Outcome evaluation of the operative management of lumbar disc herniation causing sciatica

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Object. The authors conducted a study to assess health-related quality of life (HRQOL) and the appropriateness of surgery in patients who have undergone elective lumbar discectomy.

Methods. The study involved a prospective cohort of 82 surgically treated patients with lumbar disc herniation causing lower-extremity radiculopathy. An independent study coordinator recorded demographic data and administered the North American Spine Society (NASS) lumbar spine instrument and the Short Form–36 (SF-36) before treatment, and at 6 months and 1 year after surgery. The HRQOL results were also compared with normative data for the NASS and SF-36. The influence of baseline variables on HRQOL was determined using regression modeling. The InterQual Indicators for Surgery and Procedures (ISP) were used to compare surgeon practice patterns with standardized indications for surgery.

The NASS neurogenic symptom (NSS) and pain/disability scores (PDSs) showed very significant improvement at 6 months and little change between 6 months and 1 year. The SF-36 physical function and bodily pain scale scores were associated with the greatest improvement. Interestingly, the 1-year NASS (NSS and PDS) and SF-36 (only PCS) scores remained lower than those of age-matched normative data. Other than preoperative HRQOL scores, the only other variable that inversely influenced HRQOL was the duration of time between symptom onset and surgery. Ninety-five percent of ISP forms were completed, and 97% of the indications recorded by the surgeon matched the criteria.

Conclusions. The reporting of standardized outcomes in association with indications for surgery is feasible and may help elucidate the ideal rate for discectomy.

KEY WORDS • lumbar spine • discectomy • quality of life • surgical indications • outcome

In this era of increasing accountability for healthcare services, access to effective healthcare is of paramount importance. Recently, the National Academy of Science Institute of Medicine defined quality of healthcare as the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge. Thus, improvements in accountability must clearly include indicators of efficacy. Accountability requires that increased emphasis be placed on bringing patterns of clinical practice into line with current scientific evidence and that effectiveness of current health services at producing desirable health outcomes be reported.

Radiculopathy secondary to lumbar disc herniation is a common problem that can greatly compromise QOL. Consequently, lumbar discectomies are among the most common elective surgical procedures performed in North America. Despite the prevalence of this elective procedure, controversy exists as to whether to treat lumbar disc herniations nonoperatively or surgically, as well as the optimal timing of this procedure. Although the related literature is comprehensive, most studies have not been epidemiologically sound. More importantly, little attention has been paid to the measurement of the principal outcome for which the procedure was originally designed—specifically, the patient’s HRQOL, objectively evaluated using reliable, validated, and responsive HRQOL instruments.

A recent editorial in the New England Journal of Medicine underscores the value of guidelines in surgical decision making and their use is strongly endorsed. Interestingly, even with these guidelines in the public domain, small areas of considerable variation in rates of discectomy have been identified in both Canada and the US. It is known that this variation is independent of age and sex and is not explained by differences in disease incidence. The variability probably reflects either restricted access to effective treatment or disproportionately high rates of surgery. The appropriateness of discectomy can be assured only...
when there is improvement in the patients’ HRQOL following surgery performed for the appropriate indications.

The primary objective of this study was to compare preoperative disease-specific HRQOL outcomes by using the NASS instruments NSS and PDS with 6-month postoperative scores in patients who underwent elective lumbar discectomy.

Secondary objectives included the following: 1) the assessment of self-reported NASS-based HRQOL outcomes at 1 year postoperatively, as well as the generic HRQOL scores, based on the SF-36, at 6 months and 1 year postoperatively; 2) the influence of various baseline variables on HRQOL outcomes; 3) the agreement between the InterQual ISP and current surgeon practice patterns with regard to lumbar discectomy;2 and 4) the feasibility of implementing a systematic evaluation of both outcomes following lumbar discectomy for sciatica and the appropriateness of the decision to treat these patients surgically.

