Clinical outcomes and radiological instability following decompressive lumbar laminectomy for degenerative spinal stenosis: a comparison of patients undergoing concomitant arthrodesis versus decompression alone

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One hundred twenty-four patients with degenerative lumbar stenosis underwent decompression with fusion (32 patients) and without fusion (92 patients) during a 30-month period between 1986 and 1988. Patient-reported satisfaction at a mean follow-up period of 5.8 years (range 4.6–6.8 years) revealed a 79% good or fair outcome and a 21% poor outcome (26 patients). Seven patients (6%) developed lumbar instability, three patients (2%) developed new stenosis at an adjacent unoperated level, and three patients (2%) developed a new disc herniation between 2 and 5 years after surgery. Progressive postoperative spondylolisthesis occurred in 31% of patients with normal preoperative alignment (mean 7.8 mm, range 2–20 mm) and in 73% of patients with preoperative subluxation (mean 5.1 mm, range 2–13 mm) in whom fusion was not attained. Radiological progression did not correlate well with patient-reported outcome.

The major conclusions from this study are the following: 1) the majority of patients respond well to this surgery, but complication (22%) and late deterioration (10%) rates are not insignificant; 2) radiological instability is common after decompression for degenerative lumbar spinal stenosis, but this correlates poorly with clinical outcome; 3) there are no definitive clinical or radiological factors that preoperatively predict patients at risk for a poor outcome; 4) postoperative radiological instability is more likely to occur when the following criteria are present: preoperative spondylolisthesis, abnormal motion detected on preoperative dynamic imaging, decompression occurring across a minimally degenerated L-4 or a markedly degenerated L-3 disc; and when a radical and extensive decompression greater than one level is planned; and 5) the group at greatest risk for a poor outcome consists of those patients with normal preoperative alignment who do not suffer slippage following surgery.

KEY WORDS • lumbar spinal stenosis • outcome • spinal fusion • laminectomy • spinal instability

LUMBAR spinal stenosis with or without degenerative spondylolisthesis is a common condition that can be associated with pain or neurological dysfunction. Numerous authors have demonstrated the efficacy of decompressive lumbar procedures to relieve these complaints. Patient-satisfaction rates between 59% and 96% have been reported with very low morbidity. Improper patient selection, inadequate decompression, and postoperative lumbar instability are generally cited as etiological factors that influence early surgical failures. Late failures may be due to persistent or acquired instability, recurrence of stenosis at operated levels, new stenosis at adjacent levels, epidural fibrosis, or arachnoiditis. Significant controversy exists concerning the appropriate indications and benefits of lumbar fusion combined with lumbar decompression for degenerative spinal stenosis. Some believe that the incidence of postoperative instability is low and fusion procedures are rarely indicated, whereas others believe that postoperative instability is common and that clinical outcomes are superior in patients with concomitant fusions.

The purpose of this study was to determine the incidence of radiological lumbar instability following lumbar decompression, to identify any predisposing factors for this instability, and to analyze the relationship between postoperative radiological instability and patient-reported outcome. In addition, we specifically wanted to analyze the effect of concomitant lumbar fusion on patient outcome and subsequent radiological instability.

Clinical Material and Methods

From January 1, 1986 to June 30, 1988, 178 consecutive patients underwent first-time decompressive laminectomy for degenerative lumbar spinal stenosis at the Mayo Clinic. Patients with prior lumbar surgery or whose symptoms were primarily related to disc protrusion or extrusion and not due to central canal or lateral gutter stenosis related to spondylolisthesis were excluded. Follow-up evaluation...
was determined using responses to a detailed questionnaire and standing flexion–extension lumbar spine radiographs. Twenty-six patients declined participation, 14 patients died prior to our investigation, and 14 patients could not be located. One hundred twenty-four patients (70%) participated in and form the basis for this study.

All patients received an extensive preoperative neurololgical evaluation by a neurologist. In addition to plain anteroposterior and lateral lumbar spine films, flexion-extension radiographs were performed in most patients. All patients had water-soluble contrast myelography and concomitant lumbar computerized tomography (CT) scanning. Electromyography and magnetic resonance (MR) imaging were performed when deemed necessary.

