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The Surgical Management of Degenerative Lumbar Spondylolisthesis

A Systematic Review

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Study Design. Systematic review.

Objective. To identify whether there is an advantage to instrumented or noninstrumented spinal fusion over decompression alone for patients with degenerative lumbar spondylolisthesis.

Summary of Background Data. The operative management of degenerative spondylolisthesis includes spinal decompression with or without instrumented or noninstrumented spinal fusion. Evidence on the operative management of degenerative spondylolisthesis is still divisive.

Methods. Relevant RCT and comparative observational studies between 1966 and June 2005 were identified. Abstracted outcomes included clinical outcome, reoperation rate, and solid fusion status. Analyses were separated into: 1) fusion *versus* decompression alone and 2) instrumented fusion *versus* noninstrumented fusion.

Results. Thirteen studies were included. The studies were generally of low methodologic quality. A satisfactory clinical outcome was significantly more likely with fusion than with decompression alone (relative risk, 1.40; 95% confidence interval, 1.04–1.89; $P < 0.05$). The use of adjunctive instrumentation significantly increased the probability of attaining solid fusion (relative risk, 1.37; 95% confidence interval, 1.07–1.75; $P < 0.05$), but no significant improvement in clinical outcome was recorded (relative risk, 1.19; 95% confidence interval, 0.92–1.54). There was a nonsignificant trend toward lower repeat operations with fusion compared with both decompression alone and instrumented fusion.

Conclusion. Spinal fusion may lead to a better clinical outcome than decompression alone. No conclusion about the clinical benefit of instrumenting a spinal fusion could be made. However, there is moderate evidence that the use of instrumentation improves the chance of achieving solid fusion.

Key words: systematic review, degenerative spondylolisthesis, lumbar spine, decompression, fusion, instrumentation. **Spine 2007;32:1791–1798**

Degenerative spondylolisthesis is a pathologic state where the combination of arthritic and degenerative changes in disc and facet joints results in vertebral displacement and ensuing spinal stenosis. Operative management commonly includes spinal decompression. At times, concomitant spinal fusion with or without instrumentation is performed to restrict vertebral motion in hopes of managing the condition's inherent spinal instability.

The role of adjunctive fusion with or without instrumentation remains controversial. Conclusions from previous systematic reviews were limited by their reliance on scarcely available randomized controlled trials (RCTs)[1] or dependence on pooled case series data.[2] Conclusions can be strengthened by incorporating a larger evidence base in the form of comparative nonrandomized studies while using methods to address the limitations of including such studies. The present systematic review was designed to identify and analyze comparative studies that examined the operative management of degenerative lumbar spondylolisthesis.

The null hypotheses were that, for patients with degenerative lumbar spondylolisthesis, there were no differences in outcomes between: 1) fusion *versus* decompression alone and 2) instrumented fusion *versus* noninstrumented fusion.

Methods

Relevant RCTs and comparative observational studies were identified in a computer search of Medline (1966 to June 2005), Embase, and the Cochrane Central Registry of Controlled Trials. A hand search was also performed to identify further studies. The hand search included the *European Spine Journal*, *Spine*, and the *Journal of Spinal Disorders and Techniques* as well as bibliographies of identified studies and relevant narrative reviews. In an effort to identify nonpublished studies, a hand search of conference abstracts since 2001 from the International Society for the Study of the Lumbar Spine was performed. Full details of the specific search strategies are available from the authors.

The inclusion criteria required that a study be an RCT or comparative observational study that investigated the surgical management of degenerative lumbar spondylolisthesis by com-

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The device(s)/drug(s) is/are FDA-approved or approved by corresponding national agency for this indication.

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paring: 1) fusion to decompression and/or 2) instrumented fusion to noninstrumented fusion. A minimum 1-year follow-up was required. Studies also had to include at least 5 patients per treatment group. English, German, and French articles were considered for inclusion. A study was excluded if it included patients who had received previous spine surgery, or patients with cervical injuries, spinal fractures, tumors, or isthmic spondylolisthesis. A study was also excluded if it was not possible to analyze patients with degenerative spondylolisthesis separately from another included patient population, or if it was not clearly a comparative study.

Titles and abstracts of the identified studies were reviewed, and possible studies were retrieved in full text version. Full text versions of these studies were then assessed for inclusion by 2 independent reviewers. Disagreement between reviewers was resolved by discussion or, if consensus could not be reached, by consultation with a third independent reviewer.