Clinical Material and Methods

We performed a prospective cohort study of patients undergoing operative management for lumbar disc herniation causing sciatica. The objectives and proposed methodology were presented to all 10 surgeons performing lumbar discectomy within a healthcare region. The surgeons were presented with the protocol, outcome survey instruments, and an overview of the ISP criteria relevant for the hemilaminectomy, lumbar discectomy/foraminotomy from the InterQual ISP.22

Patient Population

All consecutive patients scheduled to undergo elective lumbar discectomy at Vancouver General Hospital between November 1999 and September 2000 were identified when the operation was scheduled. Inclusion criteria included lumbar disc herniation causing lower-extremity radiculopathy, age greater than 16 years, and informed consent for both surgery and study participation. Patients were excluded if they had previously undergone spine surgery at the same level, suffered severe comorbidity that would influence outcome measures, exhibited spinal deformity (scoliosis or spondylolisthesis), or were pregnant.

The healthcare region was the lower mainland of British Columbia, a large metropolitan area in a Canadian province with a catchment population of approximately 2 million. Healthcare coverage in Canada is generally provided by one insurer, with the exception of work-related injuries that are covered by the Workers’ Compensation Board. Patients were referred to one of the 10 surgeons by their family physician. Patients were seen either in the surgeon’s office or the Acute Disc Clinic, a weekly hospital clinic staffed by one surgeon and one physician specializing in nonoperative spine care. The clinic is unique to the healthcare region, and the authors are not aware of another one of its kind in Canada. Twelve (14.6%) of the patients were seen in the clinic and 70 patients (85.4%) were seen in the surgeons’ private offices. The referral of patients to the specialist by their family doctor is the pathway by which patients see specialists in the Canadian healthcare system.

Study Protocol

After the patients were identified and informed consent was obtained, the surgeon recorded the clinical symptoms, signs, imaging results, and treatment plan on a standardized data collection sheet. An independent study coordinator conducted a follow-up review with the surgeon to collect the data sheet and obtain clarification as needed. The study coordinator reviewed the submitted data to determine if the patients’ indications matched the ISP criteria. The study coordinator mailed postoperative surveys at 6 months and 1 year after surgery. Healthcare providers were not involved in the administration of the outcome assessments.

The HRQOL Instruments

The NASS lumbar spine instrument is a widely accepted disease-specific tool by which to assess the outcome of elective spinal surgery.13,15,16,26,29,30 The authors of a previous study demonstrated that the measure was reliable, valid, and responsive in measuring back pain, neurogenic symptoms, and related disability.10 A change of 20% or more in the NASS NSS and PDS is considered a clinically significant difference.13

The SF-36 is a widely published, validated, and reliable generic HRQOL questionnaire. It consists of 36 self-administered questions that are converted to scores out of 100 for eight HRQOL domains with two summary scores—the PCS and MCS.14,36,38 It has been used previously in published studies for outcome assessment of lumbar discectomy.3,20,35

Therapeutic Principles

Surgeons completed the standard data sheet that included patients’ symptoms and signs, history of the condition, previous treatment interventions, diagnostic procedures (magnetic resonance or computerized tomography imaging), and planned treatment. At Vancouver General Hospital patients underwent an open or microscopic lumbar discectomy performed by one of six neurosurgeons or four orthopedic spine surgeons. The surgeon recorded operative findings and intraoperative complications on standard data sheets. Most patients were encouraged to mobilize progressively immediately after surgery and to return to most activities at 6 to 8 weeks postoperatively. Physiotherapy or other rehabilitation activities were left to the discretion of the treating surgeon. The study coordinator recorded early (within hospital) and late (6-week postoperative visit) complications.

The InterQual ISP guidelines22 were selected for this project from a range of commercial products now available (Appendix 1). The ISP tool provides well-validated reference and research best practice guidelines for over 600 surgical procedures.

