Anterior Versus Posterior Approach for Four-level Cervical Spondylotic Myelopathy

Dasheng Lin, MD; Wenliang Zhai, MD; Kejian Lian, MD; Liangqi Kang, MD; Zhenqi Ding, MD

Abstract

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The purpose of this study was to compare the results of 2 surgical strategies for 4-level cervical spondylotic myelopathy: a hybrid procedure using anterior cervical disectomy and fusion (ACDF) combined with segmental corpectomy versus posterior laminectomy and fixation. Between 2002 and 2010, fifty-one patients with consecutive 4-level cervical spondylotic myelopathy were treated surgically, with 27 patients undergoing the hybrid procedure and 24 undergoing posterior laminectomy and fixation. Radiologic data were compared between the 2 groups, including cervical curvature and cervical range of motion (ROM) in the sagittal plane. Pre- and postoperative neurological status was evaluated using the Japanese Orthopaedic Association (JOA) scoring system and the Nurick grading system. Mean ROM at last follow-up was not significantly different between the 2 groups (P>.05). In the hybrid group, mean JOA score and Nurick grade improved from 9.6±1.4 and 2.74±0.45 respectively, preoperatively, to 13.9±1.3 and 0.86±0.38 respectively, postoperatively. In the fixation group, mean JOA score and Nurick grade improved from 9.4±1.2 and 2.81±0.42 respectively, preoperatively, to 13.1±1.5 and 1.32±0.36 respectively, postoperatively. The JOA scores and Nurick grades at last follow-up were significantly different between the 2 groups (P<.05). In patients with preoperative cervical kyphosis, preoperative JOA score and Nurick grade were not significantly different between the 2 groups (P>.05); however, JOA scores and Nurick grades at last follow-up showed better improvement in the hybrid group than in the fixation group (P<.01). In patients with preoperative cervical lordosis, the preoperative and last follow-up JOA score and Nurick grade were not significantly different between the 2 groups (P>.05).

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The optimal surgical approach for multilevel cervical spondylotic myelopathy remains controversial. When 3 or more levels are involved in anterior corpectomy and fusion, failure rates increase. Lack of stability after anterior reconstruction seems to be the cause of this failure. Multilevel anterior cervical discectomy and fusion (ACDF) can be associated with high rates of fusion. The technique is safe and effective for managing multilevel cervical spondylotic myelopathy and may obviate the need for circumferential procedures. However, in many patients, stenotic pathology is not found at the disk level alone and the available space required for removal of the osteophytes is limited. Posterior strategies can also provide canal decompression, but the degree of decompression is sometimes insufficient because the ventral compression is not solved. Instability following laminectomy has also raised concerns. Therefore, for multilevel cervical spondylotic myelopathy, the optimal approach to provide satisfactory decompression and minimize complications remains to be determined.

The current study was designed to compare the use of a hybrid procedure (ACDF combined with segmental corpectomy) with the use of posterior laminectomy and fixation for the treatment of cervical spondylotic myelopathy involving 4 levels and to evaluate the factors that influence the outcomes of the 2 techniques.

**MATERIALS AND METHODS**

**Patient Recruitment**

From July 2002 to July 2010, fifty-one patients seen at the authors’ department who met the following criteria were recruited: (1) underwent either the hybrid procedure or the posterior laminectomy and fixation procedure for 4-level cervical spondylotic myelopathy; (2) had complete medical records and related radiographic data, including pre- and postoperative radiographs, computed tomography (CT) scans, and magnetic resonance imaging (MRI); and (3) had 24 months or more of follow-up data. Patients with cervical ossification of the posterolateral ligament or spinal injuries due to trauma were excluded. Informed written consent was acquired from all patients.

Of the 51 patients, 27 were treated with the hybrid procedure (hybrid group) and 24 were treated with posterior laminectomy and fixation (fixation group). No significant differences were found in the baseline characteristics of the 2 groups, including patients’ preoperative cervical curvature, mean preoperative cervical range of motion (ROM) in the sagittal plane, and Japanese Orthopaedic Association (JOA) scores and Nurick grades \( P > .05 \) (Table 1).

