Guidelines for the performance of fusion procedures for degenerative disease of the lumbar spine.
Part 8: lumbar fusion for disc herniation and radiculopathy

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Key Words • fusion • lumbar spine • herniated nucleus pulposus • radiculopathy • practice guidelines

Recommendations

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

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

Options. 1) Lumbar spinal fusion is not recommended as routine treatment following primary disc excision in patients with a herniated lumbar disc causing radiculopathy. 2) Lumbar spinal fusion is recommended as a potential surgical adjunct in patients with a herniated disc in whom there is evidence of preoperative lumbar spinal deformity or instability. 3) Lumbar spinal fusion is recommended as a potential surgical adjunct in patients with significant chronic axial low-back pain associated with radiculopathy due to a herniated lumbar disc. 4) Reoperative discectomy is recommended as a treatment option in patients with a recurrent lumbar disc herniation. 5) Reoperative discectomy combined with fusion is recommended as a treatment option in patients with a recurrent disc herniation associated with lumbar instability, deformity, or chronic axial low-back pain.

Rationale

Spinal fusion is a commonly performed procedure, often conducted following a decompressive procedure. In cases of lumbar disc herniation, the primary problem is usually limited to radicular pain due to nerve compression. Typically, patients with a symptomatic herniated disc refractory to medical management undergo discectomy without fusion. Spinal fusion has, however, been used as a treatment for patients with primary and recurrent disc herniations. The purpose of this review is to examine the medical evidence concerning the role of lumbar fusion in the operative treatment of patients with radiculopathy and back pain caused by a herniated lumbar intervertebral disc.

Search Criteria

A computerized search of the database of the National Library of Medicine from 1966 to November 2003 was conducted using the search terms “spinal fusion and disc herniation,” “lumbar disc herniation and surgery and outcome,” and “lumbar disc herniation and fusion.” The search was restricted to the English language. This yielded a total of 389 references. The titles and abstracts of each of these references were reviewed, and papers not concerned with the use of fusion with lumbar disc herniations were discarded. References were identified that provided either direct or supporting evidence relevant to the use of fusion as a treatment for lumbar disc herniations. These papers were pulled and reviewed, and relevant references from their bibliographies were identified. Rele-
vant papers providing Class III or better evidence are summarized in Table 1. Significant supportive data are provided by other references listed in the bibliography.

**Scientific Foundation**

Patients with a primary disc herniation typically report radicular pain as their main symptom. In these patients, surgical treatment typically involves a partial discectomy and decompression of the nerve root without the addition of a fusion. The intervertebral disc is a primary stabilizer of the functional spinal unit and decreases the biomechanical forces transmitted to the adjacent vertebral endplates. Injury to the intervertebral disc can, potentially, lead to segmental spinal instability, which may result in chronic low-back pain. Yorimitsu and colleagues reported that 74.6% of patients followed for 10 years after discectomy suffered from residual low-back pain. Thirteen percent of their patients reported severe low-back pain. Similarly, Loupassis, et al., reported that 28% of patients who treated with discectomy continued to complain of significant back or leg pain 7 to 10 years after surgery. Dvorak and associates found that 23% of patients complained of “constant heavy” back pain between 4 and 17 years following discectomy. Several authors have evaluated the addition of fusion at the time of initial discectomy as a means to improve patient outcome.

Takeshima, et al., performed a prospective study of 95 patients they treated with surgery for a primary disc herniation. Forty-four patients underwent discectomy alone; 51 underwent discectomy and fusion. Clinical outcomes were assessed approximately 7 years following surgery using the Japanese Orthopaedic Association system. Patients with a greater than 50% improvement in symptoms were considered to have an excellent or good outcome. In 73% of the discectomy-only group an excellent or good score was achieved, compared with 82% of the discectomy plus fusion group. This difference was not statistically significant (p = 0.31). The patients who underwent fusion had longer surgical times, greater blood loss, longer hospital stays, and an increased overall treatment cost. There was, however, a lower disc recurrence rate among patients who had undergone discectomy plus fusion (0% compared with 11%). This study provides Class III medical evidence (small sample size) that the routine addition of fusion to a noninstrumented PLF does not improve functional outcome in patients treated surgically for a lumbar disc herniation.

