie (L) and defensiveness (K) – three clinical scales – depression (D), hypochondriasis (Hs) and hysteria (Hy) – and five special research scales – low back pain (Lb), brain lesion (Br), conversion (Con), somatization (Som) and dissimulation (Dis).

All data were recorded on Statistical Packages for The Social Sciences (SPSS Inc, Chicago, Ill., USA) for Windows 95 and statistical analyses were performed with that software. The VAS and ODQ, which are estimators of outcome after lumbar spinal surgery, were analyzed as dependent variables. The severity of

epidural fibrosis, psychological factors (MMPI scores), type of herniation (protrusion, free fragment) and demographic characteristics known to be factors (age, education, sex) were analyzed as independent variables. All dependent and independent variables were calculated by descriptive analysis (mean ± standard deviation) and frequencies. Preoperative and postoperative scores and differences in VAS and ODQ were compared by *t*-tests for paired samples. Differences in postoperative VAS and ODQ scores by severity of epidural fibrosis and type of herniation were compared using the Kruskal-Wallis test. We opted for a non-parametric test, because we did not have enough subjects in the groups to apply a parametric test and because of non-normality of the distribution of some variables. Improvement rates according to type of herniation were compared by the Mann-Whitney U test. The groups formed according to type of herniation were compared for the stage of the severity of epidural fibrosis using the Pearson chi-square test. The correlation between dependent variables (postoperative VAS, postoperative ODQ) and independent variables (MMPI scores) was performed using Pearson correlation analysis. After correlation analysis, stepwise multiple regression analysis was performed on the effect of each independent variable on the dependent variables.

Table 2 The scores of pain visual analog scale (VAS) and Oswestry Disability Questionnaire (ODQ) in surgical groups (median ± interquartile ranges)

	All patients (N = 29)	Protrusions (N = 13)	Free fragments (N = 16)
VAS			
Preop	9.0 ± 2.0	9.0 ± 2.0	9.0 ± 2.0
Postop	3.0 ± 3.3	4.0 ± 2.5	2.0 ± 2.0
ODQ			
Preop	49.0 ± 10.0	49.0 ± 13.5	49.5 ± 9.8
Postop	19.0 ± 9.0	21.0 ± 8.0	17.5 ± 7.6

Table 3 Relationships between the type of pathology and improvement rates of VAS and ODQ (ΔVAS = preVAS–postVAS/preVAS, ΔODQ = preODQ–postODQ/preODQ)

	N	Median	Interquartile range	P
ΔODQ				
Protrusions	13	0.54	0.29	0.068
Free fragments	16	0.65	0.16	
ΔVAS				
Protrusions	13	0.56	0.36	0.028*
Free fragments	16	0.76	0.24	

* $P < 0.05$ (non-parametric Man-Whitney U test)

Results

Type I epidural fibrosis was observed in 16 cases, type II in 9 cases and type III in 4 cases. The severity of epidural fibrosis was found to be higher in the free fragment group than in the protrusion group, but this difference was not statistically significant ($P > 0.05$). On MRI, no increase in disc degeneration was found above or below the operated disc space. Metal artifact, which was defined as decreased signal intensity on T1- and T2-weighted images, was seen in 6 of the 29 cases in the surgical field. Radicular contrast enhancement and recurrent disc herniations were not found in any patient.

Preoperative and postoperative scores of VAS and ODQ are given in Table 2. Significant differences were determined ($P < 0.0001$, *t*-tests for paired samples) between preoperative VAS values (8.9 ± 1.0) and postoperative VAS values (3±1.7), and between preoperative ODQ values (47.4±6.6) and postoperative ODQ values (19.6 ± 6.8). There was also a significant positive correlation between ΔVAS and ΔODQ ($r = 0.62$, $P < 0.001$).

While ΔVAS was significantly higher ($P = 0.028$) in the free fragment group than in the protrusion group, there was no correlation between ΔODQ and surgical groups ($P = 0.068$) as shown in Table 3. No correlation was found between postoperative VAS scores and severity of epidural fibrosis or between postoperative ODQ scores and severity of epidural fibrosis (Table 4). No relationship was found between any of the demographic characteristics of the patients (sex, age, education level) and the VAS and ODQ scores.

