Outcome after laminectomy for lumbar spinal stenosis

Part I: Clinical correlations

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All patients who underwent decompressive lumbar laminectomy in the Washtenaw County, Michigan metropolitan area during a 7-year period were studied for the purpose of defining long-term outcome, clinical correlations, and the need for subsequent fusion. Outcome was determined by questionnaire and physical examination from a cohort of 119 patients with an average follow-up evaluation interval of 4.6 years. Patients graded their outcome as much improved (37%), somewhat improved (29%), unchanged (17%), somewhat worse (5%), and much worse (12%) compared to their condition before surgery. Poor outcome correlated with the need for additional surgery, but there were few additional significant correlations. No patient had a lumbar fusion during the study interval.

The outcome after laminectomy was found to be less favorable than previously reported, based on a patient questionnaire administered to an unbiased patient population. Further randomized, controlled trials are therefore necessary to determine the efficacy of lumbar fusion as an adjunct to decompressive lumbar laminectomy.

KEY WORDS • lumbar spine • spinal stenosis • low-back pain • fusion • decompressive lumbar laminectomy • outcome

LOW -back pain constitutes a major socioeconomic and medical problem in the United States. In 1984, low-back pain cost an estimated $16 billion and disabled 5.4 million Americans. In the workforce alone, low-back pain accounts for an estimated 10 million sick days per year. A growing proportion of low-back surgery is performed on the elderly, most often for decompression of degenerative lumbar spinal stenosis. In fact, it is estimated that in 1987, one of every 1000 persons over the age of 65 underwent a lumbar laminectomy.

As the incidence of lumbar degenerative disease and its associated costs multiply, evaluating the efficacy of surgical treatment becomes increasingly important. Data exist that document clinical outcome after decompressive laminectomy for spinal stenosis, but the information is difficult to interpret because of poorly defined outcome assessment, inadequate categorization of outcome data, vague data sources, incomplete follow-up evaluations, and inherent observer bias.

We present a comprehensive clinical and radiographic investigation of 119 patients who underwent decompressive lumbar laminectomy for spinal stenosis in our metropolitan area over a 7-year period between 1983 and 1990. The study is divided into two parts: clinical outcome and radiographic changes.

Clinical Material and Methods

Patient Selection Criteria

We performed a review of all patients who underwent decompressive lumbar laminectomy by a neurosurgeon in Washtenaw County, Michigan between July, 1983 and July, 1990. Patients were selected from two hospitals: the University of Michigan Hospital and St. Joseph Mercy Hospital. After obtaining institutional review board approval for the study of human subjects, hospital computers generated a list of 583 patients whose discharge diagnosis consisted of lumbar spinal stenosis with an operative code of lumbar...
laminectomy. All 583 charts were reviewed to ensure that the diagnosis of lumbar spinal stenosis was confirmed by either magnetic resonance (MR) imaging or myelography with computerized tomography scanning and that the operation performed (as described in the operative note) consisted of a standard decompressive lumbar laminectomy. A total of 58 patients were excluded from the study based on incomplete documentation of the diagnosis or because of a history of previous lumbar surgery. Any patients whose operation consisted of an interlaminar decompression, total facetectomy, fusion, or instrumentation of any kind was excluded from the study. Performance of a discectomy or foraminotomy in addition to decompressive lumbar laminectomy was not exclusionary; however, 145 patients were eliminated from our study because preoperative radiographs were unavailable or because there was radiographic evidence of previous lumbar surgery.

A total of 380 patients met all the criteria of the study; namely, a radiographically confirmed diagnosis of lumbar spinal stenosis, no history of previous lumbar surgery, and a standard lumbar laminectomy performed at one of our two hospitals during the 7-year period under study. We then attempted to contact all 380 patients by telephone: 10 patients were found to be deceased and another 46 were unavailable for follow-up evaluation.

Of the remaining 324 patients, 207 had had surgery at St. Joseph Mercy Hospital and 117 at the University of Michigan Hospital. Operations had been performed by one of nine neurosurgeons: three at St. Joseph Mercy Hospital and six at the University of Michigan Hospital.

