

# Polyetheretherketone (Peek) Cages For Cervical Interbody Replacement: Clinical Experience

## ABSTRACT

**OBJECTIVE:** This study evaluates the efficiency of interbody polyetheretherketone (PEEK) cage implantation in 85 consecutive cases treated for discogenic cervical disorders with radiculopathy or myelopathy.

**METHODS:** Between the years 2002-2005, 85 patients were treated with cervical interbody fusion using a PEEK cage. There were 60 male and 25 female patients and the mean age was 46 years (range, 21-82 years). PEEK cages were packed with demineralised bone grafts or synthetic bone grafts. Additional plating was not used in any case. The median duration of follow-up was 12 months (range, 6-36 months). Cervical x-rays were routinely used in the follow-up to assess the fusion, pseudoarthrosis, kyphosis, cage migration, subsidence or breakage.

**RESULTS:** No implant insufficiency was observed in any case.

**CONCLUSION:** Efficient interbody replacement is still an ongoing problem in cervical surgery. Different techniques and materials have been developed to overcome this problem. The use of a cervical PEEK cage seems to be a good alternative in that it does not require additional anterior plating and bone graft harvesting for achieving cervical interbody replacement.

**KEY WORDS:** Cervical surgery, interbody implant, PEEK cage.

## INTRODUCTION

Surgery for cervical disc disease is one of the most common procedures in daily neurosurgical practice. Since conventional cervical fusion surgeries using autologous bone graft have some complications such as graft collapse and expulsion, pseudoarthrosis, de novo neural compression and graft site morbidity, cervical cage implantation has been introduced during the last decade. Spinal cage instrumentation to enhance spinal fusion and stability in cervical spine surgery has ensured an adequate increase in the height and the cross-sectional area of the neural foramina and helped to correct cervical kyphosis (5,6).

Different cage types have been introduced to neurosurgical practice. Although the early results with the cages were satisfactory, problems such as migration, subsidence and structural failure of the cage with some difficulties in postoperative magnetic resonance imaging were observed (1,8). PEEK cages have recently been used in cervical surgery. PEEK is polyetheretherketone, a semi-crystal polyaromatic linear polymer. The use of a PEEK cage is becoming popular because of better elasticity and radiolucency (4,7). In this study, we evaluated the efficiency of cervical PEEK cage replacement in 85 patients with cervical discogenic disorders.

Serdar KAHRAMAN  
Mehmet DANEYEMEZ  
Hakan KAYALI  
İlker SOLMAZ  
Altay BEDÜK  
Melih AKAY

Department of Neurosurgery  
Gülhane Military Medical Academy  
06018 Etilik-Ankara, Turkey

Received : 07.02.2006  
Accepted : 09.03.2006

Correspondence address:

**Serdar KAHRAMAN**  
Gülhane Askeri Tıp Akademisi,  
Nöroşirünji Anabilim Dalı,  
06018 Etilik-Ankara, Turkey  
Phone : +90 312 304 5302  
Fax : +90 312 304 5300  
E-mail : skahraman@gata.edu.tr

**PATIENTS AND METHODS**

During a 3-year interval, 85 patients with cervical disc herniation or degenerative disease underwent surgery for cervical PEEK cage replacement. There were 60 male and 25 female patients. Mean age was 46 years (range, 21-82 years).

Clinical requirements were cervical radiculopathy in 30 patients, myelopathy in 26 patients and myeloradiculopathy in 29 patients. Anterior cervical approaches were performed at one level in 52 patients, at two levels in 28 patients and at three levels in 5 patients. Twenty of the patients with two levels and 5 patients with three levels were operated on at neighboring vertebra levels. The remainder patients with two levels were operated on at non-neighboring levels. The clinical data of the operated patients are summarized in (Table I).

The operative procedure was performed by an anterior approach and disc material was resected microscopically. Spinal cord and nerve roots were decompressed in routine fashion. Following decompression, a PEEK (Solis; Stryker Instruments, Kalamazoo, MI) cage with suitable height and width was packed with demineralised or synthetic bone grafts and the cage was introduced into the intervertebral space with the help of external manual cervical traction. Different commercial sizes of the cages are available. The available heights for the

cage are 5-6-7 mm and the widths are 12-14 mm. Additional plating was not used in any case.

In the postoperative period, cervical orthoses were only used for 6 weeks postoperatively in patients who had 2-level or 3-level surgery.

**RESULTS**

The mean operative time was 70 minutes (range, 50-90 minutes) in single-level surgery. The mean blood loss during surgery was 40 cc (range, 20-70 cc). The mean hospital stay was 2 days ranging between 1 and 3 days. Patients' follow-up ranged between 6 months and 3 years (mean, 12 months). All of the patients were followed with cervical X-rays including flexion-extension radiography to evaluate cage migration, subsidence or breakage, cervical lordosis, pseudoarthrosis and fusion.

