A comparison of anterior cervical discectomy fusion and
anterior cervical corpectomy fusion using titanium cages in
patients with postlaminectomy cervical kyphosis

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Abstract

Study design: A retrospective study.

Object: The goal in this study was to compare the outcomes of anterior cervical
discectomy fusion (ACDF) and anterior cervical corpectomy fusion (ACCF) using
titanium cages surgical treatments of postlaminectomy cervical kyphosis (PLCK).

Background Data: Cervical kyphosis is a particularly challenging problem that can
lead to progressive deformity and neurological decline. Postlaminectomy is widely
perceived as iatrogenic cause to cervical kyphosis. Anterior surgical approach is
useful for to correcting cervical kyphosis and improving neurological function.
However, the relative merits of ACDF and ACCF remain controversial.

Methods: A total of 25 patients with PLCK from a tertiary hospitals in China were
assigned to two groups. The surgical treatments included ACDF (group 1) and ACCF
(group 2).

Results: All patients were followed up for 18 to 48 months postoperatively (average,
30.6 months). Group 1 (12 patients) had a mean age 48.2 years (range 37~58 years).
Group 2 (13 patients) had a mean age 49.8 years (range 35~56 years). The operative
time was significantly lower (P<0.001) and blood loss significantly higher (P<0.001)
in Group 2 than in Group 1. Both groups showed significant improvement when
comparing preoperative to postoperative JOA scores (P<0.05). Group 1 had better
percent correction and smaller ratio of correction lost at last follow-up than groups 2
(P< 0.05). The overall complication rate for the entire group was 28%: group 1 (29%)
and group 2 (71%). The fusion rates in Group 1 were 100% and 84.6% for Group 2.

Conclusion: Both ACDF and ACCF are useful for the correction of PLCK and
achieved good clinical outcome. In addition, ACDF was stayed ahead of ACCF in
terms of blood loss, kyphosis correction, fusion rates and graft related complication
rates, apart from operation times.

Keywords: cervical kyphosis; postlaminectomy; cervical discectomy; cervical
corpectomy; treatment outcomes;

Introduction

Cervical kyphosis may develop secondary to surgery, trauma, degenerative
disease, neoplastic disease, systemic arthritides [1-4]. The most common iatrogenic cause of cervical kyphosis is laminectomy [1]. Laminectomy is the main reason of the multilevel cervical vertebra disease and tumor. We choose laminectomy to achieve posterior decompression or removal of tumor. However, Posterior decompression without fusion (laminectomy alone or laminoplasty) could disrupt the posterior tension band and added the risk of developing kyphosis [5,6]. The incidence of postoperative kyphosis after multilevel cervical spine laminectomy is as high as 20% [7], but different presentation depending on the individual's age, preoperative kyphosis angle, preoperative spinal stability, location of tumor and the scope of laminectomy [7-9].

PLCK can cause life-threatening paralysis, and surgical treatment is often regarded as the best choice. The goals of surgery should be neural decompression, correction of the deformity and spinal stabilization with fusion. Generally, for patients with PLCK, the most of the surgeon were prefer anterior procedure and combined anterior-posterior approaches. There are few cases reported the treatment of PLCK [10,11], But there are no systematic comparison of anterior approach surgical treatment of ACDF and ACCF. Controversy remains over the “best” anterior surgical approach for the treatment of these challenging cervical kyphosis deformities.

The purpose of this study was to compare the clinical and radiographic outcomes as well as the safety and efficacy of ACDF and ACCF to 25 patients with PLCK.

Materials and Methods

Clinical Information

The research was reviewed and approved by the Ethic Committee of the Xiangya Hospital of Central South University. From December 2004 to June 2011, we treated 25 patients with PLCK including 14 males and 11 females with a mean age of 49.1 years (range 35~58 years) and kyphosis as indicated by a Cobb angle of 28° to 60°(average, 41°). Each patient presented with laminectomy or laminoplasty postoperative. Clinical data retrieved from the medical records included surgical time, estimated blood loss, surgical procedure, JOA score and complications. All patients received cervical flexion-extension radiography and computed tomography with 3-dimensional reconstruction to assess the overall flexibility of the cervical spine. Magnetic resonance imaging was also obtained to evaluate the intraspinal contents and spinal cord compression. Postoperative fusion was determined on dynamic radiographs or CT scans. All patients were placed in skull traction prior to correction surgery. Traction started with a weight of 2 kg, and the weight was gradually increased day by day while we carefully observed the patient of neurological deficits. All patients in this study underwent surgical treatment while being monitored with motor-evoked potential.

