Outcomes of Posterolateral Versus BAK Titanium Cage Interbody Lumbar Fusion in Injured Workers: A Retrospective Cohort Study

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Lumbar fusion has been criticized for variable patient outcomes, though little is known regarding how outcomes vary across procedures. We examined outcomes of posterolateral versus BAK interbody lumbar fusion in workers' compensation cases. A medical record review and a follow-up survey were completed. The sample included 185 posterolateral and 185 lumbar interbody fusions. An outcome survey was conducted an average of 5 years after surgery. Arthrodesis rates, satisfaction, function, and health were better for the BAK interbody lumbar fusion cohort. Results suggest greater efficacy of the BAK interbody approach over posterolateral approaches to lumbar fusion in compensated patients. (Journal of the Southern Orthopaedic Association 11(3):157–166, 2002)

Key words: lumbar fusion techniques, patient outcomes, titanium cages, workers' compensation

Annually, approximately 200,000 patients with chronic low back pain will undergo lumbar fusion (1). A number of lumbar fusion techniques are used today including posterolateral fusion with and without instrumentation (2–6) and interbody fusions, with and without titanium cages (7–10). While the main goal of these various surgical interventions is arthrodesis, approaches for achieving it vary significantly between procedures.

Posterolateral lumbar fusion has been criticized for producing unreliable results (4–6). Turner et al. 6 reviewed 47 published spinal fusion studies (1966 to 1991) and reported the percentage of patients with satisfactory outcomes ranged from 16% to 95%, with an average of 68%. In our recent study of lumbar fusion outcomes among compensated workers in Utah, we found that a significant number of patients reported that back pain was worse (36.1%) and overall quality of life was no better or worse (35.4%) than before surgery, as measured at least 2 years postoperatively (4). Possible surgically related explanations for poor outcomes of posterolateral lumbar fusion include tissue and neural damage due to a lengthy operative period and rigorous dissection, movement and/or breaking of implanted hardware, and pseudoarthrosis. Preoperative biopsychosocial variables, including older age, litigation, increased number of previous low back operations, low income, compensation, and psychologic status, have also been prognostically implicated in poor clinical outcomes (4–6, 11–13).

The BAK method of lumbar interbody fusion is an FDA approved procedure that involves implanting typically 2 hollow, porous, cylindrical titanium cages that are packed with autogenous bone graft and screwed into the intervertebral space (7–10). The BAK procedure involves removal of the disk and distraction of the disk space via placement of the appropriately sized cages. The pain reduction qualities of this procedure are thought to occur via segmental stabilization, removal of the painful intervertebral disk, and disk space decompression. The BAK method of lumbar fusion is purported to involve a less significant operative exposure, less muscle, neural, and soft tissue dissection, and a shorter operative period than posterolateral fusion procedures. The BAK fusion technique is also thought to help facilitate normal lordosis, which has been a problematic biomechanical issue after posterolateral fusion, particularly with pedicle fixation. The BAK procedure received FDA approval in 1996. Initial results were positive, including a high arthrodesis rate, good patient outcomes, and few complications (7–9).

Although these studies show some initially promising support for the BAK device and procedure, little is known regarding how the BAK method compares with existing

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Supported by grants from the Labor Commission of Utah and Sulzer-Spinetech, Minneapolis, MN.

Received for publication June 19, 2001; accepted in revised form for publication February 18, 2002.

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1059-1052/02/1103-0157$4.00/0

posterolateral approaches to lumbar interbody fusion in terms of long-term surgical and clinical outcomes in compensated patients. The purpose of this study was to compare preoperative medical and sociodemographic factors and long-term outcomes of a patient cohort having posterolateral lumbar fusion versus a cohort having BAK lumbar interbody fusion within a workers' compensation population. This was the first study to directly compare surgical and patient outcomes across these two surgical approaches within a workers' compensation population.