Patients underwent wide decompressive laminectomies with or without medial facetectomies and foraminotomies, depending on the radiographic extent of neural compression, patient symptoms, and clinical findings. Fusion procedures were selectively performed in patients with 1) preoperative spondylolisthesis with demonstrable motion on dynamic imaging; 2) preserved preoperative disc height combined with wide laminectomy and facetectomy across that space; and 3) instability determined intraoperatively following decompression.

**Data Collection and Analysis**

All medical and surgical records were reviewed. Questionnaires comparing patient-reported pre- versus postoperative symptoms and current abilities to walk and perform activities of daily living were reviewed, in addition to current overall patient satisfaction.

All pre- and postoperative radiographs were compared and analyzed for the presence and/or progression of spondylolisthesis. A 3-mm shift of spondylolisthesis was necessary to be recorded as significant, and postoperative progression of spondylolisthesis required a 2-mm or more increase in slippage. Patient characteristics and specific findings on preoperative radiographs were correlated with progressive subluxation to determine factors predictive of instability or a poor outcome following decompression. Patient-reported outcomes were then correlated with investigator-determined evidence for postoperative radiological instability and the type of surgery performed.

**Patient Characteristics**

Of the 124 patients there were 65 men and 59 women with an average age of 67.5 years (range 34–83 years). The patients’ average weight was 82.9 kg (range 49–162 kg) and their average height was 166.8 cm (range 148–196 cm). The mean follow-up duration was 5.8 years (range 4.6–6.8 years). Preoperatively, patient symptoms included leg pain (94%), back pain (87%), leg weakness (73%), leg numbness (71%), and bladder (8%) and bowel (4%) dysfunction. Pseudoclaudication (leg pain, numbness, or neurological deficit brought on by standing or walking and relieved by sitting or lying down) was diagnosed in 83% of patients. Radiculopathy (constant pain aggravated by activity) was present in the remaining 17% of patients. Bilateral symptoms were present in 65% of patients. Thirty percent of patients demonstrated mild weakness on neurological examination, most commonly in an L-5 distribution. Fifty-three patients were examined using electromyography and nine (17%) of these had superimposed peripheral neuropathy. The other 44 patients (83%) had evidence of lumbosacral radiculopathy.

**Preoperative Radiological Characteristics**

All 124 patients had myelographic confirmation of central canal stenosis; 69 patients also had evidence of foraminal stenosis. Postmyelographic CT scanning revealed anteroposterior canal diameters measuring 12 mm or less in all patients and a complete block in 33 patients. In addition, there were 14 patients with 15 lateralized disc herniations associated with other manifestations of degenerative spondylolisthesis.

Sixty patients had 69 levels of anterior spondylolisthesis, 23 patients had 27 levels of posterior spondylolisthesis, and 42 patients had 58 levels of lateral vertebral translation. Table 1 demonstrates the level, direction, and magnitude of spinal translation in our patients.

Lateral lumbar curvature was present in 52 patients (42%). Twenty-seven had less than 10° curvature, whereas 16 had 11° to 20°. Nine patients had scoliosis measuring 21° to 29°. There were no curves greater than 30°. Facet angles averaged 43° at L5–S1 (range 21°–55°), 55° at L4–5 (range 26°–65°), 63° at L3–4 (range 38°–86°), 65° at L2–3 (range 50°–82°), and 72° at L1–2 (range 59°–88°). Anterior vertebral claw osteophytes were present in 57 patients whereas true traction spurs were found in 34 patients most commonly at the L-4, L-3, and L-2 levels. Relative sagittal angulation measurements, detailed by White and Panjabi, revealed an average 7.3° (range 0°–20°) at L4–5. Intercrestal lines were above the L4–5 interspace in 39 patients, at L4–5 in 78 patients, and below L4–5 in seven patients.

**Surgical Characteristics**

Twenty-eight patients underwent isolated decompressive laminectomies, 65 patients had laminectomies with medial facetectomies, and 31 patients had laminectomies...
TABLE 2
A comparison of preoperative symptoms and patient-reported outcomes after decompressive surgery for lumbar spinal stenosis in 124 patients

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Preop Incidence (no. of patients)</th>
<th>Postop Status (no. of patients)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>back pain</td>
<td>108</td>
<td>16</td>
</tr>
<tr>
<td>leg pain</td>
<td>116</td>
<td>8</td>
</tr>
<tr>
<td>leg numbness</td>
<td>88</td>
<td>36</td>
</tr>
<tr>
<td>leg weakness</td>
<td>91</td>
<td>33</td>
</tr>
</tbody>
</table>

Results

**Patient-Reported Outcomes**

Tables 2 and 3 summarize patient-reported changes in back and leg pain, numbness, weakness, ability to perform activities of daily living, and walking abilities. Ten patients complained of bladder incontinence before surgery while seven additional patients did so postoperatively. Eight patients complained of bowel incontinence postoperatively compared to five patients preoperatively.