Operation procedure
Because of patients with PLCK without posterior ankylosis of the facet joints, so we can choose alone anterior approach to decompression and correction the deformity. Anterior cervical corpectomy and discectomy were performed as described previously [12,13]. For ACDF cases, after confirmation and exposure of the appropriate vertebral levels, multiple discectomy was performed and small titanium cages filled with autogenous bone was installed (Figure 1). Among 12 patients who underwent ACDF, 4 patients underwent fusion at two levels, while another 8 patients were fused at three levels. For ACCF cases, the multiple vertebral body was removed using a channel technique [12], and replaced with a long titanium cages (Figure 2). Among 13 patients who underwent ACCF, corpectomy at two levels was performed in 3 patients and three levels in 10 patients.

Statistical Analysis

The Chi-square test was used to determine whether differences between groups before surgery were significant. Postoperative radiologic parameters, perioperative parameters, and clinical follow-up results were compared using independent t tests. All statistical analyses were performed using SPSS (version 19), and statistical significance was defined as P<0.05.

Results

For all 25 cases, the average follow-up period was 30.6 ±17.4 months (18~48 months). There were 12(48%) group 1 patients and 13(52%) group 2 patients (Table 1). The average operative time in Group 1 was 270±38 min (range 210~350 min), and was significantly higher (P<0.001) than Group 2, which was 193±30 min (range 150~260 min). The average blood loss in Group 1 was 332±60 ml (range 270~450 ml), and was significantly lower (P<0.001) than Group 2, which was 635±103 ml (range 490~780 ml). None of the patients in either group developed any new neurological deficits. Both groups showed significant improvement when comparing preoperative to postoperative JOA scores (P<0.05). However, the difference in improvement between groups was not statistically significant (P>0.5).

The two groups no significant differences in postoperative Cobb angle (P=0.8) (Table 2). At the last follow-up, group 1 had better percent correction (82%, mean Cobb angle: 7°) than group 2(68%, mean Cobb angle: 13°) (P < 0.001). Group 1 (6%) had smaller ratio of correction lost than group 2 (14%) (P < 0.01).

The overall complication rate for the entire group was 28%: group 1 (29%) and group 2 (71%)(Table 3). No patient in either group developed infection and hoarseness. One group 1 patient showed C5 radicular symptoms of persistent neck and shoulder pain after surgery. There were three postoperative dysphagia (one of group 1 and two of group 2) and resolved within 2 months. One group 2 patients, CSF leakage stopped after 3~5 days conservative treatment of local pressure. In Group 2, two patients developed pseudarthrosis and required re-operation. The fusion rates in
Group 1 were 100% and 84.6% for Group 2.

**Discussion**

The treatment of PLCK can be a real challenge because it can present a compound situation of exposure and decompression spinal cord, progressive kyphosis, segmental instability, and reconstruction of stability [1,5-11]. Performing a wide range of multilevel laminectomies usually does not immediately destroy whole spine. In the normal cervical lordosis and the bearing shaft is located in the back of the vertebral bodies. Therefore, the anterior column shares less of the axial load than the posterior column [14]. With the posterior tension band after resection, the compression load on the anterior vertebral body will progressively increasing and resulting in anterior wedge compression. This increased force on the anterior column may lead to further development of cervical kyphosis [15]. The spinal cord also turned to the front port of the vertebral canal, and spread in the rear of the vertebral body at the apex of the deformity [1]. This transformation can increase the mechanical stress on the anterior aspect of the spinal cord [16]. More than that, the vertebral bodies in children with incomplete ossification cannot resist compression pressure, so they are more prone to developing wedge deformity and loss of sagittal balance [17]. Constant of the kyphosis deformity may cause chronic cord ischemia and spinal cord atrophy.