Methods

Study Design

This retrospective cohort study consisted of a coding of presurgical information documented in patient medical records and a telephone outcome survey conducted with patients at least 2 years after the procedure. The institutional review boards from University of Utah School of Medicine and Utah State University approved this study, and the Workers' Compensation Fund of Utah (WCFU) and Spinetech provided permission to access patient medical records and contact patients for follow-up.

Patient Samples

Two samples of injured workers with low back pain, representing the two types of surgical intervention, were included in this study. The posterolateral fusion sample was gathered in Utah and the BAK cage sample was gathered in Minnesota. Patients were selected for inclusion if they were injured workers, did not have a preoperative diagnosis of vertebral fracture, and were at least 2 years out from their surgery at time of follow-up. Patients had been treated by posterolateral or interbody fusion between 1990 and 1995. A total of 185 patients from Utah and 185 patients from Minnesota met these criteria. For patients in this sample, spine fusion surgery resulted from a verified workplace low back injury and the workers' compensation system of each state covered medical and rehabilitation expenses and lost wages. The workers' compensation systems in the two states are similar in terms of eligibility requirements, medical and compensation coverages, and impairment/disability determination. Based upon 2000 US Census data, the rates of persons with work disability are identical in both states (8.5%), and those unable to work because of a work disability are also nearly identical (2.8% in Utah and 2.7% in Minnesota).

Medical Record Information

Objective medical record information was gathered for each cohort via standardized independent audits of medical records. Data abstractors were trained and were not involved in treatment of study patients. The sociodemographic variables coded for this study included the following: sex, age at time of injury, educational status at time of surgery, smoking status at time of surgery, history of or current depression (documented in patient medical records), household income at time of injury, involvement with a private lawyer in the compensation case at the time of surgery, number of previous low back operations, and number of vertebral levels to be fused. Preoperative diagnosis and surgical information (instrumentation, approach) were also coded.

Assessing Arthrodesis and Reoperation Rates

Methods for assessing arthrodesis were different for each of the two samples. For the posterolateral fusion sample, arthrodesis was assessed by reviewing the operating surgeon's postoperative findings in the patient medical chart. For all posterolateral fusions, operating surgeons routinely reviewed radiographs and documented the progression of bone consolidation. The operating surgeon's final determination of arthrodesis was coded as a dichotomous variable (yes/no) and was based on radiographic imaging findings. Radiologists' reports of patient radiographs were found in the medical chart and were independently reviewed by a spine surgeon (R.L.S.) and occupational physician (A.L.C.) to verify the surgeon's accurate interpretation. Neither reviewer had any involvement in the patients' treatment. The operating surgeons' final opinion of arthrodesis was typically determined and documented in the chart at the time of patients' maximal medical improvement, which on average was 2 years after surgery. For the BAK fusion sample, radiographs, including flexion and extension lateral views, were obtained at 2-year follow-up and independently reviewed by technicians working separately from the operating surgeon. Nonunion was determined by a difference in vertebral angle greater than 5° on flexion-extension angles or presence of radiolucency around the margins of the device. Reoperation rates for both cohorts were determined by asking patients during the telephone interview if they had received another lumbar spine operation on the same vertebral level(s) since the index operation.

Patient Outcome Survey

An objective outcome instrument including a script for telephone interviewers was created. This instrument included 4 patient satisfaction items (back/leg pain improvement, quality of life improvement as a result of lumbar fusion surgery, satisfaction with back condition

