Use of the PEEK cage for treatment of cervical spondylosis

Pedro Joachin-Hernández,1 Armando Alpizar-Aguirre,2 Baron Zárate-Kalfopulus,2 Luis Miguel Rosales-Olivares,2 Guadalupe Sánchez-Bringas,2 Alejandro Antonio Reyes-Sánchez3

Abstract

Background: Decompression and fusion with autograft is the gold standard technique in the treatment of narrowing of the cervical canal. Using polyetheretherketone (PEEK) cages or nonabsorbable polymer boxes with elasticity similar to bone, radiolucent, and the same degree of fusion reduces morbidity.

Methods: We carried out a prospective, longitudinal, deliberate intervention case series with evaluation panel before and after 2 years follow-up. Discectomy and PEEK housing placement were done with autologous graft. Arthrodesis, cervical lordosis, intervertebral space height, and pain were evaluated using the Visual Analogue Scale, Neck Disability Index, operative time, intraoperative bleeding, hospital stay and complications. Statistical analysis was done with Student t, Wilcoxon and Fishers exact test.

Results: Of 17 patients studied, nine (53%) were female with an average age of 62 years. The most affected level was C5-6, C6-7 with five patients. Fusion rate was 100%. No collapse or migration of the box was noted. Disc space height was conserved, but segmental lordosis was not. Clinical improvement was demonstrated in all patients as well as disability index. Bleeding was on average of 187 ml.

Conclusion: Symptom decrease, conservation of the height of the anterior and posterior space, no conservation of segmental lordosis and fusion with PEEK cage were in accordance with what has been reported in the literature. We suggest using an anterior plate to maintain cervical lordosis. We found a fusion rate of 100% and clinical improvement of symptoms, pain and disability. There was loss of global cervical lordosis.

Key words: anterior cervical spine surgery, polyetherether ketone, discectomy fusion.

Introduction

The adequate selection of patients amenable for surgical treatment of the cervical spine continues being a challenge. According to the medical literature, positive predictive markers for patients operated on are intense radicular pain, low disability, young male, one or two affected segments, adequate correlation between the radiographic and clinical findings, good strength in the upper extremities and adequate neck mobility.1

From the 1960s, various methods began to be described for anterior cervical fusion and new forms of arthrodesis for the treatment of spondylitic myelopathy2-5 and anterior cervical discectomy without arthrodesis, with favorable results according to some series; however, with time there was kyphotic deformity and instability.6-8 The natural history of cervical spondylitic myelopathy as time passes leads to gradual neurological degeneration. For this reason, surgical intervention should be undertaken as early as possible. Delay in surgical intervention leads to less total recovery with repercussions on the patient’s quality of life and increases medical costs.9,10 This is the reason why anterior decompression is the technique of choice for the treatment of spinal cord compression, which when accompanied by axial instability should always have an arthrodesis performed as well. Autologous bone grafts are the first choice for promoting bone fusion, although it has certain disadvantages: pain at the donor site and need for later surgeries.11 This is the reason techniques were designed so as to avoid a second surgery, such as allografts,12 ceramic substitutes,13,14 stainless steel cages, titanium, carbon fibers and benzene ring polymers15-17 and recently with PEEK material (polyetheretherketone).18

PEEK is a nonabsorbable polymer with elasticity similar to bone. It is radiolucent and facilitates observation of the
consolidation in plain x-rays."19 It is a linear, semicrystalline, polyaromatic polymer with qualities of strength, rigidity, hardness and resistance to the environment.20 It is compatible with magnetic resonance imaging with minimal or no effect and has demonstrated that its inflammatory response is minimal and excellent to corrosion. The elasticity of the PEEK cage is near the bone (~17 GPa), which helps to reduce stress and increase bone fusion. However, it has been found to be harmful to cells and growth factors where the products of osteoclastic activity increase such as alkaline phosphatase and production of fibroblasts after placement of the PEEK cage.19

The advantages of using the PEEK cage are to reduce recurrence, preserve lordosis and foraminal height, reduce morbidity in obtaining the graft, as well as having a high degree of fusion18 which, in fact, is >95%. If it is believed that the PEEK cage may be the reference pattern for cervical spine arthrosis, it is necessary to ask, what is the effectiveness of using the PEEK cage without plate in cervical spine arthrosis for the treatment of cervical spondylosis? For this reason, in patients with these implants we believe that it is necessary to evaluate in our department the index of fusion in the treatment of cervical spondylosis in order to decide if it is a treatment with better percentage of fusion and less index of complications compared to or similar to the world literature.21-26 The objectives specified for the investigation were as follows:

1) demonstrate the ability to PEEK box to promote fusion, cervical lordosis and maintain the height of intervertebral space
2) assess the effectiveness in relation to pain measured with the visual analog pain scale (VAS) and functionality via the cervical disability index, measurement of surgical time, intraoperative bleeding, and hospital stay
3) evaluate the safety in terms of complications (pseudoarthrosis, collapse of the cage, cage migration, loss of lordosis, dysphagia, etc.) and compare the results with the existing literature.

**Patients and Methods**

We carried out a prospective, longitudinal, deliberate intervention study as a series of cases with pre- and post-assessment, with follow up at 1 and 2 years. Seventeen patients were included who had decompression carried out by means of a discectomy and placement of a PEEK cage and autologous graft taken from the surgical site. This was a sole procedure for arthrodesis done in 2009 and 2010 on patients who met the inclusion criteria for diagnosis of narrowing of the cervical canal according to clinical and MRI data, with one or two levels of involvement and without added congenital disorder of the cervical spine. Between-group analysis was done with the Student t test and Wilcoxon test for numerical data (including age, surgical time, segment angles, disk height and subsequent examinations). Fisher test was done with categorical variables: age, index of fusion, surgical levels, surgical success.