Statistical Analysis

All variables were described using standard descriptive statistics. Time between symptom onset and surgery was transformed into a square root scale when the variable was used as a continuous variable. This transformation produced a more symmetrical Gaussian distribution and stabilized variance.
Mean values of baseline characteristics were compared with those obtained in patients who were lost to follow up at 6 months and/or 1 year; we used the t-test for continuous variables and overall differences across categories by using the Fisher exact probability test for independence. All tests of significance were based on two-sided hypotheses at the probability level of 0.05 for significance. Analyses were conducted using the Statistical Analysis System (version 8.2; SAS Institute, Cary, NC). Patients in whom values were partially missing were automatically excluded from the analyses.

Two scores were computed from the NASS: the NSS and the PDS. First, raw scores were created by computing the mean for items 47 to 49 and 51 to 53 for the NSS, as well as items 46, 50, and 54 to 62 for the PDS. Second, scores were standardized to a number between 0 and 100. Low scores indicated poor function and high scores indicated good function. Third, individual normative scores were derived, in which the mean was 50 and SD was 10. In all the analyses, the scores used were individual normalized values.

Generic HRQOL outcome was assessed using the SF-36, and eight domains were produced. All domains were scored on a scale between 0 and 100, in which 100 represented the best possible health state. The SF-36 PCS and MCS were derived from the eight SF-36 scales, which have been interpreted as physical and mental dimensions of health status. The PCS and MCS were graded in three steps according to the standard SF-36 scoring algorithms. First, each SF-36 scale was standardized using a z-score transformation and SF-36 scale means ± SD from the Canadian normative data for the SF-36. A z score for each scale was computed by subtracting the Canadian population mean from each SF-36 scale score and then dividing the difference by the corresponding scale SD. Second, calculation of an aggregate component score consisted of multiplying each SF-36 scale z score by its respective factor score coefficient and summing the eight products. Third, each aggregate component score was transformed to the normative score by multiplying each aggregate component scale score by 10 and adding the result to 50.

Comparisons of means between outcomes at 6 months and 1 year with normative values were performed with the Student t-test or with the signed rank-sum test for data with nonnormality. The NASS lumbar spine normative values for NSS and PDS were acquired from the American Academy of Orthopaedic Surgeons and were age matched. The normative data for the SF-36 were obtained from the sex-standardized Canadian normative data for the group of individuals 35 to 44 years of age. A mixed-effect model with repeated-measures analysis was used to examine the pattern of change over time for the NSS and PDS as well as the PCS and MCS. To account for the correlation among observations from the same patient, the covariance structure of the repeated-measures analysis was modeled in each case.

The changes in four scores generated from the NASS and the SF-36 (NSS, PDS, PCS, and MCS) between follow-up points and preoperative measures were assessed according to baseline predictors, Workers’ Compensation status, location for diagnosis and treatment, treatment by doctor, and time between symptom onset and surgery; calculation was performed using multiple regression models and adjusting for age and prospective preoperative evaluation. The tests of linear trend for increasing duration between symptom onset and surgery were performed using multiple regression model, by treating this duration as a continuous variable (square root scale).

**Results**

Ninety-nine patients were eligible for the study between November 1999 and September 2000 at Vancouver General Hospital. Of these, 82 patients consented to participate in the study; 77 (94%) of 82 patients participated in the 6-month follow-up examination and 71 (87%) in the 1-year follow-up evaluation. The comparison of the baseline characteristics of patients included in the study with those acquired in patients lost to 6-month and/or 1-year follow-up review showed no significant difference (data not shown).