at time of follow-up, and whether patients would chose to have surgery again) drawn from recent studies of compensated fusion patients in Utah and Washington (4, 5). Disability status at the time of follow-up was assessed by asking subjects whether they were currently receiving total disability benefits for their back condition. The Roland and Morris Back Pain Disability Questionnaire, a 24-item self-report measure designed to evaluate dysfunction associated with low back pain, was also included (14, 15). Some examples of items in this scale include the following: "Because of my back, I am not doing any of the jobs I usually do around the house"; and "I find it difficult to get out of a chair because of my back pain." The Stauffer-Coventry Index was selected as a clinical surgical outcome measure (16). This index is a widely used measure for assessing low back surgical outcomes (4, 16) and has been used as an outcome measure in two relatively recent low back surgical outcome reviews (6, 17). The measure is designed for postoperative administration and consists of four multiple response self-report questions regarding pain reduction, return to work, limitations of physical activities, and medication usage. The authors of the measure (16) indicate that based on the lowest rated category, patients may be assigned to one of three possible clinical outcome groups: 1) Good: 76% to 100% relief in leg and back pain, return to previous work status, minimal or no restriction of physical activities, occasional mild analgesics or no analgesics; 2) Fair, 26% to 75% relief of leg and back pain, return to lighter work, moderate restrictions of physical activities, regular use of non-narcotic analgesics; and 3) Poor: 0% to 25% relief of leg and back pain, no return to work postoperatively, severe restrictions of physical activities, occasional or regular use of narcotic analgesics. We should note that this method of categorization, based on the lowest rated category, is the traditional practice among published research studies that have used this measure (4, 6, 16, 17). The Short-Form Health Survey-20 (SF-20) is a 20-item general health survey that was used to assess the following six general dimensions of health: 1) physical functioning — extent to which health status interferes with a variety of activities (e.g., sports, carrying groceries, climbing stairs, and walking); 2) role functioning — extent to which health status interferes with usual daily functioning in particular roles such as work, housework, or school; 3) social functioning — extent to which health status interferes with normal social activities (e.g., visiting friends during the past month); 4) mental health — general mood or affect, including depression, anxiety, and psychologic well-being during the past month; 5) current health perceptions — overall ratings of current health in general; and 6) pain — extent of bodily pain during the past month (18, 19).

Procedures for Outcome Survey

Initial contact with patients was by a letter sent to their most recent address identified in medical records. The letter explained the research purposes of the study, procedures and assurances of confidentiality, and a request for subject participation. A self-addressed and stamped card was included so patients could inform researchers of any changes in address or telephone number and of their agreement to participate in the study. Patients who mailed cards back were immediately contacted for the survey. If patients did not respond, a telephone contact was attempted, and if the patient verbally consented, the survey was completed at that time.

Results

Preoperative and Follow-up Data

A total of 370 patients were included in the study; 185 patients were from Utah and had received posterolateral fusions, and 185 patients were from Minnesota and had received BAK interbody fusions. Patients were operated on between August 1990 and August 1995. Average time to follow-up was 5 years, and there was not a statistically significant difference in average follow-up time between the posterolateral fusion sample (4.6 years) and the BAK fusion sample (5.2 years). A total of 37 surgeons were involved in the 370 operations (28 in Utah and 9 in Minnesota). The overall sample follow-up rate for the patient survey was 56% (207/370). A MANOVA comparing respondents versus nonrespondents on the 9 preoperative characteristics was conducted. This analysis revealed no statistically significant differences, and it was tentatively assumed that results of the outcome survey were not differentially biased, according to assessed respondent versus nonrespondent preoperative characteristics.

The two follow-up samples — posterolateral ($n = 130$) and BAK cage ($n = 77$) — were compared on a number of preoperative variables including age, sex, smoking, educational status, depression, income at time of injury, litigation, number of previous low back operations, number of vertebral levels fused, preoperative diagnosis, and surgical type. Results of these comparisons are presented in Tables 1 and 2. Overall, the 2 samples were closely matched across all variables except for sex, smoking, and levels to be fused. The posterolateral and BAK samples were 84% and 64% male, respectively. Approximately 17% of the patients in the BAK sample were smokers, while 46% of those in the posterolateral sample were smokers at the time of surgery. A greater percentage in the BAK group (58.4%) had single level fusions than in the posterolateral group (46.9%). Because of these sample

TABLE 1 Descriptive statistics and comparisons of preoperative medical and sociodemographic characteristics for posterolateral fusion versus BAK fusion follow-up samples