Telephone Contact

The remaining 324 patients were interviewed by telephone by a medical student, nurse, or physician. None of the interviews was performed by personnel who had been previously involved in the care of the patient. During the interview, a brief standardized questionnaire was administered that confirmed that the patient had undergone his or her first lumbar operation on the date documented in the chart. Five questions about the patient's current clinical condition were posed as follows: 1. Had he/she undergone a subsequent lumbar operation? (yes, no); 2. Did his/her subsequent operation include a fusion? (yes, no); 3. What was his/her current work status? (retired, disabled, changed jobs to one which demanded an increased level of activity, changed jobs to one which demanded a decrease in activity level, or kept same job or got different job that demanded the same activity level required prior to his/her operation); 4. What was his/her level of walking ability, predicated on limitations related to the back condition? (housebound, less than two blocks, greater than two blocks, or unlimited); and 5. What was the patient's own assessment of the overall outcome from the operation? (poor—little or no pain relief with surgery; fair—improved with moderate persistent symptoms; good—occasional persistent symptoms; excellent—absent or minimal residual symptoms).

The interviewer explained the goals of our study and asked the patient to return to our hospitals on one of two designated days for completion of an extensive questionnaire, performance of a lower-extremity physical examination, and for standard lumbar radiographs. Each patient was informed that all aspects of the visit would be conducted without a service fee and that there were certain risks involved in the performance of radiographs.

The Core Study Group: Questionnaire, Physical Examination, and Radiographic Studies

The core group of patients in our research was represented by the 119 patients who continued to participate in the study. Each patient completed three phases of the study: comprehensive questionnaire, physical examination, and lumbosacral spine radiographs. The questionnaire was mailed to each patient prior to his or her return visit. At the time of this visit, each patient reviewed his or her entire questionnaire with a medical student or nurse to ensure the patient’s complete comprehension of each question. The questionnaire contained visual analog scales (VAS’) and multiple choice questions pertaining to pain and functional ability issues (Tables 1, 2, and 3). The VAS score was based on the patient’s grading of his or her pain on a 10-cm scale, similar to those scales reported by other authors.

The second phase required physical examination of the lower extremities. Each patient was examined by a resident or attending neurosurgeon who was unaware of the patient’s clinical outcome. The exam-
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**Chart Review**

The hospital and office charts of the 119 patients were reviewed. Data were collected pertaining to history and physical examinations, medical history including a history of tobacco use, and lumbar spine surgeries. Details of the operative procedures were derived from operative notes and were confirmed on postoperative radiographs. Details of our radiographic methods are reported separately.37

**Data Analysis**

Comparisons were performed using standard statistical methods: hypotheses related to parametric data were investigated using paired and independent t-tests, and categorical data were assessed using chi square analyses. Results are reported using p values; p values less than 0.05 were considered statistically significant.

**Results**

**Results of Telephone Questionnaire**

Of the 324 patients contacted by telephone, the average patient age was 65 years and included 54% men and 46% women. The mean follow-up period was 4.6 ± 1.6 years (range 2.0 to 8.6 years). Seventeen percent had a subsequent lumbar spine operation, but only four of the 324 patients (1.2%) had a subsequent fusion. Patients reported wide variably in their work status at the time of the interview relative to their preoperative status: 37% were retired, 26% had no change in their work status after the operation, 10% changed jobs to increase their physical activity, 16% changed jobs to decrease their physical activity, and 11% were disabled because of the low-back condition. Most patients felt that their walking ability was limited secondary to their low-back condition: 11% had unlimited walking ability, 47% felt that they were somewhat limited but could walk more than two blocks without stopping, 36% were limited to not being able to walk two blocks without stopping, and 8% were so limited that they were housebound. The patients' own opinions about the overall outcome of the operation were as follows: 27% graded their results as excellent, 32% as good, 18% as fair, and 22% as poor.

**Lack of Selection Bias**

Outcome data from telephone contacts were compiled to ensure a lack of selection bias between patients contacted by telephone and those who returned for completion of all phases of our study. We compared patient age, duration of follow-up period, gender distribution, hospital, subsequent operation, subsequent fusion, work status, walking ability, and overall outcome between the core study group and the group contacted only by telephone. We found no difference in responses to any of the questions (p > 0.1). Only four of the 205 patients contacted only by telephone had had a subsequent fusion whereas none in our core group had (p > 0.1). Thus, we believe that patients in our core group were representative of the total population that underwent decompressive lumbar laminectomy.