Donceel and Du Bois described a series of 3956 patients treated for a lumbar disc herniation with either discectomy alone (3670 patients) or discectomy and fusion (286 patients). The authors used return to work 1 year following surgery as an outcome measure. They found that 70% of the discectomy-only group were able to resume their preoperative work level at the 1-year follow up compared with only 40% of the discectomy/fusion group. They noted that the fusion group tended to have more significant symptoms and more complex preoperative histories. This retrospective review provides Class III medical evidence suggesting that discectomy combined with fusion does not improve outcomes in patients compared with discectomy alone when treating lumbar disc herniation.

Young performed a retrospective review of a large series of patients who underwent surgery for a lumbar disc herniation at the Mayo clinic. During a 40-year period, 450 patients underwent discectomy and noninstrumented PLF and 555 underwent discectomy alone. Patients were followed for a mean of 8 years. Young observed that the fusion group had superior long-term relief of sciatica (73%) and lumbago (68%) compared with the discectomy-alone group (48% relief of sciatica and 52% relief of lumbago). He reported a 95% patient satisfaction rate in the fusion group and an 84% satisfaction rate in the discectomy-alone group. Selection criteria cited for the combined operation included patients with spondylolisthesis, spondylolysis, localized degenerative arthritis, partial spondylolysis, scoliosis, fractures, facet joint degeneration, six lumbar vertebras, congenital anomalies, and recurrent disc herniation. The medical evidence provided by this report is considered Class III because of the retrospective nature of the review, dissimilar patient groups, the use of nonvalidated outcome measures, and high patient dropout.

One proposed rationale for the addition of fusion to a primary discectomy is the prevention of late-onset instability and associated chronic low-back pain. Kotilainen and Valtonen found that 22% of their patients developed clinical and radiographic signs of lumbar spinal instability following lumbar microdiscectomy. Kotilainen performed a follow-up examination 5 years later in 39 of the patients in whom clinical and radiographic instability after primary disc excision developed. He concluded that patients who experience instability after lumbar discectomy did not do well, with only 38% of these patients able to work. The author hypothesized that if lumbar instability could be identified preoperatively, or if the surgeon could identify patients at risk for the postoperative instability, these patients might be better treated with fusion at the time of discectomy. In a series of 520 patients with herniations treated by discectomy alone during an 18-year period, Cauchoix, et al., observed only 31 patients (5.9%) in whom signs or symptoms of mechanical lumbar instability subsequently developed and who required fusion. Although the follow-up duration of their cohort was unclear, these authors concluded that lumbar instability following discectomy was rare and thus did not warrant routine fusion at the time of the primary operation. Padua and colleagues studied 150 patients who underwent primary lumbar discectomy. Ten to 15 years following surgery, patients were examined clinically and radiographically (flexion-extension lateral lumbar x-ray films). Thirty patients displayed radiographic signs of instability, yet only nine patients were believed to be symptomatic. These series provide Class III medical evidence indicating that postoperative spinal instability may occur after lumbar discectomy and that the occurrence of instability is associated with a greater likelihood of a poor outcome. The incidence of symptomatic spinal instability is relatively low.

A second rationale for adjunctive fusion is in the treatment of patients with lumbar disc herniation suffering radiculopathy and significant axial back pain or patients who performs heavy, manual labor. Advocates of spinal arthrodesis in these circumstances point out that even though there is no evidence of “true” segmental lumbar instability, there is often significant lumbar pain or “fatigue.” This may prevent the full return to manual labor in
### TABLE I

Summary of studies involving the relationship of clinical and radiographic outcomes

