Factors predicting progression in early degenerative lumbar scoliosis

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ABSTRACT

Purpose. To review early radiographs of patients with de novo degenerative lumbar scoliosis to determine factors predicting early scoliosis progression.

Methods. Standing anteroposterior and lateral radiographs of 7 men and 20 women aged 48 to 83 (mean, 63) years with Cobb angles between >5º and <20º were reviewed. They were followed up for a mean of 12 (range, 10–18) years. Radiographic variables measured included (1) the Cobb angle, (2) the grade of rotation of the apical lumbar vertebra, (3) the presence of a lateral vertebral translation of ≥3 mm, (4) the degree of osteoporosis, and (5) the Harrington factor (the degree of scoliosis divided by the number of vertebrae involved).

Results. During the follow-up period, the mean Cobb angle increased 5.3º from 10.1º to 15.4º, representing an increase of 0.4º per year. In initial radiographs, the apical vertebral rotation was rated as grade 0 in 3 patients, grade 1 in 19, grade 2 in 4, and grade 3 in one. A lateral vertebral translation of ≥3 mm was noted in 9 patients. The degree of osteoporosis was rated as grade 0 in 9 patients, grade 1 in 11, grade 2 in 5, and grade 3 in 2. The mean Harrington factor was 2.4. In the multiple regression analysis, only the grade of apical vertebral rotation was significantly correlated with scoliosis progression (regression coefficient=0.502, p=0.009).

Conclusion. Apical vertebral rotation may help predict the scoliosis progression and determine the timing of surgical intervention in patients with early degenerative lumbar scoliosis.

Key words: lumbar vertebrae; risk factors; scoliosis

INTRODUCTION

Degenerative lumbar scoliosis in elderly patients usually manifests as a combination of disabling low-back pain, radicular symptoms, and neurogenic claudication. The severity of the scoliosis affects not only the symptoms but also the treatments. Surgical procedures vary from short-segment decompression alone to more aggressive options such as long-segment...
fusion to correct the spinal deformity.\textsuperscript{4-6} Extensive surgery can be avoided if patients are treated before the deformity becomes severe.\textsuperscript{7}

There are 2 types of scoliosis in adults: \textit{de novo} degenerative (which progresses faster) and adolescent onset.\textsuperscript{8-11} Previous studies on risk factors of scoliosis progression usually included both types of patients with severe scoliosis and relatively short follow-up.\textsuperscript{12-14} We reviewed early radiographs of patients with \textit{de novo} degenerative lumbar scoliosis to determine factors predicting scoliosis progression.

\section*{MATERIALS AND METHODS}

Standing anteroposterior and lateral radiographs of 7 men and 20 women aged 48 to 83 (mean, 63) years with Cobb angles between \textgreater 5° and \textless 20° were reviewed. They were followed up for a mean of 12 (range, 10–18) years. Patients who had adolescent-onset scoliosis, previous spine surgery, a history of scoliosis, or a Cobb angle of \textgreater 20° were excluded.

Radiographic variables measured included (1) the Cobb angle (standing), (2) the grade of rotation of the apical lumbar vertebra,\textsuperscript{15} (3) the presence of a lateral vertebral translation of \textgreater 3 mm, (4) the degree of osteoporosis semi-quantitated by the Jikei method\textsuperscript{16} assigning grades from 0 to 3, and (5) the Harrington factor\textsuperscript{17} (the degree of scoliosis divided by the number of vertebrae involved). The Cobb angle was measured twice by one orthopaedic surgeon using the same protractor. All variables were analysed using a multivariable linear regression model. A \textit{p} value of \textless 0.05 was considered statistically significant.

\section*{RESULTS}

During the follow-up period, the mean Cobb angle increased 5.3° (range, -8°–21°) from 10.1° (standard deviation [SD], 4.3°; range, 5°–19°) to 15.4° (SD, 8.7°; range, 2°–39°), representing an increase of 0.4° (range, -0.8°–1.3°) per year (Figs. 1 and 2). The intra-observer agreement was 0.95.

In initial radiographs, the apical vertebral rotation was rated as grade 0 in 3 patients, grade 1 in 19, grade 2 in 4, and grade 3 in one. A lateral vertebral translation of \textgreater 3 mm was noted in 9 patients. The degree of osteoporosis was rated as grade 0 in 9 patients, grade 1 in 11, grade 2 in 5, and grade 3 in 2. The mean Harrington factor was 2.4 (SD, 1.1; range, 1.2–5.5).