**Demographic and Symptomatic Presentation of the Core Study Group**

Findings related to demographic and symptomatic presentation of the core study group were derived from review of the patient charts as follows. The average age of the 119 patients at the time of operation was 61.8 ± 11 years (range 46 to 80 years), comprising 53% men and 47% women. Seventy percent were treated at St. Joseph Mercy Hospital and 30% at the University of Michigan Hospital. Thirty-five percent of the patients had symptoms for 1 to 5 years; 27% for less than 6 months, 20% for 6 to 12 months, and 14% for over 5 years.

Leg pain was the principal complaint in 60% of patients. Low-back pain predominated in 36%, and 4% had an acute cauda equina syndrome. Seventy-seven percent had low-back pain; 94% had leg pain. Only 2% had bowel or bladder symptoms attributable to spinal stenosis.

Twenty-six percent of patients were regular tobacco smokers at the time of surgery. To determine the extent of other preoperative medical conditions, we utilized the cumulative illness rating system23 and found that the average was 3.4 ± 1.6, based on a possible range of 0 to 15. This cumulative illness rating

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**TABLE 3**

**Patient responses to questionnaire at study interval concerning mobility, pain, and related problems**

<table>
<thead>
<tr>
<th>Questions</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>walking limited</td>
<td>64</td>
<td>36</td>
</tr>
<tr>
<td>back pain</td>
<td>77</td>
<td>23</td>
</tr>
<tr>
<td>leg pain</td>
<td>72</td>
<td>28</td>
</tr>
<tr>
<td>leg numbness</td>
<td>66</td>
<td>34</td>
</tr>
<tr>
<td>neurogenic claudication</td>
<td>31</td>
<td>69</td>
</tr>
<tr>
<td>bladder problems</td>
<td>2</td>
<td>98</td>
</tr>
<tr>
<td>related to back</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pain medication</td>
<td>51</td>
<td>49</td>
</tr>
<tr>
<td>additional surgery</td>
<td>15</td>
<td>85</td>
</tr>
<tr>
<td>subsequent fusion</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

* Values are expressed as percentages.
correlated positively with the patient’s age ($r = 0.82$, $p < 0.001$).

Preoperative motor and sensory examinations of the lower extremities were abnormal in 47% and 50% of patients, respectively. The L-5 or S-1 nerve roots were involved most often. The motor deficits were in foot dorsiflexors (32%), toe extensors (30%), and plantar flexors (20%). Sensory findings were abnormal in the L-5 distribution (32%) more commonly than in S-1 (25%). Three percent of patients had signs of peripheral neuropathy. Knee and ankle deep tendon reflexes were asymmetric in 20% and 16% of patients, respectively.

Operative Procedures in the Core Study Group

An average of $2.5 \pm 0.9$ laminae were removed during laminectomy (Fig. 1). The lower lumbar spine was the predominant surgical area; L-4–5 were most frequently involved (Fig. 2). Discectomy was performed at the time of decompression in 38% of operations: one patient had two discectomies performed; the rest had only a single discectomy. The majority of the discectomies were performed at the L-4–5 inter-space on a total of 32 patients.

Short-Term Outcome of the Core Study Group

The surgeons’ assessments of the patients’ status within the first 3 postoperative months were available via review of the charts for 96% of the patients. Back pain symptoms were improved in 45% of patients, 21% noted no change, 14% noted worsening, and for 19% this information was not available. Sixty-four percent of patients had improved leg pain, 5% were worse, 17% had no change, and for 13% this information was not available. Leg numbness and tingling was improved in 53% of patients, 6% were worse, 20% had no change, and for 21% the information was not available. Both patients with preoperative bowel and bladder symptoms showed improvement in function.

Worsening of motor function postoperatively did not occur, and preoperative motor deficits improved in 35% of the patients. Two patients’ sensory symptoms had worsened after surgery, both of these cases being referable to the L-5 nerve root. Twenty-six percent of patients with abnormal sensory examinations improved after surgery. The cauda equina syndrome was not seen postoperatively.

Subsequent Operations in the Core Study Group

None of the patients in this study had a subsequent lumbar fusion. Thirteen patients (11%) required one additional surgery and five (4%) required two additional operations. All of the repeat operations included further lumbar laminectomy: half of these involved widening of the previous decompression and half involved decompression of additional levels. Ten repeat operations involved discectomies within the levels previously operated on.

The average interval between operations was 2.3 ± 1.3 years. One-half of these surgeries were undertaken to relieve recurrent low-back pain, the other half for recurrent leg pain and/or weakness. Symptoms of lumbar instability were not observed.

