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Decompression in the Surgical Management of Degenerative Spondylolisthesis: Advantages of a Conservative Approach in 290 Patients

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Summary: The management of degenerative spondylolisthesis with laminectomy alone or laminectomy with fusion remains controversial. From the early 1970s to 1996, 290 patients with degenerative spondylolisthesis were treated with 249 laminectomies and 41 fenestration procedures over an average of 3.2 levels. One level olisthesis was encountered in 250 patients, and two levels of slip in 40. Patients averaged 67 years of age, and were followed an average of 10 years. Using Prolo's outcome scale, 69% of patients exhibited excellent, 13% good, 12% fair, and 6% poor outcomes. Secondary decompressions with fusions for increased olisthy/instability (five patients) and recurrent stenosis/disc disease/instability (three patients) required one posterolateral "in situ" fusion and seven Texas Scottish Rite Hospital instrumented procedures. Decompression alone successfully managed degenerative spondylolisthesis in 290 patients treated over 3 decades, because only 8 (2.7%) required secondary fusion. **Key Words:** Degenerative spondylolisthesis—Decompression—Fusion.

One group's experience managing 290 patients with degenerative spondylolisthesis over 3 decades using decompressive laminectomy and rarely fusion was reviewed, with particular attention paid to the number of patients eventually requiring secondary fusion.

MATERIALS AND METHODS

Clinical Data

The author and her colleagues operated on 290 patients with degenerative spondylolisthesis (grade I) over the last 3 decades (Figs. 1–8) (Table 1). Patients averaged 67 years of age with a range of 38–82. Most were in their 50s, 60s, or 70s. Patients exhibited a 2:1 female/male ratio. They were followed for an average of 10 years (range 1–27 years). Surgical procedures included fenestration procedures or laminectomies, the choice of decompression being determined by the severity of the central, mixed central–lateral, and lateral recess stenosis. Accompanying extruded or sequestrated disc herniations were removed where appropriate. Patient outcomes were evaluated by the surgeon using Prolo's outcome scale of excellent, good, fair, and poor.

Radiographic Studies

Lumbar instability, directly measured on dynamic lateral radiographs or lateral decubitus radiographs, was defined by >4 mm of translation (or 8%) or 10–12° of angular displacement (2,37). All 290 patients included in this study were stable, based on these criteria, on their preoperative dynamic films. Another 30 patients, excluded from

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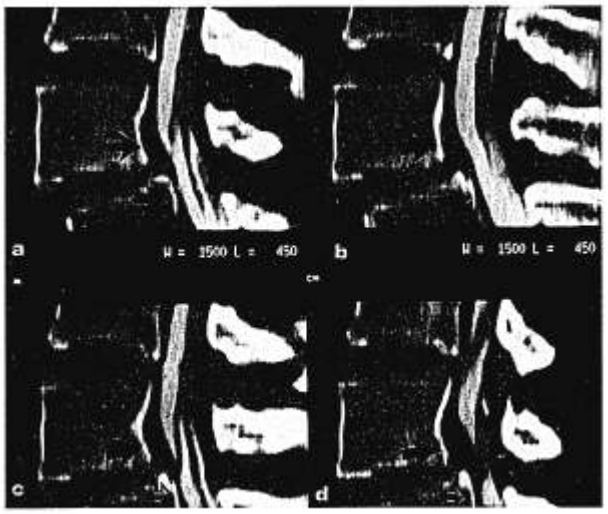

FIG. 1. Sagittal and parasagittal two-dimensional myelo-computed tomography (CT) study demonstrating L4–L5 degenerative spondylolisthesis (case 1). **a:** Parasagittal two-dimensional (2D) myelo-CT. This parasagittal myelo-CT study showed a less than grade I olisthy (black arrows) and minimal thecal sac intrusion at L4–L5 in this 47-year-old woman. **b:** Midline 2D myelo-CT. The midline myelo-CT showed only mild L4–L5 olisthy (white arrows), which did not significantly compress the thecal sac. **c:** Parasagittal 2D myelo-CT. The contralateral parasagittal myelo-CT study also demonstrated the lack of significant L4–L5 thecal sac compression (black arrows). **d:** More lateral parasagittal 2D myelo-CT. The more lateral parasagittal myelo-CT revealed slightly greater thecal sac intrusion in a narrowed L4–L5 (black arrows) lateral recess. Because these and the transaxial studies failed to confirm significant stenosis at the level of olisthy, no surgery was performed.

this analysis, found to be unstable had primary decompressions accompanied by fusions.

