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OUTCOME PREDICTION IN LUMBAR DISC HERNIATION SURGERY

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ABSTRACT

Introduction: It is a well recognized fact that a significant proportion of patients operated on for lumbar disc herniation exhibit a poor outcome, regardless of the apparent technical success of the operative procedure itself.
Aim: to identify a set of widely available variables that accurately predict short-term outcome after discectomy and to develop a predictive model based upon those variables.
Patients and methods: Basic demographic, clinical and radiological variables were evaluated in a group of 70 patient operated on for disc herniation. Outcome was assessed using VAS and RM scales 6 months postoperatively and correlated to aforementioned variables.
Results: Preoperative pain intensity and duration, age and type of disc herniation were all shown to be statistically significant predictors of short-term outcome, unlike sex, type of radiological investigation and preoperative tension sign testing results. Multivariate regression analysis including only variables previously identified as good outcome predictors revealed that the pain intensity exhibited the strongest correlation with outcome, followed by pain duration, type of disc herniation and age. Even though MR scan was more sensitive in detecting disc extrusion than CT (sensitivity of 100% versus 65%, respectively), the presence of preoperative MR scan did not influence the outcome.
Conclusion: The study identified a set of widely available and easily attainable variables as fair predictors of short-term outcome after lumbar discectomy. Subsequent logistic regression resulted in a predictive model whose accuracy is to be determined in another prospective study.

Keywords: *lumbar disc herniation; microdiscectomy; outcome*

INTRODUCTION

The benefit of surgical treatment for some disorders affecting the lumbar spine is not controversial in many clinical circumstances, such as major trauma with gross instability, unstable spondylolisthesis, persistent or complicated spinal infections, and some spinal tumors with progressive neurologic loss. More commonly a patient may contemplate surgical treatment for complications of common degenerative conditions affecting the lumbar disk. In general, 2 clinical syndromes are associated with these degenerative conditions and the clinical course and efficacy of interventions for each is very different. The first is primary back pain with little or no component of radicular symptoms due to nerve root irritation. The second is primary radicular pain, which usually has some component of back pain. Unlike primary back pain for primary lumbar radicular pain syndromes or sciatica, the common clinical perception has been that surgical treatment is more effective and more reasonably considered. In working-age persons, by far the most common cause of sciatica has been lumbar disk herniation.[1] How to treat patients seeking care for

Finding Test	Extrusion		Protrusion		Other		Total	
	N	%	N	%	N	%	N	%
CT	26	37.10	13	18.60	1	2.50	40	57.00
MR	17	24.30	11	15.70	2	2.80	30	43.00
Total	43	60.50	24	34.20	3	5.30	70	100.00

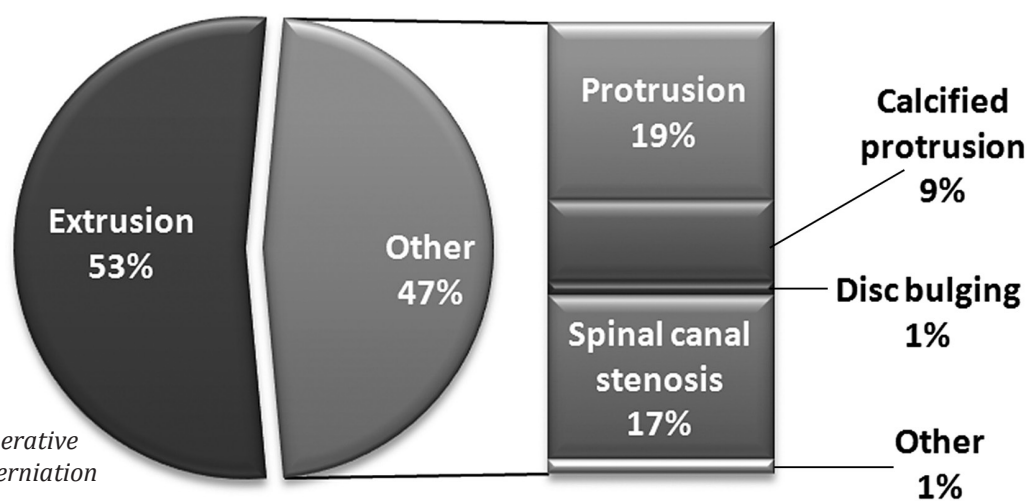**Table 1.** *Disc herniation type according to CT and MRI*