Data from the included studies were extracted by 2 independent reviewers using a standard data abstraction sheet. The data abstraction sheet identified the following information: 1) patient population's age, sex, symptoms, and degree of spondylolisthesis; 2) type of: decompression, fusion, instrumentation, bone graft material, and preoperative and postoperative treatment; 3) study design and methodologic quality using the *Cochrane RCT/CCT/Crossover Studies Checklist*,[3] modified by the additional criterion that observational studies state the use of a consecutive series of patients; and 4) study outcomes. In studies that included mixed spinal pathologies, only data from patients with degenerative spondylolisthesis were abstracted.

The main abstracted outcomes were clinical outcome, reoperation rate, and solid fusion status. An attempt was made to compare patient-centered, validated, and disease-specific outcomes, complications, and spondylolisthesis progression; but because of heterogeneity in reporting these outcomes in the primary studies, no pooled analysis could be performed on these outcomes.

When appropriate, a study's clinical outcome rating scale was altered to match a dichotomous rating scale of "satisfactory" or "unsatisfactory" clinical outcome, and results were entered into Review Manager 4.2 for weighted grouped analyses. To group the results, ratings of "excellent," "good," "significantly better," "satisfied," or "success" were classified as a satisfactory clinical outcome whereas ratings of "fair," "poor," "same," "worse," "slightly satisfied," "slightly dissatisfied," or "unsuccessful" were classified as an unsatisfactory clinical outcome. Grouped analysis was presented in terms of random effects relative risk (RR). Statistical heterogeneity was evaluated using the so-called "test of heterogeneity" at a significance level of $P < 0.1$, and using the I^2-statistic, which describes the proportion of variability due to heterogeneity.[4]

■ Results

Literature Search

A total of 1923 studies were identified in the electronic search, of which 66 were classified as possible for inclusion. Of these, 12 satisfied the inclusion/exclusion criteria. An additional study was identified by a bibliography search. Therefore, a total of 13 studies comprising 578 patients with degenerative lumbar spondylolisthesis were included in this review.

Study Details

Eight studies were included in the fusion *versus* decompression alone analysis, including 2 RCTs[5,6] and 6 observational studies.[7–12] The characteristics of these 8 studies are presented in Tables 1 and 2. The degree and extent of spondylolisthesis varied between studies, as did the method of quantifying the olisthesis. The majority of surgeons performed surgical decompression using a laminectomy procedure, with 5 studies providing details about the extent of decompression.[5,6,8,11,12] Fusion was most commonly performed with a posterolateral technique.

Limitations were found in the methodologies of both RCTs. Herkowitz and Kurz[5] enrolled patients alternatively into treatment groups, limiting their group allocation to pseudo-randomization. Bridwell *et al*[6] did not describe their method of randomization. Neither study assessed clinical outcome using a patient-centered, disease-specific, validated measure such as the Japanese Orthopedic Association questionnaire or Oswestry Disability Index, which are both now in common use. The assessment of clinical outcome by Bridwell *et al*[6] was especially limited, taking into account only a patient's ability to walk distances. Neither study overtly reported blinding of either the patients or outcome assessors.

Most of the observational studies were also limited by deficits in study design. Three studies selected their sample from a well-defined historical period,[8,11,12] but no study explicitly reported the use of a consecutive series of patients. In only one study[12] were treatment groups similar at baseline in terms of demographic factors, duration and severity of complaints, percentage of patients with neurologic symptoms, and value of main outcome measures. Criteria guiding treatment decisions were rarely reported, with the study by Satomi *et al*[9] being the only one to detail criteria for selecting the applied treatment. In this study, patients judged to have displacement of one intervertebral disc were managed with anterior lumbar surgery while patients with displacement of 2 or more intervertebral discs were treated with decompression surgery.

All of the studies except one[12] demonstrated a beneficial effect with fusion (Figure 1). Grouped analysis detected a significantly higher probability of achieving a satisfactory clinical outcome with spinal fusion than with decompression alone (relative risk [RR], 1.40; 95% confidence interval [CI], 1.04–1.89; $P < 0.05$). A test for heterogeneity indicated that a substantial amount of the variability in point estimates was likely due to clinical and/or methodologic diversity between studies rather than to chance ($I^2 = 59.3$). There was no statistical heterogeneity among RCTs. The results from the study by Matsudaira *et al*[12] accounted for the majority of the heterogeneity assigned to the observational studies. In addition, there were differences in the magnitude of effect between the study types, with sensitivity analyses revealing a larger recorded clinical benefit favoring fusion in the RCTs (RR, 2.15; 95% CI, 1.43–3.23; $P < 0.05$) compared with the observational studies (RR, 1.20; 95% CI, 0.92–1.56). The clinical benefit improved modestly

