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Obesity and litigation predict workers' compensation costs associated with interbody cage lumbar fusion

Rick A. LaCaille, PhD[a,*], M. Scott DeBerard, PhD[b], Lara J. LaCaille, PhD[a], Kevin S. Masters, PhD[c], Alan L. Colledge, MD[d]

[a]*Department of Psychology, University of Minnesota Duluth, 1207 Ordean Court, Duluth, MN 55812, USA*
[b]*Department of Psychology, Utah State University, Logan, UT 84322-2810, USA*
[c]*Department of Psychology, Syracuse University, Syracuse, NY 13244, USA*
[d]*Labor Commission of Utah, Salt Lake City, UT 84114-6600, USA*

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Abstract

BACKGROUND CONTEXT: Results of lumbar fusion surgery have been mixed and procedures are costly. Interbody cage lumbar fusion (ICLF) has been advanced to improve arthrodesis and clinical outcomes; however, little attention has been given to ICLF costs or potential predictors of these expenses.

PURPOSE: To depict medical and compensation costs associated with ICLF in a Utah cohort of patients receiving workers' compensation as well as to investigate predictors of costs.

STUDY DESIGN/SETTING: A retrospective-cohort research design was used involving completion of presurgical and postsurgical medical record reviews and accrual of medical and compensation costs. Presurgical variables included in a regression model were presurgical spinal pathophysiology rating, obesity, and litigation status.

PATIENT SAMPLE: Forty-three consecutive patients who were compensated by the Workers' Compensation Fund of Utah and underwent ICLF.

OUTCOME MEASURES: Total accrued compensation and medical costs.

METHODS: A retrospective review of presurgical variables and total accrued compensation and medical costs was conducted.

RESULTS: Multiple regression analysis indicated that nonpathophysiological factors predicted compensation costs (lawyer involvement [β=0.40]; obesity [β=0.34]). Specifically, compensation for those with versus without lawyers was $41,657 versus $24,837, and for those who were obese versus nonobese was $46,152 versus $28,168. Arthrodesis was correlated with medical costs ($r=-0.47$, $p=.002$), with incurred costs for patients achieving solid fusion versus pseudarthrosis equaling $38,881 versus $71,655, respectively.

CONCLUSIONS: Considerable costs were associated with ICLF, particularly for those who were obese, involved in litigation, or failed to achieve solid fusion. With regard to compensation costs, the findings support the importance of assessing nonpathophysiological factors in spinal fusion patients.

Keywords: Lumbar fusion; Medical costs; Compensation costs; Obesity; Litigation

Introduction

The effects of low back pain (LBP) are wide reaching in terms of both the number of people involved and economic cost. It is estimated that 80% of the U.S. population will experience LBP at some point in their lives, resulting in a projected overall economic toll of nearly $171 billion [1,2]. The costs associated with medical treatment of chronic LBP are estimated to range from $9,000 to $19,000 per

FDA device/drug status: approved for this indication (interbody cage lumbar fusion).

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* Corresponding author: Department of Psychology, 1207 Ordean Court, University of Minnesota Duluth, Duluth, MN 55812. Tel.: (218) 726-7411; fax: (218) 726-7186.

E-mail address: rlacaill@d.umn.edu (R.A. LaCaille)

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person annually [3]. Not surprisingly, workplace injuries and compensation claims are an important aspect of the fiscal equation with more than $11 billion paid annually in workers' compensation benefits for work-related LBP and disability [4]. Interestingly, LBP injury constitutes 10% to 19% of all workers' compensation claims but accounts for approximately 33% to 41% of total costs [5,6].

In response to the escalating costs and disability of LBP, increased emphasis has been placed upon prevention and treatment. Although a great deal of attention has been given to nonoperative treatments [7–10], some individuals turn to surgical interventions as a potential remedy for pain and disability. One particular surgical intervention, lumbar fusion, has seen a dramatic increase in rates of utilization over the past two decades [11] and accounts for a significant proportion of the low back operations with approximately 192,000 performed annually [12,13].

Despite the increased utilization of lumbar fusion techniques, the efficacy of this surgery in treating LBP remains controversial, with some researchers contending that lumbar fusion has not been shown to be effective in treating LBP resulting from degenerative discs [6,14,15]. Several possible explanations for mixed lumbar fusion outcomes have been suggested, including poor surgical technique, instrumentation failure, poor patient selection, and psychosocial variables such as litigation/secondary gain [5,14, 16–19].