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<th>Authors &amp; Year</th>
<th>Class</th>
<th>Description</th>
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<td>Young, 1962</td>
<td>III</td>
<td>Large retrospective study; 450 patients discect only &amp; 555 discect + noninstrumented PLF. Fusion group 68% relief of back pain, 73% of sciatica, discect group 48% relief of back pain, 52% of sciatica only. Overall poor result in 4% of combined group &amp; 13% group. Overall patient satisfaction favored fusion group (95% vs 84% in nonfusion group). All RDHs (unclear no.) did better w/ fusion. Concluded that each patient must be evaluated individually. For cases w/ spondylolisthesis, instability, or RDH, advocated combined op.</td>
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<td>Cauchoix, et al., 1978</td>
<td>III</td>
<td>Retrospective paper (2 groups): 60 patients w/ recurrent sx after prior discect; however, drawn from mixed sources. Flawed by no statement of how many were fol-</td>
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<td>Eie, 1978</td>
<td>III</td>
<td>Retrospective study of 259 patients: 119 discect only, 68 discect + in situ noninstrumented PLF. At 6 mos: 89% disc, 88% fusion satisfied. At 6 yrs: 76% vs 85% (not significant). Much higher pain recurrence in discect group in 2–5 yrs (27% disc, 15% fusion). Ability to maintain work at preop status (79% disc, 86% fusion) at 6–7 yrs. No p values cited.</td>
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<td>Inoue, et al., 1984</td>
<td>III</td>
<td>Retrospective study of 350 patients. Long FU of 8.5 yrs; 64–81% relief of primary sx, 94.3% fusion rate. No comparison arm of discect, etc. Primary ALIF for herniated disc as study group.</td>
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<td>Matsunaga, et al., 1993</td>
<td>III</td>
<td>Retrospective study of 82 patients (microdiscect 30, perc discect 51, fusion 29). Roughly similar demographics w/ slightly shorter sx in perc discect group. Unclear technique of preop “instability” assessment to determine need for op. 3–7yr FU. Return to work at 1 yr (75% disc but 22% could not sustain work [53% in end], 89% in spinal fusion group, 58% perc disc). Time to return to work (9 wks perc discect, 15 wks microdisc- ect, 25 wks fusion). Concept of “lumbar fatigue” as inability of many discect patients to return to former line of work.</td>
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<td>Donceel &amp; Du Bois, 1998</td>
<td>III</td>
<td>Retrospective—very large; 3956 cases (126 perc, 3544 microdisc, 286 discect + fusion; p &lt; 0.0001). 1 yr FU. Fitness to resume work at 1 yr (70% both discects, 40% fusion group); poorest overall outcomes in fusion group (tended to have more complex histories &amp; longer duration). Large cohort w/ clear poorer outcomes w/ fusion although no clear op indications; no differences between disc techniques.</td>
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<td>Kotilainen, 1998</td>
<td>III</td>
<td>39 patients w/ clinical lumbar instability after microdisc were evaluated for their long-term outcome. There were 21 (54%) males &amp; 18 (46%) females (mean age 55 yrs). All had undergone op for a virgin single-level lumbar disc herniation b/t 1985–1989 &amp; were evaluated for lumbar instability in 1991. Signs &amp; sx of segmental instability were then detected in all patients, w/ the symptom of “apprehension” positive in 30. During the FU, 2 (5%) had undergone lumbar spondylodesis. At the present investigation, both gave the information that their LBP &amp; sciatica had diminished compared w/ the predisc; both were retired. The sx of “apprehension” was negative in both. Of the remaining 37, LBP had completely recovered in 4 (11%) &amp; 23 (62%), whereas in 9 (24%), LBP had remained unchanged &amp; become worse in 1 (3%). Sciatica had completely recovered in 4 (11%) &amp; dimensioned in 23 (62%), whereas in 7 (19%), sciatica had remained unchanged &amp; became worse in 3 (8%). Only 14 (38%) of these were able to work; however, based on the ODI, the overall outcome in ADL had significantly improved in all 37 since 1991 (p = 0.01). The sx of apprehension was now positive in 26. A significant correlation was observed b/w the positivity of this test &amp; persistence of LBP (p = 0.02) &amp; a poor outcome in ADL (p &lt; 0.0001). Confirming earlier observations, the findings support the concept that patients w/ postop lumbar instability have a poor prognosis. Further studies are needed to define the optimal treatment for this problematic group.</td>
<td>This is a group of patients that had instability after primary microdisc. Only 38% were able to work &amp; not to fusion in the short FU. These patients did not do well. Identifying patients who may develop instability is essential. Those w/o instability are not discussed in this study.</td>
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<td>Eule, et al., 1999</td>
<td>III</td>
<td>Patients w/ LBP &amp; stenosis or MDHs underwent decompression w/o fusion. 152 patients w/ lumbar spinal stenosis or MDHs were surgically treated w/ bilateral laminect. Short-term FU was available for 138 patients (2 wks–2 mos) and long-term FU was available for 88 patients (1–6 yrs, mean 3.5 yrs). Clinical outcome was determined by chart review &amp; standardized questionnaire. Preop &amp; postop back &amp; leg pain, ambulation, employment status, &amp; satisfaction were assessed. Overall improvement was noted in 88% of the spinal stenosis patients &amp; 91% of the MDHs at long-term FU. Mean hospital stays for the spinal stenosis group &amp; the MDH group were 3.7 &amp; 2.8 days, respectively. Only 2 patients had undergone subsequent lumbar fusions after bilateral laminect. For LBP, simple decompression w/ fusion for MDHs has reasonably good results. For primary disc herniations, this would argue against fusion.</td>