Table 1. Characteristics of the Included Studies: Randomized Controlled Trials

Study	Methodology	Participants	Interventions	Outcomes
Fusion *versus* decompression alone				
Herkowitz (1991)	Randomization:* Pseudo-randomized Allocation concealment:† Inadequate Blinding: unclear Dropout rate described and acceptable:‡ yes	50 patients: 14 male; 36 female; age, 52–84 yr Degenerative lumbar spondylolisthesis with spinal stenosis	Group 1: laminectomy n = 25 Group 2: Same + bilateral intertransverse process fusion n = 25	Patient/physician composite rating VAS Radiographic outcomes Successful fusion rate 3-yr follow-up
Instrumented fusion *versus* noninstrumented fusion				
Fischgrund (1997)	Randomization: adequate Allocation concealment: adequate Blinding: unclear Dropout rate described and acceptable: yes	76 patients: 13 male; 55 female; age, 52–86 yr Degenerative lumbar spondylolisthesis with spinal stenosis	Group 1: laminectomy + posterolateral fusion n = 33 Group 2: Same + pedicle screw and plate instrumentation n = 35	Patient/physician composite rating VAS Radiographic outcomes Successful fusion rate Reoperation rate ≥2-yr follow-up
France (1999)	Randomization: unclear Allocation concealment: Inadequate Blinding: unclear Dropout rate described and acceptable: yes	83 patients: age, 23–73 yr Mixed spine conditions 10 patients with degenerative lumbar spondylolisthesis	Group 1: posterolateral fusion n = 41 Group 2: same + pedicle screw and plate instrumentation n = 42	Patient graded results VAS§ Radiographic outcomes§ Reoperation rate§ Medication use§ ≥1-yr follow-up
Mixed				
Bridwell (1993)	Randomization: inadequate Allocation concealment: inadequate Blinding: unclear Dropout rate described and acceptable: yes	44 patients: 10 male; 33 female; age, 46–79 yr Degenerative lumbar spondylolisthesis and spinal stenosis 4 patients with coronal olisthesis	Group 1: decompression n = 9 Group 2: same as Group 1 + posterolateral fusion = 10 Group 3: same as Group 2 + mixed pedicle fixation instrumentation n = 24	Functional/pain status Radiographic outcomes Successful fusion rate Complications Reoperation rate ≥2-yr follow-up

*Adequate, unpredictable assignment sequence; Pseudo-randomized, alternative sequence.
†Adequate, assignment generated by an independent person not responsible for determining the eligibility of patients.
‡Acceptable dropout ≤80% attrition.
§Outcome not reported for degenerative spondylolisthesis patients. VAS, Visual Analog Scale.

(RR, 1.52, 95% CI, 1.09–2.11) when a comparison between noninstrumented fusion and decompression alone was isolated by eliminating data from patients with instrumented fusions. Clinical benefit also minimally changed (RR, 1.41; 95% CI, 0.93–2.14) when studies with patients afflicted by comorbid degenerative scoliosis were excluded. The clinical benefit favoring fusion decreased when analysis was limited to studies where the majority of patients were reported to be experiencing neurologic symptoms such as intermittent claudication and/or leg pain (RR, 1.19; 95% CI, 0.93–1.52).

The results from the study by Ghogawala *et al*[11] were provided in a continuous data format that precluded inclusion in grouped analyses. The study concluded that postoperative outcomes, assessed using the Japanese Orthopedic Association questionnaire and SF-36 questionnaire, were significantly better with adjunctive fusion than with decompression alone.

There was a nonsignificant trend towards a lower repeat operation rate in the fusion group compared with decompression alone (RR, 0.40; 95% CI, 0.09–1.84).

Six studies were included in the instrumented fusion *versus* noninstrumented fusion analysis, including 3 RCTs[6,13,14] and 3 observational studies.[15–17] The characteristics of these studies are presented in Tables 1 and 2. The degree and extent of spondylolisthesis among patients varied in and between studies. Fusion was most commonly performed with a posterolateral technique. Instrumentation methods varied and included screw and/or plate[6,13–15,17] and screw and/or hook and rod.[16]

Fischgrund *et al*[13] was the only study to clearly use an adequate method of randomization and allocation concealment. Bridwell *et al*[6] did not describe the randomization method used in their study, and used a poor method of allocation concealment. They had an exception to their allocation sequence and, as a result, the instru-