A statistically significant positive correlation was found between postoperative VAS scores and scores of Hs ($r = +0.61$, $P < 0.001$), Con ($r = +0.54$, $P < 0.01$), Hy ($r = +0.37$, $P < 0.05$), and Som ($r = +0.40$, $P < 0.05$). We did not find any correlation between postoperative VAS scores and the other scales of MMPI ($P > 0.05$). We found that only Hs ($P = 0.000$) and Dis ($P = 0.002$) scores had effects on postoperative VAS scores, by stepwise multiple regression analysis (postoperative VAS = 0.873 + 0.362 Hs–0.222 Dis). We checked the level of correlation among the potential predictors. We found that Hs score was the most determinative parameter and, according to the variance inflation factor (VIF) value, we could ignore Dis score in this model. While there was no correlation between postoperative ODQ scores and the scales of the MMPI ($P > 0.05$), ΔODQ was negatively correlated with

Table 4 Relationships between the severity of epidural fibrosis (type I = least severe, type IV = most severe) and postoperative scores of VAS and ODQ (median ± interquartile range)

	Protrusion (N = 13)	Free fragment (N = 16)	Postoperative VAS	Postoperative ODQ
Epidural fibrosis severity				
Type I	8 (61.5%)	8 (50%)	2.50 ± 1.75	17.50 ± 8.00
Type II	4 (30.8%)	5 (31.3%)	3.00 ± 3.50	21.00 ± 4.50
Type III	1 (7.7%)	3 (18.8%)	3.25 ± 1.71	16.00 ± 12.00
Type IV	–	–	–	–

the low back pain scale of the MMPI ($r = –0.49$, $P < 0.01$) by stepwise multiple regression analysis.

Discussion

FBSS, unsuccessful surgical outcome after lumbar disc surgery, is a complex and poorly understood syndrome, with as many different imaging findings as different possible etiologic mechanisms. The main differential diagnosis is between postoperative epidural fibrosis and recurrent disc protrusion [1, 3, 4, 19, 28]. Epidural fibrosis may play an important role in the development of the pain [33, 35]. Epidural scarring almost invariably follows lumbar laminectomy [6]. The formation of scar tissue takes place from 6 weeks to 6 months postoperatively [34]. The reported incidence of epidural fibrosis ranges from 10 to 75% [2, 3, 6, 19, 34, 35, 38]. The exact pathogenic role of epidural fibrosis has not established; however, the mechanisms of fibrosis may be related to persisting cotton debris from sponges used during surgery, and this debris may act as a fibrogenic stimulus [18]. In the current study, the high rate of metal artifacts was thought to be dust from the lower quality surgical tools we had to use (i.e. periost elevator). This may also play a role in the development of epidural fibrosis.

MRI is a more accurate diagnostic tool in postdiscectomy problems. The multiplanar imaging capability, superior soft-tissue contrast resolution, and excellent tissue characterization are its major advantages. Contrast-enhanced MRI, in particular, displays the changes caused by surgical intervention as well as associated postoperative findings, many of which cause the failed back surgery syndrome. Moreover, there are some reports suggesting that the contrast enhancement of nerve root may be responsible for the pain [7, 19]. Ross et al. [35] suggested that there was a correlation between the extent of epidural fibrosis and the level of postoperative complaints. However, 87.3% of their patients with extensive epidural fibrosis on MRI were asymptomatic. Jinkins et al. [19] suggested that fibrosis in the epidural space may be less important in the pathogenesis of FBSS. If the symptoms are caused by scar tissue, a repeat operation is of questionable value [2, 19]. We found different degrees of epidural fibrosis on MRI in our patients, but there was no relationship between the severity of epidural fibrosis and pain scores or disability scores ($P > 0.05$). For that reason, we suggest that epidural fibrosis may be considered as a radiological entity that is not correlated with patients' complaints.

In chronic low back pain patients, the relationship between pain intensity and disability is complex, and has been observed to be moderate [13]. VAS is the most commonly used measurement for pain intensity assessment [23]. ODQ has a proven reliability and validity for low back pain patients [9]. It has been reported that both VAS and ODQ are useful tests in follow-up of the patients and both have been shown to be valid and reliable [5, 11]. In assessing the outcome of surgery in the lumbar spine, the percentage change in ODQ is reliable, independent of surgeon bias, and correlates well with the patients' subjective assessment of improvement [21, 36]. We observed a strong correlation between ΔVAS and ΔODQ ($r = 0.62$, $P < 0.001$).