Table 1 provides a summary of basic descriptive baseline data. The mean and median ages were 42.2 and 40 years, respectively. Of 82 patients, 52 (63.4%) were male; 10 (12.2%) were receiving Workers’ Compensation; 12 (14.6%) went to the Acute Disc Clinic for diagnosis and treatment and 70 (85.4%) consulted at a private office; 54 patients (65.9%) were treated by neurosurgeons, whereas 28 (34.1%) were treated by orthopedic spine surgeons. In 76 patients (92.7%) there was a primary operative indication of lower-extremity pain continuing or worsening and/or weakness/motor deficit continuing or worsening. Thirty-eight patients suffered a disc herniation at L4-5 (46.3%), 41 (50%) at L5–S1, and the remainder at L2–3.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. of Patients (%)</th>
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<tbody>
<tr>
<td>sex</td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>52 (63.4)</td>
</tr>
<tr>
<td>female</td>
<td>30 (36.6)</td>
</tr>
<tr>
<td>age (yrs)</td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>42.2</td>
</tr>
<tr>
<td>range</td>
<td>17–83</td>
</tr>
<tr>
<td>receiving Workers’ Compensation</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>10 (12.2)</td>
</tr>
<tr>
<td>no</td>
<td>72 (87.8)</td>
</tr>
<tr>
<td>place of diagnosis/treatment</td>
<td></td>
</tr>
<tr>
<td>Acute Disc Clinic</td>
<td>12 (14.6)</td>
</tr>
<tr>
<td>consult (private office)</td>
<td>70 (85.4)</td>
</tr>
<tr>
<td>treatment by physician</td>
<td></td>
</tr>
<tr>
<td>neurosurgeon</td>
<td>54 (65.9)</td>
</tr>
<tr>
<td>orthopedic spine surgeon</td>
<td>28 (34.1)</td>
</tr>
<tr>
<td>primary op indications</td>
<td></td>
</tr>
<tr>
<td>LE symptoms continued</td>
<td>43 (52.4)</td>
</tr>
<tr>
<td>weakness/motor deficit continued</td>
<td>3 (3.7)</td>
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<tr>
<td>weakness/motor deficit worsened</td>
<td>3 (3.7)</td>
</tr>
<tr>
<td>LE symptoms/weakness, motor deficit continued</td>
<td>25 (30.5)</td>
</tr>
<tr>
<td>LE symptoms continued &amp; weakness/motor deficit worsened</td>
<td>8 (9.8)</td>
</tr>
<tr>
<td>levels of discectomy</td>
<td></td>
</tr>
<tr>
<td>L2–3</td>
<td>2 (2.4)</td>
</tr>
<tr>
<td>L3–4</td>
<td>1 (1.2)</td>
</tr>
<tr>
<td>L4–5</td>
<td>38 (46.3)</td>
</tr>
<tr>
<td>L5–S1</td>
<td>41 (50)</td>
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</table>

* LE = lower-extremity.
TABLE 2

Summary of distributions between symptom onset and surgery*

<table>
<thead>
<tr>
<th>No. of Mos</th>
<th>No. of Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–3</td>
<td>9 (11)</td>
</tr>
<tr>
<td>3.1–6</td>
<td>18 (22)</td>
</tr>
<tr>
<td>6.1–9</td>
<td>16 (19.5)</td>
</tr>
<tr>
<td>9.1–12</td>
<td>9 (11)</td>
</tr>
<tr>
<td>&gt;12</td>
<td>25 (30.5)</td>
</tr>
<tr>
<td>missing</td>
<td>5 (6.1)</td>
</tr>
<tr>
<td>total</td>
<td>82</td>
</tr>
</tbody>
</table>

* The mean duration between symptom onset and operation was 51 weeks (range 0.4–209.9 weeks).

and L3–4. The mean time from symptom onset to surgery was 51 weeks and the median was 38 weeks. Table 2 provides a summary of durations between initial onset of symptoms and surgery.

Table 3 shows the NSS and PDS as well as the MCS and PCS preoperatively, at 6 months, and at 1 year. The higher score implies a better health status. For all measures, the scores increased with the length of follow-up period. The probability values determined when comparing baseline, 6-month, and 1-year evaluation data were strongly statistically significant (all p < 0.001). There was little change between the 6-month and 1-year HRQOL scores. Clinically significant improvement (> 20%) occurred in 77% of patients according to the NSS and 82% according to the PDS, whereas in 10% of patients NSS declined and in 3% the PDS declined. Two patients experienced early (within-hospital) complications (incidental durotomy) and six patients suffered late (> 4 weeks after surgery) complications (recurrent disc), all requiring revision surgery (7.7%).