In the multiple regression analysis, only the grade of apical vertebral rotation was significantly correlated with scoliosis progression (regression
would then be the primary, not the secondary, deformity of idiopathic scoliosis. Similarly, lateral spondylolisthesis in idiopathic lumbar scoliosis is not ‘true’ spondylolisthesis and is due to rotation of the lumbar vertebrae.25 As for the de novo degenerative lumbar scoliosis, increased lateral spondylolisthesis is associated with increased intervertebral rotation.26

In a retrospective study on the natural course of progressive adult scoliosis,11 rotatory subluxation seems to be the initial event in de novo degenerative lumbar scoliosis, whereas it also occurs during progression in adolescent-onset scoliosis in adults. Therefore, rotational instability plays an essential role in degenerative lumbar scoliosis, and shares a similar pathogenesis to idiopathic scoliosis. Apical vertebral rotation may help predict the scoliosis progression and determine the timing of surgical intervention in patients with early degenerative lumbar scoliosis (not responding to conservative therapy).

One limitation to our study was that scoliosis may increase during the day, and there was no control on how long patients were upright before radiographic examinations. The follow-up period varied from 10 to 18 years, although there was no correlation between the follow-up period and scoliosis progression. A lack of yearly radiography may have affected the results (e.g. scoliosis remained stable for >10 years and then rapidly deteriorated over a few years). The extent of apical vertebral rotation should have been more quantitatively evaluated using the torsion meter27 or computed tomography. The sample size was small and hence statistical power may be inadequate; some significant factors predictive of scoliosis progression in addition to apical vertebral rotation may have been missed.

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**Table**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Regression coefficient</th>
<th>Standard error (95% CI)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cobb angle</td>
<td>-0.04</td>
<td>0.05 (-0.14 to 0.06)</td>
<td>0.431</td>
</tr>
<tr>
<td>Apical vertebral rotation</td>
<td>0.502</td>
<td>0.17 (0.14 to 0.86)</td>
<td>0.009</td>
</tr>
<tr>
<td>Lateral vertebral translation</td>
<td>0.054</td>
<td>0.19 (-0.34 to 0.45)</td>
<td>0.777</td>
</tr>
<tr>
<td>Harrington factor</td>
<td>-0.01</td>
<td>0.19 (-0.4 to 0.38)</td>
<td>0.959</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>0.189</td>
<td>0.1 (0.03 to 0.4)</td>
<td>0.081</td>
</tr>
<tr>
<td>Follow-up period</td>
<td>0.006</td>
<td>0.02 (-0.03 to 0.05)</td>
<td>0.754</td>
</tr>
</tbody>
</table>

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**Discussion**

Osteoporosis was initially considered to be the cause of degenerative lumbar scoliosis in adults,18,19 but such association was not found.20 Our findings also suggested that the degree of osteoporosis does not play a role in scoliosis progression. Factors predicting scoliosis progression are a Cobb angle of ≥30º, an apical vertebral rotation of ≥grade 2, a lateral vertebral translation of ≥6 mm, and an intercrest line through the L5 vertebra.12,14 Nonetheless, these studies included both de novo degenerative and adolescent-onset lumbar scoliosis types, as the range of scoliosis was wide (14º to 60º12 and 12º to 50º14). In a study using multivariate logistic regression analysis,13 lateral spondylolisthesis of the apical vertebra, the Harrington factor, and disc index21 were all associated with scoliosis progression. Yet patients with a Cobb angle of >30º were also included, and the follow-up period was only 2 to 4.5 years.

In our study, only patients with early adult-onset degenerative lumbar scoliosis were included and followed up for at least 10 years. This may have excluded patients with more advanced degenerative lumbar scoliosis, but would not affect our analysis of scoliosis progression in its early stages. Conceivably there may have been a selection bias, as patients with rapid scoliosis progression or those followed up for <10 years were excluded. However, only 3 such patients were excluded; their Cobb angles ranged from 5º to 12º initially and progressed to 18º to 23º over 3 to 6 years.

An interesting concept of spinal column buckling was developed, in which rotation about one axis of the vertebral column was coupled with translation along a second axis.22-24 Vertebral rotation coefficient=0.502, p=0.009, Table). Even after eliminating the explanatory variables (the Harrington factor and the lateral vertebral translation), osteoporosis was still not a significant factor (p=0.067).
REFERENCES