**Overall Outcome of Patients Following Decompressive Surgery**

Patient outcome was graded as good if the patients had no back or leg pain, unlimited walking, and the ability to perform daily activities. A fair outcome indicated improved back and/or leg pain but some modification of performance of daily activities. A poor outcome denoted no improvement or worsening of preoperative symptoms, increased difficulty in walking and ability to perform daily activities, or continued, severe postoperative back pain. In this study, 60 patients (48%) claimed good results, 38 patients (31%) reported fair results, and 26 patients (21%) claimed poor results from their surgery.

A comparison of the 26 patients with poor outcomes with the other 98 patients revealed no significant differences with respect to age, weight, height, preoperative back or leg symptoms, preoperative bladder or bowel function, preoperative walking ability, or performance of daily activities.

The patients with a poor outcome were slightly more likely to be male (16 men vs. 10 women) and to have preoperative retrospondylolisthesis (27% of those with preoperative retrospondylolisthesis had poor outcomes compared to only 2% of those without). There was also a reduced incidence in poor outcomes among those whose spines were fused. Ninety-one percent of those who underwent comcomitant fusion procedures had good or fair outcomes compared to 75% of those who had decompression alone. Table 4 summarizes patient outcomes based on the presence or absence of preoperative anterior subluxation, whether a fusion was performed and what type was performed, and whether postoperative progression of anterior subluxation had occurred.

A review of available medical and surgical records was performed on the 54 patients who declined or were unable to participate in this study. In this group, the investigator-determined outcomes for 37 patients with an average 4.7-month follow up (range 1 month–2 years) revealed a good outcome in 15 (41%), a fair outcome in 19 (51%), and a

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Incidence of Postoperative Subluxation

**Anterior Spondylolisthesis.** Anterior spondylolisthesis was present at 69 levels in 60 patients prior to surgery (Table 1). Progressive postoperative subluxation occurred in 32 of these patients. The mean slippage was 5.1 mm (range 2–13 mm). Twenty of 64 patients without preoperative anterior subluxation developed anterior slippage postoperatively (mean 7.8 mm, range 2–20 mm). For those with preoperative slippage, the incidence of further postoperative subluxation was one of one at L1–2, 10 of 11 at L3–4, 40 of 51 at L4–5, and one of six at L5–S1. Table 5 correlates the degree of preoperative anterior subluxation with the incidence of postoperative progression at L4–5, the most common site for progressive subluxation.

**Posterior Spondylolisthesis.** Table 1 summarizes the incidence and level of preoperative posterior spondylolisthesis. It was most common at the L-3 and L-4 levels (10 and eight patients, respectively) and less common at the L-2 and L-5 levels (four of five patients in each case). The incidence of progressive postoperative posterior subluxation was one of four at L-2, 3 of 10 at L-3, 0 of eight at L-4, and one of five at L-5. Fusion was not attained in any of these patients. No patients without preoperative retro-

### Table 1

<table>
<thead>
<tr>
<th>Degree of L4–5 Preop Slippage</th>
<th>No Fusion</th>
<th>Fusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–2 mm (73 patients)</td>
<td>14 of 71 (19.7%)</td>
<td>0 of 2 (0%)</td>
</tr>
<tr>
<td>3–5 mm (21 patients)</td>
<td>10 of 16 (62.5%)</td>
<td>2 of 5 (40%)</td>
</tr>
<tr>
<td>6–10 mm (23 patients)</td>
<td>4 of 6 (66.7%)</td>
<td>7 of 17 (41.2%)</td>
</tr>
<tr>
<td>11–15 mm (6 patients)</td>
<td>2 of 2 (100%)</td>
<td>1 of 4 (25%)</td>
</tr>
<tr>
<td>&gt;16 mm (1 patient)</td>
<td>0</td>
<td>0 of 1 (0%)</td>
</tr>
<tr>
<td>total</td>
<td>30 of 95 (31.6%)</td>
<td>10 of 29 (34.5%)</td>
</tr>
</tbody>
</table>

*Includes all levels of preoperative anterior subluxation.