When patients present with a neurological injury, have severe mechanical pain or functional disability, the conservative treatment is not effective in most cases, and the positive surgical intervention should be performed early [4]. Treatment of PLCK is a challenge to the spinal surgeon and the ideal strategy of surgical correction remains controversial. Anterior approach allows the surgeon ventral decompression, correction of deformity and spinal reconstruction under direct vision. Both ACDF and ACCF are effective treatments for patients with PLCK. To our knowledge, such comparison has never been published in the literature. In our study, the two groups no significant difference in the age and gender. The average operative time in Group 1 was significantly higher and the average blood loss was significantly lower than Group 2 (P<0.001). Both group demonstrated a significant increase in JOA scores at the last follow-up. However, the difference in improvement between groups was not statistically significant. Gore [18] and Wada et al.[19] reported a 84% and 74% incidence of fusion rate utilizing multilevel corpectomies. Park et al. [20] have reported that there were no significant differences in bone graft fusion rate between a single-level corpectomy and a two-level discectomy. In our series, the fusion rates in Group 1 were 100% and 84.6% for Group 2. Group 1 offered greater possibility of fusion because of a larger cage-bone interface compared with the use of an expansion cage. In contrast, multilevel corpectomies utilizes only two graft-host interfaces.

Group 1 kyphosis angle from a preoperative mean of 41° to a postoperative mean of 5°. Group 2 kyphosis angle from a preoperative mean of 40° to a postoperative
mean of 9°. Meanwhile, group 1 (6%) had smaller ratio of correction lost than group 2 (14%). Loss of correction is usually observed during the early follow-up period. Both ACDF and ACCF can correct kyphosis, but in multilevel ACDF, lordosis can be achieved and maintained easier than in ACCF. Multilevel ACDF can provide multiple support points and therefore can restore lordosis more effectively than ACCF procedure. This is due to multilevel ACDF can restore curvature by pulling the related vertebral bodies toward the lordosis ventral plate, nevertheless, ACCF just put the cervical spinal column between the remaining vertebral bodies to straighten [21].

Riew et al.[22] used anterior cervical corpectomy to treat 18 patients with postlaminectomy kyphosis, nine patients of them (50%) had graft-related problems including graft extrusion, collapse, pseudarthrosis, and progressive kyphosis. With the development of the cervical plate and screw fixation system, the complications were decreased. In our study, we used internal fixation in all patients. One group 1 patient showed C5 radicular symptoms of persistent neck and shoulder pain after surgery. Dysphagia developed in one patient in group 1 and two patients in group 2. Swallowing problem often occurred in both anterior cervical discectomy and multilevel corpectomies [23]. This may be due to large surgical exposure range and long operation time. Vaccaro et al.[24] and asso et al.[25] reported a 50% and 71% incidence of graft-related complications after multilevel corpectomies reconstruction, respectively. There were no graft-related complications in group 1 while there were two cases in group 2. With ACDFs, screws are placed in the two caudal end plates and intervening vertebral segments share the load of the construct. In contrast, with a multilevel corpectomies, screw only implanted in the cranial and caudal vertebral segments and the caudal end plate bears the full load of the construct [20,25]. This may help to explain why ACCF group had higher graft-related complications.

In terms of all studies, the present study had some weaknesses and limitations. Although the lower incidence of PLCK, the sample size is still not large to have a sufficient statistical power. Future prospective, randomized trials with larger sample sizes are warranted to evaluate the optimal surgical approach for this complex problem.

**Conclusions**

Based on the results of this study, surgical managements of PLCK by ACDF or ACCF showed no significant differences in terms of achieved clinical symptom improvements. In addition, ACDF was stayed ahead of ACCF in terms of blood loss, kyphosis correction, fusion rates and graft related complication rates, apart from operation times. Furthermore, in order to avoid serious neurological deficits during the correction of the spinal deformities, the motor-evoked potential monitoring is very important.