Preoperative Variable				Posterolateral Fusion (n = 130)		BAK Fusion (n = 77)		ANOVA
				Mean	SD	Mean	SD	
Age				38.7 (range, 22.3–62.8)	9.50	40.88 (range, 21.7–65.4)	9.91	f = 2.441 p = .120
Sex				1.17	.376	1.36	.484	f = 10.38 p = .001
	Freq	PL	BAK					
	1 = Male	83.1%	63.6%					
	2 = Female	16.9%	36.4%					
Smoking				1.44	.50	1.17	.38	f = 16.83 p = .000
	Freq	PL	BAK					
	1 = No	56.2%	83.1%					
	2 = Yes	43.8%	16.9%					
Educational status				3.60 (range, 2–7)	1.16	3.68 (range, 1–6)	1.163	f = .204 p = .652
	Freq	PL	BAK					
	1 = <HS	0.0%	3.9%					
	2 = Some HS	13.8%	7.8%					
	3 = HS/GED	45.4%	35.1%					
	4 = Technical	14.6%	29.9%					
	5 = Some coll	20.0%	16.9%					
	6 = Coll grad	5.4%	6.5%					
	7 = Grad study	0.8%	0.0%					
Depression				1.09	0.29	1.10	0.307	f = .074 p = .786
	Freq	PL	Cage					
	1 = No	90.8%	89.6%					
	2 = Yes	9.2%	10.4%					

cohort differences, subsequent comparison analyses were conducted using sex, smoking, and levels fused as covariates. Results of these covariate analyses versus noncovariate analyses were compared, and statistical outcomes were pragmatically equivalent. Given this finding, we decided to present the noncovariate data for purposes of this study. Preoperative diagnostic schemes are presented for each follow-up sample in Table 2, and patients could receive multiple diagnoses. Percentages of patients with disk herniations, degenerative disk disease, and spondylolisthesis were similar in both samples. In terms of surgical type, 86.9% of posterolateral fusions were instrumented, and 89% of these cases were instrumented with pedicle screws. Of the BAK caged fusions, 35.1% were done by a posterior approach and 64.9% by an anterior approach. We also conducted separate outcome analyses comparing posterior and anterior approach BAK fusions and found no statistically significant differences.

Fusion and Reoperation Rate

Arthrodesis for the overall study population was achieved in 73.0% (135/185) of the posterolateral sample versus 93.5% (173/185) in the BAK sample (chi-square = 28.78, p = .000). The arthrodesis rate for the posterolateral follow-up sample was 73.8% (96/130) versus 93.5% for the BAK cage sample (72/77) (chi-square = 12.224, p = .000). Reoperation rate for the posterolateral sample was 23.8% (31/130) versus 14.3% (11/77) for the BAK fusion sample, and this difference was statistically significant (chi-square = 6.134, p = .047).

Patient Satisfaction Items

Patient responses to the 4 satisfaction items are presented in Tables 3, 4, 5, and 6. Patient satisfaction outcomes for the BAK interbody fusion technique were better than for the posterolateral lumbar fusion. All of the differences in patient satisfaction items were statistically significant, indicating that overall, patients who had BAK fusion were more satisfied with the results than patients who had posterolateral fusion.

Disability Status

In the posterolateral fusion sample, 24.6% (32/130) were totally disabled at follow-up versus 18.2% (14/77)

TABLE 2 Descriptive statistics and comparisons of preoperative medical and sociodemographic characteristics for posterolateral fusion versus BAK fusion follow-up samples

