Multiple-level lumbar spondylolysis and spondylolisthesis

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OBJECT Lumbar spondylolysis and isthmic spondylolisthesis occur most commonly at only one spinal level. The authors report on 13 cases of lumbar spondylolysis with spondylolisthesis at multiple levels.

METHODS During July 2007–March 2012, multiple-level spondylolysis associated with spondylolisthesis was diagnosed in 13 patients (10 male, 3 female) at Qilu Hospital of Shandong University. The mean patient age was 43.5 ± 14.6 years. The duration of low-back pain was 11.7 ± 5.1 months. Spondylolysis occurred at L-2 in 2 patients, L-3 in 4 patients, L-4 in all patients, and L-5 in 5 patients. Spondylolysis occurred at 3 spinal levels in 3 patients and at 2 levels in 10 patients. All patients had spondylolisthesis at 1 or 2 levels. Japanese Orthopaedic Association and visual analog scale scores were used to evaluate preoperative and postoperative neurological function and low-back pain. All patients underwent pedicle screw fixation and interbody fusion or direct pars interarticularis repair.

RESULTS Both low-back pain scores improved significantly after surgery ($p < 0.05$). Postoperative radiographs or CT scans showed satisfactory interbody fusion or pars interarticularis healing. No breakage, dislodging, or loosening of the pedicle screw hardware was observed for any patient.

CONCLUSIONS Multiple-level lumbar spondylolysis and spondylolisthesis occurred more often in men. Most multiple-level lumbar spondylolysis occurred at 2 spinal levels and was associated with sports, trauma, or heavy labor. Multiple-level lumbar spondylolysis occurred mostly at L3–5; associated spondylolisthesis usually occurred at L-4 and L-5, mostly at L-4. The treatment principle was the same as that for single-level spondylolisthesis.

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KEY WORDS lumbar spine; multiple-level; spondylolisthesis; spondylolysis

AMONG the general population, the estimated incidence of lumbar spondylolysis is 3%–10% and that of isthmic spondylolisthesis is 2.6%–4.4%.⁴ Lumbar spondylolysis and isthmic spondylolisthesis occur most commonly at a single spinal level, usually the unilateral or bilateral L-5 pars interarticularis. Only a few cases of multiple-level lumbar spondylolysis have been reported.^{1–3,5–11} Ravichandran⁸ calculated that only 1.48% of patients with back pain have multiple-level spondylolysis. Sakai et al.⁹ reviewed CT scans of 2000 persons without low-back pain and found lumbar spondylolysis in 117 (5.9%) and multiple-level spondylolysis in 5 (0.3%).

Even fewer reports of multiple-level spondylolysis associated with spondylolisthesis are found in the literature.^{1,3,11} We report 13 such cases, provide a literature review, and

briefly describe clinical and radiological features and management alternatives for patients with this condition.

Methods

From July 2007 through March 2012, a total of 13 patients (10 male, 3 female) received a diagnosis of multiple-level spondylolysis associated with spondylolisthesis; 9 of these patients performed heavy manual labor. Mean patient age ($\pm$ SD) was 43.5 ± 14.6 years, and duration of low-back pain ($\pm$ SD) was 11.7 ± 5.1 months. Before surgery, all patients underwent routine and dynamic radiography, CT, and MRI. Spondylolysis was located at 3 spinal levels for 3 patients and at 2 levels for 10 patients (Fig. 1). Spondylolysis was located at L-2 in 2 patients (bilateral), L-3 in 4

ABBREVIATIONS JOA = Japanese Orthopaedic Association; VAS = visual analog scale.

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FIG. 1. Left: Two-level spondylolysis (L-4 and L-5) with spondylolisthesis (L4–5 and L5–S1). Right: Three-level spondylolysis (L-2, L-3, and L-4) (upper arrows) with spondylolisthesis (L4–5) (lower arrow). Figure is available in color online only.

patients (unilateral in 1 and bilateral in 3), L-4 in all patients (bilateral), and L-5 in 10 patients (bilateral in 7 and unilateral in 3). For 1 patient, a transitional vertebra (L-5) was observed. We used the Meyerding classification⁶ to evaluate the degree of spondylolisthesis. For all patients, spondylolisthesis occurred at L4–5 (Grade I for 11 patients and Grade II for 2 patients), for 6 patients at L5–S1 (Grade I for all 6 patients), and for 1 patient at L2–3 (Grade I). At spinal levels with spondylolisthesis or bilateral pars interarticularis defect with neurological deficit, posterior lumbar interbody fusion (11 levels) or transforaminal lumbar interbody fusion (9 levels) was performed. At spinal levels of pars interarticularis defects without instability or degenerative lumbar spinal canal stenosis, direct repair of spondylolytic defects was performed.