### Table 5

<table>
<thead>
<tr>
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<th>No Fusion</th>
<th>Fusion</th>
</tr>
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<td>0</td>
<td>0 of 1 (0%)</td>
</tr>
<tr>
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<td>30 of 95 (31.6%)</td>
<td>10 of 29 (34.5%)</td>
</tr>
</tbody>
</table>

poor outcome in three patients (8%). Records were unavailable or an outcome was not interpretable from the medical record in seven patients and no follow-up information was found in 10 patients.

Lateral Spondylolisthesis. Seven (9%) of 82 patients without preoperative side-to-side or lateral subluxation developed lateral slippage following decompressive surgery, whereas six (14%) of 42 patients with preoperative lateral slippage progressed at eight levels. The most common sites were L-4 and L-3 (four and three patients, respectively), although the degree of preoperative slippage did not correlate with the risk for progression.

**Lateral Lumbar Curvature and the Incidence of Progressive Anterior Subluxation**

As the degree of preoperative lateral lumbar curvature increased, so did the patients’ risk for progression following decompression. However, only at lumbar curvatures greater than 21° did this become significant. The risk for postoperative anterior spondylolisthesis was less for those patients with preoperative lateral lumbar curvature than for those with normal curvatures.

**Preoperative Disc Height and the Incidence of Progressive Anterior Subluxation**

Data collected suggest that a normal or near-normal disc height at L-4 may predispose to an increased risk for postoperative subluxation when decompression spans this disc space. Conversely, a markedly narrowed disc height at L-3 predisposes to an increased incidence for subluxation at L-3 following decompression across the L-3 disc space.

**Preoperative Facet Angles and the Incidence of Progressive Anterior Subluxation**

Facet angles were measured at L3–4 and L4–5 where postoperative subluxation most commonly occurred. Only patients who underwent laminectomy alone without violation of the facet joints and without fusion were analyzed (23 patients). A review of patients who did not experience slippage postoperatively at L3–4 revealed no significant difference in facet angle when compared to those who did. However, those patients who experienced slippage at L4–5 had a mean preoperative facet angle of 65.8° (nine patients), compared to a mean facet angle of 50.4° (14 patients) in patients who did not have slippage at L4–5 postoperatively. These data indicate that more sagittally
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**Table 6**

Comparison of extent of decompression and incidence of progressive anterior subluxation following decompression for patients with degenerative lumbar spinal stenosis

<table>
<thead>
<tr>
<th>Type of Surgery</th>
<th>No. of Patients</th>
<th>Preop Anterior Slippage</th>
<th>Postop Anterior Slippage</th>
<th>Preop Anterior Slippage</th>
<th>Postop Anterior Slippage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laminectomy only</td>
<td>23</td>
<td>7</td>
<td>4 (57%)</td>
<td>16</td>
<td>4 (25%)</td>
</tr>
<tr>
<td>Laminectomy + bilateral</td>
<td>49</td>
<td>17</td>
<td>13 (76%)</td>
<td>32</td>
<td>10 (31%)</td>
</tr>
<tr>
<td>Medial facetectomy</td>
<td>16</td>
<td>5</td>
<td>4 (80%)</td>
<td>11</td>
<td>4 (36%)</td>
</tr>
<tr>
<td>Total facetectomy</td>
<td>4</td>
<td>2</td>
<td>2 (100%)</td>
<td>2</td>
<td>1 (50%)</td>
</tr>
</tbody>
</table>

* Patients with fusions are not included.

**Table 7**

Complications after decompressive surgery in 124 patients with degenerative lumbar spinal stenosis

<table>
<thead>
<tr>
<th>Complication</th>
<th>No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound infection, superficial</td>
<td>1</td>
</tr>
<tr>
<td>Dural tear repaired at surgery</td>
<td>3</td>
</tr>
<tr>
<td>DVT/pulmonary embolus</td>
<td>2</td>
</tr>
<tr>
<td>Arachnoiditis</td>
<td>2</td>
</tr>
<tr>
<td>Charcot’s joint (based on disc space)</td>
<td>2</td>
</tr>
<tr>
<td>Cerebral infarction</td>
<td>2</td>
</tr>
<tr>
<td>Failed fusion (pseudarthrosis)</td>
<td>3</td>
</tr>
<tr>
<td>Instrument failure (repeated surgery)</td>
<td>1</td>
</tr>
<tr>
<td>Tracheostomy for respiratory insufficiency</td>
<td>1</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>5</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
</tr>
</tbody>
</table>

* DVT = deep venous thrombosis.