More recently, a surgical technique known as interbody cage lumbar fusion (ICLF) has been advanced in an effort to improve outcomes. It is thought that ICLF reduces LBP by providing improved stabilization, disc space decompression, and extraction of intervertebral disc material [20–22]. Despite its more technically demanding technique, the interbody cage method of lumbar fusion was initially touted as a more cost-effective alternative with a shorter operative period and increased rate of arthrodesis relative to other lumbar fusion procedures [23–25]. Nevertheless, few studies have been conducted independent of the developers of the different cages and fewer yet have reported data on the costs of ICLF [26,27]. In one such study involving 23 patients, Hacker [28] estimated costs for posterior lumbar interbody fusion-BAK at $49,800 and noncage interbody circumferential fusion at $73,200, though median hospital-related and other medical expenses did not significantly differ between the fusion procedures.

In a recent study by LaCaille and colleagues [27] examining ICLF outcomes, a considerable number of patients continued to report poor quality of life and continued functional impairment, with 38% totally disabled at follow-up an average of 2.5 years postsurgery. Moreover, the odds of total disability were 9.1 times greater for patients involved in litigation at the time of surgery. Thus, it appears that evidence as to the long-term effectiveness and clear benefit for the use of ICLF remains inconclusive and may be influenced by personal characteristics of the patient and the patient's particular psychosocial circumstances.

Poor outcomes from surgical procedures may have a considerable impact on the limited resources of a health-care system as well as potentially increased financial and physical burdens to patients. Characteristics of patients at risk for poor ICLF outcome and increased costs have not yet been sufficiently identified in the literature. Although litigation has been shown to be associated with poorer outcomes after ICLF in one study [27], it has not been studied with regard to medical and compensation costs. Similarly, obesity has been found to increase the risk for development of musculoskeletal pain [29–31] and poorer functional outcome after spinal surgery [32], but little is known regarding its association with ICLF outcomes. Examination of patient characteristics and other issues within the presurgical environment may offer a basis for targeted interventions and improving patient selection, thereby also improving spinal fusion outcomes and reducing costs. The purpose of the present study was to examine the costs associated with ICLF and investigate a multivariate predictive model of presurgical variables that include a combination of biopsychosocial influences.

Methods

Study design

A retrospective-cohort design was used, which involved the coding of pre- and postsurgical information from medical records and assessing compensation and medical costs via the Workers' Compensation Fund of Utah (WCFU) computer databases. This study received institutional review board approval from Utah State University, and access to patient medical records was granted by WCFU.

Patient inclusion criteria and identification

All WCFU patients were eligible for inclusion if they had undergone ICLF from 1997 to 2000, had no presurgical diagnosis of vertebral fracture, and were at least 18 months postsurgery at the time of record review. For each patient, lumbar fusion surgery resulted from a verified workplace low back injury. Workers covered by the federal workers' compensation systems and self-insured employers were excluded. Approximately 53% of Utah workers are insured by the WCFU. Potential patients were identified by current procedural terminology codes in the WCFU databases.

Procedures

Presurgical medical record data were collected using a standardized review procedure documented elsewhere [17,33]. The data abstractor was one of the authors, and he was not involved with the treatment of the patients. Presurgical radiology reports for each patient's lumbar spine were also obtained and independently reviewed. A diagnostic pathophysiological severity rating was calculated for

each patient by another one of the authors who is a physician trained in orthopedic medicine. He was blind to the patient's surgical or cost outcomes. The presurgical variables coded for this study included body mass index at the time of surgery, litigation defined as patient private lawyer involvement in their case at the time of surgery, and spinal diagnostic severity rating.

Materials and instruments

Diagnostic Severity Rating Index (DSRI)

The DSRI provided a summary score of spinal pathophysiology and was slightly modified from the coding system used in previous studies [19,34]. This instrument allows for the coding of seven major types of common lumbar spinal diagnoses (degenerative changes, facet changes, disc bulge, lithesis, lysis, foraminal stenosis, and central stenosis) and provides a graduated scale for each diagnosis from none (0) to severe (3). Additionally, the DSRI is applied to four intervertebral levels (L2–L3, L3–L4, L4–L5, and L5–S1) with the total score being based upon the sum of the scores from each of the levels. Higher scores reflect greater spinal pathophysiology. This revised instrument has been previously shown to have good interrater reliability [27].

