



## Research Article

### Early Changes in The Operated and Adjacent Segments After Anterior Cervical Microdiscectomy and Interbody Fusion With Polyetheretherketone (PEEK) Cage Containing Synthetic Bone Particulate: A Prospective Study of 20 Cases

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## Summary

**Objective:** To evaluate the effects of implantation of PEEK cage containing synthetic bone particulate on the height and cross-sectional area of the foramen, the intervertebral disc height and the degree of lordosis in the treatment of cervical disc disease.

**Methods:** Twenty patients, with cervical disc herniation were operated a standard cervical microdiscectomy. The heights of the intervertebral discs, cross-sectional areas and heights of neural foramen bilaterally in the affected level and in the upper and lower adjacent levels were calculated.

**Results:** There were no implant related complications or additional surgeries required for any cause. There were significant decrease in VAS scores of patients between the preoperative time and the postoperative follow-ups. The radiological outcomes showed that, there were significant increase in the height of the intervertebral disc, the cross sectional areas and heights of bilateral neural foramen at the operated level, between the preoperative time and the postoperative follow-ups. However, there was not statistically significant radiological change at the upper and lower adjacent levels between the preoperative time and the postoperative follow-ups.

**Conclusions:** The use of PEEK cage in the ACDF had obvious positive effects on the disc heights and neural foramina at the operated level. However, no negative effects at the adjacent levels were determined.

**Key words:** Anterior cervical microdiscectomy and interbody fusion (ACDF); cervical lordosis; disc height; foramen cross sectional area; foramen height; polyetheretherketone (PEEK) cage

### Anterior Servikal Mikrodiskektomi ve Sentetik Kemik Partikülü İçeren Polietereterketon (PEEK) Cage ile İnterbody Füzyon Uygulamasında Opere Segmentte ve Komşu Segmentlerde Erken Dönem Değişiklikler: 20 Olguluk Prospektif Çalışma

## Özet

**Amaç:** Servikal disk hernisi tedavisinde kullanılan sentetik kemik partikülü içeren PEEK cage implantasyonunun foramen yüksekliği ve alanı, intervertebral disk yüksekliğine ve lordoz açısına olan etkilerini araştırmak.

**Yöntem ve Gereç:** Servikal disk hernisi tanısıyla standart servikal mikrodiskektomi yapılan 20 hasta çalışmaya dahil edildi. Opere edilen segment ile üst ve alt komşu segmentlerinde intervertebral disk yüksekliği ile bilateral nöral foramen alanı ve yükseklikleri ölçüldü.

**Bulgular:** Hiçbir hastada implanta bağlı komplikasyon izlenmedi ve ikinci bir cerrahiye ihtiyaç olmadı. Radyolojik olarak preoperatif ve postoperatif bulgular karşılaştırıldığında, opere edilen segmentte, intervertebral disk yüksekliğinde, bilateral nöral foramen alan ve yüksekliğinde istatistiki olarak anlamlı artış görüldü. Üst ve alt komşu segmentlerde ise istatistiki olarak anlamlı bir artış izlenmedi.

**Sonuç:** Anterior servikal mikrodiskektomide PEEK cage uygulanması opere edilen segmentte disk yüksekliği ve nöral foramenler üzerine olumlu etki göstermiştir. Bunun yanında, komşu segmentlerde olumsuz bir etki izlenmemiştir.

**Anahtar Kelimeler:** Anterior servikal mikrodiskektomi ve interbody füzyon, polietereeterketon cage, foramen yüksekliği, foramen alanı, servikal lordoz

## INTRODUCTION

Cloward, Robinson and Smith first described the anterior approach as an option for cervical disc herniation and spondylosis, reporting excellent results in the treatment of degenerative cervical disc disease<sup>(4,10)</sup>. This operation has undergone changes involving synthetic interbody-cages and materials over the past three decades. The main advantages of this procedure are immediate restoration and maintenance of disc height, thereby reducing postoperative neural foraminal compromise following interspace decompression<sup>(1,7)</sup>. More recently, the debate whether to perform fusion remains ongoing and allografts and autografts have been used with varying degrees of success. On the other hand, using a cage instead of bone graft after discectomy has offered advantages including the absence of complications at the donor site, easier implantation technique and good immediate and long-term stabilization<sup>(6,11)</sup>. There are numerous types of cages developed for ACDF including titanium, carbon fibre, and PEEK cages.