Radiological Comparison of Patients With Good to Fair Versus Poor Outcomes

Radiographic comparison of preoperative imaging revealed no differences between these groups with respect to disc heights, facet angles, or scoliosis. Outcome was not influenced by the number of levels decompressed or the extent of bone removal. Notably, the presence of preoperative anterior spondylolisthesis or lateral vertebral slippage did not influence outcome. Also, increased postoperative anterior subluxation did not influence outcome: 45% of patients with a good or fair outcome had increased postoperative subluxation compared to 35% of those with a poor outcome.

Current radiographic analysis of the 26 patients with poor outcomes included standing flexion–extension lumbar radiographs and either CT myelography or MR imaging. Seventeen patients had no change from their preoperative alignment. Two patients with fusions had pseudarthroses and one of the 15 patients without fusion was found to have had an inadequate surgical decompression; arachnoiditis was found in two patients. Nine patients, one of whom had fusion, exhibited increased postoperative subluxation.

Number of Levels Decompressed Versus Progressive Anterior Slippage

Patients undergoing a one-level decompression had a 13% chance of progressive anterior subluxation after surgery. This compares to a fourfold increase in patients undergoing a two- or three-level decompression (53% and 59%, respectively). There were too few patients to evaluate four- and five-level decompressions.

Extent of Decompression Versus Progressive Anterior Subluxation

Table 6 summarizes the extent of bone decompression and the incidence of postoperative progression of anterior spondylolisthesis. For patients with no preoperative slippage, the greater the bone decompression, the higher the incidence of postoperative progressive subluxation.

Patients with preoperative slippage had a significantly greater chance of progressive subluxation compared to those without preoperative slippage.

Surgical Complications

Complications occurred in 27 (22%) of the 124 patients and are listed in Table 7. There were no deaths as a result of surgery. Additionally, 16 patients (13%) were diagnosed with a urinary tract infection during their postoperative period. All had in-dwelling Foley catheters during the perioperative period.

Repeated Surgeries

Three patients experienced abnormal spinal motion after decompression and fusion giving a 9% pseudarthrosis rate; none of these patients had instrumentation placed; two of them were symptomatic. In one patient the symptoms were a result of metastatic breast cancer located at the operative site, which was unsuspected at the initial surgery. The other symptomatic patient underwent repeated fusion with pedicle screw instrumentation resulting in a fair outcome. One additional patient had repeated surgery for an initial inadequate neural decompression.

Six patients developed new stenosis or a new disc herniation postoperatively. Three had symptomatic lumbar stenosis at adjacent unoperated levels. Symptoms developed at 3, 4, and 5 years following the initial surgeries. Repeated surgery was successful in two patients and was declined by the third. Three patients had new disc herniations 1, 2, and 4 years following initial surgery. Two patients had disc herniations within decompressed levels (both L-4), whereas the third patient had an L-3 disc herniation after an L-4–5 decompression. Surgery provided relief in all three patients.

Seven patients had progressive symptomatic anterior vertebral subluxation. All had good outcomes initially with earlier decompression procedures, but developed new back and/or leg pain(s) between 2 and 4 years after the initial surgery. Instrumented fusions were performed in four patients with good or fair outcomes in three. One patient declined further surgery, one was not deemed an appropriate surgical candidate due to age and poor med-
Back pain is most likely due to disc degeneration. This information would help determine which patients might benefit from concomitant fusion procedures after decompressive surgery for degenerative lumbar spinal stenosis.