Arthrodesis outcome

The operating surgeons routinely reviewed postoperative radiographs and reported the progression of bone consolidation in the patient's medical record. Consequently, arthrodesis was determined by reviewing medical records for the surgeons' assessments of the radiographs, with the final determination of solid fusion coded as a dichotomous variable (yes/no). These surgeons were not otherwise involved in the study.

Medical and compensation costs

Total medical and compensation costs were retrieved from the databases of WCFU. Compensation costs included all wage replacement and the final impairment settlement. Medical costs included all direct and ancillary medical care, including rehabilitation services. The time interval for calculating costs was from the time of injury to determination of maximum medical improvement (MMI). In Utah, MMI is judged as the point in time at which an injured worker has realized the maximum amount of improvement from an injury given the current standard of medical care. The operating surgeon is responsible for monitoring the patient's status and declaring the date of MMI, at which point the patient's degree of impairment is assessed, recommendations are made about ability to return to work, and a final settlement is determined. The specific date for MMI used in this study was the official date coded in WCFU computer records. It should be noted that the WCFU covers lifetime medical costs for work-related injuries, thus it is possible for ICLF patients to receive additional medical costs beyond MMI. However, because we needed to draw a logical line for calculating total medical costs and MMI appeared to be the point at which the majority of these costs are achieved for most patients, we selected MMI date as the criterion.

Statistical analysis

Descriptive statistics were used to characterize the sample and the medical and compensation costs accrued through WCFU. Standardized mean difference effect sizes were calculated for comparison of ICLF cost outcomes with an existing sample of WCFU non-ICLF patients [35]. Multiple regression analyses were performed with arthrodesis outcome, the radiology severity rating, obesity status based on body mass index at the time of surgery, and litigation at time of surgery as the predictors and medical and compensation costs as the dependent variables. Arthrodesis status was entered in the first step of the regression equation, whereas the remaining three presurgical predictors were entered in the second step of the regression to allow for examination of the relative importance (using standardized beta weights) of the respective predictor variables beyond the potential influence of achieving solid fusion. All data were analyzed using the Statistical Packages for Social Sciences (SPSS) version 10 for Windows with an alpha level of .05 considered statistically significant.

Results

Characteristics of patients and ICLF surgery performed

Descriptive data for the ICLF patients are displayed in Table 1. The total population included 43 patients of whom 79% were male and all were Caucasian. Preoperative diagnoses, which may co-occur in patients, were as follows: degenerative disc disease (60.5%), disc herniation (60.5%),

Table 1
Descriptive statistics of patients undergoing interbody cage lumbar fusion

Variable	Frequency (n=43)	Percentage
Gender, male	34	79.1
Married	28	65.1
Education, ≥high school	35	81.4
Obesity, BMI≥30	7	16.3
Lawyer involvement	16	37.2
Number of previous back surgeries		
None	13	30.2
One	17	39.5
Two	9	20.9
Three or more	4	9.3

	Mean	SD	Min–Max
Age, years	40.4	9.2	28–64
DSRI	9.67	4.69	3–29

BMI=body mass index; DSRI=diagnostic severity rating index.

spinal stenosis (23.3%), spondylolisthesis (18.6%), motor segmental instability/motion (9.3%), and pseudarthrodesis (7.0%).

In nearly 85% of the patients, the ICLF was their first lumbar fusion, whereas the index surgery was the second and third fusion surgeries for 9.3% and 7.0% of the patients, respectively. The ICLF approach performed was divided equally between posterior and anterior (41.9%), whereas a circumferential approach was taken in 16.3% of the surgeries. The Ray and BAK interbody cage devices were the predominant choices of instrumentation, with these used in 51.2% and 25.6% of the operations, respectively. Patients had one lumbar level operated upon during the procedure in 55.8% of the cases, whereas the remaining 44.2% had a two-level ICLF performed. The vast majority of lumbar surgeries involved either L5–S1 or L4–L5 levels, with these sites being the target in 76.7% and 55.8% of the surgeries, respectively. Eighty-one percent of the surgeries were reported to have no complications of any type during the perioperative period or follow-up. The most frequent complications that did occur included superficial (2.3%) and deep (2.3%) infection, instrumentation failure (2.3%), and failed back syndrome (9.3%). An in-hospital surgical mortality secondary to internal bleeding was also documented in one case. The average length of hospital stay for the remaining patients after ICLF surgery was 4.6 days (SD=1.4, range=3–9).