Polyetheretherketone (PEEK) cages are now widely used in the ACDF surgery. The PEEK is a semicrystalline polyaromatic linear polymer that has been used in variety of industries including medical devices. The PEEK cage is thought to be a safe biomaterial spacer for spine surgery with biocompatible, nonabsorbable, and corrosion-resistant abilities. Moreover, the modulus elasticity

of PEEK is similar to that of bone<sup>(2,12)</sup>. This distinguishing feature is thought to be able to prevent cage subsidence induced by metallic cages. The implantation of PEEK cage provides an adequate volume for bone refilling and immediate mechanical stability in ACDF. Also, PEEK cage is radiolucent and allowing the surgeon to better evaluates fusion status on radiographs or CT scans<sup>(11)</sup>.

Preliminary results of PEEK cage placement effects onto the bilateral neural foramina at the operated level reported previously by Sekerci et al<sup>(11)</sup>. The authors reported that, implantation of PEEK cage provides an increase in height and cross sectional area of the neural foramina at the operated level. Lied et al.<sup>(6)</sup>, compared implantation of a tricortical iliac crest graft or a PEEK cage for ACDF surgery and found similar clinical results in 258 patients. Because of lack of donor site morbidity, they have recommended the use of PEEK cage instead of tricortical iliac crest graft. Similarly, Chou et al.<sup>(3)</sup>, compared the efficacies and outcomes of anterior cervical fusion using titanium cages, PEEK cages and autogenous tricortical bone grafts. They reported that; anterior cervical fusion using PEEK cages yielded similar fusion rates to anterior cervical fusion using autogenous tricortical bone grafts, with fewer donor site complications.

Multislice computerized tomography (CT), also called as multidetector-row CT, multidetector CT or volume CT,

transforms transaxial images to a truly three-dimensional images. Multislice helical technology and the increasing speed of processing software have led to a wide variety of possible data manipulations. The performance of multislice CT is 20 times higher than that of a conventional spiral CT scanner. This can be used for shorter duration, longer scan ranges and thinner sections. These features make near-isotopic multiplaner imaging possible with a spatial resolution in any arbitrary plane that equals or often exceeds the resolution of magnetic resonance imaging especially in bone structure of spine<sup>(9)</sup>.

In this prospective study, our main aim was to determine the radiological changes in the cervical lordosis angle, intervertebral disc height, cross-sectional area and the height of the bilateral neural foramina of the operated and two adjacent segments following ACDF with PEEK cage implantation.

## **MATERIAL AND METHODS**

Twenty patients who underwent single-level anterior cervical microdiscectomy and interbody fusion with PEEK cage (Solis; Stryker instruments, Kalamazoo, MI) containing synthetic bone particulate (DBM; Grafton, Osteotech, Eatontown, NJ, USA) as bone substitute were analyzed in terms of radiological changes and clinical outcomes. The patients were 10 (50%) men and 10 (50%) women, with a mean age of 47.6 years (range: 33-70 years). In 13 patients (65%) the operated segment was C5-6 and in 7 patients (35%) was C6-7. The patient's demographic data are shown in Table-1.

Patients with multisegmental cervical stenosis, two or more level disc compressions, diffuse and severe osteoarthritis, previously treated disc disease, significant myelopathic findings, traumatic herniation and poor general health were disqualified from the study.

## ***Surgical Technique***

All patients underwent a standard cervical microdiscectomy via a right-sided anterolateral approach under general anesthesia. The anterior cervical discectomy and osteophyctectomy were performed under an operating microscope. After discectomy, in each case, the posterior longitudinal ligament was opened and a portion of the ligament was removed to provide good exposure of the dura and the origins of the affected nerve roots. This allowed the dura and nerve roots to be decompressed. While retraining slight distraction, the disc space was prepared for introduction of the cage. The endplate of the vertebral body was prepared by removing the cortical cartilaginous layers. The test cage should be closely fit and not to be introduced with force. The PEEK cage was then introduced, before this; the cage was filled with synthetic bone particulate. Before closing the wound in a standard fashion, a control intraoperative lateral fluoroscopic image was obtained to check the position of the implant. All patients wore a soft cervical collar for a period of 4 weeks postoperatively.

