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Opinion paper

Is stand alone PEEK cage the gold standard in multilevel anterior cervical discectomy and fusion (ACDF)? Results of a minimum 1-year follow up

You-Sub Kim, Jae-Young Park, Bong Ju Moon, Sang-Deok Kim, Jung-Kil Lee *

Department of Neurosurgery, Chonnam National University Hospital and Medical School, Research Institute of Medical Sciences, Gwangju, Republic of Korea

A R T I C L E I N F O

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Introduction: This study was designed to evaluate the clinical and radiologic results of stand-alone synthetic polyetheretherketone (PEEK) cages for two- or three-level anterior cervical discectomy and fusion (ACDF), with a focus on subsidence.

Materials and methods: We retrospectively reviewed a total of 68 patients who underwent two- or three-level ACDF with a stand-alone PEEK cage between April 2005 and August 2016. Radiologic parameters were assessed on lateral radiographs, and fusion was assessed on computed tomography scans. For the evaluation of clinical outcomes, visual analogue scale, neck disability index, and modified Japanese Orthopedic Association scores were measured.

Results: Among the total of 68 patients with a total of 144 segments, ACDF at two and three levels was performed in 60 and 8 patients, respectively, with a mean follow-up duration of 27.6 months. The overall fusion rate was 81.3% (117 of 144 segments), and subsidence occurred in 63 segments (43.8%) at the last follow-up. There was no statistically significant difference between the subsidence group and the non-subsidence group in terms of fusion rate, radiologic outcomes, and clinical outcomes ($p > .05$).

Conclusion: Subsidence might be an inevitable course and only a radiologic phenomenon with no effect on the clinical and radiologic outcomes of the use of stand-alone cages.

1. Introduction

Anterior cervical discectomy and fusion (ACDF) has been considered a standard procedure for the treatment of degenerative cervical diseases associated with radiculopathy or myelopathy. Although many modifications and surgical techniques for ACDF have been performed in the last decades, the success of the procedure undoubtedly depends on proper decompression of neural structures and solid bony fusion with maintenance of cervical sagittal alignment.

Anterior plating may provide immediate stability, a high fusion rate, and maintenance of cervical lordosis [1,2]. However, it is associated with plate-related complications such as loosening or pull-out of screws, esophageal injury, dysphagia, and paralysis of the recurrent laryngeal nerve [3,4].

To prevent plate-related complications, the use of stand-alone cages has been advocated. This method is effective for restoring the intervertebral disc height and lordosis, and providing load-bearing support to the anterior column; however, it has a relatively higher probability of subsidence than anterior plating [5].

However, many reports examining subsidence did not assess the correlation between subsidence and the clinical outcomes (including fusion rate) of single-level ACDF [6,7].

Although many techniques for single-level ACDF have yielded successful fusion rates with good clinical outcomes, the fusion rate declines as the number of affected levels in multilevel ACDF increases [8,9]. Therefore, anterior plating, which could provide postoperative stability and decrease the micro-movement of fusion segments, has been widely used for multilevel ACDF [10]. However, the rate of plate-related complications after multilevel anterior plating ACDF has reached 24%, and Topuz et al. and Demircan et al. reported that the fusion rate was comparable with multilevel stand-alone ACDF [1,11,12].

The purpose of this study was to establish the usefulness of stand-alone synthetic polyetheretherketone (PEEK) cages for two- or three-level ACDF, by evaluating the clinical and radiologic results.

* Corresponding author at: Department of Neurosurgery, Chonnam National University Hospital, 42, Jebong-ro, Dong-gu, Gwangju 501-757, Republic of Korea.
E-mail address: jkl@chonnam.ac.kr (J.-K. Lee).

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2. Materials and methods

2.1. Study population

In this study, we retrospectively reviewed 68 patients who were treated with two-level and three-level ACDF without anterior plating from April 2005 and August 2016. Patients with cervical radiculopathy or myelopathy caused by degenerative disc disease or spondylosis were included. Moreover, patients with trauma, recent infection, osteoporosis, prior cervical surgery, and cervical instability were excluded. For ACDF, a stand-alone synthetic PEEK cage filled with local autologous bone chips and demineralized bone matrix (DBM) was used.

2.2. Surgical technique of ACDF

The surgical procedure was performed with the patient in supine position with slight neck extension. After exposing the affected prevertebral space, intraoperative fluoroscopy was used to confirm alignment and the affected level. After discectomy was performed, the posterior annulus, posterior longitudinal ligament, and osteophytes were removed. Nerve roots or the spinal cord was totally decompressed, and the upper and lower cartilaginous end plates were decorticated, preserving the bony endplates. Local autologous bone chips were collected during the removal of osteophytes for graft. The proper PEEK cage was selected (Solis cage [Stryker, Allendale, NJ, USA] and Cornerstone cage [Medtronic, Memphis, TN, USA]). The cages packed with DBM (Osteotech, Shrewsbury, NJ, USA), CG-DBM (CGBio, Seongnam, Gyeonggi, Korea), or DBX (MTF, Edison, NJ, USA) mixed with autologous bone chips were inserted into the disc space. The operation was completed without anterior plating. A Philadelphia cervical collar (Philadelphia Cervical Collar Co., Thorofare, NJ, USA) was applied for 4 weeks in all patients.