Medical and compensation costs

The average time to MMI was 385 days (SD=222), which was significantly correlated with total medical costs (r (41)=.32, p=.041) and approached statistical significance with compensation costs (r (41)=.27, p=.079). The mean total combined compensation and medical costs associated with ICLF were $77,251 (SD=$43,778) for patients covered by WCFU. As seen in Table 2, the mean total medical expenses for the ICLF sample were considerably higher than compensation costs (ie, $15,061). Comparison of the medical and compensation costs of the ICLF patients versus a WCFU sample of non-ICLF posterolateral lumbar fusion patients [35] revealed notable standardized mean difference effect sizes. That is, the mean medical costs associated with ICLF were $16,053 greater than the posterolateral lumbar fusion, yielding an effect size of 0.71. The average compensation expenditures for ICLF were $3,876 more costly than the comparison fusion sample and resulted in an effect size difference of 0.22.

Table 2
Medical and compensation costs associated with ICLF

	ICLF sample		Posterolateral fusion sample*		
	Mean	SD	Mean	SD	ES†
Total compensation costs, $	31,095	20,428	27,219	15,139	0.22
Total medical costs, $	46,156	28,645	30,103	16,399	0.71
Overall costs, $	77,251	43,778	—	—	—

ES=effect size; ICLF=interbody cage lumbar fusion.

* Posterolateral lumbar fusion published in DeBerard et al. [35]; n=203.

† Standardized mean difference effect size with pooled SD between ICLF sample and posterolateral fusion sample.

Arthrodesis outcome

Arthrodesis was established in 78.6% of the cases, with one individual excluded owing to in-hospital mortality. Arthrodesis was conceptualized as constituting a mediating variable, and as such, it was examined separately from the other proposed predictors of costs. Achieving solid fusion was negatively related to total medical expenses (r(41)= –0.47, p=.002), indicating that arthrodesis was associated with lower medical costs. That is, patients with solid fusion incurred an average of $38,881 (SD=$19,307) in medical expenditures compared with $71,655 (SD= $43,047) for those failing to achieve arthrodesis. It was very interesting to note, however, that achieving solid fusion was not significantly correlated with total compensation costs (r(41)=–.20; p=.195).

Presurgical variables and prediction of ICLF costs

Examination of the intercorrelations among the presurgical variables indicated that multicollinearity was not a concern for interpretation of the regression weights for subsequent analyses. Using simultaneous-entry multiple linear regression analysis to predict the total compensation costs, while also partialing out arthrodesis, the three-variable model (litigation, obesity, spinal pathology severity rating) was statistically significant (F=3.94, p=.009) with an R-square of .299. Two of the predictor variables (presurgical lawyer involvement and obesity) had statistically significant regression beta weights (Table 3). In multiple linear regression, beta weights are interpreted as indicating the expected change in the dependent variable (eg, ICLF costs) associated with a unit change in the predictor variable,

Table 3
Linear multiple regression model predicting total compensation costs*

	Coefficients			
	Unstandardized coefficients		Standardized coefficients	
Variable	β	SE	β	p
Step 1				
Arthrodesis	−9,978.1	6,869.1	−.201	.155
Step 2				
Lawyer involvement	16,595.7	5,929.8	.398	.008
Obesity	18,417.3	8,091.2	.337	.029
DSRI	−394.1	661.5	−.089	.555
Constant	−9,266.7	12,249.9		

DSRI=Diagnostic Severity Rating Index.

* Model summary: p<.01; R=.547; R^2=.299.

while partialing out the other predictor variables. However, because of the lack of comparability of the beta weights, it is helpful to examine the standardized beta weights to address the relative importance of the respective predictor variables. Given this, lawyer involvement at the time of surgery (β=.398) and obesity (β=.337) were comparable in terms of predictive importance, whereas presurgical severity rating of spinal pathology (β=−.089) was not influential in accounting for the variance in costs. As seen in Figure 1, obese patients received nearly $18,000 more than nonobese patients ($46,152.56 vs. $28,168.21) in compensation, while those patients with lawyers received nearly $17,000 more than those patients without lawyers ($41,657.03 vs. $24,837.44). The multiple regression analysis predicting total medical expenses was not statistically significant (p>.05).