**SURGICAL TECHNIQUE**

For the hybrid procedure, patients were placed in the supine position with the head slightly extended. Following routine procedures to expose the anterior longitudinal ligament, a rectangular area of the ligament was resected. According to preoperative imaging findings, the vertebrae corresponding with the level of the most severe stenosis was confirmed. At the other levels, a curette and a laminectomy rongeur were used for discectomy, and distraction posts were inserted in a convergent fashion to restore regional kyphosis. All osteophytes were removed from the anterior face of the spine, and a wedge-shaped autogenous iliac crest graft was used for fusion. Then, corpectomy of the vertebrae was performed corresponding with the level of the most severe stenosis, and distraction posts were inserted in a convergent fashion to restore regional kyphosis. A wedge-shaped autogenous iliac crest graft or a titanium mesh cage and plate was used for fixation (Figure 1).

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**Table 1**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Anterior</th>
<th>Posterior</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. (male:female)</td>
<td>27 (19:8)</td>
<td>24 (17:7)</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Mean age at surgery, y</td>
<td>52.2 ± 9.7</td>
<td>54.5 ± 10.3</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Mean follow-up, mo</td>
<td>39.8 ± 5.2</td>
<td>41.5 ± 6.4</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Mean cervical curvature, deg</td>
<td></td>
<td>&gt;.05</td>
<td></td>
</tr>
<tr>
<td>Lordotic</td>
<td>12</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Kyphotic</td>
<td>15</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Mean ROM, deg</td>
<td></td>
<td>&gt;.05</td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>65.2 ± 3.4</td>
<td>67.6 ± 3.8</td>
<td></td>
</tr>
<tr>
<td>Postoperative</td>
<td>42.7 ± 2.7</td>
<td>40.5 ± 2.2</td>
<td></td>
</tr>
<tr>
<td>Mean operative time, min</td>
<td>124 ± 47</td>
<td>115 ± 36</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Mean intraoperative blood loss, mL</td>
<td>259 ± 131</td>
<td>284 ± 120</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Mean JOA score</td>
<td>9.6 ± 1.4</td>
<td>9.4 ± 1.2</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Preoperative</td>
<td>13.9 ± 1.3</td>
<td>13.1 ± 1.5</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Mean Nurick grade</td>
<td>2.74 ± 0.45</td>
<td>2.81 ± 0.42</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Postoperative</td>
<td>.86 ± .38</td>
<td>1.32 ± .36</td>
<td>&lt;.05</td>
</tr>
</tbody>
</table>

**Abbreviations:** deg, degrees; JOA, Japanese Orthopaedic Association; ROM, range of motion.

*As measured in the sagittal plane.*
For the fixation procedure, patients were placed in the prone position and a midline incision was made. Subsequently, the paraspinous muscles were peeled back to expose the bilateral laminae of the affected vertebrae. The starting point for the pedicle screw is just medial to the hillock of the lateral mass in the coronal plane and midway between the surfaces of the superior and inferior articular process. A 2-mm burr was used to start the hole. Next, a hand drill was inserted into the starting hole, angling laterally approximately 20° and parallel to the facet joint in the sagittal plane. This can be judged best by placing a thin, flat instrument into the joint to be fused. Drilling proceeded carefully just to, but not through, the second cortex because bicortical fixation has not been demonstrated to be of biomechanical advantage. A depth gauge was then inserted to determine screw length, and a pedicle screw system was used for fixation. The laminae were resected on the levels to be decompressed (Figure 2), and small wedges of bone were placed adjacent to bilateral joints to facilitate fusion.

**Figure 2:** Intraoperative photograph showing how the laminae were resected and the spinal cord was floated.

**Postoperative Care and Assessment of Surgical Outcomes**

Postoperatively, patients were told to wear neck braces for 3 months for protection. Radiographs, CT scans, and MRIs were taken the day of surgery; 3, 6, 12, and 24 months postoperatively; and at last follow-up. The JOA scoring system and the Nurick grading system were used to assess the postoperative improvement of neurological status.\(^7,8\)

**Statistical Analyses**

Statistical analyses were performed using SPSS version 13.0 statistical software (SPSS, Inc, Chicago, Illinois). A paired \(t\) test and group \(t\) test were used for comparison of quantitative data. Fisher’s exact test was applied for qualitative data. The results were considered significant at a \(P\) value less than .05.