Preoperative and Postoperative Assessments

To assess neurological function, we used Japanese Orthopaedic Association (JOA) scores, and to assess low-back pain, we used a 10-cm visual analog scale (VAS) (0 indicated no pain; 10 indicated the worst pain). The healing of pars interarticularis defects or interbody fusion was evaluated on plain radiographs or CT scans. The postoperative images were evaluated by 3 surgeons (Y.T., L.W., and J.L.), who did not know the patients' preoperative and postoperative status.

Statistical Analyses

SPSS version 12.0 software (SPSS, Inc.) was used for statistical analyses. In the event of statistical significance, a Student t-test was performed. The level of significance was set at $p < 0.05$. Mean values are presented $\pm$ SD.

Results

The mean follow-up time was 30 months (range 25–36 months). VAS and JOA scores for low-back pain improved

significantly after surgery ($p < 0.05$). Preoperative JOA (maximum 29 points) and VAS scores were 15.7 ± 2.0 and 8.3 ± 0.6 , respectively, and the latest postoperative JOA and VAS scores were 25.2 ± 0.8 and 1.8 ± 0.8 , respectively. Plain radiographs and/or CT scans showed satisfactory interbody fusion or pars interarticularis healing. No breakage, dislodging, or loosening of the pedicle was documented in any patient.

Illustrative Case

A 56-year-old man with a 4-month history of low-back pain, bilateral leg pain, and numbness sought care at the Department of Orthopedic Surgery at Qilu Hospital. The pain had been caused by lifting heavy objects. After 4 months of conservative treatment including acupuncture, massage, bed rest, and nonsteroidal antiinflammatory drugs, the patient was admitted for surgery because of worsening back pain and leg numbness. His preoperative JOA and VAS scores for low-back pain were 8 and 10, respectively. Radiographs, CT scans, and MR images showed bilateral spondylolytic defects at L-2, L-4, and L-5, associated with spondylolisthesis (retrolisthesis at L2–3 and anterolisthesis at L4–5) and spinal canal stenosis at L4–5. The patient underwent spinal canal decompression at L4–5, transforaminal lumbar interbody fusion at L2–3, posterior lumbar interbody fusion at L4–5 and L5–S1, and pedicle screw fixation at L2–S1 (Fig. 2).

Discussion

Similar to the etiology of single-level spondylolysis, the etiology of multiple-level lumbar spondylolysis is thought to be fatigue fractures.¹⁰ Only a few reports of multiple-level lumbar spondylolysis have been published.^{1–3,5,7,8,10,11} The main data gleaned from the literature are shown in Table 1. Multiple-level lumbar spondylolysis occurs more often in men than in women.^{7,10,11} Most cases are associated with sports, trauma, heavy labor, or Albers-Schönberg disease.^{3,7,10,11} Consistent with the trends reported in the literature, in our study most ($n = 10$) of the 13 patients were male, and 9 patients worked at jobs requiring heavy manual labor. Multiple-level lumbar spondylolysis occurs from L-1 to S-1, but according to the literature, it occurs mainly at L3–5,^{1–3,5,7,8,10,11} which is also consistent with the cases in our study. Moreover, 2-level spondylolysis is more common than 3- or 4-level spondylolysis. According to the literature, patients seek care for severe low-back pain or associated symptoms mainly in their teens and 20s (range 14–43 years). However, in our study, the mean age at which patients sought care was 43.5 years, which is much older than the age reported in the literature. This finding might be associated with the poor economic status of these patients, who mainly lived in rural areas of China. Their economic status might have prevented them from seeking medical treatment until severe symptoms (e.g., low-back pain, leg pain, and numbness) had arisen and might also be the reason why all spondylolisthesis was at 1 or 2 levels. According to the literature and our results, spondylolisthesis usually occurs at L-4 and L-5, mostly at L-4 (Fig. 1). This finding differs from reports of single-

FIG. 2. Preoperative and postoperative images obtained in a 56-year-old man with a 4-month history of low-back pain, bilateral leg pain, and numbness. **A–C:** Spondylolysis at L-2, L-4, and L-5, and spondylolisthesis at L-4 (arrows). **D:** Postoperative radiographs. **E:** Two-year follow-up radiographs. Figure is available in color online only.

level lumbar spondylolysis and isthmic spondylolisthesis that most commonly occurs at L-5.