Discussion

In the present study, the medical and compensation costs associated with ICLF were considerable, with the former comprising 60% of the average overall workers' compensation expenditures of nearly $77,000. Compared with a similar sample of Utah workers' compensation patients undergoing posterolateral lumbar fusion [35], whose medical costs comprised 53% of the total costs, the expenditures associated with ICLF were greater than anticipated in light of initial claims that the procedure yielded shorter hospitalizations, better patient outcomes, and improved cost-effectiveness [23–25]. Seventy-nine percent of the patients in the current study established arthrodesis after ICLF, which is generally commensurate with those reported elsewhere in the literature for non-ICLF techniques [14,34]. However, this rate is considerably lower than the impressive rates of 92% and higher reported by the developers of ICLF devices [23–25]; likely reflecting the careful selection of patients in the clinical trials and restriction of inclusion of patients with complicated psychosocial issues (eg, pending litigation). We believe the arthrodesis rate and costs associated with ICLF observed in the present study are likely more reflective of typical injured workers with LBP.

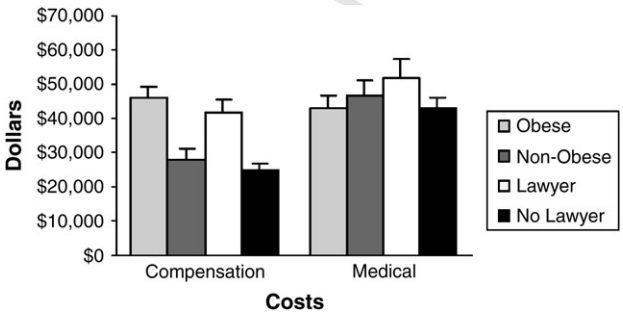

Fig. 1. ■■■

Our finding that litigation at the time of surgery was associated with higher compensation costs (ie, nearly $17,000) is consistent with previous studies [35–37]. In fact, several LBP studies have shown a relationship between litigation/compensation and increased rates of disability and greater levels of posttreatment pain [16,38–42]. Interestingly, post hoc analyses of litigation and presurgical spinal pathophysiological ratings did not reveal a statistically significant (F=.786, p=.381) difference between those patients employing the services of an attorney versus those not involved in litigation. Taken together, these findings suggest that in this population of patients, recommendations about performing an invasive procedure such as ICLF should be made with caution. The data from this study do not, however, support the position that patients receiving compensation or involved in litigation cannot benefit from surgical interventions or ICLF. It may be that patients involved in litigation experience poorer outcomes and seek more compensation to offset the additional personal expenditures they have amassed as a result of the poor outcome or loss of income. It is also important to note that the presence of litigation/compensation (or secondary gain) does not necessarily confirm that lumbar fusion patients are malingering. Indeed there is likely a complex psychophysiological relationship between perceived symptoms, pain, disability, and documented organic insult. The findings from the current study are similar to those reported elsewhere [18,32,37], suggesting that litigious patients may also experience an increased somatic sensitivity to pain as a consequence of financial incentives and social-contextual variables. Nevertheless, it is important to remember that it remains standard medical practice for surgeons to require evidence of spinal pathophysiology via routine radiographs before performing spinal fusion procedures [43,44].

The relationship between obesity-associated morbidity and health-care costs has been widely recognized as a public health problem [45]. The present investigation also found that patients considered obese (body mass index $\geq$ 30) had 61% (ie, nearly $18,000) greater compensation expenditures than did their nonobese counterparts undergoing ICLF. There was, however, no association between obesity and ICLF-related medical costs. Our findings support two recent studies examining lumbar surgery with obese individuals [46,47], which found no significant differences between obese patients and control groups with regard to duration of surgery, blood loss, duration of hospitalization, and most clinical outcomes. Interestingly, however, Gepstein and colleagues [47] found that the percentage of very dissatisfied patients was significantly higher among obese patients and that increased body mass index had a negative impact on pain perception (ie, greater pain) and activities of daily living after surgery. Although not assessed in our current study, the latter finding is consistent with our observation that obese individuals garnered considerably greater compensation costs and reports elsewhere that dissatisfaction, limited functioning, and increased pain perception are related

to poorer outcomes and higher compensation costs [32,37,38] An additional hypothesis that was not directly assessed in the present investigation, is that obesity is related to a more sedentary lifestyle which in turn leads to chronic LBP [31]. This theory was indirectly supported in that we did not find a significant relationship between presurgical spinal pathophysiology or medical costs associated with ICLF in obese patients. Rather, obesity was related to compensation costs which are a reflection of disability status (and a corollary of decreased functioning and mobility). Certainly, further data are necessary to explain the association found between obesity and workers' compensation expenditures associated with lumbar fusion.