Table 2. Characteristics of Included Studies: Comparative Observational Studies

Study	Methodology	Participants	Interventions	Outcomes
Fusion *versus* decompression alone				
Feffer (1985)	Type: retrospective	19 patients: 8 male; 11 female; age, 38–78 yr	Group 1: laminectomy n = 11	Patient graded results
	Consecutive patients: no	Degenerative lumbar spondylolisthesis	Group 2: same + fusion n = 8	Radiographic outcomes
	Similar baseline:* unclear			Complications
	Blinding: no			≥1-yr follow-up
	Dropout rate described and acceptable:† yes			
Lombardi (1985)	Type: retrospective	47 patients: 7 male; 40 female; age, 49–81 yr	Group 1:‡ laminectomy n = 6	Patient graded results
	Consecutive patients: no	Degenerative lumbar spondylolisthesis	Group2:‡ laminectomy, less extensive than Group 1 n = 20	Radiographic outcomes
	Similar baseline: unclear		Group 3: same as Group 2 + intertransverse process fusion n = 21	Successful fusion rates
	Blinding: no			Reoperation rate
	Dropout rate described and acceptable: NA			≥1-yr follow-up
Satomi (1992)	Type: retrospective	41 patients: 14 male; 27 female; age, 36–81 yr	Group 1: interlaminal fenestration or laminectomy n = 14 ± fusion n = 4	Radiographic outcomes
	Consecutive patients: unclear	Degenerative lumbar spondylolisthesis	Group 2: ALIF ± instrumentation n = 27	Successful fusion rates
	Similar baseline: no	40% with lumbar scoliosis		JOA questionnaire
	Blinding: no			~ 3-yr follow-up
	Dropout rate described and acceptable: no			
Yone (1996)	Type: retrospective	34 patients: 19 male; 15 female; age, 60–89 yr	Group 1: laminotomy n = 7	JOA
	Consecutive patients: unclear	Spinal stenosis with or without instability	Group 2: laminectomy or laminotomy + posterolateral fusion + pedicle screw or hook and rod instrumentation n = 10	Successful fusion rates Complications
	Similar baseline: unclear	17 patients with nonspondylolytic sagittal instability		≥2-yr follow-up
	Blinding: no			
	Dropout rate described and acceptable: NA			
Ghogawala (2004)	Type: prospective	34 patients: 11 male; 23 female; average age, 68.8 yr	Group 1: laminectomy n = 20	ODI
	Consecutive patients: unclear	Degenerative Grade 1 lumbar spondylolisthesis	Group 2: same + posterolateral fusion + pedicle screw instrumentation n = 14	SF-36
	Similar baseline: unclear	24% of patients had >15° rotational scoliosis and 12% >15° lateral scoliosis		Radiographic outcomes
	Blinding: yes (assessors)			Reoperation rate
	Dropout rate described and acceptable: unclear			Successful fusion rates Complications 1-yr follow-up
Matsudaira (2005)	Type: unclear	55 patients: 15 male; 22 female; average age, ~67 yr	Group 1: laminoplasty n = 19	JOA
	Consecutive patients: unclear	Spinal stenosis and grade 1 degenerative lumbar spondylolisthesis	Group 2: laminectomy + posterolateral fusion + pedicle screw instrumentation n = 20	Radiographic outcomes
	Similar baseline: yes		Group 3:‖ conservative treatment n = 16	Satisfaction
	Blinding: no			Complications
	Dropout rate described and acceptable: yes			2-yr follow-up

(*Continued*)

Table 2. Continued

Study	Methodology	Participants	Interventions	Outcomes
Instrumented fusion *versus* noninstrumented fusion				
Kakiuchi (1998)	Type: unclear	73 patients: 0 male; 33 female; age, 60–79 yr	Group 1: laminectomy + PLIF n = 14	Radiographic outcomes
	Consecutive patients: unclear	Disc herniation, postdiscectomy or degenerative spondylolisthesis	Group 2:‡ same as Group 1 + pedicle screw instrumentation n = 11	Successful fusion rates
	Similar baseline: unclear	33 patients with degenerative lumbar spondylolisthesis	Group 3:‡ same as Group 1 + hook and rod instrumentation n = 8	Complications§
	Blinding: no Dropout rate described and acceptable: yes			≥2-yr follow-up
Mochida (1999)	Type: unclear	102 patients: 26 male; 76 female; age, 43–69 yr	Group 1: decompression + posterolateral fusion n = 35	JOA
	Consecutive patients: unclear	Degenerative lumbar spondylolisthesis of L4	Group 2:‖ same as Group 1 + syndesmoplasty n = 33	Radiographic outcomes
	Similar baseline: unclear		Group 3: same as Group 1 + pedicle fixation instrumentation n = 34	Successful fusion rate
	Blinding: no Dropout rate described and acceptable: unclear			Satisfaction Complications ≥2-yr follow-up
Kimura (2001)	Type: retrospective	60 patients: 10 male; 47 female; age, 42–69 yr	Group 1: mixed decompression + posterolateral fusion n = 31	JOA
	Consecutive patients: unclear	L4–L5 degenerative spondylolisthesis	Group 2: same + pedicle screw instrumentation n = 29	Radiographic outcomes
	Similar baseline: yes Blinding: no Dropout rate described and acceptable: yes			Complications Satisfaction Successful fusion rates Reoperation rate ≥2-yr follow-up

