Lumbar disc herniation (LDH) causing sciatica is one of the most common spinal conditions requiring surgery in neurosurgical practice. Although LDH can often be managed conservatively, resection of the sequestrated disc is usually reserved for symptomatic patients whose condition is refractory to medical treatment for a prolonged time. Also, there are many surgical approaches noted in the literature that have demonstrated effectiveness for the treatment of LDH. In past decades, microdiscectomy through a tubular or expandable retractor has been reported to be efficacious and has become a popular surgical technique. This minimally invasive approach is not only clinically effective but also economically cost-effective.

Most of the LDH patients who received microdiscectomy had satisfactory results. However, a portion (5%–15%) of patients will develop LDH recurrence, even after a very successful discectomy. In the literature, it has been reported that the risk factors of recurrent LDH included male sex, old age, cigarette smoking, trauma, diabetes, high body mass index (BMI), occupational heavy weight lifting, and degenerative disc disease. Furthermore, the degree of annular competence, type of herniation, and protrusion type of LDH have been demonstrated to increase the risk of the recurrence of LDH.

Patients with adolescent idiopathic scoliosis have altered biomechanics in the lower lumbar spine. It is not clear whether this change in weight bearing causes a high-

### Scoliosis may increase the risk of recurrence of lumbar disc herniation after microdiscectomy

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**OBJECT** The aim of this paper was to investigate the risk of recurrence of lumbar disc herniation (LDH) in patients with scoliosis who underwent microdiscectomy.

**METHODS** A series of consecutive patients who underwent microdiscectomy for LDH was retrospectively reviewed. The inclusion criteria were young adults younger than 40 years who received microdiscectomy for symptomatic 1-level LDH. An exclusion criterion was any previous spinal surgery, including fusion or correction of scoliosis. The patients were divided into 2 groups: those with scoliosis and those without scoliosis. The demographic data in the 2 groups were similar. All medical records and clinical and radiological evaluations were reviewed.

**RESULTS** A total of 58 patients who underwent 1-level microdiscectomy for LDH were analyzed. During the mean follow-up of 24.6 months, 6 patients (10.3%) experienced a recurrence of LDH with variable symptoms. The recurrence rate was significantly higher among the scoliosis group than the nonscoliosis group (33.3% vs 2.3%, p = 0.001). Furthermore, the recurrence-free interval in the scoliosis group was short.

**CONCLUSIONS** Young adults (< 40 years) with uncorrected scoliosis are at higher risk of recurrent LDH after microdiscectomy.

http://thejns.org/doi/abs/10.3171/2015.7.SPINE15133

**KEY WORDS** lumbar disc herniation; recurrence; scoliosis; microdiscectomy

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er incidence of LDH. The effect of scoliosis in terms of risk of LDH recurrence is unknown. Therefore, the optimal management of LDH in scoliosis patients remains uncertain.

The current study aimed to investigate the differences in recurrence rates of LDH between patients who had scoliosis and those who did not. To date, there has been a paucity of data on the effect of microdiscectomy in patients with adolescent idiopathic scoliosis, and, to our knowledge, no reports have addressed this issue.

Methods

Inclusion Criteria of Patients

This retrospective study included consecutive patients who had single-level LDH proven by advanced imaging studies (MRI or CT) with corresponding symptoms and signs such as low-back pain, neurogenic claudication, radiculopathy, or a positive straight leg-raising test. All patients received medical treatment for at least 6 weeks before undergoing surgery and had no other comorbidities contraindicating surgery. Exclusion criteria were prior lumbar surgery, thoracolumbar fractures, spondylolisthesis, spinal infection, tumor, inflammatory spondylarthropathy, and pregnancy. Patients older than 40 years were also excluded to mostly eliminate degenerative scoliosis and spondylolisthesis-related kyphotic deformity.

The patients were divided into 2 groups: those with scoliosis and those without scoliosis. The identification of scoliosis was made prior to surgery, but was not considered a preclusion for surgery, described in the following paragraph. All demographic data and perioperative records were reviewed and compared between the 2 groups. Every patient underwent follow-up for more than 2 years with both clinical and radiographic evaluations.