this problem is controversial. In a landmark 1983 randomized controlled study Weber[2] showed that, among patients with more or less tolerable sciatica and without serious motor weakness, a laminectomy and disk removal appeared to be more effective than nonoperative care over at least the first year. Recently several randomized studies reaffirmed the role of surgery in treating disc herniation.[3, 4, 5] It is a well recognized fact that a significant proportion of patients operated on for lumbar disc herniation exhibit a poor outcome, regardless of the apparent technical success of the operative procedure itself. Thus, outcome assessment for patients undergoing lumbar disc surgery may assist in clinical decision making process. Several demographic, clinical and radiological features had been shown to bare some prognostic significance regarding outcome of lumbar disc surgery, while data regarding prognostic influence of other variables is sparse. In fact there are only several studies that attempted to develop a model for predicting outcome of lumbar disc surgery. The aim of this study was to identify a set of widely available variables that accurately predict short-term outcome after discectomy and to develop a predictive model based upon those variables.

PATIENTS AND METHODS

The study was conducted prospectively and encompassed 70 patients operated on for lumbar disc herniation, 30 of which had been subjected to MR scan prior to surgery. Specific inclusion criteria at enrollment were radicular pain (below the knee for lower lumbar herniations, into the anterior thigh for upper lumbar herniations) and evidence of nerve-root irritation with a positive nerve-root tension sign (straight leg raise–positive between 30° and 70° or positive femoral tension sign) or a corresponding neurologic deficit (asymmetrical depressed reflex, decreased sensation in a dermatomal distribution, or weakness in a myotomal distribution). Additionally, all participants were surgical candidates who had undergone advanced vertebral imaging showing disk herniation (protrusion, extrusion, or sequestered fragment) at a level and side corresponding to the clinical symptoms. Patients with multiple herniations were included if only one of the herniations was considered symptomatic (i.e., if only one was planned to be operated on). Exclusion criteria included prior lumbar surgery, cauda equina syndrome, scoliosis greater than 15°, segmental instability (10° angular motion or 4-mm translation), vertebral fractures, spine infection or tumor, inflammatory spondyloarthropathy, pregnancy, comorbid conditions contraindicating surgery, or inability/unwillingness to have surgery within 6 months. Neuroradiological work-up encompassed either CT or MRI scan of the lumbar spine. Scans were analyzed by neuroradiologists and again by neurosurgeons. Measures used in the study were:

•   Roland-Morris (RM) Low Back Pain and Disability Questionnaire

Figure 1. *Distribution of operative findings according to disc herniation type*

Table 2. *Outcome of surgery*

	Pre op	Post op	Difference (%)	p
VAS	76.38	22.65	53.73	< 0.0001
RM	14.04	5.87	8.17	< 0.0001

• Visual Analogue Scale (VAS)

Patients were considered for inclusion only if they had persistent symptoms despite some nonoperative treatment for at least 6 weeks. The content of preenrollment nonoperative care was not prespecified in the protocol but included physical therapy, epidural injections, chiropractic therapy, antiinflammatory medications, and opioid analgesics.

Patients were required to asses their level of pain and functional disability using afore mentioned scales preoperatively and 6 months after the surgery. All patients were operated by the same neurosurgeon and the procedure performed was standard open microdiscectomy. Operative findings in terms of disc herniation type were noted and included in the statistical analysis as a potential predictive factor. Due to the fact that our data were primarily ordinal numbers (acquired by RM test) and continuous values (obtained by VAS scale) unparametric methods were used for calculating statistical significance. Wilcoxon's test and its version for unpaired variables Mann-Whitney test were used for calculating the difference among groups. The first step in statistical analysis was univariate analysis; demographic (age and sex), clinical (pain intensity, duration of pain, dermatomal distribution and Lasegue sign value) and radiological (type of neuroradiological investigation) features were related to outcome graded by VAS and RM scales. Subsequent multivariable re-

gression analysis encompassing variables shown to be fair outcome predictors were performed, followed by logistic regression that revealed a predictive model. A statistical analysis was performed using SPSS software, by a qualified statistician.

RESULTS

Seventy patients were operated on for uncomplicated disc herniation in our department between January and June 2008, 36 (51.4%) of which were male. The mean age at presentation was 45.8 years (SD + 9.39), ranging from 22 to 65 years. All patients presented with back pain radiating to lower extremities, predominantly in L5 (43%) and S1 (39%) dermatomes. Mean duration of pain was 17,4 months (SD + 37.05), ranging from 15 days to 20 years. Strait leg raising test (SLR test) was positive in all patients, ranging from 10 to 90 degrees. Mean SLR test value was 50.7 degrees (SD + 22.73). Motor deficit was present in 12 patients. 30 patients were subjected to magnetic resonance (MR) scanning and the remainder of 40 patients was scanned by computed tomography (CT). Radiological findings were classified as protrusion, extrusion or spinal canal stenosis as depicted in table 1.