*Similar baseline regarding demographic factors, duration and severity of complaints, percentage of patients with neurologic symptoms, and value of main outcome measure(s).
†Acceptable dropout ≤80% attrition.
‡Grouped together for analyses.
§Outcome not reported for degenerative spondylolisthesis patients.
‖Intervention group not included in analyses. NA, not applicable; ODI, Oswestry Disability Index; ALIF, anterior lumbar interbody fusion; PLIF, posterior lumbar interbody fusion; JOA, Japanese Orthopaedic Association questionnaire.

mented fusion treatment arm included patients with more severe progression of their spondylolisthesis. France *et al*[14] randomized patients with mixed spine pathologies and only included 10 patients with degenerative spondylolisthesis. In addition, they did not provide baseline data for the degenerative spondylolisthesis patients, so it is uncertain whether randomization of such a small number of patients controlled for important confounding factors. No study described blinding of either the patients or outcome assessors. In all 3 studies, radiographic measures were assessed by an independent observer not aware of the clinical status of the patient.

Although none of the observational studies explicitly reported the use of a consecutive series of patients, samples were selected from well-defined historical periods, and a detailed description of pretreatment attrition was provided in 2 studies.[16,17] The study by Mochida *et al*[15] included 3 treatment groups, with 2 groups receiving different instrumentation methods and a third control group receiving no instrumentation. The instrumentation groups were pseudo-randomized in alternating sequence. However, no description of the noninstrumented control group selection was provided, making the assessment of study type difficult. Patients in different intervention groups were similar at baseline regarding important prognostic factors in one study.[17] In another study,[15] radiographic outcomes were assessed by an independent observer not aware of the preoperative and postoperative patient status.

The RR (Figures 2, 3) of achieving a satisfactory clinical outcome with instrumented spinal fusion was not statistically higher than with noninstrumented fusion (RR, 1.19; 95% CI, 0.92–1.54). A substantial amount of variability between point estimates was due to statistical heterogeneity (I^2 59.0%). The highest quality study by Fischgrund *et al*,[13] which demonstrated no effect for instrumented fusion, accounted for the majority of the heterogeneity.