2.3. Radiologic and clinical assessment

For radiologic assessment, anteroposterior and lateral radiographs were obtained before surgery; immediately after surgery; at 1, 6, and 12 months after surgery; and at the last follow-up. The overall cervical sagittal angle (CSA, C2-7 angle), segmental angle (SA) of the treated level, and interbody height (IBH) were measured. The overall CSA was measured according to the Cobb angle between the lower endplate of C2 and lower endplate of C7 on lateral radiographs. The SA was measured as the angle formed by the lines between the upper endplate of the upper body and the lower endplate of the lower body. The IBH was divided into three points: anterior IBH (AIBH), middle IBH (MIBH), and posterior IBH (PIBH) of the vertical distance between two adjacent vertebral bodies (Fig. 1). Subsidence was defined as a >2.5 mm decrease of IBH by comparing the lateral radiographs at any of the three points or any of the treated levels.

Fusion was assessed with both flexion–extension lateral radiographs and cervical computed tomography (CT) scans. We defined fusion when the following two conditions were satisfied: (i) <2 mm gap between the tips of the spinous process on flexion–extension lateral radiographs and (ii) partial or complete bony bridging on CT scans but not on lateral radiographs. A method of measurement of fusion with CT scan is shown in Fig. 2. We considered fusion type III or IV as a successful fusion.

Pain and function were assessed with the visual analogue scale (VAS) for neck pain and arm pain, modified Japanese Orthopedic Association (mJOA) score, and neck disability index (NDI). These outcome parameters were evaluated preoperatively, immediately postoperatively, and at the last follow-up, and scored by the patients without assistance.

2.4. Statistical analysis

All data were analyzed with SPSS for Windows version 22.0 (SPSS, Chicago, IL, USA). The demographic differences between the subsidence group and the nonsubsidence group were analyzed by using Pearson's chi-square test. The independent *t*-test and Mann-Whitney *U* test for parametric or nonparametric variables were used for analyzing the baseline characteristics between the two groups. Furthermore, repeated-measures analysis of variance was used for assessing the radiologic and clinical outcomes between the two groups. Data are presented as mean ± standard deviation. For all analyses, a p-value of <0.05 was considered statistically significant.

3. Results

A total of 68 patients with a total of 144 treated levels were included in this study. Of the 68 patients, ACDF was performed at two levels and three levels in 60 and 8 patients, respectively. ACDF was most commonly performed at C5/6 (54 segments, 37.5%) followed by C4/5 (41 segments, 28.4%), C6/7 (28 segments, 19.4%), and C3/4 (21 segments, 14.6%). Male patients were predominant in this study (38 versus 30), and the mean follow-up duration was 27.6 months (range, 13–139 months).

The overall fusion rate was 81.3% (117 out of 144 segments). Subsidence occurred in 37 (54.4%) patients and 63 segments (43.8%) at the last follow-up.

The patients were divided into the subsidence group (group I) and the nonsubsidence group (group II). In group I, there were 20 male and 17 female patients with a mean age of 54.3 years (range, 39–76 years). Group II included 18 male and 13 female patients with a mean age of 57.2 years (range, 35–72 years). The mean follow-up duration was 24.6 months (range, 13–139 months) and 33.2 months (range, 13–127 months) in group I and group II, respectively.

The demographics and baseline characteristics of group I and group II are described in Table 1. There was no significant difference in age, sex, treated level, preoperative IBH, SA, and overall CSA.

3.1. Radiologic outcomes

The decrease of IBH mainly occurred at the anterior and middle portions. Anterior-only subsidence and combined anterior, middle, or posterior subsidence occurred; however, posterior-only subsidence was not detected.

The mean decrease of AIBH, MIBH, and PIBH in group I was 4.01 ± 0.99, 3.57 ± 1.23, and 3.10 ± 1.42 mm between the immediate postoperative and last follow-up data. In group II, the mean decrease of AIBH, MIBH, and PIBH was 1.43 ± 0.76, 1.40 ± 0.98, and 1.04 ± 0.82 mm, respectively. Although all of AIBH, MIBH, and PIBH significantly decreased from after surgery to the last follow-up in both groups I and II, IBH significantly decreased more over time in group I than in group II ($p < .001$).

The SA significantly increased ($p < .001$) from −0.91 ± 6.05 degree before surgery to 1.70 ± 6.70 degree at the last follow-up in group I and from −0.83 ± 7.01 to 1.45 ± 5.54 in group II, but there was no significant difference between the two groups. (p = .880) Also, the overall CSA significantly increased ($p < .001$) overtime in both group I and group II, the difference between two groups was not statistically significant (p = .212).

The fusion rate at the last follow-up was 79.7% in group I (63 of 79 segments) and 83.0% in group II (54 of 65 segments) in segmental analysis, and the difference in fusion rates between the two groups was not statistically significant (p = .621) (Table 2).