**Clinical Criteria for Lumbar Instability.** Historically, recurrent, usually acute episodes of low-back pain produced by mechanical stresses of diminishing magnitude is suggestive of clinical instability. Lying or sitting often provides relief. Patients with associated degenerative central or foraminal lumbar spinal stenosis may also have pseudoclaudication or leg pain with activity. Neurological examination generally yields normal results although abnormal motions during flexion and extension may be observed. Back pain is most likely due to disc degeneration, annular tears, and osteoarthritic changes within the facet joint, as proposed by Kirkaldy-Willis and Farfan and others. Postoperative low-back pain may persist or result from altered stresses on these same structures or a wide variety of psychosocial etiologies. External bracing or immobilization has been used by some authors to determine the potential effects of fusion.

Preoperative symptoms and radiographs, as well as the extent of bone removal, are important, but the final test of stability should occur in the operating room following surgical decompression. If the spine seems hypermobile, concomitant fusion may be considered. In our study, 23 of 26 patients with poor outcomes had persistent complaints of low-back pain, which could be related to radiological evidence of instability in 11 patients. Other etiologies probably included degenerative disc disease, painful facet arthropathies, excessive stresses placed on the remaining spinal supporting structures following decompression, or other anatomical or physiological factors. Interestingly, Rosenberg noted that back symptoms presumed to be caused by instability after decompression diminished with time. His patients were generally able to accommodate functionally to their back symptoms and later fusion was rarely necessary. found that patients bothered predominantly by back pain preoperatively were significantly less satisfied with the results of surgery for degenerative lumbar spinal stenosis.

**Radiological Criteria for Instability.** Knutsson originally described degenerative discogenic pain and reported that narrowing of the intervertebral disc space, reactive changes in the adjacent vertebral bodies, vacuum disc phenomenon, spondylolisthesis (anterior or posterior), and abnormal motion of 3 mm or more on flexion-extension radiographs are all indicative of lumbar instability. Traction spurs, as described by Macnab, are also believed to be abnormal and suggest lumbar instability. Posner and White and colleagues have developed a radiological checklist for the diagnosis of lumbar instability, but it does not correlate clinical symptoms.

**Discussion**

**Lumbar Instability: Clinical, Radiological, and Biomechanical Criteria**

Many investigators have attempted to define lumbar spinal instability. This information would help determine which patients might benefit from concomitant fusion procedures after decompressive surgery for degenerative lumbar spinal stenosis.

In summary, the facet joints in the lumbar spine contribute greatly to stability in the sagittal plane, and should be spared, in part, when possible during decompressive surgery for lumbar spinal stenosis. The annulus and intact disc are also important, although our data indicate that disc removal at surgery does not increase the incidence of either clinical or radiological instability. The intervertebral disc becomes hypermobile during early degeneration and stiffer as the degenerative process continues. Therefore, decompression across a minimally degenerated disc may lead to increased stresses and the risk for subluxation. Adequate decompression of neural elements may lead to instability.

**Preoperative and Intraoperative Predictive Factors for Postoperative Radiological Instability**

A review of both the clinical and radiological features of the 124 patients in this study found that the single most important predictor for postoperative radiological instability after decompressive surgery for degenerative lumbar spinal stenosis was the presence of anterior spondylolisthesis preoperatively. In our study, 73% of patients with preoperative anterior spondylolisthesis experienced progression after surgery compared to 31% of patients without preoperative slippage who developed spondylolisthesis postoperatively (patients with fusions excluded). The degree of preoperative spondylolisthesis did not correlate with the tendency or amount of postoperative slippage. Also, we did not find that preoperative retrospondylolisthesis or lateral spondylolisthesis significantly contributed
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to increased sagittal or axial radiological instability after surgery.

Other preoperative factors found in our review that increased the likelihood for postoperative radiological instability included the patient’s sex, sagittally oriented L-4 facet joints with little coronal joint area ventrally, lateral lumbar curvature, and a low intercrestal line.

The single intraoperative factor that was not associated with postoperative radiological instability included violation of normal or minimally degenerated discs for disc protrusions at the time of surgery.

Of the 14 patients who had discs removed at initial surgery, only three had progressive subluxation, which occurred at L-4 in two patients and at L-5 in the third. Hopp and Tsui found no incidence of progressive subluxation after discectomies and lumbar decompressions in patients with degenerative lumbar spinal stenosis. Tuite and colleagues found that postoperative spondylolisthesis is less likely to occur after laminectomy plus discectomy than after laminectomy alone, indicating a stabilizing influence of discectomy.