Unlike obesity and litigation, arthrodesis was not associated with compensation costs, but rather was negatively correlated with medical costs. That is, achieving a solid fusion was related to significantly lower medical costs associated with undergoing ICLF. This finding is not entirely unexpected with the sample studied considering the nature of workers' compensation and medical costs. That is, compensation costs include wage replacement and, if applicable, a final permanent disability settlement related to the injury. Moreover, total compensation cost is a function of the length of time on disability. Medical costs, on the other hand, include expenses paid toward the spinal fusion procedure, hospitalization, and physician appointments that accrue as a result of actual treatment provided to the patient. Thus, achieving arthrodesis would signify to the surgeon and insurance carrier that medical care has been completed, whereas an individual's ability to return to gainful employment and discontinue collecting disability/compensation benefits is more subjective in nature and influenced by nonmedical social and environmental-contextual contingencies. For instance, some individuals may view successfully obtaining compensation after a poor surgical outcome (eg, final permanent disability payment) as likely only when obtaining representation and services from an attorney [36].

The findings from this study have several important implications. Lumbar fusion studies have typically emphasized biomedical outcomes and technical success with correspondingly less attention to other outcomes such as medical costs and patient compensation expenditures. The current study is also a rare examination of presurgical predictors of costs associated with lumbar fusion and, to our knowledge, the only investigation identifying nonpathophysiological factors related to costs for ICLF. Thus, this study provides additional support for consideration of biopsychosocial factors involved in health care. Specifically, the presurgical variables that emphasized potential psychosocial factors (ie, litigation, obesity) predicted compensation costs, whereas the biological variables (ie, presurgical spinal pathology, arthrodesis) were not related to compensation expenditures. This finding is not surprising, given that biological factors appear to be more instrumental in the initiation of pain, whereas psychosocial factors play a greater role in the exacerbation and maintenance of chronic pain [32] and are also important variables in the complex mix of factors that determine disability and functional limitations. A related implication of this study is the potential utility of assessing presurgical variables in assisting with identification of patients likely to have a poor response to spinal fusion procedures or to accrue considerable costs relative to the anticipated benefit. In particular, recognition of patients at risk for litigation or considered obese could signal the need to implement interventions designed to reduce these risk factors, such as early coordinated case management between injured workers and employers as well as lifestyle and weight loss interventions. Additionally, it may be helpful to provide information to health-care providers as to the importance of these risk factors relative to spinal pathology and develop further criteria for noting when a second opinion may be indicated.

Although the current investigation is the only known study having used a multivariable model to predict ICLF workers' compensation expenditures, limitations exist with the use of a retrospective-cohort design. This design lacked direct comparison/control groups, used existing groups of patients, and relied upon extant medical records. Thus, it is conceivable that potential bias and error may have influenced the data and findings. For instance, using such a design may leave patient outcomes open to being influenced by regression to the mean, natural history, or placebo effects [48]. It is notable that these biases would, however, likely produce effects appearing as more favorable patient outcomes such as reduced pain and increased functioning. Reliance on medical records for gathering presurgical and postsurgical information also has several inherent problems that were unavoidable in the current examination of ICLF. Although thorough and standardized reviews were conducted, it is possible that data may sometimes be missing or influenced by factors beyond the control of the researchers. For instance, we relied upon operating surgeons reliably recording in the medical record the postsurgical complications such as failed back syndrome. Another limitation of the current investigation is the relatively homogeneous small sample size, which restricted our ability to consider other potential predictors and generalize to other populations. The current findings, therefore, need to be further validated with diverse and larger samples, using a prospective design comparing other surgical methods and nonsurgical treatments, examination of additional types of costs and funding sources, and randomized controlled trials.

References

[1] Garofalo JP, Polatin P. Low back pain: an epidemic in industrial countries. In: Gatchel RJ, Turk DC, editors. Psychosocial factors in pain: critical perspectives. New York: Guilford Press, 1999:164–74.