All patients were subjected to standard microdicectomy, performed by experienced neurosurgeons. Distribution of operative findings according to disc hernia-

Table 3. *Correlation between demographic, clinical, radiological and morphological variables with outcome*

Variable (cut-off point)*	Correlation with outcome – VAS**	Correlation with outcome – RM**
Gender	0.92	0.85
Age (50 years)	0.0093	0.0355
Pain intensity	<0.0001	<0.0001
Pain duration (6 months)	0.0172	<0.0001
Dermatome distribution of pain (L5 or S1)	0.4479	0.4674
SLR test value (45 degrees)	0.1015	0.3608
Herniation type (operative findings)	0.0018	0.0020
Neuroradiological test type (CT or MRI)	0.3671	0.9527

Cut-off points for continuous variables are based on mean values
**Correlation is expressed by p value*

Table 4. *Multiple regression analysis encompassing statistically significant outcome predictors*

Parameter	VAS			RM		
	Correlation coeficient	Standard error	t-value	Correlation coeficient	Standard error	t-value
Pain intensity	0.482	6.95478	4.876	0.484	1.62157	4.428
Operative findings (herniation type)	0.325	8.82460	-2.054	0.270	1.62633	1.686
Pain duration	0.309	8.84330	-1.787	0.352	1.69184	1.693
Age	0.208	8.51974	-1.545	0.275	1.61881	2.837

*Outcome graded by VAS and RM scales was used as an independent variable

tion type is depicted in figure 1.

Outcome after discectomy as graded by VAS and RM scales (defined as difference in pain intensity and functional capabilities prior to and after surgery) is shown in table 2. Recovery is defined as percentage of reduction of either VAS or RM values 6 months after the surgery as compared to values prior to surgery.

Table 3 reveals correlation between demographic (age and sex), clinical (pain duration and intensity, SLR test), radiological (type of preoperative radiological test, type of disc herniation on CT or MR scans) and morphological variables (operative findings) and outcome.

Based on afore mentioned results it is evident that pain intensity, pain duration, operative findings and age correlate fairly (significantly) with outcome, thus relative predictive value of those variables was compared by multiple regression analysis, as shown in table 4. Logistic regression analysis revealed a model for outcome prediction after lumbar disc surgery.

DISCUSSION

Studies yielding prognostic models for lumbar disc surgery are indeed infrequently encountered, and moreover, they seem to be inconsistent in terms of factors they analyze and seem to include variables that are not routinely obtained in common clinical practice. It was our intent to provide a prognostic model for lumbar disc surgery encompassing solely variables that are easily and routinely attainable that have previously been postulated as fair outcome predictors. It seemed intuitive to include basic demographic data such as age and gender in our study. We showed that gender bares no prognostic significance, unlike study by Strömqvist

et al.[6] that revealed that women have somewhat less favorable outcome after lumbar disc surgery.

Unlike gender, age proved to be statistically significant outcome predictor. Few other authors investigated influence of age on outcome of lumbar disc surgery, and they generally failed to reveal prognostic relationship.[7,8] As far as clinical variables are concerned both pain duration and intensity were shown to be fair outcome predictors, which is in concordance with the vast majority of similar studies.[9,10,11,12] SLR test values failed to exhibit prognostic power in our study, which opposes common clinical opinion that SLR values pose most reliable element in decision making process regarding surgery. However, several other studies support our findings, including study by Wilco et al.[13] Their findings were that classical signs did not show any contribution as decision support tools in deciding when to operate for sciatica, whereas treatment effects of early surgery are emphasized when sciatica is provoked by sitting and negligible when this symptom is absent. Dermatomal pain distribution correlated poorly with outcome. Similar conclusions were reached in the study that analyzed SPORT study cohort in order to examine relationship between dermatomal distribution of pain and outcome.[14]

Radiological features play a crucial role in decision making process regarding lumbar disc surgery. We analyzed the impact that the choice of preoperative neuroradiologic test poses on outcome, and failed to reveal any significant relation. Even though randomized studies investigating prognostic value of neuroradiological test type are lacking, several studies indirectly imply that there is no significant correlation.[15,16] We determined that intraoperative finding of extrusion (as opposed to protrusion) implies a significantly better outcome. Similar conclusions were reached by Dewing et

al.[17] and Caragee et al.[1]

Regarding multiple logistic regression there are very few studies that compared predictive power of various outcome predictors. The great majority of these were focused on a very limited set of variables (i.e. several studies included only demographic data in multiple logistic regression). Among those studies the study of Barrios et al.[18] encompassed 150 patients subjected to microdiscectomy, with follow up period of 5 years. This study revealed that the application of autotraction during conservative treatment showed the major prognostic value, predicting excellent outcome.