Preoperative Variable				Posterolateral Fusion (n = 130)		BAK Fusion (n = 77)		ANOVA
				Mean	SD	Mean	SD	
Household income at time of injury				$420.70 (range $36.00-$1,061.50)	$187.60	$471.70 (range $0.00-$1,400.00)	$212.43	f = 3.238 p = .073
Litigation				1.38	.488	1.44	.499	f = .646 p = .422
	Freq	PL	BAK					
	1 = No	61.5%	55.8%					
	2 = Yes	38.5%	44.2%					
Previous low back operations				.615	.719	.662	1.163	f = .192 p = .662
	Freq	PL	BAK					
	0 = none	50.8%	50.6%					
	1 = one	38.5%	35.1%					
	2 = two	9.2%	11.7%					
	3 = ≥3	1.5%	2.6%					
Levels fused				1.58	.582	1.415	.4961	f = 4.133 p = .043
	Freq	PL	BAK					
	1 = 1 level	46.9%	58.4%					
	2 = 2 level	48.5%	41.6%					
	3 = ≥3 levels	4.6%	0.00					
Preoperative diagnosis				Disk herniation	68.5%	Disk herniation	55.5%	
				Degenerative disk disease	50.8%	Degenerative disk disease	54.5%	
				Spondylolisthesis	16.9%	Spondylolisthesis	9.1%	
Surgical type				Posterolateral	Cases 100% Instrm 86.9%	BAK Posterior approach	35.1%	
						Anterior approach	64.9%	

TABLE 3 Patient satisfaction outcomes: back or leg pain better than, worse than, or what you expected it to be at this point

Outcome Category	Posterolateral Fusion Frequency (%)	BAK Fusion Frequency (%)
Much better	26 (20.0)	38 (49.4)
Somewhat better	25 (19.2)	17 (22.1)
No expectations	32 (24.6)	7 (9.1)
Somewhat worse	19 (14.6)	7 (9.1)
Much worse	28 (21.5)	8 (10.4)

Chi-square = 27.44, p = .000.

in the BAK fusion sample. This difference was not statistically significant.

Roland and Morris Disability Questionnaire

The total mean Roland and Morris Disability Questionnaire score for the posterolateral fusion sample was 11.4 (SD = 6.96; severe pain) versus a mean score of 8.79 (SD = 7.43; moderate pain) for the BAK fusion sample. This difference in means was statistically significant (f = 6.454, p = .021) and suggests the BAK group had less postoperative disability related to back pain than the posterolateral fusion group at time of follow-up.

TABLE 4 Patient satisfaction outcomes: quality of life improvement resulting from lumbar fusion surgery

Outcome Category	Posterolateral Fusion Frequency (%)	BAK Fusion Frequency (%)
Great improvement	37 (28.5)	41 (53.2)
Moderate improvement	28 (21.5)	19 (24.7)
Little improvement	12 (9.2)	7 (9.1)
No change	11 (8.5)	3 (3.9)
A little worse	7 (5.4)	3 (3.9)
Moderately worse	15 (11.5)	3 (3.9)
Much worse	20 (15.4)	1 (1.7)

Chi-square = 20.67, p = .002.

Stauffer-Coventry Data

Table 7 contains the four subscale values and aggregate ratings for the Stauffer-Coventry Index for the posterolateral and the BAK fusion samples. The aggregate index value was determined by the lowest rated value in any of the subscales and was not determined by averaging the subscale scores. There were no statistically significant differences on the overall index rating, with 6.9% and 14.3% of the posterolateral and BAK fusion samples, respectively, having good outcomes. Across the 4 subscale dimensions, the only statistically significant difference

TABLE 5 Patient satisfaction outcomes: satisfaction with back condition as it is right now

Outcome Category	Posterolateral Fusion Frequency (%)	BAK Fusion Frequency (%)
Extremely dissatisfied	24 (18.5)	8 (10.4)
Very dissatisfied	9 (6.9)	1 (14.3)
Somewhat dissatisfied	16 (12.3)	5 (6.5)
Neutral	26 (20.0)	8 (10.4)
Somewhat satisfied	30 (23.1)	7 (22.1)
Very satisfied	15 (11.5)	9 (24.7)
Extremely satisfied	10 (7.7)	9 (11.7)

Chi-square = 17.60, $p = .014$.

