Guidelines for the performance of fusion procedures for degenerative disease of the lumbar spine.
Part 10: fusion following decompression in patients with stenosis without spondylolisthesis

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Recommendations

Standards. There is insufficient evidence to recommend a treatment standard.

Guidelines. There is insufficient evidence to recommend a treatment guideline.

Options. 1) In situ posterolateral lumbar fusion is not recommended as a treatment option in patients with lumbar stenosis in whom there is no evidence of preexisting spinal instability or likely iatrogenic instability due to facetectomy. 2) In situ lumbar PLF is recommended as a treatment option in addition to decompression in patients with lumbar stenosis without deformity in whom there is evidence of spinal instability. 3) The addition of pedicle screw instrumentation is not recommended in conjunction with PLF following decompression for lumbar stenosis in patients without spinal deformity or instability.

Rationale

The surgical management of patients with lumbar stenosis without spondylolisthesis has traditionally involved posterior decompressive procedures including laminectomy or laminotomy and judicious use of partial medial facetectomies and foraminotomies, with or without discectomy. In a subset of patients who have undergone lumbar laminectomy progressive vertebral displacement and slippage at or adjacent to the decompressed levels will be demonstrated. This has led some surgeons to recommend the routine use of PLF, with or without placement of instrumentation, to achieve an in situ arthrodesis following decompression. Given the additional blood loss and fusion-related risk, its use as an adjunct in patients with lumbar stenosis without deformity remains controversial. The purpose of this review is to examine the literature concerning the use of PLF after decompression in patients with lumbar stenosis without deformity. The following two key questions are examined. 1) Is there evidence that the addition of PLF improves outcome compared with decompression alone in patients with lumbar stenosis without deformity? If so, which patients with lumbar stenosis are likely to benefit from the use of adjunctive spinal fusion? 2) Is there evidence that the application of spinal instrumentation, in addition to PLF, improves outcome compared with fusion without instrumentation in this patient population?

Search Criteria

A computerized search of the database of the National
Spinal stenosis without spondylololisthesis

Library of Medicine from 1966 to March 2003 was conducted using the search terms “lumbar stenosis and fusion and spinal surgery” or “lumbar stenosis and arthrodesis.” The search was restricted to the English language and yielded 204 references. The titles and abstracts of each reference were reviewed, and papers not concerned with decompression and fusion for lumbar stenosis were discarded. Thirty-two references were identified that provided either direct or supporting evidence relevant to the use of spinal fusion in the treatment of lumbar stenosis without spondylololisthesis. These papers were reviewed, and relevant references from their bibliographies were identified. All papers providing Class III medical evidence or better regarding the use of fusion and decompression for nondeformity-based lumbar stenosis are summarized in Table 1. Additional supportive data are provided by references listed in the bibliography.

Scientific Foundation

In the treatment of symptomatic lumbar stenosis lumbar decompression has been demonstrated to have a clinical efficacy of between 60 and 75% in RCTs. In their meta-analysis of the available literature, Turner, et al., identified an overall 64% good outcome rate for all surgically treated patients with lumbar stenosis. The surgery-derived benefit decreased over time, however, with increased patient dissatisfaction with a longer follow-up duration. In the lumbar stenosis population, several subgroups have been consistently identified and subcategorized. These include patients with preexisting spondylolisthesis, scoliosis, prior destabilizing laminectomies, and the presence of segmental vertebral motion on flexion-extension radiographs.

Longitudinal studies have identified a discreet proportion of patients with lumbar stenosis without deformity who have undergone decompression and in whom progressive lumbar spinal instability, deformity, and/or spondylolisthesis have developed. The reported incidence of this progressive slippage has ranged from as low as 9% in patients with no evidence of preoperative lumbar spinal instability to as high as 73% in those with preoperative evidence of spondylolisthesis.