Surgical Techniques

In the current series, every operation was performed using the same surgical technique, standard microdiscectomy, which was similar to that first described by Williams in 1978, with various modifications over time. In this series, the operative level was identified using intraoperative fluoroscopy. Subsequently, a skin incision of about 3 cm was made close to the midline, and the fascia and muscles were split until the hemilamina was exposed. Through a tubular or expandable retractor, under the microscope, laminotomy was carried out using high-speed drills and Kerrison rongeurs. Decompression of the neuroforamen was achieved after excision of the ligamentum flavum and surrounding osteophytes. Disc excision was then performed through this window, with the nerve root retracted medially when needed. Unless an obviously ruptured disc or a sequestrated disc fragment was met, a small incision was made with a sharp knife over the annulus fibrosus of the intervertebral disc.

Loose disc fragments were removed using a curette and disc rongeurs. In the few instances in which a dura tear and CSF leakage were encountered, primary repair with suture and tissue glue sealants was performed. The muscles and fascia were then closed tightly before skin closure. For an initial postoperative period of time, we encouraged early ambulation but with the avoidance of bending, heavy weight lifting, and excessive exercising.

Clinical and Radiological Evaluations

All patients’ data, including charts, operative notes, clinical follow-up reports, subsequent telephone interviews, and radiographic images were reviewed. Standardized clinical outcome measurements, such as the visual analog scale (VAS) score, were collected during clinical visits at each time point of follow-up, at approximately 6 weeks and 3, 6, 12, and 24 months, by 2 special nurse assistants under the physicians’ supervision.

All patients underwent screening radiographs of the entire spine prior to the operation. Identification of scoliosis was confirmed by radiologists. Whether the patient had thoracolumbar scoliosis did not affect the decision for microdiscectomy. Recurrence of LDH was assessed by clinical evaluation or radiological studies (i.e., MRI) during the follow-up. Confirmation of recurrence had to meet both of the following criteria: 1) recurrent symptoms or signs, such as neurogenic claudication and/or radiculopathy, that could be correlated to the LDH after a symptom-free postoperation interval; and 2) radiographic evidence of LDH on CT scan or MRI at the same level to previous surgery but morphologically different (Fig. 1).

All related risk factors reported in the literature, including smoking, diabetes, sex, trauma, occupational heavy weight lifting, and BMI were compared between the scoliosis and nonscoliosis groups.

Statistical Analysis

Using SPSS software (SPSS Inc.), independent t-tests and paired t-tests were applied for analysis of continuous variables, and the Pearson chi-square test was used for categorical variables. Statistical significance was set at p < 0.05.

Results

A total of 58 consecutive patients were analyzed in the current series with a mean follow-up period of 24.6 months. Fifteen patients (25.8%) comprised the scoliosis group, and 43 (74.2%) comprised the nonscoliosis group. Most instances of LDH occurred at the L5–S1 (55.1%, n = 32) and L4–5 (43.1%, n = 25) levels; only 1 instance (1.7%) occurred at the L3–4 level.

All patients had symptom relief after the operation, and significantly decreased VAS scores were demonstrated overall (Fig. 2). When comparing the scoliosis and nonscoliosis groups, there were no differences in demographic data or the risk factors of recurrent LDH, including sex, age, BMI, cigarette smoking, diabetes, traumatic events, and occupational heavy weight lifting (Table 1). There was 1 intraoperative dural tear in the scoliosis group; there were no other surgical complications in the other patients (Table 2).

Among the 15 patients in the scoliosis group, 5 patients (33.3%) experienced a recurrence of LDH at an average of 5.5 months postoperatively, at the time of diagnosis. On the other hand, only 1 of 43 patients (2.3%) in the nonscoliosis group had a recurrence of LDH. A significantly
higher rate of recurrence was demonstrated in the scolio-
sis group (33.3% vs 2.3%, p = 0.001) (Table 3). All patients
identified for recurrent LDH were symptomatic and were
initially managed with medication and rehabilitation. In
the scoliosis group, 2 patients (40%) did not improve with
conservative treatment and subsequently received second-
ary surgery. On the other hand, in the nonscoliosis group,
the only patient with recurrent LDH eventually received
secondary surgery (Fig. 3). The only patient who had a
recurrence of LDH in the nonscoliosis group had a recur-
rence-free interval of 39 months, whereas the recurrence-
free interval for the scoliosis group was 5.5 months (range
2–12 months; Fig. 4).