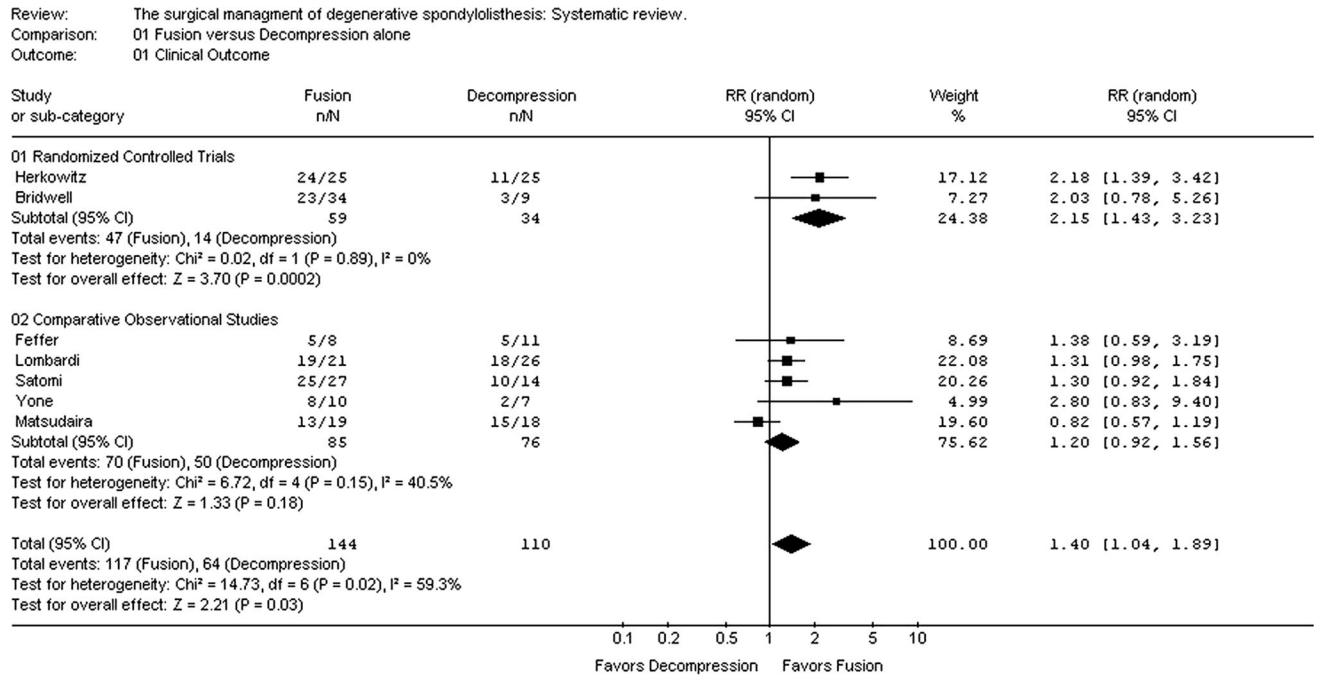

Figure 1. Clinical outcome in studies of fusion *versus* decompression alone for the treatment of degenerative lumbar spondylolisthesis.

Instrumented fusion, however, resulted in a significantly better RR of achieving solid fusion than did noninstrumented fusion (RR, 1.37; 95% CI, 1.07–1.75; $P < 0.05$). The test for heterogeneity revealed an I^2 score of 69.9%, indicating substantial heterogeneity. This heterogeneity was related to varying strength of effect, with Bridwell *et al*[6] demonstrating substantially better fusion rates for instrumentation. No study reported on lower fusion rates for instrumentation. Sensitivity analyses revealed that the RCTs reported a higher probability of achieving solid fusion with instrumentation (RR, 1.96; 95% CI, 1.35–2.84; $P < 0.05$). than did the observational studies (RR, 1.20; CI, 1.05–1.36, $P < 0.05$).

The RR of requiring a secondary surgical intervention was not significantly different between instrumented and noninstrumented fusion groups, although there was a trend toward higher repeat surgery rates following instrumented fusion (RR, 1.86; 95% CI, 0.41–8.46).