Additional diagnostic studies included myelography in the 1970s, and computed tomography (CT) or myelo-CT

FIG. 2. Dynamic myelogram. Lateral flexion view of active anterolisthesis 1 year after coronal L4–L5 laminectomy for degenerative spondylolisthesis (case 2). This lateral flexion myelogram documented an active anterolisthesis (> 1 cm) at the L4–L5 level (black arrows) in this 57-year-old patient 1 year after an original L4–L5 coronal hemilaminectomy performed to address degenerative spondylolisthesis.

FIG. 3. Dynamic myelogram. Lateral extension view of active anterolisthesis 1 year after a coronal L4–L5 laminectomy for degenerative spondylolisthesis (case 2). The extension myelogram demonstrated active posterior slippage of the L4 over the L5 vertebral body (black arrows), the degree of slip decreasing from 1 cm in flexion to <4 mm in extension.

examinations with or without accompanying magnetic resonance examinations at the present time (Figs. 1–6).

Surgical Techniques

The fenestration procedure typically includes a bilateral interlaminar laminotomy with medial undercutting facetectomy and foraminotomy, carefully preserving the pars interarticularis (9–15) (Fig. 7). Anterior–posterior diameter stenosis and bilateral lateral recess stenosis resulting from the increased olisthy of degenerative spondylolisthesis are readily decompressed. Segmental decompression of both the thecal sac and nerve roots is effected while preserving the spinous processes, supraspinous, and interspinous ligaments and portions of the cephalad and caudad laminae to enhance stability.

Laminectomy may be performed to address central, mixed central–lateral, or lateral recess stenosis (9–15). The severity of the stenosis will often dictate the choice of procedures, because adequate foraminal decompression becomes increasingly limited in a stenotic canal if an attempt is made to preserve the midline structures using the more limited fenestration technique. The laminectomy is defined by removal of the laminae bilaterally, including excision of the spinous processes, supraspinous and interspinous ligaments. Laterally, medial facetectomy with foraminotomy is accomplished, the lateral two-thirds of the facet joints being maintained to preserve stability. Additionally, the pars interarticularis is spared. Where laminectomy is completed for olisthy at the L4–L5 level,

FIG. 4. Transaxial myelo-computed tomography (CT) 1 year after an L4–L5 coronal hemilaminectomy showing recurrent bilateral dorsolateral intrusion now secondary to hypertrophic scar associated with instability (case 2) (arrows). Clinical instability and dynamic myelo-CT evidence of recurrent L4–L5 stenosis with instability prompted the performance of an L4–L5 laminectomy with Texas Scottish Rite Hospital fusion in this patient. Two years postoperatively, she had fused and was asymptomatic.

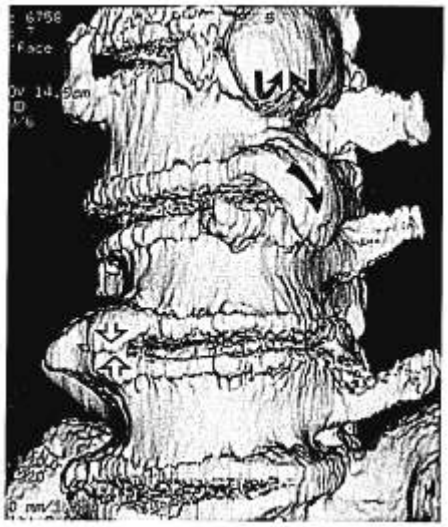

FIG. 5. Ventral three-dimensional computed tomography 3D CT (3D CT) study demonstrates marked osteophytic lipping at the L2–L3 (retrolisthesis), L3–L4, and L4–L5 levels (case 3). The ventral 3D CT scan of this 69-year-old man with disabling neurogenic claudication demonstrated increased olisthy at L2–L3, and severe osteophytic lipping at L2–L3 (double curved arrows), L3–L4 (curved arrow), and L4–L5 (double open arrows).

bony removal is directed at decompression of the thecal sac medially, and the nerve roots compressed within the lateral recesses below hypertrophied facet joints laterally (Fig. 8).

Where fusions were performed, earlier procedures included " in situ" posterolateral application of autogenous iliac crest bone graft, whereas the more recent fusions included Texas Scottish Rite Hospital (TSRH) instrumentation in conjunction with autogenous iliac crest bone graft. The author advocates performing fusions with pedicle screw-rod systems, to reduce postoperative pseudarthrosis and to manage prior failed fusions.