Six-month and 1-year follow-up values of the NASS (NSS and PDS) and SF-36 scale (PCS and MCS) compared with normative data are shown in Fig. 1. Both of the NASS scores were significantly lower than normative values after 6 months and 1 year (all p < 0.001). The SF-36 MCS at 1 year, however, was not significantly different from the normative data, which indicated that the MCS had recovered to normal. The mean PCS at 6 months and 1 year was significantly less than normative data (both p < 0.001).

Comparisons of the 6-month and 1-year postoperative scores acquired using the SF-36 eight individual domains with normative data are shown in Fig. 2. Similar to the SF-36 PCS, individual scores related to pain and physical status were significantly lower than normative scores.

The participating surgeons completed clinical indications forms for 95% of patients. Ninety-seven percent of indications stated by surgeons for lumbar discectomy matched the ISP criteria (Appendix 1).

Of the 77 patients participating in 6-month follow up, 57 (74%) were working prior to onset of their leg/back symptoms. Of these 57 patients 21 (37%) took time off work because of leg/back symptoms, whereas 36 (63%) continued working even after the onset of symptoms. At follow up seven of the 21 patients not working returned to work, whereas 35 of 36 who continued to work after symptom onset also returned to work postoperatively. The mean number of days to return to work was 73. Fourteen of the 21 patients did not return to work for the following reasons: health related to leg/back symptoms (six cases); disability related to leg/back symptoms (two cases); student (one case); retraining (one case); could not find work (one case); and missing information (three cases). One of 36 was receiving disability benefits (did not return to work) because of leg/back problems.

Using multiple regression models, we examined the effect that baseline variables had on HRQOL. Independent variables included Workers’ Compensation status, location of consultation, surgeon, and time between symptom onset and surgery. A change in PDS from preoperative to 1 year after surgery was associated with time from symptom onset to surgery after adjustment for sex, age, and PDS at preoperative assessment (Table 4). In an adjusted model, when time between symptom onset and surgery was 6.1 to 9, 9.1 to 12, and more than 12 months the PDS was significantly worse at 1 year compared with when this period was only 0 to 3 months (p = 0.04, 0.024, and 0.029, respectively). At 1 year postoperatively, patients in whom the duration between symptom onset and surgery was longer had significantly less improvement in PDS than those who underwent surgery early on (p = 0.026). All other predictors at baseline showed no evidence of association with the mean change in the NASS or the SF-36 scores.

**Discussion**

This study’s primary objective was to compare preoperative disease-specific HRQOL outcomes (NASS) with 6-month postoperative scores in patients undergoing elec-
Health-related quality of life after lumbar discectomy

tive lumbar discectomy. The NASS instrument demonstrated striking improvement after surgery compared with preoperative measures, as reflected by the NSS and PDS. There was a comparable significant improvement in the generic HRQOL SF-36 scores. The minimal difference between scores at 6 months and 1 year suggests that the effect can be adequately determined at 6 months and that the 1-year follow-up review is probably redundant. A similar observation has been noted in cases involving spinal stenosis. This study, however, was not conducted to address long-term follow-up results, where outcome after lumbar discectomy has been reported to be inferior to that obtained in the first 2 years following surgery. In the present study 96% of respondents registered improvement in the NASS PDS, with 82% being greater than the generally accepted clinically significant improvement (20% on the NASS instrument) at 6-month follow-up review. For the NSS, 85% improved, 5% were the same, and 10% were worse. As expected, there was a positive correlation between the magnitude of symptoms/disability preoperatively and the degree of improvement reported after surgery.