The authors declare that they have no competing interests.
REFERENCES


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**TABLE 1 Clinical and JOA score Comparison of Group 1 and 2**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Group 1(ACDF)</th>
<th>Group 2(ACCF)</th>
<th>P</th>
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</thead>
<tbody>
<tr>
<td>Age(years)</td>
<td>48.2±6.5</td>
<td>49.8±4.4</td>
<td>P=0.475</td>
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<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>7</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>5</td>
<td>6</td>
<td></td>
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<tr>
<td>Operation time(min)</td>
<td>270±38</td>
<td>193±30</td>
<td>P&lt;0.001</td>
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<tr>
<td>Blood loss(ml)</td>
<td>332±60</td>
<td>635±103</td>
<td>P&lt;0.001</td>
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<tr>
<td>JOA Score</td>
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<tr>
<td>Preoperative</td>
<td>11.2±1.3</td>
<td>10.9±1.5</td>
<td>P=0.6</td>
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<tr>
<td>Postoperative</td>
<td>13.3±0.8</td>
<td>13.1±0.9</td>
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<tr>
<td>Lost follow-up</td>
<td>14±0.7</td>
<td>13.9±0.7</td>
<td>P=0.8</td>
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<tr>
<td>Correction ratio(%)</td>
<td>48±6</td>
<td>49±9</td>
<td>P=0.9</td>
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### Table 2  Cobb angle comparison of the groups 1 and 2

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (ACDF)</th>
<th>Group 2 (ACCF)</th>
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<tr>
<td>Preoperative</td>
<td>41±9</td>
<td>40±9</td>
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<tr>
<td>Postoperative</td>
<td>5±3</td>
<td>9±3</td>
<td>P&lt;0.05</td>
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<td>Last follow-up</td>
<td>7±3</td>
<td>13±6*</td>
<td>P=0.003</td>
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<tr>
<td>Correction ratio postoperative</td>
<td>87±7</td>
<td>79±4</td>
<td>P=0.002</td>
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<tr>
<td>Correction ratio last follow-up</td>
<td>82±7</td>
<td>68±8</td>
<td>P&lt;0.001</td>
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<tr>
<td>Ratio of correction lost</td>
<td>6±4</td>
<td>14±7</td>
<td>P=0.002</td>
</tr>
</tbody>
</table>

*Two patients developed pseudarthrosis and cause excessive of Cobb angle.

### Table 3  Complications

<table>
<thead>
<tr>
<th>Complications</th>
<th>Group 1 (ACDF)</th>
<th>Group 2 (ACCF)</th>
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<tbody>
<tr>
<td>CSF</td>
<td>0</td>
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<tr>
<td>Infection</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Hoarseness</td>
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</tr>
<tr>
<td>C5 radiculopathy</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Dysphagia</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Graft related</td>
<td>0</td>
<td>2</td>
</tr>
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### Figure legends

Figure 1. Preoperative lateral cervical spine radiograph of a 47-year-old female with postlaminectomy kyphosis due to intramedullary astrocytoma underwent operation 11 years ago (Cobb angle, 36°), C2-6 lamina and spinous process partial deletion (a,b). Sagittal T2-weighted magnetic resonance image demonstrates anterior compression of spinal cord by kyphotic apex at the C3-5 level (c). The Cobb angle was corrected to 12° after 2 weeks skull traction (d). Three month’s postoperative lateral radiograph showed correction of kyphosis deformity (e). Twenty-one months postoperative lateral radiograph showing maintenance of the cervical angle without obvious correction loss and bone graft fusion (f).

Figure 2. Preoperative lateral cervical spine radiograph of a 36-year-old female with postlaminectomy kyphosis due to paravertebral tumor resection 9 years ago (Cobb angle, 47°), C4-6 laminae and spinous process partial deletion (a). Sagittal T2-weighted magnetic resonance image demonstrates anterior compression of spinal cord by kyphotic (b). One-week postoperative lateral radiograph showing a Cobb angle of 12° (c). Six month’s postoperative lateral radiograph showed internal fixation with good (d). Eighteen months postoperative lateral radiograph showing a Cobb angle of 16° (e). Twenty-nine months postoperative lateral radiograph showed stable internal fixation and without Significant progress of correction loss (f).
Figure 2
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