RESULTS

Primary Decompressions without Fusions

Laminectomies and laminotomies/fenestration procedures/hemilaminectomies addressed an average of 3.2 levels of stenosis found in association with degenerative spondylolisthesis (Table 1). Laminectomies were performed in 249 patients with average 3.4 level disease, whereas fenestration procedures/hemilaminectomies/coronal hemilaminectomies were completed in 41 patients having average 1.7 level disease. A single level of slip was demonstrated in 250 patients mostly at the L4–L5 level (225 patients), whereas two levels of slip were noted in 40 patients (13%), predominantly at the L3–L4/L4–L5 levels. The average overall number of levels of olisthy was 1.1. Disc herniations were found at the first operation in 59 (20%) patients. Using Prolo's outcome criteria, 69% of patients exhibited excellent, 13% good, 12% fair, and 6% poor outcomes. Of interest, there appeared to be little correlation between clinical outcome and postoperative radiographic findings (2).

Secondary Decompressions with Fusions

Secondary decompressions were accompanied by one posterolateral in situ and seven (2.8%) TSRH instrumented fusions. Increased olisthy rarely contributed to secondary instability, because only five (1.7%) patients in the entire series required secondary fusions to address increases in olisthy. For the remaining three, new disc herniations and more cephalad stenosis (two patients) or recurrent stenosis [one patient—laminectomy (L4–L5) after an original fenestration procedure] contributed to instability warranting secondary decompression/fusion.

Only one of these eight patients required yet a third operation. After an initial L3–S1 laminectomy for stenosis, a secondary L3–S1 decompression and posterolateral fusion was performed for recurrent stenosis/instability. The third

FIG. 6. Three-dimensional parasagittal computed tomography (CT) study shows retrolisthesis at the L2–L3 level and congenital spinal stenosis from L2–L5 (case 3). The three-dimensional parasagittal CT study demonstrated congenital L2–L5 lumbar stenosis with laminar shingling (single arrows), L2–L3 retrolisthesis (curved arrows), and fusion of the L3–L5 vertebrae. One year after an L2–L5 laminectomy, he remains asymptomatic.

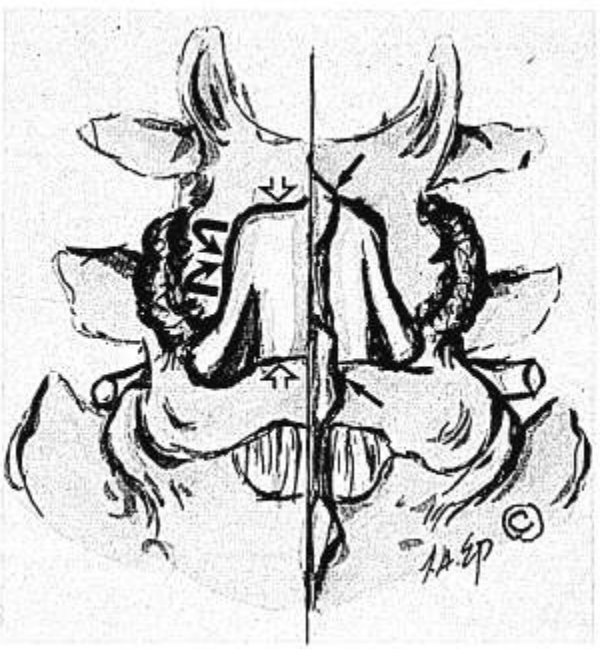

FIG. 7. Illustration of fenestration technique: Bilateral laminotomy with preservation of the spinous processes and interspinous ligaments. The fenestration technique, illustrated here for decompression of bilateral lateral recess stenosis associated with degenerative spondylolisthesis at the L4–L5 level, includes a bilateral interlaminar laminotomy (open arrows), medial undercutting facetectomy and foraminotomy (double curved arrows), with preservation of the midline structures (single black arrows). Note that the severe arthrosis enhances stability. [Original illustration courtesy of Dr. Joseph Epstein.]

procedure addressed recurrent stenosis, far lateral L4–L5 disc, and instability requiring posterolateral fusion.

DISCUSSION

Frequency

As in other series, the majority of olisthy was observed at one level (86%), L4–L5 being most commonly involved, with two-level disease (14%) also including the L4–L5 level (i.e., L3–L4/L4–L5) being observed in the remainder (4,12–15,26) (Table 1). Although most of our patients were in their 50s–70s, other series report a higher frequency in patients in their 40s–60s (3,4,30). Our patients with degenerative spondylolisthesis showed a 2:1 female to male ratio, comparable to that found in the literature (4,15,30).