TABLE 6 Patient satisfaction outcomes: in retrospect, would have surgery again

Outcome Category	Posterolateral Fusion Frequency (%)	BAK Fusion Frequency (%)
Yes	94 (74.0)	68 (88.3)
No	32 (25.2)	8 (10.4)
Undecided	1 (0.8)	1 (1.3)

Chi-square = 8.850, $p = .031$.

between the posterolateral and BAK samples was for postoperative physical limitations, and in this case 16.9% of the posterolateral sample and 37.7% of the BAK sample reported good outcomes (chi-square = 12.22, $p = .002$). The relatively low percentage of patients with overall good outcomes on this measure is partly because many patients with otherwise good outcomes in terms of return to work, pain relief, and medication use still indicate at least moderate physical limitations after the surgery, thus relegating them to the fair outcome category. Thus, we believed the aggregate index may under-represent the number of patients who had an overall good outcome from lumbar fusion surgery. If averages across subscales were used instead of the lowest rated single category to determine total aggregate scores, then the percentage of good outcomes would be substantially higher for both groups (BAK = 39.6%; posterolateral = 29.6%) and the percentage of poor outcomes would be substantially lower (BAK = 18.2%; posterolateral = 26.6%). Nevertheless, the aggregate index was still used in analyses to maintain the reliability and validity associated with established normative scoring criteria.

Short Form-20 Survey

Table 8 contains the follow-up means and standard deviations for the six SF-20 subscales for the posterolateral and BAK fusion groups, along with normative sample means and standard deviations for medical outpatients as provided by Stewart et al. (18, 19). In general, the posterolateral and BAK fusion follow-up means are lower than the normative means, indicating a trend of overall poorer perceived health among patients having lumbar fusion. This is also true for the pain severity subscale because it is coded in an opposite direction from the other subscales and higher scores on this scale are reflective of more severe pain. A MANOVA comparing posterolateral versus BAK mean differences was statistically significant. Post-hoc tests revealed that patients who had BAK procedures perceived better health on the Role Functioning, Mental Health Index, and Pain Severity subscales than those who had posterolateral lumbar fusion. Effect sizes were also calculated for the posterolateral and BAK groups using the guidelines of Glass (20). The normative sample posterolateral deviation was used as the equation denominator. In all cases, the BAK effect sizes reflected better perceived health than comparable effect sizes from the posterolateral fusion group and represented only small to moderate negative differences from the normative patient sample. Table 8 also includes a comparison of the percentage of "poor" outcomes for each subscale in terms of posterolateral fusion, BAK fusion, normative medical outpatient sample, and a general population sample. The general population sample consisted of a random sample of subjects selected for telephone administration of the SF-20 (18, 19). In general, a greater percentage of patients who had had fusion were in poor health across the SF-20 subscales than the normative of general population groups. The BAK group did show consistently lower percentages of patients in poor health than the posterolateral sample for all SF-20 subscales.

Discussion

The purpose of this study was to compare preoperative medical and sociodemographic factors and long-term outcomes of injured workers having posterolateral lumbar fusion versus BAK lumbar interbody fusion. Patients included 370 compensated workers from Utah and Minnesota who received either posterolateral lumbar fusion or BAK lumbar interbody fusion. Patients' medical records were reviewed, and pertinent medical and sociodemographic variables were coded. A telephone outcome survey was conducted with 207 patients (56%) an average of 5 years after surgery. Results of statistical analyses indicated that the 2 cohorts were well matched in terms of preoperative medical and sociodemographic characteristics. Statistical analyses indicated that solid fusion rates, reoperation rate, patient satisfaction, Roland and Morris disability scores, Stauffer-Coventry Index physical limitation subscale, and 4 of 6 SF-20 Multidimensional Health Status subscales were statistically significantly better for the BAK lumbar fusion group. Postoperative disability rates were lower among patients who had BAK fusion than those who had posterolateral fusion (18.2% and 24.6%, respectively).