In an analysis of 100 laminectomy-treated patients, Caputy and Luessenhop found that the main risk factor for 5-year clinical and radiographic failure was preoperative spondylolisthesis. In topic reviews and metaanalyses of the literature, several authors have stressed the importance of identifying spondylolisthesis and scoliosis as significant risk factors for delayed clinical and radiographic failure after lumbar decompressive procedures. Multilevel laminectomies and extensive (wide) decompression have also been shown to have a positive correlation with an increased incidence of progressive spondylolisthesis. Whereas spondylolisthesis and scoliosis are easily identified on radiography as potential risks for postdecompression instability, several techniques have been advocated as a means by which to identify more subtle forms of preoperative spinal hypermobility or deformity. The most popular of these methods are criteria based on dynamic lateral flexion-extension images. In general, PLF at the time of lumbar decompression has been reserved for patients with lumbar stenosis and preoperative radiographic evidence of hypermobility or deformity in an attempt to minimize the chance of delayed symptomatic spondylolisthesis or deformity. Jolles, et al., reported that only in 9% of 155 decompression-treated patients without preoperative evidence of instability did delayed slippage eventually develop. Hopp and Tsou as well as others have reported that aggressive wide decompression and facetectomy performed at the time of the decompression result in iatrogenic destabilization in certain patients and may account for delayed deformity in those with stenosis and normal preoperative alignment.

At the time of lumbar decompression in patients without instability PLF has been performed to prevent late-onset instability and potentially to improve outcome. Corneljord, et al., retrospectively reviewed 124 patients of whom 96 were available for follow up. Three treatment groups were described: 59 patients underwent lumbar spinal fusion with or without placement of supplemental instrumentation, in addition to decompression. In all surgical patients statistically significant benefits were demonstrated for walking tolerance, leg pain, and back pain (p < 0.001), with an overall 65% satisfaction rate at 7 years. No significant differences in outcome were identified between those who underwent fusion and those who did not. This paper provides Class III medical evidence suggesting that the addition of fusion does not improve long-term outcomes in patients with stenosis and no evidence of preoperative spinal instability. Grob, et al., randomized 45 patients with stenosis but no evidence of preoperative spondylolisthesis or instability into three treatment groups: decompression alone (Group 1), decompression and single-segment fusion (Group 2), and decompression and multi-segment fusion (Group 3). In all three treatment groups patients reported significant improvement in ambulatory status and pain (p < 0.001). Blood loss and operative duration were, however, higher in the lumbar fusion groups. No differences among the three groups were noted on a patient satisfaction survey administered at the last follow-up evaluation. This paper provides Class III medical evidence (due to the small sample size and nonvalidated outcome measure) suggesting that the addition of PLF does not improveoutcome following decompression in patients with lumbar stenosis and no preoperative deformity or instability.