Fenestration Technique

Fenestration procedures, hemilaminectomies, coronal hemilaminectomies, and the trumpet laminectomy, and in part the "ipsi-contra" approaches are alternatives to laminectomy for the management of degenerative spondylolisthesis with moderate lateral recess and central stenosis (3,8,9,12–15,23,27). Ninety percent of Aryanpur and Ducker's 32 patients with lateral recess stenosis having fenestration procedures experienced good to excellent outcomes 5 years postoperatively (3). After fenestration procedures (34 patients), Nakai et al.'s patients with moderate central stenosis had relief of symptoms for an average of 5.5 postoperative years, with new bone deposition enhancing stability without contributing to recurrent stenosis (27). Additionally, DiPierro et al. ipsi-contra procedure, offered unilateral restricted decompression plus contralateral fusion (8).

Laminectomy

Adequate decompression of severe degenerative spondylolisthesis with multilevel stenosis, spondylosis, and arthrosis, especially in older patients, may be successfully addressed with laminectomy alone (1,3,15,20,29–34,36). Of Nasca's 80 patients with stenosis, some with degenerative spondylolisthesis, 71% showed good to excellent outcomes 5 years after laminectomy (28). Silvers et al. found

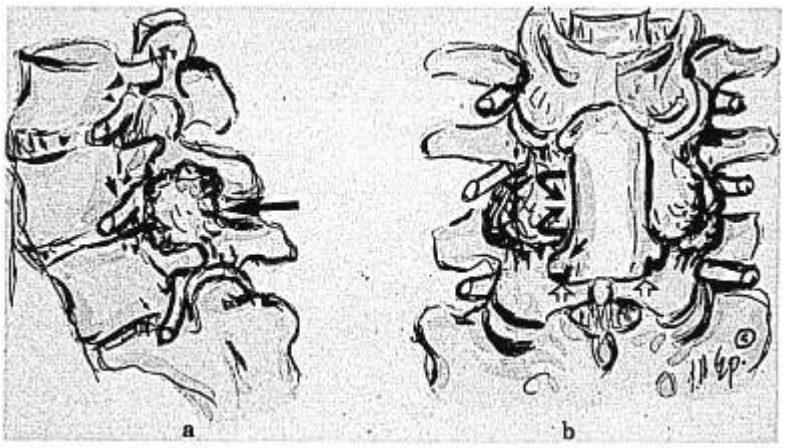

FIG. 8. Illustration of L4–L5 degenerative spondylolisthesis before and after laminectomy. **a:** Preoperative lateral view of degenerative spondylolisthesis at the L4–L5 level. At the L4–L5 level, olisthy and hypertrophy of the facet joints (single large arrow) contribute to marked L4–L5 thecal sac and nerve root compression. Observe the intrusion on both the superiorly exiting L4 (small single arrow) and inferiorly exiting L5 (double small arrows) nerve roots, the latter being more seriously compromised in the lateral recess and foramen. **b:** Postoperative anteroposterior view after complete L4 and partial L5 laminectomy. This view shows both thecal sac and nerve root decompression (small black arrow) achieved after complete L4 and partial L5 laminectomy (open arrows), with L4–L5 medial facetectomy and foraminotomy (large curved closed arrow). [Original illustration courtesy of Dr. Joseph Epstein.]

that laminectomy alone in 75% of 258 patients with stenosis, with or without degenerative spondylolisthesis, achieved good to excellent results for an average of 4.7 postoperative years (33). Similarly, in Sanderson and Wood's series, 81% of patients having lumbar decompressions alone without fusion exhibited good to excellent results, the results remaining the same for younger patients with stenosis alone compared with the older individuals with accompanying olisthy (31). Our own excellent/good outcomes were nearly the same, totaling 82%.

Furthermore, as in the Turner et al. meta-analysis of 74 articles on lumbar stenosis with or without degenerative spondylolisthesis, outcomes after laminectomy with or without fusion were the same: 64% of patients showed excellent results whether or not a fusion had been performed (35).

Fusion requirements in patients with stenosis (with/without degenerative spondylolisthesis) treated with laminectomy alone are low (30,33,34,36). Only 2 (0.8%) of 258 patients in Silvers et al's. series warranted secondary fusion (33). Similarly, just 4% of Young et al.'s 50 patients with grade I degenerative spondylolisthesis required secondary fusion, with no correlation between outcome quality, the number of levels decompressed, nor the presence of a preoperative slip being demonstrated (36). Consistent with these findings, 8 (2.7%) of our 290 patients with degenerative spondylolisthesis treated initially with laminectomy alone required secondary fusion.