The main surgeries performed for spondylolysis and isthmic spondylolisthesis were direct repair of pars interarticularis defect, posterolateral fusion, posterior lumbar intervertebral fusion, and transforaminal lumbar intervertebral fusion. We thought that the principle of multiple-level lumbar spondylolysis and spondylolisthesis treatment was the same as that for single-level spondylolisthesis. Multiple-level lumbar spondylolysis can be treated with conservative management or surgery. Conservative management is the standard treatment for spondylolysis and spondylolisthesis in cases in which the Meyerding grade is lower than III.³ Useful for pain relief are brace therapy,¹⁰ bed rest, lumbar flexion/distraction and activity modification,³ chiropractic manipulation, and rehabilitation of the spine¹¹ (Table 1). In general, surgery is necessary for patients who respond poorly to conservative treatment.^{2,7,10} For multiple-level lumbar spondylolysis without spondylolisthesis, pars interarticularis defects can be directly repaired using segmental wire fixation and bone grafting¹ or using pedicle screw fixation, a laminar hook, and bone

grafting.⁷ However, these methods cannot achieve adequate segmental stability for multiple-level lumbar spondylolysis with spondylolisthesis. In our study, all patients accepted pedicle screw fixation and underwent interbody fusion of most affected levels (12 levels in 6 patients). We performed direct repair of pars interarticularis defect only in relatively younger patients or in those who had a unilateral defect without degenerative disc changes and segmental instability. Direct repair of the pars interarticularis defect was performed at only 3 levels.

Conclusions

We have reported on 13 cases of multiple-level lumbar spondylolysis associated with spondylolisthesis and have summarized the results of a literature review. We found that multiple-level lumbar spondylolysis and spondylolisthesis occur more often in men than women and are associated with sports, trauma, or heavy manual labor. Multiple-level lumbar spondylolysis occurs mainly at L3–5, and spondylolisthesis usually occurs at L-4 and L-5, but mostly at L-4.

TABLE 1. Literature review findings

Authors & Year	No. of Patients (M/F ratio)	Mean Age in Yrs (range)	Remote Cause (no. of patients)	Amount of Spondylolysis (no. of patients)	Spinal Levels (no. of patients; side)	Spondylolisthesis	Treatment	Results
Wiltse et al., 1975	4 (3:1)	16 (14–17)	Sports (2), trauma (1), Albers-Schönberg disease (1)	2 levels (1), 3 levels (1), 4 levels (2)	L-1 (1; unilat), L-2 (2; bilat), L-3 (4; 3 bilat, 1 unilat), L-4 (3; 2 bilat, 1 unilat), L-5 (3; unilat)	No	Corset or brace	Some defects, achieved solid healing
Grantham & Imbriglia, 1975	1 (1:0)	20	Not reported	2 levels (1)	L-5 & S-1 (bilat)	No (S-1 is transitional vertebra)	Posterolateral fusion L4–S1	Pain free & working
Al-Khawashki & Wasef Al-Sebai, 2001	1 (0:1)	15	Not reported	3 levels (1)	L-2, L-3, L-4 (bilat)	Yes (L-3 & L-4)	L-4 corpectomy, L2–S1 posterolateral fusion	Improved
Ogawa et al., 2007	7 (5:2)	26.7 (19–37)	Sports (7)	2 levels (5), 3 levels (2)	L-4 & L-5 (1), other not reported (6 bilat)	No	Defect repair by segmental wire fixation & bone grafting	Healing of all defects (4 patients), healing of 3 of 4 defects (2 patients), & no healing of 4 defects (1 patient)
Chung et al., 2007	6 (6:0)	22 (20–25)	Not reported (all ser-viceman)	2 levels (6)	L-3 (6), L-4 (4), L-5 (2)	No	Defect repair by pedicle screw, laminar hook, & bone grafting	Of 24 pars interarticularis evaluated, 18 were healed & 6 showed persistent nonunion defects
Wong, 2004	1 (1:0)	26	Sports	2 levels (1)	L-4 & L-5 (bilat)	Yes (L-3 & L-4)	Conservative	Pain relief
Dunn et al., 2009	1 (1:0)	43	Trauma	2 levels (1)	L-3 & L-4 (bilat)	Yes (L-4 & L-5)	Conservative	Pain relief
Sakai et al., 2009	5 (4:1)	Not reported	Not reported	2 levels (3), 3 levels (2)	L-3 (4), L-4 (3), L-5 (5)	Not reported	Not reported	Not reported

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Author Contributions

Conception and design: Liu. Acquisition of data: Liu, Tian. Analysis and interpretation of data: Wang. Drafting the article: Liu. Critically revising the article: Li. Reviewed submitted version of manuscript: Liu, Zheng, Li. Approved the final version of the manuscript on behalf of all authors: Liu. Statistical analysis: Yuan. Administrative/technical/material support: Li. Study supervision: Zheng.

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