**RESULTS**

Mean operative times were 124 ± 47 minutes (range, 90-180 minutes) for the hybrid group and 115 ± 36 minutes (range, 75-180 minutes) for the fixation group. Mean intraoperative blood loss was 259 ± 131 mL (range, 160-400 mL) for the hybrid group and 284 ± 120 mL (range, 200-600 mL) for the fixation group. Mean operative time and blood loss were not significantly different between the 2 groups (\(P > .05\)). Patients were followed up for a mean of 39.8 ± 5.2 months (range, 24-56 months) in the hybrid group and 41.5 ± 6.4 months (range, 24-60 months) in the fixation group.
Table 2

<table>
<thead>
<tr>
<th>Cervical Curvature</th>
<th>No. of Cases</th>
<th>Mean JOA Score</th>
<th>Mean Nurick Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preop</td>
<td>Postop</td>
<td>Preop</td>
</tr>
<tr>
<td>Anterior</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lordotic</td>
<td>12</td>
<td>9.7±1.1</td>
<td>13.5±1.3</td>
</tr>
<tr>
<td>Kyphotic</td>
<td>15</td>
<td>9.5±1.5</td>
<td>14.2±1.2</td>
</tr>
<tr>
<td>Posterior</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lordotic</td>
<td>14</td>
<td>9.4±1.1</td>
<td>13.3±1.5</td>
</tr>
<tr>
<td>Kyphotic</td>
<td>10</td>
<td>9.4±1.4</td>
<td>12.7±1.3</td>
</tr>
</tbody>
</table>

Abbreviations: JOA, Japanese Orthopaedic Association; postop, postoperative; preop, preoperative.

In the hybrid group, 12 patients had preoperative cervical lordosis (mean, 9.5°±3.8°; range, 5°-12°), and 15 had cervical kyphosis (mean, 8.9°±4.1°; range, 6°-13°). At last follow-up, mean ROM in the sagittal plane decreased from 65.2°±3.4° (range, 52°-78°) preoperatively to 42.7°±2.7° (range, 34°-66°) postoperatively. In the fixation group, 14 patients had preoperative cervical lordosis (mean, 9.7°±4.3°; range, 6°-15°), and 10 had cervical kyphosis (mean, 8.5°±3.7°; range, 5°-12°). At last follow-up, mean ROM in the sagittal plane decreased from 67.6°±3.8° (range, 58°-82°) preoperatively to 40.5°±2.2° (range, 32°-60°) postoperatively. Mean preoperative and last follow-up ROM were not significantly different between the 2 groups (P>.05).

Mean JOA score for the hybrid group increased from 9.6±1.4 (range, 6-13) preoperatively to 13.9±1.3 (range, 10-16) postoperatively, with a mean improvement rate of 57.7±10.4%. Mean JOA score for the fixation group improved from 9.4±1.2 (range, 5-14) preoperatively to 13.1±1.5 (range, 9-16) postoperatively, with a mean improvement rate of 49.3±11.2%. Mean JOA score at last follow-up was significantly different between the 2 groups (P<.05). Mean Nurick grade for the hybrid group decreased from 2.74±0.45 (range, 2-4) preoperatively to 0.86±0.38 (range, 0-2) postoperatively. Mean Nurick grade for the fixation group improved from 2.81±0.42 (range, 2-4) preoperatively to 1.32±0.36 (range, 0-3) postoperatively. Mean Nurick grade at last follow-up was significantly different between the 2 groups (P<.05).

For patients with preoperative cervical kyphosis, mean preoperative JOA scores and Nurick grades were not significantly different between the 2 groups (P>.05), but the JOA score and Nurick grade showed better improvement at last follow-up for the hybrid procedures group than for the fixation group (P<.01). In the patients with preoperative cervical lordosis, mean preoperative and last follow-up JOA score and Nurick grade were not significantly different between the 2 groups (P>.05) (Tables 1, 2; Figure 3).

Complications for the hybrid procedure include dysphagia symptoms, with 2 patients reporting this complication. The time of initial onset of the dysphagia symptom was within 3 days postoperatively. One month postoperatively, 1 patient’s symptoms resolved and symptoms in the other patient were relieved but not completely resolved. Physical examination showed no abnormalities, and no intervention was performed. Three patients demonstrated asymptomatic adjacent segment degeneration, and no specific measure was taken. No case of implant failure was observed.