Long-Term Outcome of the Core Study Group Based on Questionnaire

The average duration of follow-up study was 4.6 ± 1.6 years (range 2.0 to 8.6 years). The majority of patients complained of residual back and leg symptoms. Low-back pain, leg pain, and leg numbness and tingling were present in 77%, 72%, and 66% of patients, respectively. The average VAS score for these symptoms was 4.8 ± 2.5, 5.2 ± 2.7, and 5.1 ± 2.7 respectively. Seventy-seven percent of patients had some limitations on walking: although 23% reported no limitation and 41% said their walking was not limited to more than two blocks, 32% reported that their walking was limited to more than two blocks and 4% said their walking was limited to within the house, but none was bedridden. Eighty-two percent of patients attributed their limitations to lower back or leg symptoms. Thirty-one percent of patients had
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complaints consistent with neurogenic claudication: two-thirds of these patients reported relief of symptoms on cessation of walking or bending. A detailed list of patients’ responses can be found in Tables 1, 2, and 3.

Sixty-six percent of patients did not change their work status as a result of their back problem, 47% retired for other reasons, and 19% kept the same job or found a similar job with no decrease in physical activity. Thirty-five percent changed jobs because of their low-back condition: 12% were on total disability, 12% retired because of their back condition, and 11% were forced to change jobs or decrease their work status because their level of activity was restricted.

Fifty-one percent of patients are currently taking some form of medication for complaints related to their lower back or legs (Table 3). Forty-four percent are taking a non-narcotic analgesic medication for their symptoms; 14% and 8% of patients are taking narcotics or muscle relaxing drugs, respectively.

Seventy-nine percent of patients believed that their clinical status at 1 year after the operation had improved: overall, 49% felt much better, 30% felt somewhat better, 8% were unchanged, 5% were somewhat worse, and 8% were much worse. Sixty-six percent of patients believed that their current condition remained improved over their preoperative status: overall, 37% were much improved, 29% were somewhat better, 17% were unchanged, 5% were somewhat worse, and 12% were much worse compared to their preoperative status. The VAS scores for the patients’ current overall level of discomfort was 4.1 ± 3.0.

Fifteen percent of patients reported that they had undergone additional lumbar surgery, findings confirmed by our chart review. All additional surgery involved laminectomy and/or discectomy. No patient in this study group required lumbar fusion. Seventy-four percent of patients who had additional surgery believed that symptoms of back pain led to the further procedure: 40% complained of leg pain, 19% of leg numbness and tingling, 15% of leg weakness, and none of bowel or bladder symptoms prior to additional surgery. Each patient’s overall status after the repeat operation was graded as: much better (30%), somewhat better (15%), no change (10%), somewhat worse (20%), and much worse (20%) than their status just prior to their additional operation.

Long-Term Physical Examination Findings in the Core Study Group

Physical findings assessed in follow-up evaluations by independent observers found motor deficits and sensory deficits in 24% and 54% of patients, respectively. Sixteen percent of patients had an abnormal sensory examination that was consistent with a peripheral neuropathy.

Clinical Correlations

Outcome. Patients’ assessment of overall outcome (much better, somewhat better, no change, somewhat worse, and much worse) at 1 year and at the study interval did not correlate with age, sex, duration of preoperative symptoms, length of follow-up interval, or extent of or need for discectomy at the time of surgery. Predominant symptoms before surgery also did not correlate with outcome; those who complained primarily of low-back pain had similar outcomes to those who complained of neurogenic claudication or radicular symptoms (p > 0.05). Preoperative physical examination, walking ability, work status, and litigation status similarly failed to correlate with outcome (p > 0.05).

Patients who had additional laminectomy had poorer outcomes at 1 year and at the conclusion of the study than patients who underwent a single operation (p < 0.05). Fifteen percent of patients who had a single operation felt worse at the study interval but 38% who had more than one operation felt worse than they did before their first operation (p < 0.05). Of those patients who had additional surgery, smokers had poorer outcomes than nonsmokers (p < 0.05).

There was no difference between outcome at 1 year and at the conclusion of the study (p > 0.05). Seventy-nine percent of the patients believed that their status was better after surgery, compared to 66% at the most recent follow-up evaluation. Thirteen percent of patients thought that their outcome at 1 year was worse, but 17% felt their conditions had worsened during the study interval.