Discussion

Lumbar disc surgery is one of the most commonly
performed surgical procedures in the United States, with
more than 200,000 cases performed per year.21 Recurrence
of LDH after the first surgery is not uncommon and can
adversely affect the patient’s quality of life.16,21 In the cur-
rent series of 58 consecutive patients with LDH, initially
100% experienced symptom relief after microdiscectomy.
Their preoperative VAS score improved significantly after
the operation. However, 6 patients (10.3%) who were free
of symptoms after microdiscectomy later had a relapse of
symptoms caused by recurrent LDH at the operated level.
Interestingly, most of these patients (83.3%, 5 of 6) who
had recurrent LDH also had thoracolumbar scoliosis. Pa-
tients in the scoliosis group had a significantly higher rate
of recurrent LDH than those in the nonscoliosis group
(33.3% vs 2.3%, p = 0.001). Overall, patients with scoliosis
had a greater propensity for a secondary discectomy, al-
though statistical significance was not reached (13.3% vs
2.3%, p = 0.097).

In summary, although microdiscectomy for patients
with thoracolumbar scoliosis yields comparably good ef-
fects for symptom relief for LDH, there is a significantly
higher rate of recurrence within the 1st year after surgery.

In the current study, most (89.7%) of the patients re-
mained symptom free after microdiscectomy for LDH
throughout the follow-up. The recurrence rate of 10.3%
(6/58) was compatible with that in most of the published
series of surgery for LDH, despite various surgical tech-
niques.20,21 The true etiology of recurrence after success-
ful discectomy remains unclear. There were several risk
factors reportedly associated with recurrence of LDH, in-

### Table 1. Demographic data in all patients

<table>
<thead>
<tr>
<th>Variable</th>
<th>Scoliosis Group (n = 15)</th>
<th>Nonscoliosis Group (n = 43)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of females</td>
<td>7 (46.6%)</td>
<td>11 (25.5%)</td>
<td>0.116</td>
</tr>
<tr>
<td>Median age at op in yrs</td>
<td>28.1</td>
<td>30.9</td>
<td>0.143</td>
</tr>
<tr>
<td>Mean BMI ± SD</td>
<td>28.13 ± 6.66</td>
<td>25.08 ± 3.59</td>
<td>0.902</td>
</tr>
<tr>
<td>Diabetes</td>
<td>0 (0%)</td>
<td>1 (2.3%)</td>
<td>0.556</td>
</tr>
<tr>
<td>Smoking</td>
<td>5 (33%)</td>
<td>8 (18.6%)</td>
<td>0.171</td>
</tr>
<tr>
<td>Traumatic event</td>
<td>2 (13.3%)</td>
<td>9 (20.9%)</td>
<td>0.541</td>
</tr>
<tr>
<td>Heavy weight bearing</td>
<td>2 (13.3%)</td>
<td>9 (20.9%)</td>
<td>0.541</td>
</tr>
<tr>
<td>Mean follow-up in mos</td>
<td>23.1</td>
<td>25.1</td>
<td></td>
</tr>
</tbody>
</table>
Scoliosis and increased risk of disc herniation recurrence

including male sex, cigarette smoking, traumatic events, “in-competent” annulus fibrosus, high BMI, diabetes, and occupational heavy weight lifting. However, there are controversies among these series. For example, Suk et al. and Miwa et al. demonstrated that cigarette smoking increased risks of recurrent LDH, but Swartz and Trost did not concur. Likewise, Kim et al. reported that high BMI could cause recurrence of LDH, whereas Moliterno et al. demonstrated that lower BMI was associated with a greater risk of recurrence. In Moliterno’s series, there was a lower mean BMI in the recurrence group than the nonrecurrence group (24.9 vs 28.3).