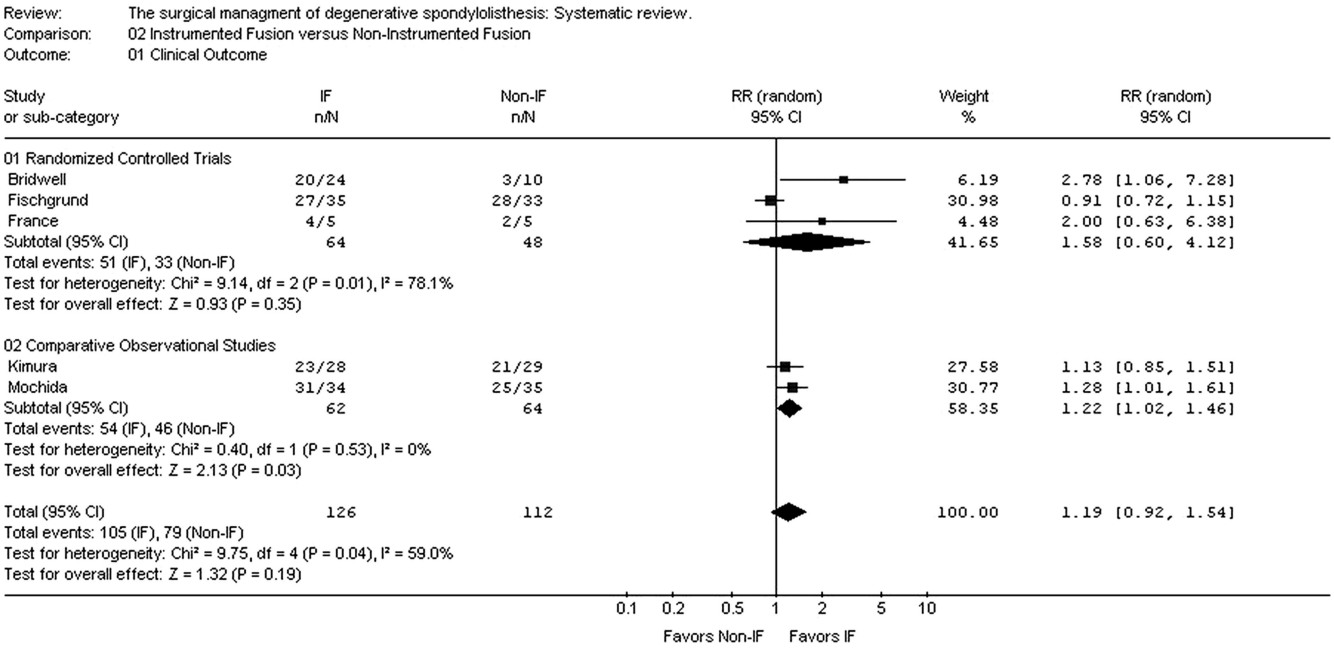

Figure 2. Clinical outcome in studies of instrumented fusion (IF) *versus* noninstrumented fusion (non-IF) for the treatment of degenerative lumbar spondylolisthesis.

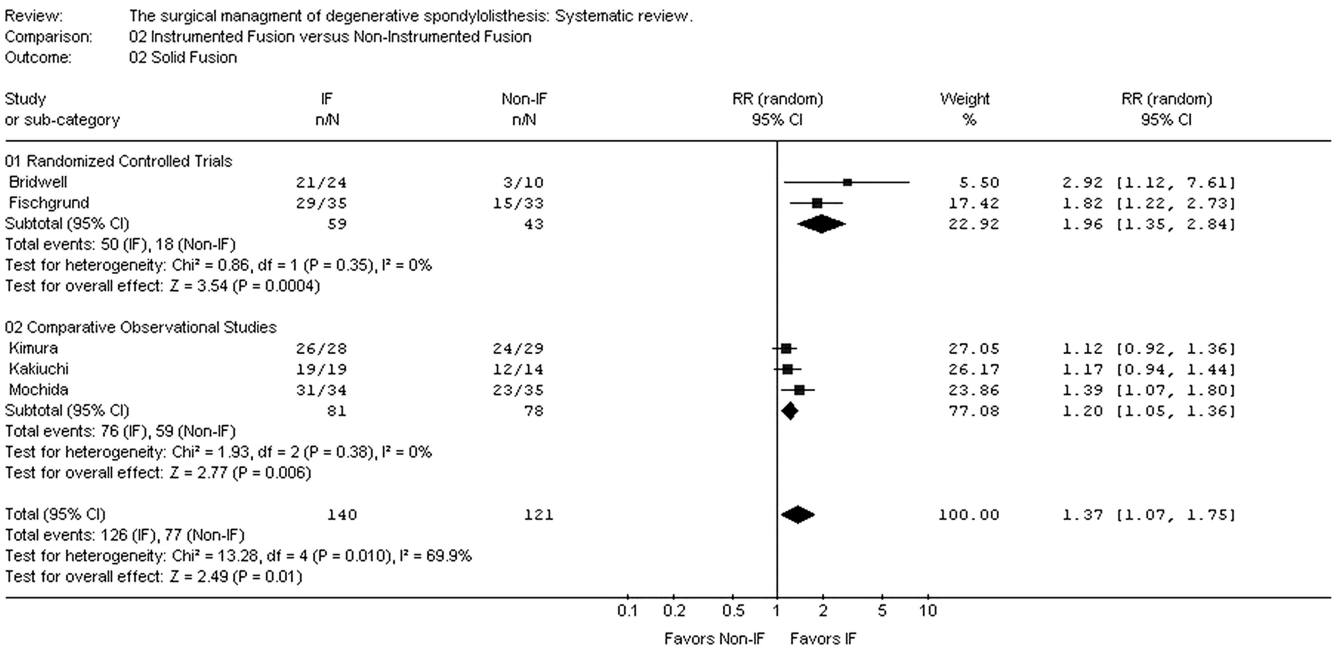

Figure 3. Fusion status in studies of instrumented fusion (IF) *versus* noninstrumented fusion (non-IF) for the treatment of degenerative lumbar spondylolisthesis.

■ Discussion

The current review identified the best evidence, in the form of all comparative studies, addressing whether an advantage exists to using instrumented or noninstrumented spinal fusion over decompression alone in the treatment of degenerative lumbar spondylolisthesis. A significantly higher chance of achieving a satisfactory clinical outcome was identified for spinal fusion compared with decompression alone. Sensitivity analyses demonstrated that the RCTs actually reported a larger benefit to the use of adjunctive fusion than did the weaker nonrandomized studies. This might be attributable in part to the reservation, in observational studies, of more aggressive management for the treatment of patients with more severe disease progression.