Herron and Mangelsdorf reported their experience with a retrospective cohort study of 140 patients treated for symptomatic lumbar stenosis. Nine patients underwent fusion in addition to decompression. Because of this extremely small sample, the authors were unable to demonstrate a significant benefit to fusion. Rompe, et al., reviewed their results with 117 consecutive patients in whom they performed surgery for lumbar stenosis: 90 patients underwent decompression only and 27 underwent decompression and fusion. Both groups of patients reported improved walking endurance and pain scores (p < 0.01). There were no statistical differences in outcome between the fusion and nonfusion groups. Nasca first reported a retrospective series of 80 patients, and 2 years later he described 114 patients treated with lumbar stenosis. He classified patients based on the anatomical location of stenosis, either in the lateral recess, central canal, or both, and noted the presence of associated scoliosis or deformity. In addition to decompression, fusion was performed in 51 patients and decompression alone was per-
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<th>Authors &amp; Year</th>
<th>Method</th>
<th>Description</th>
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<tr>
<td>Tile, et al., 1976</td>
<td>III</td>
<td>Retrospective series of 90 patients with lumbar stenosis. All had improvement in claudication symptoms. Patients were treated with decompression and fusion.</td>
<td>No comparison of fusion vs no fusion in matched patients.</td>
</tr>
<tr>
<td>Shenkin &amp; Hash, 1979</td>
<td>III</td>
<td>Retrospective series of 59 patients with intractable pain treated with multilevel laminectomies. Although progressive slip noted in 6-15% of patients, overall results were good.</td>
<td>Recommended sparing of dorsal elements as much as possible during decompression.</td>
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<tr>
<td>Hutter, 1985</td>
<td>III</td>
<td>Retrospective review of 142 patients treated with PLIF: 78% good result. Technical report &amp; case series.</td>
<td>Recommended sparing of dorsal elements as much as possible during decompression.</td>
</tr>
<tr>
<td>Nasca, 1989</td>
<td>III</td>
<td>Retrospective review of 80 patients with lumbar stenosis. Paper very similar to that published in 1989 (see Nasca, 1989).</td>
<td>Recommended sparing of dorsal elements as much as possible during decompression.</td>
</tr>
<tr>
<td>Hopp &amp; Tsou, 1988</td>
<td>III</td>
<td>Retrospective study of 334 patients. Authors noted 17% reoperation rate for instability. Preoperative predictors of instability included traction spurs, decreased disc height, listhesis, &amp; scoliosis.</td>
<td>Recommended sparing of dorsal elements as much as possible during decompression.</td>
</tr>
<tr>
<td>Nasca, 1989</td>
<td>III</td>
<td>Retrospective review of 114 patients with lumbar stenosis. Divided into 4 groups: lateral recess stenosis (15), unilateral disc, radiculopathy (11), adjacent level stenosis (11), and fusion over major curve (73). Overall, noticed trend of better outcomes in each subgroup compared to laminectomy alone.</td>
<td>No conclusions drawn from this report.</td>
</tr>
<tr>
<td>Conley, et al., 1990</td>
<td>III</td>
<td>Retrospective review of 25 patients, with 2-yr FU. All had intraoperative instability noted. Knodt rod facet fusions done. Basically a technique paper.</td>
<td>No conclusions drawn from this report.</td>
</tr>
<tr>
<td>Heron &amp; Mangelsdorf, 1991</td>
<td>III</td>
<td>Retrospective review of 140 patients. Only 9 underwent fusion. No correlation of outcome with fusion.</td>
<td>No conclusions drawn from this report.</td>
</tr>
<tr>
<td>Caputy &amp; Luessenhop, 1992</td>
<td>III</td>
<td>Retrospective series of 100 patients treated with laminectomy; 5-yr FU in 88 patients. 27% failure rate at 5 yrs. Case series. No significant conclusions can be reached.</td>
<td>No conclusions drawn from this report.</td>
</tr>
<tr>
<td>Louis &amp; Nazarian, 1992</td>
<td>III</td>
<td>Retrospective review of 350 patients, 280 with 2-yr FU. Initially used fusion with screws/plates in 43% cases, then dropped to 17% of cases. The use of fusion was associated with better relief of LBP in some patient groups.</td>
<td>No conclusions drawn from this report.</td>
</tr>
<tr>
<td>Turner, et al., 1992</td>
<td>III</td>
<td>Metaanalysis on ops for stenosis included 74 articles. Commented on poor quality of available studies—very different outcome variables, ops techniques.</td>
<td>No conclusions drawn from this report.</td>
</tr>
<tr>
<td>Grob, et al., 1995</td>
<td>III</td>
<td>RCT of 45 patients with disc herniation &amp; an instability or deformity. Patients divided into 3 groups: laminectomy, laminectomy &amp; fusion, instrumented fusion.</td>
<td>No conclusions drawn from this report.</td>
</tr>
<tr>
<td>Fox, et al., 1996</td>
<td>III</td>
<td>Retrospective series of 124 patients treated with laminectomy; 32 treated with fusion as well. Mean FU was 5.8 yrs. Listhesis was major predictor of delayed slip/failure.</td>
<td>No conclusions drawn from this report.</td>
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**TABLE 1**

Summary of studies involving postdecompression fusion in patients with degenerative lumbar disease.
Spinal stenosis without spondylolysis