Benefits and Long-Term Complications of Fusions After Decompression for Degenerative Lumbar Spinal Stenosis

Benefits. Several authors have reported that patients with preoperative spondylolisthesis and spinal stenosis who undergo decompression and fusion have better outcomes than those who undergo decompression alone. 5,18,44,52,59 Caputy and Luessenhop predicted that 15% of patients would benefit from concomitant fusions after decompression based on a retrospective analysis of their surgical failures related to progressive radiological subluxation.

Long-Term Complications. The long-term effects on adjacent spinal levels is not well understood; however, accelerated degeneration above and below areas of fusion is generally found. 24,33,58,60,61 Subsequent acquired spinal stenosis or recurrence of stenosis at previously operated levels could contribute to late failures that occur after lumbar decompressive surgery. 6,7,93 New lumbar instability above or below a previous fusion would also account for late failures. Katz and associates reported a 17% reoperation rate within 4 years for postoperative instability or stenosis after decompressive surgery for lumbar spinal stenosis. Caputy and Luessenhop predicted that stenosis and instability could affect as many as 50% of patients within 10 to 15 years of surgery. In our study, three (2%) of 124 patients developed new symptomatic spinal stenosis at an adjacent unoperated level within 5 years of surgery, whereas no patient developed instability adjacent to a fusion in our study with an average follow-up duration of 5.8 years. Lehmann and colleagues reported that 45% of patients demonstrated segmental instability at an adjacent level after lumbar fusions without decompressions at an average follow-up duration of 3 years. This was associated with significant stenosis in about one-third of cases.

Additional Surgery

In our study seven patients who initially had good outcomes developed recurrent symptoms between 2 and 4 years postoperatively due to progressive subluxation and spinal instability; this indicates that patients may initially adjust to decompression, but repeated stresses on the remaining supporting structures and continued degenera-
tive processes can result in destabilization, with resultant pain or neurological symptoms. Four of these patients underwent fusion procedures with good or fair outcomes in three cases. These results are similar to those reported by others.

New disc herniations were observed in three patients (2%) during the average 5.8-year follow-up period. This may be due to increased stresses placed on anterior stabilizing elements following posterior decompressions. As noted earlier, only 2% of patients developed new stenosis at adjacent levels during follow-up in our study patients.

Of the 26 patients with poor outcomes following initial surgery, only three patients underwent additional surgery. One patient had further decompression and two patients had fusions. All three had fair outcomes. None of the remaining 23 patients had additional surgery and, therefore, it is unknown whether a fusion procedure would benefit these patients.

Conclusions

Based on this retrospective review and a review of the literature, we have drawn the following conclusions:

1) Surgery for degenerative lumbar spinal stenosis can be successful in the majority of patients, but complication rates (22% in our series), early surgical failures (poor outcomes in 21% in this series), and late deteriorations due to acquired instability, restenosis, or disc herniation (10% in this series) are not nominal. Therefore, accurate diagnosis and careful patient selection remain paramount in achieving satisfactory results. Adequate neural decompression should be the primary goal of surgery for patients with degenerative lumbar spinal stenosis. The extent of bone removal should be dictated by clinical and radiological findings.

2) Radiological instability, as judged by postoperative flexion–extension studies, is often displayed in progressive subluxation after surgery in all patients, but this occurs most often in those with preoperative spondylolisthesis. Notably, however, radiological progression does not necessarily correlate with a poor outcome, particularly in patients with preexisting spondylolisthesis.

3) Radiological factors predictive of progressive anterior or subluxation include preoperative anterior spondylolisthesis, abnormal motion on dynamic radiographs, decompression across a minimally degenerated L-4 or markedly degenerated L-3 disc space, CT scans demonstrating sagittally oriented facet joints, or radical decompression that is greater than one level. Patients who have these preoperative findings or who are deemed unstable after decompression should be considered candidates for fusion.

4) As a group, patients who underwent fusion procedures fared better when compared to patients who did not. However, fusion procedures may not necessarily improve outcomes in patients without radiological and/or clinical evidence for instability. Notably, the group at greatest risk for a poor outcome consisted of patients without preoperative spondylolisthesis who did not undergo fusions or develop radiological instability postoperatively. Prospective, randomized controlled trials will need to be performed to determine more adequately the unequivocal indications for lumbar fusion in patients undergoing decompression for lumbar spinal stenosis.

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