Outcomes in this study are comparable and perhaps more favorable than those of other prospective or randomized studies. In the most widely recognized study, Weber reported that only 65% of patients who underwent surgery experienced improvement. The validity of that study has been questioned because of concerns regarding significant selection bias. The authors of several recent well-designed prospective cohort studies have shown favorable early results in patients who underwent lumbar discectomy. The authors’ results are similar for both disease-specific and generic outcome measures, although it has been noted that unless identical outcome measures are used comparisons between studies and centers are difficult.

The only relevant difference between our study and others appears to be in the mean time between symptom onset and surgery. The mean of 49 weeks was considerably longer than that in most comparable studies. The considerably longer period between symptom onset and surgery was probably a result of limited access to care within the Canadian healthcare system where there are waiting lists for both surgical assessment and treatment. In the study by Atlas, et al., in only 30% of patients who under-

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**Fig. 1.** Bar graphs. Upper: The NASS subscale scores at 6 months postoperatively, 1 year postoperatively, and normative age-matched data. Lower: The SF-36 subscale scores 6 months postoperatively, 1 year postoperatively, and normative age-matched data.
went surgery was the duration between symptom onset and operation longer than 6 months, with 47% experiencing symptoms for 3 months or less. The patients in our study still experienced significant improvement in outcome despite greater duration of symptoms; the trend of waiting longer was associated with less improvement. This supports previous findings that prolonged sciatica is correlated with a poorer outcome.\textsuperscript{19,28}

The comparison of the disease-specific and generic HRQOL outcome scores with normative data in disc disease is unique to this study and has generated interesting results. Despite very significant improvements in 6-month and 1-year postoperative scores compared with preoperative scores, the NSS, PDS, and PCS at 6 months and 1 year did not return to what would be considered “normal.” If one assumes that the study patients were “normal” prior to the onset of their disc herniations, these findings would suggest that once the impairment is relieved, function and pain improves, but an element of disability remains even at 1 year. Anecdotally this may not be highly relevant because it has been noted by the authors that most patients “appear” to get back to “normal”—hence, the importance of objective HRQOL measures. Although 1 year would appear ample time for complete recovery and rehabilitation, this may not be the case. These results make one speculate that perhaps more focused or unique perioperative counseling and/or a postoperative rehabilitation program is necessary to enhance an already good surgery-related outcome to one that all healthcare professionals strive for—that is, returning the patient to normal health. Finally, the assumption these patients were healthy prior to their illness may be flawed, and perhaps patients who develop disc herniations represent a domain of the overall population that would exhibit abnormal baseline SF-36 values.

There were six patients (8%) in this study who underwent reoperation for recurrent herniation. This rate is higher than the 6.5% reported in the Maine study\textsuperscript{3} and that reported in retrospective studies.\textsuperscript{17,28} Surgery-related complications in the present study included a superficial infection rate (1%) and incidental durotomy (2.2%), which are consistent with the literature.\textsuperscript{17}

A unique feature of this study is that it combines standardized outcomes with standardized indications for surgery (InterQual ISP). Some degree of standardization for reporting indications is necessary to ensure appropriateness and to arrive at guidelines that will assist in minimizing variation in regional rates of surgery.

The reported discectomy rate of 24 per 100,000 individuals in the Health Region in which this study was conducted is low compared with rates in other parts of the province and other countries (US 70/100,000 and Finland 35/100,000 individuals).\textsuperscript{9} This low rate, in conjunction with the high rate of matching indications, excellent outcomes, and mean duration of preoperative symptoms (49 weeks), suggests that the ideal rate of discectomy may be significantly higher than that evident in this region.

Limitations of this study are not insignificant. This is a prospective cohort outcome study examining only the results of one treatment option for lumbar disc herniation with radiculopathy. There was no nonoperative (control) arm. There is a strong possibility of selection bias in the type of patient that had access to surgical care, the choice

![Fig. 2. Bar graph illustrating eight SF-36 subscale scores preoperatively, at 6 months, at 1 year, and normative age-matched data.](image-url)
of patients for whom information was submitted, and those to whom surgery was offered. Furthermore, the fact that the surgeons know that they are being assessed for use of surgical guidelines would probably modify their patient selection, the so-called Hawthorne effect. Outcome was not influenced by whether the patient was seen in the Acute Disc Clinic or the surgeon’s office and if the surgeon was a neurosurgeon or orthopedic spine surgeon.