Only Matsudaira *et al*[12] concluded that there was no improvement in clinical outcome with the addition of adjunctive fusion. Their study compared laminoplasty to laminectomy and instrumented spinal fusion; no other study performed spinal decompression with a laminoplasty procedure. This study's diversion from trend might therefore be partly explained by the greater stability and potentially better clinical outcome provided by laminoplasty, which preserves more of the posterior vertebral structure compared with laminectomy.

The relative effectiveness of instrumented fusion compared with noninstrumented fusion was difficult to discern. The study by Fischgrund *et al*[13] was the highest quality study in the grouped analysis and the only RCT to use an adequate method of randomization and allocation concealment. It was also the sole study to report a treatment effect favoring noninstrumented fusion compared with instrumented fusion, although the result was not statistically significant. All of the remaining studies reported either a statistically significant or nonsignificant benefit to using instrumentation. As a result, there is no conclusive evidence in the literature on the benefits of instrumented fusion compared with noninstrumented fusion in improving clinical outcomes with short-term to midterm follow-up. However, there was reasonable evidence, especially among RCTs, to suggest that instrumentation increases the chance of achieving solid fusion.

The association between fusion status and clinical outcome might change with length of follow-up. Kornblum *et al*[18] extended the initial 2- to 3-year follow-up period for patients treated with noninstrumented fusion in the Herkowitz and Kurz[5] and Fischgrund *et al*[13] studies to 5 to 14 years. Unlike the original short-term studies that found no relation between solid fusion and clinical outcome, Kornblum *et al*[18] found that successful fusion correlated with an improved functional outcome and less pain in the long-term. Since instrumentation seems to increase the chance of achieving solid fusion, this may confer a long-term clinical advantage. However, using results of noninstrumented data to imply a possible advantage to the use of instrumentation in the long-term may be misleading, and further research is required.

There have been 2 previously published systematic reviews on this topic.[1,2] A meta-analysis conducted by Mardjetko *et al*[2] reviewed the literature on the operative management of degenerative spondylolisthesis from 1970 to1993. Mardjetko *et al*[2] did not adequately assess the quality of the primary studies, insufficiently addressed heterogeneity, and pooled results using series data. There has also been a large increase in research on the topic since 1993.

Another recent systematic review, performed by Gibson and Waddell,[1] studied the evidence on the sur-

gical treatment of degenerative lumbar spondylosis. Although well designed, the review was limited in its ability to draw specific conclusions about patients with degenerative spondylolisthesis because only 3 of the 31 identified RCTs exclusively studied patients with degenerative lumbar spondylolisthesis.

This current review was designed to address limitations within the previous reviews. The methodologic design was based on proposed specifications for reporting reviews of observational studies[19] and systematic reviews on back pain.[3] Incorporating comparative observational studies in addition to RCTs expanded the base of available evidence, and methods were used to address the limitations of including nonrandomized studies. These methods included: limiting inclusion to comparative studies; assessing methodologic quality; and analyzing heterogeneity and sensitivity.

Regardless, there were several limitations to this review. The identified studies were generally of low methodologic quality, with short-term to midterm follow-up, and outcome assessment using nonvalidated methods. Much of the study data were statistically heterogenous and did not permit analysis of patients according to duration of symptoms, type of pain, previous conservative management, extent of decompression, degree of spondylolisthesis, and intraoperative and postoperative complications. Therefore, the findings of this review should be interpreted in the context of the low methodologic quality and poor reporting of the primary studies.

■ Conclusion

There is moderate evidence that fusion leads to a better clinical outcome than decompression alone in the treatment of degenerative spondylolisthesis. This is supported by the fact that most studies either statistically or nonstatistically favored fusion and no study statistically favored decompression alone. Given the poor methodologic quality of the primary studies and the conflicting evidence, no solid conclusion can be drawn about the clinical effectiveness of instrumented fusion compared with noninstrumented fusion. However, there is moderate evidence to suggest that the use of supplementary instrumentation leads to improved fusion rates and reduced risk of pseudarthrosis. In light of these findings, an adequately powered, well-controlled study using validated outcome assessments with long-term follow up is needed to delineate the role of spinal fusion with or without instrumentation in treating degenerative lumbar spondylolisthesis.

■ Key Points

- Previous systematic reviews were limited by a reliance on scarcely available randomized controlled trials or a dependence on case series data.
- There is moderate evidence that fusion may lead to a better clinical outcome compared with decompression alone.
- There is moderate evidence that the use of adjunctive instrumentation leads to improved fusion status and less risk of pseudarthrosis.
- No conclusion could be made about the clinical effectiveness of instrumented fusion *versus* noninstrumented fusion.
- Conclusions made in the current review should be interpreted with recognition of the low methodologic quality and poor reporting of the primary studies.

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