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<td>Takeshima, et al., 2000</td>
<td>III</td>
<td>A prospective study evaluating clinical &amp; radiographic results in 95 patients w/ lumbar DH. To evaluate results of discect, w/ &amp; w/o PLF. 44 underwent discect, &amp; 51 underwent discect &amp; fusion. Symptoms were evaluated using the JOA system. Clinical outcome was excellent or good in 73% of the nonfusion group &amp; 82% in the fusion group (p = 0.31). The postop reduction in LBP postop was &gt; in the fusion group. The rate of RDH at the op level in the nonfusion group increased, but intraop blood loss, op time, LOS, &amp; total cost of op were all significantly less in the discect-alone than in the fusion group. The radiological analysis revealed that the DH at the level of discect &amp; PLF in the fusion group decreased with time, as in the nonfusion group. Changes in DH &amp; spinal motion were not related to the clinical results. Although there is controversy regarding the pros &amp; cons of fusion in association w/ discect, there is seldom an indication for primary fusion for lumbar DH.</td>
<td>Prospective study of discect vs discect &amp; fusion for primary DHs. Although the results were better in the fusion group, this difference was not statistically significant. There was less back pain &amp; less recurrence in the fusion group, but the fusion group had increased intraop blood loss, op time, LOS, &amp; total cost of procedure.</td>
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<td>Chitnavis, et al., 2001</td>
<td>III</td>
<td>Authors followed their 1st 50 patients for a max of 5 yrs &amp; a min of 6 mos after implant of the CFCs. Patients in whom MRI demonstrated &quot;simple&quot; recurrent herniation did not undergo PLIF. Op was performed in patients w/ sx of neural compression, tension signs, &amp; back pain w/ focal disc degeneration &amp; nerve root distortion depicted on MRI compatible w/ clinical signs. In 40 patients (80%) PSs were not used. Clinical outcome was assessed using the Prolo Economic Scale; fusion outcome was assessed using an established classification. Sx in 46 patients (92%) improved, &amp; given their outcomes 45 (90%) would undergo the same op again. 2/3 of patients experienced good or excellent outcomes (Prolo score ≥ 8) at early and late FU. No difference in clinical outcome btwn those w/ PSs &amp; those w/o (p = 0.83, Mann–Whitney U-test). The fusion rate at 2 yrs was 95%. There were min complications, &amp; no patients fared worse after surgery. No additional op treatment of the fused intervertebral space.</td>
<td>Patients w/ RDHs alone only were excluded. Patients w/ degenerative changes &amp; LBP were treated successfully w/ posterior fusion &amp; did well. This is again a good treatment option w/ patients w/ LBP &amp; RDHs.</td>
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<td>Vishteh &amp; Dickman, 2001</td>
<td>III</td>
<td>To demonstrate the feasibility of ant lumbar microdiscect in patients w/ recurrent, sequestered lumbar DHs. Btw 6 patients w/ sequestered RHDs underwent ALIF 1997 &amp; 1999, 6 patients underwent a muscle-sparing &quot;minilaparotomy&quot; &amp; subsequent microscopic ant lumbar microdisc &amp; fragmentectomy for recurrent lumbar disc extrusions at L5–S1 (4) or L4–5 (2). A contralat distraction plug permitted ipsilateral discect under microscope. Extruded disc fragments were excised by opening the PLL. Interbody fusion was performed by placing cylindrical TTCs (4) or TABDs (2). There were no complications, &amp; blood loss was min. FU MRI revealed complete resection of all herniated disc material. Plain films revealed excellent interbody cage position. Radicular pain &amp; neurological deficits resolved in all 6 patients (mean FU 14 mos). Ant lumbar microdiscect w/ interbody fusion provides a viable alternative for lumbar DHs.</td>
<td>6 patients w/ sequestered RHDs underwent ALIF w/ titanium or TABDs. The main principle is that ant disc are sufficient for neural decompression.</td>
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<td>Huang &amp; Chen, 2003</td>
<td>III</td>
<td>28 patients w/ RDHs w/ LBP &amp; degenerative spondylolisthesis underwent decompressive PLF (single TTC &amp; PS supplementation). FU period was 8–39 mos (mean 14.4 mos). Clinical outcomes were assessed. Dynamic radiographs for fusion mass interpreted by an independent radiologist. Overall, 92.86% were satisfied w/ their postop conditions. Radiographic fusion rate was 82.14%. Fibrous union was noted in 5. No cage migration was observed. 1 case of dural laceration w/o clinical sequelae. 1 patient w/ transient paraparesis recovered w/in 2 wks, 1 w/ transient bladder atony recovered w/in 3 days. Overall, complications were negligible &amp; no patients sustained a motor deficit or permanent complication. This PLIF resulted in satisfactory outcome w/in short-term or long-term FU. For RDHs w/ evidence of spondylolisthesis, fusion yields good results.</td>
<td>* ADL = activities of daily living; ALIF = anterior lumbar interbody fusion; CFC = carbon fiber cage; DH = disc herniation; discect = discectomy; facetect = facetectomy; FU = follow up; JOA = Japanese Orthopaedic Association; laminect = laminectomy; LBP = low-back pain; LOS = length of stay; MDH = midline DH; MRI = magnetic resonance imaging; ODI = Oswestry Disability Index; perc = percutaneous; PLIF = posterior LIF; PLL = posterior longitudinal ligament; PS = pedicle screw; RDH = recurrent DH; sx = symptom(s); TABD = threaded allograft bone dowel; TTC = threaded titanium cage.</td>
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Fusion for disc herniation