[2] Straus BN. Chronic pain of spinal origin: the costs of intervention. Spine 2002;27:2614–9.

[3] Luo X, Pietrobon R, Sun SX, Liu GG, Hey L. Estimates and patterns of direct health care expenditures among individuals with back pain in the United States. Spine 2004;29:79–86.

[4] Webster BS, Snook SH. The cost of 1989 workers' compensation low back pain claims. Spine 1994;19:1111–6.

[5] Hadler NM, Carey TS, Garrey J. The influence of indemnification by workers' compensation insurance on recovery from acute backache. Spine 1995;20:2710–5.

[6] Nachemson AL. Newest knowledge of low back pain: a critical look. Clin Orthop 1992;279:8–20.

[7] Atlas SJ, Keller RB, Chang Y, Deyo RA, Singer DE. Surgical and nonsurgical management of sciatica secondary to a lumbar disc herniation. Spine 2001;26:1179–87.

[8] Gatchel RJ, Turk DC. Interdisciplinary treatment of chronic pain patients. In: Gatchel RJ, Turk DC, editors. Psychosocial factors in pain: critical perspectives. New York: Guilford Press, 1999: 435–44.

[9] McCracken LM, Turk DC. Behavioral and cognitive-behavioral treatment for chronic pain. Spine 2002;27:2564–73.

[10] Wheeler AH, Hanley EN. Nonoperative treatment for low back pain: rest to restoration. Spine 1995;20:375–8.

[11] Katz JN. Lumbar spinal fusion: surgical rates, costs, and complications. Spine 1995;20:785–835.

[12] Taylor VM, Deyo RA, Cherkin DC, Kreuter W. Low back pain hospitalization: recent United States trends and regional variations. Spine 1994;19:1207–13.

[13] Owings MF, Kozak LJ. Ambulatory and inpatient procedures in the United States, 1996. National Center for Health Statistics. Vital Health Stat 1998;13(139).

[Q7]

[14] Franklin GM, Haug J, Heyer NJ, McKeefrey SP, Picciano JF. Outcome of lumbar fusion in Washington state workers' compensation. Spine 1994;19:1897–903.

[15] Nachemson AL, Zdeblick TA, O'Brien JP. Lumbar disc disease with discogenic pain: what surgical treatment is most effective? Spine 1996;21:1835–8.

[16] Block AR, Callewart C. Surgery for chronic spine pain: procedures for patient selection and outcome enhancement. In: Block AR, Kremer EF, Fernandez E, editors. Handbook of pain syndromes: biopsychosocial perspectives. Mahwah, NJ: Lawrence Erlbaum Associates, 1999:191–212.

[17] DeBerard MS, Masters KS, Colledge AL, Schleusener RL, Schlegel JD. Outcomes of posterolateral lumbar fusion in Utah patients receiving workers' compensation: a retrospective cohort study. Spine 2001;26:738–47.

[18] Epker J, Block AR. Presurgical psychological screening in back pain patients: a review. Clin J Pain 2001;17:200–5.

[19] Robinson ME, Riley JL. Presurgical psychological screening. In: Turk DC, Melzack R, editors. Handbook of pain assessment, 2nd ed. New York: Guilford Press, 2001:385–99.

[20] Matge G, Leclercq TA. Rationale for interbody fusion with threaded titanium cages at cervical and lumbar levels, results on 357 cases. Acta Neurochir 2000;142:425–34.

[21] Onesti ST, Ashkenazi E. The Ray threaded fusion cage for posterior lumbar interbody fusion. Neurosurgery 1998;42:200–4.

[22] Weiner BK, Fraser RD. Spine update lumbar interbody cages. Spine 1998;23:634–40.

[23] Kuslich SD, Ulstrom CL, Griffith SL, Ahern JW, Dowdle JD. The Bagby and Kuslich method of lumbar interbody fusion: history, techniques, and 2-year follow-up results of a United States prospective, multicenter trial. Spine 1998;23:1267–79.

[24] Kuslich SD, Danielson G, Dowdle JD, et al. Four-year follow-up results of lumbar spine arthrodesis using the Bagby and Kuslich lumbar fusion cage. Spine 2000;25:2656–62.

[25] Ray CD. Threaded titanium cages for lumbar interbody fusions. Spine 1997;22:677–80.