It is essential to elucidate the variables that predict individuals at risk for developing a chronic LBP condition. After disc surgery, sex, age, and psychological factors influence the outcome [28]. Melzack and Wall developed the gate-control theory of pain, in an attempt to explain the interplay of the various psychophysiologic aspects involved in pain perception [25]. Early identification of psychological problems is important in understanding, and hopefully preventing, the progression to chronicity in low back trouble [11, 29]. Especially if correlations with diagnostic studies are uncertain, concomitant psychological evaluation is mandatory [4, 10,].

The MMPI has been found useful in assessing emotional disorders that occur secondary to the pain complaint or pre-existing personality factors that could potentially adversely affect patients' response to treatment [17, 22]. The investigation of Hansen et al. [14] supports the hypothesis that LBP is followed by elevations on the Hs-D-Hy scales. The reverse may be the case in certain groups and individuals, in some of whom the presence of emotional disorders preceding LBP might be detected by preoperative assessment with the MMPI. The age-old chicken or egg debate about which one is the primary cause of this overlap, the physical illness or psychological disturbance, remains unresolved [10, 11, 29]. Riley et al. [31] suggest that the results of MMPI-based studies are also applicable to MMPI-2, the more recent version. The Turkish version of MMPI-2 has not been tested for validity and reliability yet. The disadvantage of using both the MMPI and MMPI-2 is the length of the test. The short forms are approximately equivalent to MMPI in ability to predict response to conservative treatment for back pain [16, 27]. The studies have generally found scales Hs, Hy and frequently D to be the most predictive of surgical outcome [14, 17, 32, 39]. Three MMPI scales, Hs, D, and Hy, called the neurotic triad, are of particular importance in studies of chronic pain patients [4, 10, 11, 16, 32]. For that reason, we established the mini MMPI form by using these clinical scales and their research scales, which were obtained from the Turkish version of MMPI in our study.

Hanvik [15] was the first to describe the so-called conversion-V profile, which is formed by significantly elevated scores on Hs and Hy and slightly lower scores on D. Fair or poor outcome was associated with higher scores on conversion-V scales but their presence did not rule out success [22]. Moreover, elevations of the MMPI scales on D, anxiety, Hs, and Hy are related to unfavorable outcome of the operative treatment of lumbar disc disease [16, 17,

24]. McCreary et al. [24] found that low scores on Hy, Hs and D Lb scales were related to good outcome of conservative treatment. High scores on Hy and Hs scales have been consistently linked with poor response to surgery [17, 39, 40]. These studies revealed that a relationship seems to exist between MMPI scores and response to medical treatment, and the MMPI should therefore be included in assessment and planning of the reoperation [10, 16, 22, 32]. However, Watkins et al. [40] has reported that the ODQ was shown to be improved significantly in a group of anterior lumbar fusion patients and this was together with an improvement in the physical examination. In that study, the MMPI was not predictive of outcome, nor did it change appreciably with surgery. Moreover, Turner and Leiding [39] reported that MMPI had some slight predictive power in outcome, but this was not as strong a factor as compensation or litigation, and no statistical relationship was proved. In our study, outcomes of the patients were evaluated by postoperative back pain intensity (VAS) and disability (ODQ) and the scores were compared with the scores of the mini MMPI. It was found that postoperative VAS scores also decreased with a decrease in the scores on the MMPI Hy, Con, Hs and Som scales. However, these results were not supported by stepwise multiple regression analysis. In this test we found a significant relationship only between postoperative VAS scores and Hs and Dis scores.

The present study questioned the effects of the presence and severity of MRI-determined epidural fibrosis on pain and disability. It also assessed pain intensity and disability in 29 patients with single-level lumbar disc herniation, using VAS and ODQ, and compared the results with the MRI findings and mini MMPI scores of the patients. Our results suggested that epidural fibrosis may be considered as a radiological entity that is not correlated with patients' complaints. Moreover, the mini MMPI should be included in assessment and planning of the reoperations in failed back patients, because of the importance of psychological factors in postoperative pain and disability.

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