A large portion of patients despite treatment with discectomy alone. Inoue, et al., reported the use of anterior lumbar discectomy and primary fusion in the treatment of a lumbar disc herniation in 350 patients followed for longer than 8.5 years. They observed a 75% good outcome rate with regard to primary symptoms. They concluded that fusion provides sustained improvement in these select patients compared with historical results of series of similar patients treated with discectomy alone. Eie examined 259 patients with a herniated disc who underwent one of two treatments: discectomy alone (119) or discectomy and noninstrumented PLF (68); the author observed equivalent rates of good outcome between the two treatment groups during the first few months after surgery (89 and 88%, respectively). The author, however, found that the satisfaction rates reported by the discectomy-alone group deteriorated over time compared with the satisfaction rate reported by the discectomy/fusion group. At 6 years post-surgery, 76% of the discectomy-alone group reported satisfaction compared with 85% of the discectomy/fusion group. Additionally, the discectomy-only patients reported a significantly higher incidence of pain recurrence (27% of cases) compared with the discectomy/fusion group (15% of patients) (p = 0.001). Manual laborers with significant preoperative axial back pain were especially likely to suffer recurrences of pain when treated with discectomy alone. Seventy-nine percent of the discectomy patients and 86% of the discectomy/fusion patients maintained their preoperative work status at the 6-year follow-up. These papers provide Class III medical evidence in support of the use of fusion at the time of disc herniation, especially in manual laborers or those with significant preoperative low-back pain.