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<tr>
<th>Author &amp; Year</th>
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<tr>
<td>Gibson, et al., 1999</td>
<td>III</td>
<td>Coochiene et al. 1994 review of 4 RCTs for DS/stenosis: 3 of the identified RCTs analyzed adjacent fusion w/ 119 patients</td>
<td>No difference between lumbar fusion vs laminectomy only when combined analysis of 3 RCTs performed.</td>
</tr>
<tr>
<td>Katz, et al., 1999</td>
<td>III</td>
<td>Raiman, 1999</td>
<td>No clinical difference achieved in 93/96% fusion rate.</td>
</tr>
<tr>
<td>Yone &amp; Sakou, 1999</td>
<td>III</td>
<td>Retrospective review of 124 patients with lumbar stenosis and varying degrees of spondylolisthesis treated for lumbar fusion and spondylolisthesis. In terms of patients without preoperative deformity or instability, this paper provides Class III medical evidence supporting the use of lumbar fusion in patients with lumbar stenosis, particularly those with evidence of preoperative instability.</td>
<td>Fox, et al., 8 performed a retrospective analysis of 124 patients they had treated for symptomatic lumbar stenosis. They observed that 91% of those who had undergone laminectomy and fusion reported good outcomes compared to 75% of those treated with laminectomy alone. The majority of patients selected for fusion were reported to have preoperative instability or spondylolisthesis. Only two patients without instability or spondylolisthesis underwent fusion. Their mean follow-up duration was 5.8 years; they were administered a patient satisfaction survey. This paper provides Class III medical evidence supporting the use of lumbar fusion in patients with lumbar stenosis, particularly those with evidence of preoperative instability. Herkowitz and Kurz11 alternately assigned a group of 50 patients with stenosis and varying degrees of spondylolysis-thesis to laminectomy alone or laminectomy combined with in situ noninstrumented fusion (25 patients in each group). Fusion-treated patients fared much better than those treated with laminectomy alone at the 2.4-year follow-up in terms of satisfaction and pain control (visual analog scale, p &lt; 0.0001). Progressive spondylolysis-thesis and segmental vertebral angulation were noted more frequently in the laminectomy-alone group and were associated with poor outcomes. This paper provides Class II medical evidence that the addition of a noninstrumented fusion improves outcomes in patients with lumbar stenosis and spondylolisthesis. In terms of patients without preoperative deformity or instability, this paper provides Class III medical evidence in favor of the addition of fusion at the time of decompression in that poor outcomes were associated with late-onset deformity. Katz, et al.,14 reported on 272 patients who had undergone treatment for lumbar stenosis. In a multicenter retrospective trial, 71% of patients were treated with laminectomy alone and 29% with instrumented/noninstrumented fusion. At 6 months, the authors observed that fusion-treated patients fared better with regard to back pain scores (p &lt; 0.004) and walking tolerance (p &lt; 0.05), but this benefit deteriorated by the time of the 24-month follow-up (p &lt; 0.01 low-back pain; p &lt; 0.05 walk tolerance). For the subset of patients with preoperative spondylolisthesis or scoliosis, the benefit of fusion was statistically significant and more stable over time (p &lt; 0.0001). In a different prospective nonrandomized observational trial, Katz, et al.,11 reported a similar benefit of fusion in 58 patients. He reported an overall good outcome rate of 70%. There was a trend toward better results with fusion in patients with spondylolisthesis, scoliosis, severely degenerated facet joints, collapsed disc spaces, and preoperative movement noted on dynamic spinal radiographs. These trends, however, did not achieve statistical significance, even in the subgroup in which these identified risk factors were present. All of the aforementioned papers provide Class III medical evidence suggesting that PLF is not necessary or beneficial in the majority of patients undergoing decompression for symptomatic lumbar stenosis without deformity or instability. Because of the retrospective nature of all of these studies, the fact that patient selection criteria for fusion compared with no fusion were not standardized, and the relatively small number of patients involved in each study, definitive conclusions regarding the role of fusion in this patient population cannot be made.</td>
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</table>
fusion in 199 patients with lumbar stenosis, 61 of whom were treated with fusion (31 in situ and 30 instrumented). These two studies provide Class III medical evidence in support of a beneficial effect derived from adding fusion at the time of decompression in patients with stenosis and concomitant spinal deformity.

Gibson, et al., performed a meta-analysis on the subject of spinal stenosis for the Cochrane review. They identified three RCTs with a total of 139 patients; 99% of patients were available for follow up at 2 to 3 years (these studies have been discussed in previous paragraphs). In their meta-analysis Gibson and colleagues concluded that no significant benefit existed for lumbar fusion in the treatment of patients with lumbar stenosis (odds ratio 0.8, 95% confidence interval 0.31–2.10). The rationale used to justify the combined analysis of these studies with disparate patient populations (for example, Grob, et al., and Bridwell, et al., treated completely different patient populations) is not well described. Turner, et al., attempted a separate meta-analysis regarding this issue and concluded that the medical evidence available from the 74 papers they reviewed could not be combined to provide definitive conclusions regarding the use of fusion as an adjunct in the treatment of patients with lumbar stenosis. They reported that the primary problem was the heterogeneous outcome measures utilized among the different patient series. A third metaanalysis performed on this subject revealed the potential influence of symptom duration. Niggemeyer, et al., demonstrated that among patients with symptoms of less than 8 years’ duration, decompression alone yielded the best outcomes; however, in patients with symptoms of stenosis for longer than 15 years’ duration, instrumentation-augmented fusion and decompression yielded the best results (p < 0.05). Because of the previously cited difficulty in combining data from different studies involving different outcome measures, these observations must be considered with caution.