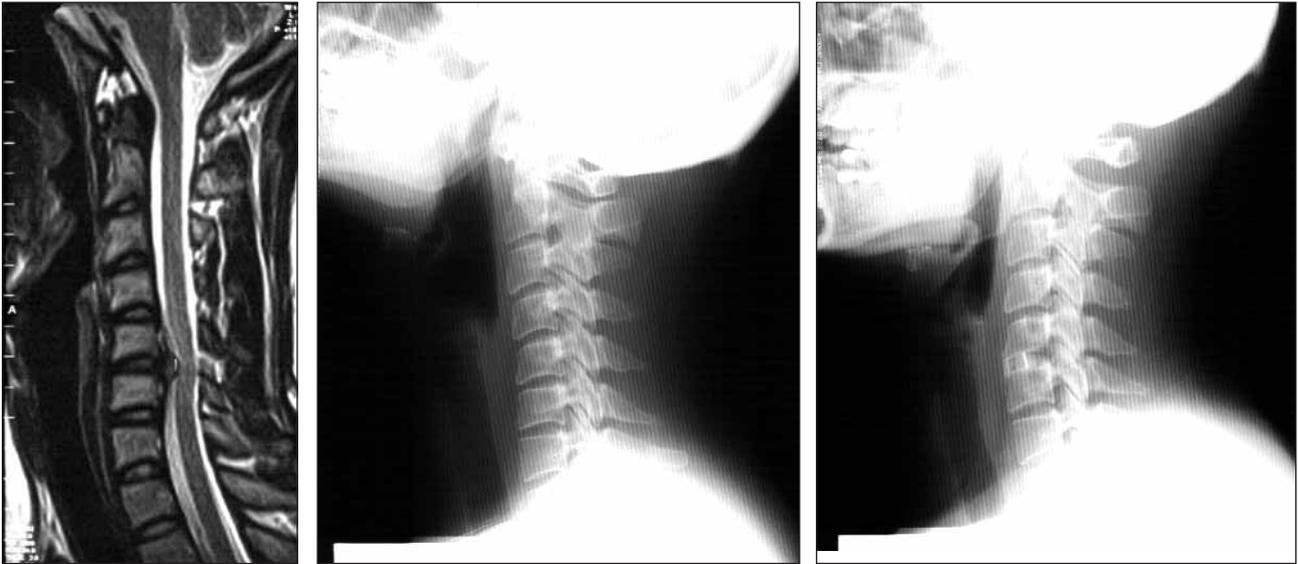
In one patient, a minimal collapse fracture was observed due to bone resorption in the superior corpus. Conservative treatment was preferred and the patient recovered without additional surgery. In another patient, there was primary decompressive surgery insufficiency. The patient was reoperated on 6 months after primary surgery and strong cage fusion was observed peroperatively. The PEEK cage was removed with the use of a pneumatic high-speed drill. More extensive decompression was done and a bigger PEEK cage was impacted into the disc space. Cervical interbody replacement with PEEK cage was uneventful in all patients, continuing to the present (Figure 1). Dynamic cervical x-rays were used to assess the cages for fusion. A strong bony bridge was observed between the two corpuses with no mobility and no radiolucency around the cage in all patients. In rare instances, 3D CT-scan reconstruction was used to confirm bone fusion. There were no patients with pseudoarthrosis or wound infection. We did not observe any problems such as cage migration, subsidence or breakage. Fusion rates of PEEK cages were 100% in cases with two years follow-up. The fusion rate and duration were not related to the number of operated levels.

**DISCUSSION**

The PEEK cage is a polyetheretherketone, which provides strength and stiffness in the intervertebral space. Biomechanical studies on PEEK cages demonstrate satisfactory physiological values. The resistance to pressure is 4170 N (Newton) under a static position and 2160 N under a dynamic position. The elastic character of the cage is similar to bone (4,6,12). The PEEK cage induces cell attachment and

**Table I.** Demographic data of the patients operated on using PEEK cages.

Men / Women	60/25
Radiculopathy	30
Myelopathy	26
Myelo-radiculopathy	29
<b>One Level</b>	<b>52</b>
C3-4	6
C4-5	9
C5-6	24
C6-7	13
<b>Two Levels</b>	<b>28</b>
C3-4, 4-5	4
C4-5, 5-6	6
C5-6, 6-7	10
C3-4, 5-6	3
C4-5, 6-7	5
<b>Three Levels</b>	<b>5</b>
C3-4, 4-5, 5-6	2
C4-5, 5-6, 6-7	3



**Figure 1.** Preoperative and postoperative images of the case. Follow-up image of the patient with one-level PEEK cage at the C5-6 level. Image shows corrected cervical lordosis and bone fusion while the cage location is easily recognized by the titanium pins.

fibroblast proliferation and increases the protein content of the osteoblasts (4,9).