Matsunaga, et al., performed a retrospective study of 80 manual laborers and athletes who underwent either open or percutaneous discectomy (51) or via open discectomy combined with fusion (29). Their primary outcome measure was return to work or participation in athletics. At 1 year they observed that 54% of the discectomy group and 89% of the discectomy/fusion group were able to return to and maintain preoperative work or athletic activities. They found that although discectomy-treated patients returned to work earlier (12 weeks) than the discectomy/fusion-treated group (25 weeks), 22% of the former could not maintain their previous activity level because of so-called lumbar fatigue. These authors concluded that the addition of fusion should be considered in manual laborers and active athletes because it appeared to provide a better chance of return to and maintenance of a preoperative level of function. This paper is considered to provide Class III medical evidence in support of the use of PLF at the time of discectomy for patients involved in heavy labor and athletics.

No study was identified that compared outcomes after reoperative discectomy compared with reoperative discectomy/fusion in patients with a recurrent disc herniation. There are a number of case series describing outcomes after either reoperative discectomy or reoperative discectomy combined with fusion. For example, Suk, et al., reported that patient outcomes following reoperative discectomy were satisfactory and similar to those in patients treated with primary disc excision. Cinotti, et al., reported an overall good outcome rate of 85% and a return-to-work rate of 81% among 26 patients who had undergone reoperative discectomy. Their results were similar to those identified among a cohort of 50 other patients who underwent primary disc excision during the same time period (88% good outcome and 84% return to work). Ozgen, et al., performed reoperative decompressions in 114 patients, including reoperative discectomies in 89 patients with a recurrent disc herniation. Good outcomes were demonstrated in 69% of patients. Several other authors describe similar findings. These series indicate that patients improve following reoperative discectomy for recurrent disc herniation and provide Class III medical evidence in support of this practice.

Other authors have described the results of reoperative decompression and supplemental fusion for patients with recurrent lumbar disc herniation. Glassman and colleagues used the 36-item Short Form to perform a prospective study of patients with recurrent herniated discs undergoing reoperative discectomy and fusion. They described significant improvement in physical function, social function, and bodily pain 1 year after surgery. Huang and Chen described a series of 28 patients with a recurrent disc herniation who also experienced low-back pain and spondylolisthesis, who underwent posterior decompressive surgery and interbody fusion. During a follow-up period ranging from 8 to 39 months (mean 14 months), 93% of the patients were satisfied with their condition and 82% were considered to have achieved radiographic fusion. Chitnavis and associates also reported on patients with recurrent disc herniations and symptoms of back pain or signs of instability who underwent posterior decompression and interbody fusion. Patients with recurrent disc herniation without low-back pain or instability were excluded. Of the 50 patients with 6 months to 5 years of follow-up data, 92% improved and 90% were very satisfied with their outcome. The fusion rate was 95% and the complication rate was low. Vishteh and Dickman presented a small series of five patients with recurrent sequestered disc herniations treated by anterior lumbar discectomy and interbody fusion alone. The results were very good in all five patients: 100% fusion rate and relief of leg pain. These series provide Class III medical evidence in support of performing a fusion at the time of reoperative discectomy, particularly in patients with associated deformity, instability, or chronic axial back pain.

Summary

There is no convincing medical evidence to support the routine use of lumbar fusion at the time of a primary lumbar disc excision. There is conflicting Class III medical evidence regarding the potential benefit of the addition of fusion in this circumstance. Therefore, the definite increase in cost and complications associated with the use of fusion are not justified. Patients with preoperative lumbar instability may benefit from fusion at the time of lumbar discectomy; however, the incidence of such instability appears to be very low (< 5%) in the general lumbar disc herniation population. Patients who suffer from chronic low-back pain, or are heavy laborers or athletes with axial low-back pain, in addition to radicular symptoms may also be candidates for fusion at the time of lumbar disc excision. Patients with a recurrent disc herniation have been
treated successfully with both reoperative discectomy and reoperative discectomy combined with fusion. In patients with a recurrent lumbar disc herniation with associated spinal deformity, instability, or associated chronic low-back pain, consideration of fusion in addition to reoperative discectomy is recommended.

**Key Directions for Future Research**

A direct comparison between reoperative discectomy and reoperative discectomy/fusion would provide needed information regarding the role for fusion in this patient population. A detailed analysis of patients who do and do not suffer from postoperative chronic low-back pain (case control study) could potentially provide Class II medical evidence to support the use of fusion in the subgroup of patients in whom there is likely to be a benefit.

**References**


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