It is reasonable to infer that patients with thoracolumbar scoliosis would have altered biomechanical wearing in their lumbar intervertebral discs. Ozgen et al. reported that 82% of adolescent patients with LDH had scoliosis. However, the actual causal effect of scoliosis in LDH has not been established. Only case reports exist in the literature to associate scoliosis with LDH. It is still uncertain about the mechanism and frequency of LDH in patients with scoliosis. This study therefore attempted to demonstrate for the first time the association between scoliosis and recurrent LDH in young adults. There were 15 patients in the current study who had scoliosis and underwent microdiscectomy without previous or later corrective surgery for scoliosis. This substantial portion (25.8%) of young adult patients with scoliosis implies that scoliosis could be a risk factor of LDH. The rates of recurrence of LDH were even more discrepant (33.3% vs 2.3%) between the nonscoliosis and scoliosis patients, respectively. Nevertheless, the association between LDH and scoliosis requires a larger number of patients to corroborate.

Management of recurrent LDH after surgical discectomy varies tremendously. There is a wide range of treatment options, including observation, pharmacological therapy, physical rehabilitation, and reoperation. The surgical options also vary among experts, such as endoscopic/open discectomy, redoing microdiscectomy, or spinal instruments. The optimal management for recurrent LDH in patients with scoliosis has been infrequently reported. In the current study, all 5 patients with recurrent LDH were treated initially with medication and physical rehabilitation. Subsequently, 2 underwent reoperation because of refractory symptoms. However, the optimal strategy and timing of intervention for these cases of recurrent LDH remain elusive.

There are limitations to the current study. This was a relatively small cohort of patients with LDH. This series retrospectively analyzed 58 consecutive young adults (< 40 years) with LDH who underwent microdiscectomy. Thus, the strict inclusion/exclusion criteria, which tended to eliminate other confounding factors (e.g., degenerative scoliosis, spondylosis, and spondylolisthesis), unfortunately also reduced the number of patients, which could have been substantially increased if the study had involved older patients. However, this design of the study reduced the effect of degeneration in these degenerative disc diseases, and yielded a more homogeneous cohort for evaluation (Table 1). Furthermore, this study had an average follow-up of slightly longer than 2 years, which might not be adequate for those late recurrences of LDH. However,

<table>
<thead>
<tr>
<th>Variable</th>
<th>Scoliosis Group</th>
<th>Nonscoliosis Group</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recurrence</td>
<td>5 (33.33%)</td>
<td>1 (2.32%)</td>
<td>0.001*</td>
</tr>
<tr>
<td>Recurrence w/ 2nd op</td>
<td>2 (13.33%)</td>
<td>1 (2.32%)</td>
<td>0.097</td>
</tr>
</tbody>
</table>

* Statistically significant.
the follow-up rate was extremely high in the current study and the duration was already adequate for the detection of significance. Nevertheless, the relatively early recurrence of LDH in patients with scoliosis warrants future studies with longer follow-up in a larger cohort.

Conclusions

Young adults (< 40 years) with scoliosis are at higher risk of recurrent LDH after microdiscectomy than patients without scoliosis. Although some of the recurrences may be asymptomatic, patients with scoliosis should be aware of this risk before they undergo microdiscectomy for LDH.

References

Disclosures
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions
Conception and design: all authors. Acquisition of data: all authors. Analysis and interpretation of data: all authors. Drafting the article: JC Wu, HK Chang, HC Chang, Tu, PY Chang, CL Wu. Critically revising the article: JC Wu, HK Chang, HC Chang, Tu, PY Chang, Huang, Cheng. Reviewed submitted version of manuscript: JC Wu, HK Chang, HC Chang, Tu, PY Chang, Huang, Cheng. Approved the final version of the manuscript on behalf of all authors: JC Wu. Statistical analysis: JC Wu, HK Chang, HC Chang, Tu. Administrative/technical/material support: JC Wu, HK Chang, HC Chang, CL Wu. Study supervision: JC Wu, HK Chang, HC Chang, Huang, Cheng.

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