The 94% response rate to postoperative questionnaires at 6 months and the 87% response rate at 1 year are well above the 50 to 60% range that is considered to be adequate for sound analysis, and they surpass the gold standard of 80%. This suggests that sampling bias is not an issue. The fact that this patient population reflects all the discectomies performed in one health region also limits the sampling basis.

The results of this study suggest that with appropriate infrastructure, the systematic collection of indications and outcomes can be introduced to a healthcare region. Implementation strategies would have to include incentives for both healthcare providers and administrators. Furthermore, well-defined epidemiological data should be used to guide this process and properly evaluate the resulting rates of surgical procedures and quality of patient care. This might facilitate and objectify the policymakers’ decision process with respect to resource allocation.

**Conclusions**

The NASS NSS and PDS showed very significant improvement at 6 months, with little change between 6 months and 1 year after surgery. The SF-36 scales demonstrated the greatest improvement. Interestingly, the 1-year NASS (NSS and PDS) and SF-36 (PCS only) values remained lower than age-matched normative data. Other than preoperative HRQOL scores, the only other variable that inversely influenced HRQOL was the duration between symptom onset and surgery. Ninety-five percent of ISP forms were completed, and 97% of the indications recorded by the surgeon matched the criteria. These results show that when ISP guidelines are followed excellent surgery-related results with respect to HRQOL can be expected. Furthermore, with the prolonged duration of preoperative symptoms appearing to impact negatively the patient’s outcome and the relatively low rate of surgery in this healthcare region, it appears that a higher rate of surgery should be considered.

**Acknowledgments**

We would like to thank Dr. Charles Wright, and Yoel Robens-Paradise for their invaluable contributions to this project.

**Appendix**

InterQual Indications for Surgical Procedures
Hemilaminectomy, Lumbar Discectomy/Foraminotomy

**Physician:**

**Patient:**

**D.O.B. (yy/mm/dd):**

**Patient Diagnosis:**

**Scheduled Surgical Procedure:**

Check all SYMPTOMS/FINDINGS that apply:

- L-3 nerve root compression
- severe unilat quadriceps weakness/mild atrophy
- mild-to-moderate unilat quadriceps weakness
- unilat hip/thigh/knee pain

- L-4 nerve root compression
- severe unilat quadriceps/anterior tibialis weakness/mild atrophy
- mild-to-moderate unilat quadriceps/anterior tibialis weakness
- unilat hip/thigh/knee/medial pain

- L-5 nerve root compression
- severe unilat foot/toe/dorsiflexor weakness/mild atrophy
- mild-to-moderate foot/toe/dorsiflexor weakness
- unilat hip/lateral thigh/knee pain

- S-1 nerve root compression
- severe unilat foot/toe/plantar flexor/hamstring weakness/mild atrophy
- mild-to-moderate unilateral foot/toe/plantar flexor/hamstring weakness
- unilat buttock/posterior thigh/calf pain

Check all the IMAGING FINDINGS which apply:

- nerve root compression
- L3
- L4
- L5
- S1
- lat disc rupture
- lat recess stenosis

Diagnostic IMAGING STUDIES performed:
- MR imaging
- CT scanning
- myelography
- CT myelography

NONSURGICAL TREATMENTS performed:
- nonsteroidal antiinflammatory drug therapy (≥ 6 wks)
- other analgesic therapy (≥ 6 wks)
- corticosteroid therapy (≥ 6 wks)
- muscle relaxants (≥ 6 wks)
- activity modification (≥ 6 wks)
Afer nonsurgical treatment, check ALL applicable statements:
symptoms (pain) continued
findings (weakness/motor deficit) continued
weakness/motor deficit worsened

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