In the fixation group, 3 patients had C5 nerve root palsy symptoms (1 bilaterally and 2 laterally). The time of initial onset of C5 palsy symptoms was within 8 hours postoperatively. Patients were treated conservatively using oral neurotrophic drugs, hyperbaric oxygen therapy, and exercise. Three months postoperatively, all patients’ symptoms resolved. Two patients had asymptomatic adjacent segment degeneration, and no specific measures were taken.

**DISCUSSION**

The optimal surgical approach for cervical spondylotic myelopathy remains a matter of debate, especially for multilevel cervical spondylotic myelopathy. Many articles on cervical reconstruction after a multilevel corpectomy have reported a high failure rate of long segment anterior cervical plate fixation or fibular strut grafting after a corpectomy spanning more than 3 levels.1-3 The lack of fixation points is likely the mechanism underlying the relatively high complication rates and lower fusion rates seen in series with longer corpectomy constructs.9,10

Ikenaga et al11 introduced an anterior pedicle screw fixation technique after multilevel corpectomy. It is likely that this technique will result in better clinical outcomes with fewer complications for the treatment of patients with multilevel cervical spondylotic myelopathy. However, this is a plurality of special techniques for an even greater plurality of potential difficulties. Multilevel anterior cervical disectomy and fusion can be associated with high rates of fusion. The technique is safe and effective for managing multilevel cervical spondylotic myelopathy and results in shorter hospital stays, less intraoperative blood loss, and shorter operative times for patients.4,12,13 However, in many patients, stenotic pathology is not simply at the disk level, and the available space...
required for removal of the osteophytes is limited. During the process, the gradually decompressed bony structure causes repeated bulging of the spinal cord. This leads to repeated severing, which may cause spinal damage or even paraplegia.

Yilmaz et al. demonstrated that skip corpectomy is a good alternative to standard 3-level corpectomy to improve stability, especially during lateral bending. Under pure moment loading, the screws of a cervical multilevel plate experience the highest pullout forces during axial rotation. According to the theoretical analysis, direct removal of the osteophytes by hybrid procedures, such as ACDF combined with segmental corpectomy, offers better decompression, reserves more vertebrae, and provides an additional screw purchase and strengthened the construct. Moreover, the wedge-shaped autogenous iliac crest graft allows substantial restoration of cervical lordosis, and hence is theoretically the optimal option. Compared with posterior laminectomy and fixation in the current study, the hybrid procedures showed better clinical outcomes, especially for the preoperative kyphotic alignment of the cervical spine.

Posterior laminectomy with decompression and fixation is a well-established technique and is relatively simple and safe. The current authors found that it is an effective strategy for multilevel cervical spondylotic myelopathy. Effective and safe decompression of the spinal cord was accomplished for most patients. It can also provide immediate and long-term stability of the cervical spine and avoid development of kyphosis. Nevertheless, because the compression is located anteriorly, decompression in posterior surgery is indirect, without removal of the osteophytes. Moreover, multilevel cervical spondylotic myelopathy is often accompanied by various levels of nerve root compression, and posterior surgery is ineffective for the decompression of nerve roots, causing postoperative symptoms. Furthermore, it has been reported that segmental root palsy occurs in 3.2% to 28.6% of patients. Meanwhile, posterior surgery had no advantage for preoperative kyphotic alignment of the cervical spine in the current study. Therefore, knowledge of the preoperative cervical curvature is essential for the efficacy of posterior decompression, thus narrowing the scope of application.

In the hybrid group, although no case of implant failure was observed at the last follow-up, 3 patients demonstrated asymptomatic adjacent segment degeneration. Meanwhile, patients undergoing multilevel procedures have a high risk for dysphagia. Long-term follow-up is necessary to evaluate the safety and effectiveness of this technique, especially with regard to the potential complications and the incidence of adjacent segment degeneration.

**CONCLUSION**

Both anterior and posterior surgery can achieve satisfactory outcomes. Although patients in the current study had comparable preoperative JOA scores and Nurick grades, the preoperative kyphotic alignment of the cervical spine managed anteriorly had better outcomes than that managed posteriorly. Anterior cervical disectomy and fusion combined with segmental corpectomy can directly relieve compression, provide an additional screw purchase and strengthen the construct, and allow substantial restoration of cervical lordosis. Despite its limitations with regard to cervical curvature, posterior fixation can achieve effective decompression and maintain or restore stability of the cervical spine using multilevel laminectomy, thereby improving symptoms of spinal cord compression, especially for patients with cervical lordosis.

**REFERENCES**