Table 4. *Logistic regression analysis*

Variable	VAS OR *	RM OR*
Pain intensity	2.094	4.7002
Operative findings	1.083	0.4412
Duration of pain	0.944	0.2909
Age	0.7847	0.2468

* OR- Odds ratio

Other statistically significant parameters were a sedentary type of work and absence of motor or sensory deficits. The presence of intraoperative complications, namely dural tears, level errors, or root damage indicated a poor prognosis. When the combined influence of all epidemiological variables was assessed by multiple regression analysis, a significant correlation could be found; the use of autotraction prior to surgery was the most important predicting factor. Graver performed multiple regression analysis on 122 patients revealing that female participants experienced less favorable outcome and that both impaired fibrinolytic activity and stress resulted were related to poor outcome. Age, body weight, smoking habits, number of operated discs did not prove to be good outcome predictors.[19] Caragee et al.[1] concluded that clinical and demographic data could predict outcome of lumbar disc disease in conservatively treated patients, while MR features are far better outcome predictors in surgically treated patients.

Nygaard et al.[10] investigated different variables that can be used to predict outcome after lumbar microdiscectomy. In a prospective study of 132 consecutive patients who underwent surgery for lumbar disc herniation, the authors evaluated the prognostic value of different variables in the duration of symptoms for the 1-year period after surgery. As for factors predictive of outcome, only duration of leg pain and sick leave reached statistical significance in the multivariate analysis. Results of the univariate analysis demonstrated that in patients experiencing preoperative leg pain few-

er than 4 months and between 4 and 8 months, a significantly lower COS (Clinical Overall Score based on four subsets-pain intensity (VAS), physical signs, functional status (Oswestry) and analgesics-was used as the main outcome criterion) at the 1-year follow up was demonstrated compared with those in whom the duration of leg pain was longer (> 8 months). One hundred eight patients returned to work within the 1st year after surgery. Patients who took a sick leave of more than 28 weeks before the operation were at higher risk of not returning to work. Analysis of these results indicates that leg pain lasting more than 8 months correlates with an unfavorable postoperative outcome in patients with lumbar disc herniation, as well as a high risk of not returning to work.

Results of the study conducted by Geatani et al. were published in 2004.[20] The records of 403 patients treated for herniated lumbar disc disease were analyzed in a retrospective observational study in order to verify how three outcome measures, i.e., satisfaction with the outcome of surgery, the degree of return to activities of daily living including work (ADL), and duration of interruption of ADL, may be influenced by clinical variables. Age, type of disc herniation, radiological evidence of recurrence (radiological recurrence), and need for a second surgical operation for disc herniation (surgical recurrence) were found to be significantly related to the patient's satisfaction with the outcome of surgery at follow up. Satisfaction with the outcome of surgery was not found to depend on the interval between clinical onset and radiological diagnosis, or on the timing of surgery. The degree of return to ADL was found to be significantly related to age, surgical recurrence, type of disc herniation, and timing of surgery. Authors concluded that age and type of disc herniation are among the most important factors to consider when deciding whether or not to operate on a patient for herniated lumbar disc and that return to ADL after surgery is closely correlated with disc disease recurrence.

Based on this brief review it is evident that most studies on outcome prediction in lumbar disk surgery included variables that are not routinely attainable (such as impaired fibrinolytic activity in the study by Barrios) or variables that are not available in early postoperative period (such as need for second surgery in the study by Gaetani). Unlike previously mentioned studies, our set of outcome predictors included only widely available and easily attainable variables.

We managed to show that certain clinically attainable variables such as pain intensity, type of disc herniation as assessed preoperatively, duration of pain in the preoperative period and age are fair outcome predictors in lumbar disc herniation surgery.

Logistic regression analysis performed on all variables that proved to be fair outcome predictors resulted in prognostic model for predicting outcome of lumbar disc surgery, whose accuracy is yet to be confirmed by prospective study.

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