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Surgical treatment for unstable low-grade isthmic spondylolisthesis in adults: a prospective controlled study of posterior instrumented fusion compared with combined anterior-posterior fusion

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Abstract

BACKGROUND CONTEXT: The surgical treatment for low-grade isthmic spondylolisthesis in adults with intractable lumbar pain is usually spinal fusion. It has been postulated that anterior column reconstruction may be relatively advantageous in those patients with unstable slips.

PURPOSE: To compare the early and medium term treatment efficacy of two common fusion techniques in isthmic spondylolisthesis.

STUDY DESIGN/SETTING: Prospective controlled trial comparing single-level posterior-lateral instrumented fusion with combined anterior and posterior-lateral instrumented fusion in sequential matched cohorts of patients with radiographically unstable isthmic spondylolisthesis.

OUTCOME MEASURES: Primary outcome measure of success was an Oswestry Disability Index (ODI)≤20. Secondary outcome measures included patient determined minimum-acceptable outcome on four questionnaires: pain intensity (visual analog scale), ODI, medication intake, and work status. Radiographic outcome of fusion was determined by radiographic union and motion on flexion/extension X-rays. Risk ratios (RRs) and 95% confidence intervals (CIs) were calculated for primary outcome of success for combined fusion compared with posterior fusion.

METHODS: The study was conducted over a 6-year period. The first cohort of 50 consecutive patients was treated with a single-level instrumented posterior-lateral fusion; the second sequential cohort was treated with an anterior interbody fusion and the same posterior operation. Observations were made at baseline, 6 months, 1 year, and 2 years after surgery. Final radiographic assessment was made at 2 years after surgery.

RESULTS: Baseline demographic and clinical factors were well-matched in the two cohorts. At 2 years, 46 posterior-only fusion subjects and 47 combined fusion subjects completed the full follow-up regimen. Outcomes were better by all measures at 6 months and 12 months in the anterior-posterior cohort. Comparing the primary outcome measure (ODI outcome≤20) in the posterior versus the combined groups, success was achieved at 6 months in 11 versus 30 (RR=2.67, 95% CI 1.53, 4.67; p=.0001); at 1 year, 20 versus 34 (RR=1.66, 95% CI 1.14, 2.42; p<.005); and at 2 years, 29 versus 36 subjects (RR=1.21, 95% CI 0.93, 1.59; p=.14). At 6 months, 13 posterior-only and 25 combined group subjects had returned to work (RR 1.88, 95% CI 1.10, 3.21; p=.01). More patients achieved their preoperatively determined minimum-acceptable outcome at each time point. There were three nonunions in the posterior-alone cohort and one in the combined group. Serious complications and reoperations were similar in both groups.

CONCLUSION: Outcomes up to 2 years were superior by clinically important differences after a combined anterior-posterior operation compared with posterior-alone surgery for unstable spondylolisthesis; however, between-group differences attenuated appreciably after 6 months. The apparent clinical and occupational benefits of combined fusion should be considered along with

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possible increases in minor complications and procedure-related costs.

Keywords: Isthmic spondylolisthesis; Degenerative spondylolisthesis; Posterolateral fusion; Anterior-posterior fusion; Combined fusion; Instrumented fusion; Unstable spondylolisthesis

Introduction

The majority of the persons with isthmic spondylolisthesis are not clinically symptomatic. The initial treatment in most symptomatic patients is nonsurgical supportive care [1]. The mainstay of surgical treatment for adult patients with persistent symptomatic isthmic spondylolisthesis is usually fusion [2], with or without decompression [3,4]. Fusion techniques considered for the treatment of this deformity include posterolateral intertransverse process fusion, anterior, posterior, or transforaminal interbody fusion, and combined anterior and posterior fusion [2,5]. Much has been written about the theoretical advantages of each approach; however, no clearly optimal approach has been established to date.

The current controlled trial is a follow-on study to a randomized control trial of surgical treatment of isthmic spondylolisthesis performed at our center from 1993 to 1995 [3]. In that trial, subjects treated with posterior-lateral fusion did not appear to benefit from concurrent laminectomy when there was no serious neurologic loss preoperatively. Concurrent review, however, identified relatively poorer outcomes in subjects with more mobile slips compared with subjects with slips that were either stable over time or showed little motion on dynamic radiographs. Subgroup analysis suggested better results in subjects treated with instrumented fusions when dynamic radiographs revealed clear motion. On the other hand, subjects with little motion seemed to do as well or better without transpedicular instrumentation. Similar conflicting reports on the efficacy of instrumentation in treating isthmic spondylolisthesis have been reported by others [2,6–14].

Many slips appear to move little or not at all on dynamic testing [15,16]. It is not clear that more aggressive fusion techniques (eg, instrumentation, interbody grafting) are appropriate in cases with minimal motion when fusion may otherwise be indicated. Radiographic instability certainly exists but is neither well-defined nor commonly appreciated in patients with symptomatic spondylolisthesis [15,17–19]. Progression of the degree of anterolisthesis over time is one measure of instability [17]. Another is relatively increased translation or angular motion seen either on flexion and extension X-rays or upright and prone comparisons [19,20]. We have postulated that instrumentation or anterior column fusion techniques may be most appropriate in these subjects with some degree of instability, but the advantages of one compared with another have not been proven.

To explore this issue, we conducted a prospective clinical trial comparing posterior instrumented fusion alone with a combined anterior and posterior instrumented fusion in the subgroup of patients with isthmic spondylolisthesis who had radiographic evidence of relative instability.

Materials and methods

Study design

This is a sequential cohort study of two groups, with 50 subjects in each treatment arm. Fifty consecutive subjects were treated with instrumented posterior spinal fusion on an established evaluation and follow-up protocol (1995–1997). An equal number of subjects were then treated with a combined anterior and posterior spinal fusion using the same protocol (1998–2001). The study was approved by the Human Subjects Research Committee at Stanford University and followed Department of Health and Human Services guidelines.

Enrollment criteria. Consecutive patients (1995–2001) with intractable low back pain (with or without leg pain) and radiographically confirmed, unstable Grade I or II isthmic spondylolisthesis of either the L5–S1 or L4–L5 anatomic segments were considered for enrollment. Unstable spondylolisthesis was defined in this study as follows: documented slip progression (3 mm or one Meyerding grade) under observation in the 2 years before surgery; or $\geq$3 mm translation and/or $\geq 22^{\circ}$ of angulation as seen on standing flexion-extension or recumbent (prone) lateral radiographs. Patients were excluded if the preoperative evaluation found: greater than trace motor weakness; retrolisthesis, disc protrusion, painful disc injection, or instability of an adjacent segment; positive straight leg raising sign; metabolic bone disease; previous spinal surgery, other lumbar deformity ($>15^{\circ}$ scoliosis), or fracture; inflammatory arthritis/autoimmune disease. Enrollment was limited to subjects undergoing single-level fusions.

Posterior instrumented fusion. The posterior instrumentation and fusion procedure alone was performed in the first cohort. A midline incision, followed by a small Wiltse paraspinal interval exposure, was used in each patient. An operating microscope was used to assist dissection to expose the transverse processes, pars, and facet region, which were thoroughly decorticated. No decompression was performed. Bilateral pedicle screw instrumentation (Variable Angle Screw, Synthes, Paoli, PA) was applied. Transpedicular screw insertion was directed by fluoroscopic imaging. Autograft was harvested, through the same incision, from the inner table of the iliac crest and grafted in each patient.