TABLE 7 ***Stauffer-Coventry Index: subscale scores and aggregate ratings***

Pain Relief			Employment Status			Physical Limitations*			Medication Use			Overall Index Rating†		
Category	PL	BAK	Category	PL	BAK	Category	PL	BAK	Category	PL	BAK	Category	PL	BAK
Good (76%–100% Improvement)	32.3% (42)	44.2% (34)	Good (Return to previous work status)	25.4% (33)	31.2% (24)	Good (Minimal or no restrictions)	16.9% (22)	37.7% (29)	Good (Occasional or no use of mild analgesics)	43.8% (57)	45.5% (35)	Good	6.9% (9)	14.3% (11)
Fair (26%–75% Improvement)	43.1% (56)	42.9% (33)	Fair (Return to lighter work)	50.8% (66)	50.6% (39)	Fair (Moderate restrictions)	51.5% (67)	45.5% (35)	Fair (Regular use of non-narcotic analgesics)	30.0% (39)	29.9% (23)	Fair	43.1% (56)	44.2% (34)
Poor (0%–25% Improvement)	24.6% (32)	13.3% (10)	Poor (No return to work)	23.8% (31)	18.2% (14)	Poor (Severe restrictions)	31.5% (41)	16.9% (13)	Poor (Occasional or regular use of narcotic analgesics)	26.2% (34)	24.7% (19)	Poor	50.0% (65)	41.6% (32)

Posterolateral fusion percentages based on follow-up of 130 subjects; BAK percentages based follow-up of 77 subjects.

*Chi-square = 12.2, $p = .002$

†Final classification based on lowest rated single category.

TABLE 8 Descriptive statistics for short form 20-Multi-Dimensional Health Survey Subscales

SF-20 Subscale*	Posterolateral Fusion Mean (SD)	BAK Cage Mean (SD)	Normative Mean (SD)†	Posterolateral Fusion Effect Size	BAK Effect Size	Percent in Poor Health**			
						Posterolateral Fusion	BAK Fusion	Normal Patients	General Population‡
Physical Functioning (6 items)	46.2 (29.6)	52.3 (35.1)	78.5 (30.8)	−1.05	−0.85	91	84	45	22
Role Functioning§ (2 items)	48.3 (42.9)	63.3 (42.3)	77.5 (38.3)	−0.76	−0.37	66	49	28	12
Social Functioning (1 items)	71.7 (34.1)	80.0 (30.6)	87.2 (23.6)	−0.66	−0.31	27	18	9	NA
Mental Health Index§ (5 items)	62.7 (22.9)	72.6 (24.1)	72.6 (20.2)	−.49	−0.00	51	19	31	19
Current Health Perceptions§ (5 items)	53.7 (27.7)	64.7 (29.2)	63.0 (26.8)	−.35	0.06	66	19	52	20
Pain Severity§ (1 items)	57.2 (22.7)	48.3 (29.6)	31.4 (27.7)	0.93	0.61	67	60	29	NA

*Observed range of all scores was 0–100. A high score indicates better health except for pain, where a high score indicates more pain.

†Normative sample consists of patients presenting to physicians, psychologists, and other mental health providers within HMOs, multispecialty groups, and solo fee for service groups.

**Poor health defined as: physical and role functioning = one or more limitations; social functioning = limitations a good bit of the time or more; mental health = lowest 19% of scores in general population sample (score of 67 or lower) (cutoff defined as close as possible to bottom 20%); health perceptions = lowest 20% of scores in general population sample (score of 70 or lower); pain = moderate, severe, or very severe pain.

‡General population refers to a random sample of subjects selected for telephone administration of the SF-20.19

§$p = <.05$. (ANOVA comparing posterolateral fusion/BAK fusion means).

NA = Not available.