Following neural decompression, interbody replacement and bone fusion are the main goal of cervical spine surgery (3). With autologous bone graft fusion, arthrodesis was reported to be 97% by Brown et al. (2). Savolainen et al. reported a 98% fusion rate with autologous bone grafts but there was a 16% rate of donor site complication (10). Reviews with titanium cages reveal bone fusion in 98% (11). When compared with these data, the fusion rate with the PEEK cage presented in this study seems to be superior to the autologous bone graft and titanium cage applications. In different studies, fusion with PEEK cage showed excellent resistance to crushing (12). The force values applied during these biomechanical experiments were higher than the forces applied to the cervical spine under normal circumstances (11,12). In our cases, we did not observe any problem such as cage migration, subsidence or breakage. Since we did not use additional plating, we suggest that teeth on the surfaces and the upper and bottom titanium pins are enough to keep the PEEK cage in the disc space and do not lead to cage migration.

Increasing the height and cross-sectional area of foramina serves up nerve root decompression after cervical spine surgery. However, extensive distraction for cage placement may end up causing radicular pain due to stretching of the nociceptive

fiber in the joint capsule (5,8). Cages with 5-6-7 mm thickness were inserted to maintain adequate foraminal space. In our series, there was no case with postoperative radicular pain, indicating adequate foraminal height and decompression.

Demineralised or synthetic bone grafts were used for packing the PEEK cages to avoid the necessity of autologous bone harvesting. Cho et al. reported 40 patients who were operated on using PEEK cages and autologous bone graft. They reported no donor site complications. However, other series reported a 10-18% rate of donor site complications (4). In our series, demineralised or synthetic bone grafts demonstrated effective bone fusion without any complication and with short hospital stay which may justify the downside of cost of these grafts.

Another advantage of the PEEK cage is its radiotransparency. It is compatible with magnetic resonance and computed tomography imaging. This feature provides good postoperative spinal cord and nerve root imaging without implant artifact. Bone fusion can be easily evaluated with postoperative X-rays. The upper and bottom titanium pins of the PEEK cage also let us identify the actual cage position.

The biocompatibility of the cage was excellent. There was no foreign body reaction in our series. The time of implantation was short with limited blood loss.

## CONCLUSION

In our clinical study, usage of PEEK cage in cervical spine surgery has a low complication rate, and is physiological, strong and biocompatible, providing a good alternative for interbody replacement.

## REFERENCES

1. Brantigan JW, Steffee AD (1993) A carbon fiber implant to aid interbody lumbar fusion. Two year clinical results in the first 26 patients. *Spine* 15:18(14):2106-7
2. Brown MD, Malinin TI, Davis PB (1976) A roentgenographic evaluation of frozen allografts versus autografts in anterior cervical spine fusions. *Clin Orthop* (119):231-6.
3. Casey ATH (1999) Bone grafts and anterior cervical discectomy-lack of evidence, but no lack of opinion. *Br J Neurosurg* 13(5):445-448
4. Cho DY, Liao WR, Lee WY, Liu JT, Chiu CL, Sheu PC (2002) Preliminary experience using a polyetheretherketone (PEEK) cage in the treatment of cervical disc disease. *Neurosurg* 51(6):1343-50
5. Kandziora F, Pflugmacher R, Schaefer J, Scholz M, Ludwig K, Schleicher P, Haas NP (2003) Biomechanical comparison of expandable cages for vertebral body replacement in the cervical spine. *J Neurosurg Spine* 99(1):91-97
6. Krammer M, Dietl R, Lumenta CB, Kettler A, Wilke HJ, Buttner A, Claes L (2001) Resistance of the lumbar spine against axial compression forces after implantation of three different posterior lumbar interbody cages. *Acta Neurochir (Wien)* 143(12):1217-22
7. Malone Q, Lynn J, Lunn J (2003) Surgical outcome for anterior cervical discectomy and fusion using the Signus Rabea PEEK cage. *Proceedings of the NASS 18th Annual Meeting / The Spine Journal* 3:129S-130S
8. Matge G (2002) Cervical cage fusion with 5 different implants: 250 cases. *Acta Neurochir (Wien)* 144(6):539-50
9. Petillo O, Peluso G, Ambrosio L, Nicolais L, Kao WJ, Anderson JM (1994) In vivo induction of macrophage Ia antigen (MHC class II) expression by biomedical polymers in the cage implant system. *J Biomed Mater Res* 28(5):635-46
10. Savolainen S, Usenius JP, Hernesniemi J (1994) Iliac crest versus artificial bone grafts in 250 cervical fusions. *Acta Neurochir (Wien)* 129(1-2):54-7
11. Siddiqui AA, Jackowski A (2003) Cage versus tricortical graft for cervical interbody fusion. *J Bone Joint Surg (Br)* 85-B(7):1019-25
12. Wilke HJ, Kettler A, Claes L (2002) Stabilizing effect and sintering tendency of 3 different cages and bone cement for fusion of cervical vertebrae segments. *Orthopade* 31(5):472-80