Patients’ assessments of their outcomes correlated with the severity of their current individual complaints. Patients with good outcomes (much or somewhat better) had less frequent back pain, leg numbness, and fewer symptoms of neurogenic claudication than those who reported poor outcomes (p < 0.05). Patients with poor outcomes were also more likely to have limitations in their walking ability and to take narcotic analgesic medication for their low-back complaints than those with better outcomes (p < 0.05).

Type of Operation and Need for Reoperation. Patient age positively correlated with the number of levels that were decompressed during surgery: 45% of patients over 50 years old had had more than two levels decompressed, but only 28% of younger patients had had more than two levels removed (p < 0.05). Men were more likely than women to undergo concomitant discectomy, and of those who underwent discectomy, 73% were men and 23% were women (p < 0.05).

Patients who were regular smokers at the time of surgery were more likely to undergo further surgery (54% vs. 36%, p < 0.05). Patients whose back problems were related to an injury were more likely to require a second operation (40% vs. 13%, p < 0.05). Those patients with worker’s compensation claims related to their low-back condition were also more likely to undergo additional lumbar surgery (50% vs. 16%, p < 0.05).
Discussion

Presenting Signs and Symptoms and the Surgical Procedure

The demographics, signs, symptoms, and surgical details in our patient population are similar to those reported previously. Patients who undergo decompressive lumbar laminectomy for lumbar spinal stenosis are typically elderly and more frequently male. Symptoms vary in duration, and most patients in our study had symptoms for at least 1 year prior to surgery. As previously reported, half of our patients had abnormal motor and sensory examinations, frequently complained of neurogenic claudication and leg pain, but infrequently had an acute cauda equina syndrome. Back pain was the primary complaint in 35% of our patients, more than in most other series. An average of 2.5 laminae were removed in our patients, and the L3–4 through L5–S1 levels were most commonly involved.

Clinical Outcome

Previous outcome studies of decompressive lumbar laminectomy have suggested that good to excellent results can be expected in greater than 70% of patients. However, these studies are difficult to interpret because of inadequate patient analysis, unclear sources of outcome data, and incomplete follow-up evaluation. We placed great emphasis on minimizing these factors. We believe that our patients are a representative subgroup of all patients who had their first laminectomy within our metropolitan area over a 7-year period. Outcome was measured by statistical analysis of data obtained independently from both patients and physicians.

Our study found that outcome is less favorable than previously reported. Sixty-six percent of our patients reported an improvement in their symptoms at their most recent follow-up evaluation, while 17% believed that their status was worse at the study interval compared to their preoperative state. This is in agreement with reports by Katz, et al., and Herno, et al., who also minimized observer bias in similar outcome study designs.

Correlations With Clinical Outcome

We compared preoperative signs and symptoms to eventual outcome at a 4.6-year mean follow-up interval. Our analyses included the patients’ assessment of overall outcome as well as measures of pain and functional limitation. These comparisons revealed few statistically significant associations of preoperative state to eventual outcome. Patient age, gender, duration of preoperative symptoms, the presence of a worker’s compensation claim, and the character of the presenting symptoms were not related to outcome.

The extent of laminectomy, the need for discectomy, and the duration of follow-up interval were similarly unrelated to outcome. As previously reported, patients whose original symptoms were related to an injury or who were involved in worker’s compensa-

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The authors concluded that the literature on the results of decompressive lumbar laminectomy for lumbar spinal stenosis was “totally inadequate” because of inherent flaws in research designs and a lack of randomized, controlled studies of the efficacy of lumbar fusion. In addition, Herkowitz, et al., have since reported the results of 50 patients with degenerative spondylolisthesis and lumbar spinal stenosis who alternately underwent decompressive lumbar laminectomy and decompressive lumbar laminectomy with fusion; these researchers found significantly better results in patients who had a fusion compared to those who did not. However, the strength of their conclusions is weakened by the relatively small number of patients, possible observer bias, and the lack of a randomized, controlled study design.

Conclusions

The results of our study and others recently reported indicate that long-term outcome from decompressive lumbar laminectomy is less favorable than previously suggested and the role of concomitant fusion needs to be studied further. Without demonstrative differences in outcome and reoperation rates between decompressive lumbar laminectomy with and without fusion, further studies are required to address the efficacy of these procedures. Contrary to the belief of some authors cited here, we believe that it is unclear whether fusion, with its greater cost and rate of complication, improves outcome, lessens residual symptoms, or lessens reoperation rates.

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References


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