The positive medical and clinical outcomes associated with compensated patients who had BAK interbody fusion are consistent with outcomes in other published series and in fact are comparable to BAK outcomes in noncompensation patients (7–9). Further, clinical outcomes after posterolateral lumbar fusion in this study are generally better than those reported in many published series of compensation patients. For example, in the study of compensated patients from Washington State (5), 68% of patients reported their back or leg pain was worse than what they had expected after surgery, as compared with 36% among our Utah subjects. Fifty-six percent of subjects in the Washington sample believed their quality of life was no better or worse as a result of their surgery, compared with 41% in our Utah sample.

The postsurgical disability rate in Washington was 68% versus 25% in Utah. These Washington and Utah posterolateral samples were comparable in terms of preoperative characteristics and fusion rates, and these outcome differences suggest that the Utah patients who had posterolateral fusion had more favorable outcomes for this procedure. This finding further supports the overall outcome advantages presently identified for the BAK fusion technique.

The most significant limitations of the present study are the use of intact samples and a low follow-up rate. We cannot say definitively that the samples were identical preoperatively in terms of workers' compensation, state disability qualifications, or physical dysfunction, nor can we completely determine whether patients lost to follow-up were systematically different from persons who responded to the survey. However, the statistical analyses comparing respondents versus nonrespondents in terms of preoperative sociodemographic characteristics that are known to influence outcomes were for the most part not statistically different. Arthrodesis rates were obtained for all 370 patients and these rates did not differ as a function of response/nonresponse or by surgical technique. It might also be asserted that the BAK criteria for determining pseudarthrosis were more stringent than the criteria used within the posterolateral cohort. However, if the BAK pseudarthrosis criteria had been applied across the board, the overall difference between the cohorts in terms of fusion rates would likely be even greater in favor of BAK. We also note that while arthrodesis is clearly a critical biomechanical goal of the operation, the correlation between arthrodesis and important patient-oriented outcomes such as disability status and physical function were low across both cohorts. For example, the correlations between arthrodesis (coded 1 = yes/2 = no) and postoperative disability status and the Roland and Morris Disability Scale across the combined outcome cohort ($N = 207$) were $-.248$, and $-.338$, respectively. The correlations did not vary significantly across the two study cohorts. Thus, it is highly unlikely that the overall general conclusion regarding the differing rates of fusion for the two procedures would change if the BAK criteria were applied to both cohorts. We should also mention that outcomes did not differ within the BAK and posterolateral cohorts as a function of operating surgeon.

It is also unlikely that differences in the compensation systems between the states had a differential impact on the patient outcomes observed in this study. As was noted earlier, the rates of persons with work disability within these two states are identical (8.5%). We also note that the percentage of permanent total disability cases due to back pain (including failed back surgery syndrome) in Utah is 63% versus 65% in Minnesota. The 2000 US Census data also revealed substantial similarity between the two states in terms sociodemographic variables such as age, marriage rates, and average income rates. Additionally, data from the CDC Behavioral Risk Factor Surveillance System (2000) indicates that in general, Utah residents tend to engage in slightly better health habits and have slightly lower risk for diseases related to poor health habits (e.g., smoking, drinking, lack of physical activity) than residents in Minnesota. The implication here is that poorer general health status should increase the risk for poor outcomes after surgery. If the samples were equated in terms of these health variables, we believe an even greater advantage for the BAK device might be realized. These data and the fact that BAK outcome advantages were robust across a wide range of measures suggest that the results are interpretable and not likely due to patient differences in the groups

In conclusion, it appears that medical and clinical outcomes for the BAK interbody lumbar fusion are better than posterolateral approaches among injured workers. The strengths of this study were large study cohorts and the use of multiple outcome measures. There is a need for researchers to validate the present findings via a randomized-controlled trial in which nonexperimental variation can be controlled.

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Erratum

In the article titled "Cost Impact of Botulinum Toxin Use in Medicaid-Enrolled Children with Cerebral Palsy" by Balkrishnan et al., which appeared on pages 71–79 of the Summer 2002 issue of the *Journal of the Southern Orthopaedic Association*, James F. Mooney III, MD, was inadvertently omitted from the author listing. We apologize for this omission.