Several retrospective series were identified that describe the results of various procedures for instrumented spinal fusion in addition to decompression for spinal stenosis in patients without deformity. For example, Conley, et al., retrospectively reviewed the use of Knodt rods as a routine adjunct to decompression in patients with stenosis and reported a 66% excellent outcome rate and a 72% radiographic fusion rate. In general, these series offer little insight into the advantage of adding modern segmental instrumentation to a PLF during the treatment of lumbar stenosis.

A few series have compared the use of instrumented fusion and decompression with lumbar decompression alone. Louis and Nazarian summarized their experience with 350 patients of whom nearly 34% underwent fusion supplemented with pedicle screw fixation in addition to decompression in patients with preoperative spondylolisthesis or instability, and in cases in which a wide decompression was accomplished. In terms of lumbar pain, they were able to demonstrate a trend toward better outcomes in patients treated with decompression and pedicle screw–augmented fusion (85%) compared with those who underwent decompression alone (65%). No patient underwent noninstrumented fusion in this cohort. Yone, et al., performed a retrospective analysis of 60 patients with lumbar stenosis. Thirty-three patients were identified as having preoperative spinal instability based on lateral flexion–extension radiography. Three groups were assessed: patients with stenosis and instability treated with laminectomy and instrumented fusion (some pedicle screws and some Knodt rods), those with stenosis and instability treated with laminectomy alone, and those with stenosis and no instability treated with laminectomy alone. In patients with stenosis and instability, improvements in low-back pain outcomes were significantly greater (p < 0.05) in the fusion group. The authors observed similar rates of good outcomes (80%) among fusion-treated patients with preoperative instability or deformity and those without instability or deformity who underwent decompression alone.

Cornefjord, et al., performed a retrospective review of 124 patients who underwent surgery for lumbar stenosis. Fifty-nine patients underwent fusion, of whom 42 also received supplemental pedicle screw instrumentation. No differences were observed between patients in the fusion and nonfusion groups or between patients in the instrumentation-augmented fusion group and those in the noninstrumented fusion group. Because of differences in selection criteria for instrumentation, the use of nonvalidated outcome measures, and the retrospective nature of these reports, all of their medical evidence regarding the use of supplemental instrumentation for PLF following decompression in patients with lumbar stenosis and without deformity is considered Class III.

Summary

Based on the medical evidence derived from the scientific literature on this topic, there does not appear to be evidence to support the hypothesis that fusion (with or without instrumentation) provides any benefit over decompression alone in the treatment of lumbar stenosis in patients in whom there is no evidence of preoperative deformity or instability. A single report provides Class II medical evidence and several papers provide Class III medical evidence suggesting that the addition of fusion to decompression in patients with lumbar stenosis and instability evidenced by movement on preoperative flexion–extension radiographs does improve outcome. There are also reports (Class III medical evidence) indicating that patients with lumbar stenosis, without deformity or instability, treated with wide decompression or facetectomy may suffer iatrogenic lumbar instability. Fusion in these patients may improve outcome. There is conflicting Class III medical evidence regarding the application of instrumentation in addition to PLF in patients treated for lumbar stenosis without deformity or preoperative instability.

Future Research Directions

Clinical outcome in patients without deformity or instability undergoing decompression for lumbar stenosis should be radiographically confirmed in patients with and without evidence of instability on preoperative x-ray films. Such patients could be randomized into fusion or nonfusion groups, thus allowing accrual of Class I evidence to support or refute the hypothesis that the added expense, operative time, and increased morbidity associated with fusion is justified by a clinical benefit. The study should use validated
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clinical outcome measures for both decompression- (such as walking tolerance) and fusion- (such as back pain and disability scales) related outcomes. If the value of fusion is convincingly demonstrated, then the issue of supplemental internal fixation can be addressed.

References