**Results**

Of the 17 patients studied, there were eight males (47%) and nine females (53%) with an average age of 62 years (range: 42-82 years). Height ranged from 1.53 to 1.75 m. The average body weight of the patients was 68.9 kg (57-92 kg). The levels affected were as follows: two patients at the C3-C4 level, two patients at the C5-C6 level, four patients each at the C3-C4 and C4-C5 level, and five patients at the C5-C6 and C6-C7 levels. The average pre-surgical anterior intervertebral height was 4.11 mm (SD 1.49). The following year, patients obtained 7.23 mm average anterior intervertebral height (SD 1.92). At 2 years the average anterior intervertebral height was 7.11 mm (SD 1.86). The average pre-surgical posterior intervertebral height was 2.6 mm (SD 1.56 mm). At 1 year the posterior intervertebral height was, on average, 5.52 mm (SD 1.36 mm) and at 2-year follow-up was 5.35 mm (SD 1.32 mm) (Table 1). In all cases there was cage collapse with average of 2 mm, principally seen in the superior platform of the inferior vertebra.

As for pre-surgical segmental lordosis there was a median of 12 (range: -16° to 40°), at 1 year of evolution, median was 8 (range: -6° to 18°) and at 2 years with a median of 8 (range: -5° to 18°). Global presurgical lordosis had a median of 22 (range: 16°-52°), at 1 year had a median of 20 (range: -6° to 40°) (p = 0.017), and at 2 years a median of 20° (range: -6° to 40°) (p = 0.188). In cases of global lordo-

<table>
<thead>
<tr>
<th>Table 1. Radiologic variables</th>
<th>Intervertebral height</th>
<th>Posterior intervertebral height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>4.11</td>
<td>2.6</td>
</tr>
<tr>
<td>SD</td>
<td>1.49</td>
<td>1.56</td>
</tr>
<tr>
<td>1 year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>7.23</td>
<td>5.52</td>
</tr>
<tr>
<td>SD</td>
<td>1.92</td>
<td>1.36</td>
</tr>
<tr>
<td>2 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>7.11</td>
<td>5.35</td>
</tr>
<tr>
<td>SD</td>
<td>1.86</td>
<td>1.32</td>
</tr>
</tbody>
</table>

SD, standard deviation.
sis with a median of 22 (range: -16° to 52°) there were sig-
nificant changes seen at 1 year with a median of 20 (range: 
-6° to 40°) ($p = 0.014$) with loss of global lordosis; how-
ever, there were no significant changes ($p = 0.317$) during follow-up at 1 and 2 years.

The most common surgical level was C5-C6, C6-C7 (29.4%), for a total of 30 levels for the 17 patients who had radicular symptoms, myelopathy, or both. The fusion rate reached 100% according to X-rays with follow-up at 1 and 2 years. The maximal surgical time was 180 min and the minimum was 90 min (average of 126 min). The maximum bleeding was 750 mL, and the minimum 50 mL (average of 187 mL).

With respect to pain evaluated preoperatively with the VAS, it was 7, at 1 year it was 2, and at 2 years it was 2. With respect to the cervical disability index, in our patients during the preoperative period there was a median of 49.46 (SD 13.27); the median at 1 year was 21.00 (SD 16.68); at 2 years a median of 21.82 (SD 17.02).

During and after surgery there were no complications and none of the patients required revision.

**Discussion**

The use of the cage without plate for anterior cervical arthrodesis, which includes distraction and compression, was introduced by Bagby,27 Cho24 and Boakye et al.28 who reported a fusion rate of 100% with PEEK cage. In our study the fusion rate was 100%, and there were no cases of collapse >3 mm or migration of the cage in any of the patients studied. The graft used was mineralized bone matrix with cage filling. The surgeries were carried out by four different surgeons using standardized techniques.

All patients experienced a decrease of the symptoms from the myelopathy and radiculopathy and only two manifested residual cervical pain. Our results are similar to those obtained by Niu et al.29 For segmental lordosis, results were compatible with the same author obtained with respect to the use of the PEEK cage in which the segmental lordosis was not preserved. This is similar to the case we demonstrated on sustaining loss of the segmental and global lordosis. Even with recovery of normal ranges, there is loss of lordosis when consolidation of the arthrodesis in the segments operated is provoked (Figures 1-4). This suggests that in order to establish a definitive judgment one should evaluate the global and segmental cervical lordosis. Although there was increase in the height of the anterior and posterior intervertebral disk space ($p <0.001$), in both measurements (preoperative and at 1-year follow-up) it was due to the increase of the PEEK cage per se, which acts as an interspacer; however, collapse of the posterior part favors loss of lordosis with a clear relationship of loss of lordosis, consolidation index and the collapse. No changes were seen during the 1- and 2-year follow-up, which defines that the collapse and alteration of the lordosis is seen during the first months of follow-up as reported in the literature in the long term where the difference in collapse and loss of cervical lordosis is maintained from the first year without changes.30,32 It may be inferred that what is mentioned by other authors with respect to the use of an anterior plate does not improve the fusion index but is narrowly relat-
dosis, additional methods of stabilization are required with anterior cervical plate.

References