[26] Agazzi S, Reverdin A, May D. Posterior lumbar interbody fusion with cages: an independent review of 71 cases. J Neurosurg 1999;91:186–92.

[27] LaCaille RA, DeBerard MS, Masters KS, Colledge AL, Bacon W. Presurgical biopsychosocial factors predict multidimensional patient outcomes of interbody cage lumbar fusion. Spine J 2005;5:71–8.

[28] Hacker RJ. Comparison of interbody fusion approaches for disabling low back pain. Spine 1997;22:660–5.

[29] Peltonen M, Lindroos AK, Torgerson JS. Musculoskeletal pain in the obese: a comparison with the general population and long-term changes after conventional and surgical obesity treatment. Pain 2003;104:549–57.

[30] Hellsing AL, Bryngelsson IL. Predictors of musculoskeletal pain in men: a twenty-year follow-up from examination at enlistment. Spine 2000;25:3080–6.

[31] Leboeuf-Yde C, Kyvik KO, Bruun NH. Low back pain and lifestyle. Part II–obesity: information from a population-based sample of 29,424 twin subjects. Spine 1999;24:779–84.

[32] Block AR, Gatchel RJ, Deardorff WW, Guyer RD. The psychology of spine surgery. Washington, DC: American Psychological Association, 2003.

[33] DeBerard MS, Colledge AL, Masters KS, Schleusener RL, Schlegel JD. Outcomes of posterolateral versus BAK titanium cage interbody lumbar fusion in injured workers: a retrospective cohort study. J South Orthop Assoc 2002;11:157–66.

[34] Turner JA, Ersek M, Herron L, et al. Patient outcomes after lumbar spinal fusions. JAMA 1992;268:907–11.

[35] DeBerard MS, Masters KS, Colledge AL, Holmes EB. Presurgical biopsychosocial variables predict medical and compensation costs of lumbar fusion in Utah workers' compensation patients. Spine J 2003;3:420–9.

[36] Harris I, Mulford J, Solomon M, van Gelder JM, Young J. Association between compensation status and outcomes after surgery: a meta-analysis. JAMA 2005;293:1644–52.

[37] Rohling ML, Binder LM, Langhinrichsen-Rohling J. Money matters: a meta-analytic review of the association between financial compensation and the experience and treatment of chronic pain. Health Psych 1995;14:537–47.

[38] Greenough CG, Taylor LJ, Fraser RD. Anterior lumbar fusion: a comparison of noncompensation patients with compensation patients. Clin Orthop 1994;300:30–7.

[39] Vaccaro AR, Ring D, Scuderi G, Cohen DS, Garfin SR. Predictors of outcome in patients with chronic back pain and low-grade spondylolisthesis. Spine 1997;22:2030–5.

[40] Bernard TN. Repeat lumbar spine surgery: factors influencing outcome. Spine 1993;18:2196–200.

[41] Junge A, Dvorak J, Ahrens S. Predictors of bad and good outcomes of lumbar disc surgery: a prospective clinical study with recommendations for screening to avoid bad outcomes. Spine 1995;20:460–8.

[42] Kaptain GJ, Shaffrey CI, Alden TD, Young JN, Laws ER, Whitehill R. Secondary gain influences the outcome of lumbar but not cervical disc surgery. Surg Neurol 1999;52:217–23.

[43] Burke PJ. Anterior lumbar interbody fusion. Radiol Technol 2001;72: 423–30.

[44] Mooney V, Saal JA, Saal JS. Evaluation and treatment of low back pain. Clin Symp 1996;48:1–32.

[45] Quesenberry CP, Caan B, Jacobson A. Obesity, health services use, and health care costs among members of a health maintenance organization. Arch Intern Med 1998;158:466–72.

[46] Andreshak TG, An HS, Hall J, Stein B. Lumbar spine surgery in the obese patient. J Spinal Disord 1997;10:376–9.

[47] Gepstein R, Shabat S, Arinzon ZH, Berner Y, Catz A, Folman Y. Does obesity affect the results of lumbar decompressive spinal surgery in the elderly? Clin Orthop Relat Res 2004;426:138–44.

[48] Turner JA, Deyo RA, Loeser JD, VonKorff M, Fordyce WE. The importance of placebo effects in pain treatment and research. JAMA 1994;271:1609–14.