Secondary decompressions and fusions after initial laminectomies for stenosis and/or degenerative spondylolisthesis also address new or recurrent stenosis up to 16% of the time (5,7,12–14,18,22,24). In the study of Katz et al.'s 88 patients, followed an average of 6 postoperative years, demonstrated recurrent stenosis as part of the 17% frequency of reoperation (24). Of 100 of Caputy and Luessenhop's 100 patients (mean age 67) followed for an average of 5 years, 16 exhibited recurrent stenosis at or above prior surgical levels (5). Of note, in our series, three of the eight having second operations exhibited significant stenosis, focally recurrent in one, and new cephalad compromise in two.

Did an increase in postoperative olisthy correlate with a poorer outcome? In our series, five (1.7%) of 290 patients requiring secondary surgery exhibited progression of olisthy

TABLE 1. *Data for 290 patients with degenerative spondylolisthesis*

Average age (yrs)	67 (range 38–82)
Sex	Men 94, Women 196
Average follow-up	10 yrs
Outcome Prolo scale	Excellent 69%
	Good 13%
	Fair 12%
	Poor 6%
Levels of slip: One level	250 (86%)
Average levels of slip	1.1
One-level slip	L3–L4, 20 patients
	L4–L5, 214 patients
	L5–S1, 16 patients
Total slip at two levels	40 (14%)
Two-level slip	L2–L3/L4–L5, 1 patient
	L3–L4/L4–L5, 34 patients
	L4–L5/L5–S1, 5 patients
1st Surgery laminectomy	249 Patients
Average levels	3.4
Levels of initial laminectomy	1 Level, 3 patients
	2 Levels, 86 patients
	3 Levels, 118 patients
	4 Levels, 35 patients
	5 Levels, 7 patients
1st Surgery hemilaminectomy or laminotomy	41 Patients
Average levels	1.7
Average overall levels	3.2
Levels of initial hemilaminectomy or laminotomy	1 Level, 21 patients
	Two levels, 11 patients
	Three levels, 9 patients
Total 2nd fusions	8 (2.7%)
Posterolateral in situ fusion	1
Texas Scottish Rite Hospital	1

with clinical evidence of instability. However, progression of slip in other series has failed to correlate as closely with the need for repeated surgical intervention (19,21,25,32). In Herron and Mangelsdorf's series, 20 of 24 patients (83%) having laminectomy alone for degenerative spondylolisthesis did well despite a slight increase in slip over 18 postoperative months (19). Johnsson et al.'s 20 patients with preoperative slips, although showing further postoperative olisthy, remained asymptomatic (21). Shenkin and Nash's 59 patients with stenosis treated with multilevel laminectomy and full inferior facetectomy, although demonstrating a 10% incidence of olisthy progression, warranted secondary fusions in just 2 (3.3%) patients (32).

Disc Herniations

Laminectomy for spinal stenosis addresses disc herniations 15–45% of the time, with the frequency in degenerative spondylolisthesis, 4.3–20%, being somewhat lower (1,12–14,17,34). In our series, 20% of patients with degenerative spondylolisthesis had extruded or sequestrated disc herniations (47—routine discs in the spinal canal, 12—far lateral beyond the pedicle). These disc herniations, and far lateral discs in particular, moderately predisposed patients to instability warranting secondary fusion (10,11). Of the eight patients having secondary decompressions/fusions for instability, five (62.5%) had discs removed at their original surgery (three—routine, two—far lateral), whereas three (two—far lateral, one—routine) had disc herniations excised as part of their secondary procedures.

Disc herniations observed at initial procedures occurred at the level of slip 84% of the time. For the eight patients warranting secondary decompression/fusion, disc herniations observed at both procedures occurred at the level of olisthy.

Risks of Fusion in Geriatric Patients

Deyo et al. (6) and Deyo et al. (7) determined that fusion for patients with lumbar stenosis, particularly in the geriatric population, markedly increased morbidity and mortality. For patients >75 years of age, an 18% complication rate was observed (6). When Deyo et al. looked at 5.6% of 27,111 patients having fusions, the 6-week mortality rate was twice that for the overall population, and their complication rate was 1.9 times greater (7). Additionally, transfusion requirements were 5.8 times higher, nursing home referrals 2.2 times more frequent, and hospital charges 1.5 more than for nonfused patients. Finally, reoperation and failure rates were the same irrespective of whether patients had fusions accompanying their original laminectomies. Along these same lines, Grob et al. (16) observed that 45 patients with lumbar stenosis and degenerative spondylolisthesis treated with decompression, decompression/focal fusion, or decompression with complete fusion exhibited comparable outcomes. Certainly, because two-thirds of our patients, averaging 67 years of age, fell within this geriatic age range, they would have been considered at higher risk if fused.

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