## ***Clinical Evaluation***

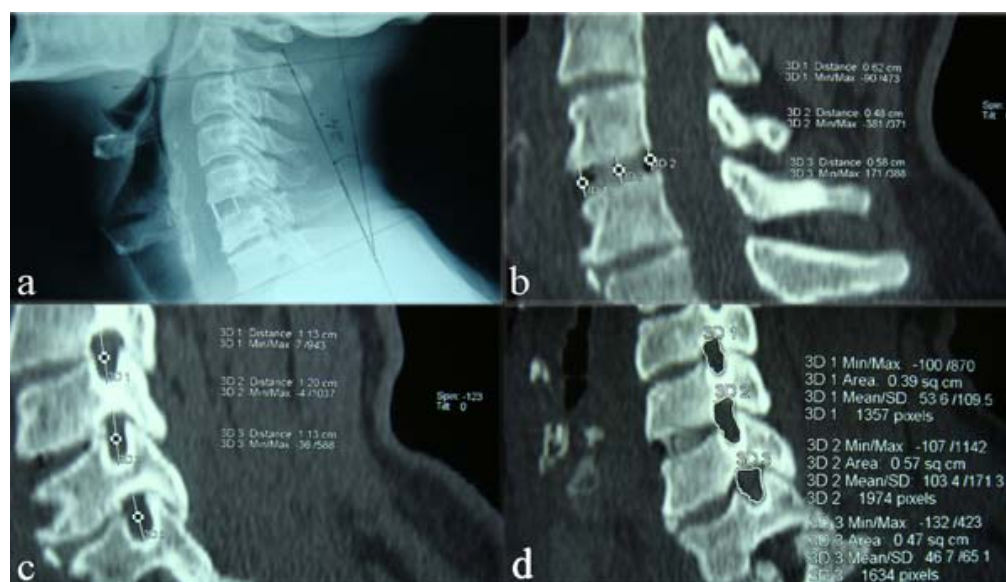
In each case, a physical therapy and rehabilitation specialist recorded the level of pain at baseline (immediately before surgery), at first postoperative day, and at 3 months postoperatively, using a visual analogue scale (VAS).

## ***Radiologic Evaluation***

Cobb's angle was used to evaluate lordosis of the cervical spine using lateral X-rays on neutral position at immediate preoperative period, at the first postoperative day, and at 3 months postoperatively. The Cobb's angle was measured between intersecting lines drawn perpendicular to the bottom of the C2 vertebra and the bottom of the C7 vertebra (four-line Cobb method) in lateral view (Figure-1a)<sup>(5)</sup>.

**Table-1.** Demographic characteristics of the patients.

Characteristic	Patients (n=20)
<b>Female</b>	10 (50%)
<b>Male</b>	10 (50%)
<b>Age (year)</b>	47,6 (33-70)
<b>Operated level</b>	
<b>C5-6</b>	13 (65%)
<b>C6-7</b>	7 (35%)



**Figure 1:** a. The measurement of the cervical lordosis angle with Cobb's method in the plain radiogram. b. The measurement of the disc height using multislice CT. c. The measurement of the foraminal heights using multislice CT. d. The measurement of the cross-sectional areas of the foramina using multislice CT.

Fusion was assessed by examining for trabecular continuity, bridging of bone across the disc space, and sclerosis at the vertebral end plates on both sides with CT at 3<sup>rd</sup> month. Also, the cage subsidence was assessed with CT at 3<sup>rd</sup> month.

Disc heights, bilateral foramen heights and cross-sectional areas were measured using computer software analysis (Somatom Volume Zoom; Siemens, Forchheim, Germany) of multislice computerized tomography images (Figure-1B, C, D).

Each patient's disc heights, bilateral foramen heights, and bilateral cross-sectional areas of the neural foramina at the affected level, and at the two adjacent levels (upper and lower) were recorded at 3 time points: preoperatively, at first postoperative day and at 3 months postoperatively.

#### **Statistical Analysis**

Statistical analysis was performed by using SPSS for windows, version 16.0 (SPSS Inc., Chicago, IL, USA). Results were

analyzed using Student's t-test, probability of values less than 0.05 being considered significant. Results were expressed as  $\pm$ SD.

## RESULTS

### *Clinical Outcome*

The mean pain VAS scores of patients preoperatively and at postoperative first day, and at postoperative 3 months were 7.5, 3.1, and 2.7 respectively. When we compared both VAS scores at the postoperative first day and at the postoperative 3 months with the VAS score at the preoperative period, the decrease in pain VAS values was statistically significant ( $p < 0.05$  for both comparisons).

### *Radiological Findings*

#### *1. Cervical Sagittal Alignment*

The mean sagittal curve angles of each patient was measured by Cobb's angle preoperatively and at postoperative first day, and at 3 months, and the results were 15.45 ( $\pm 8.57$ ), 24.15 ( $\pm 7.65$ ), and 25.80 ( $\pm 8.18$ ) degrees respectively. When we compared the Cobb's angles between the preoperative time and the first postoperative day, the increase of the lordosis angle was statistically significant ( $p < 0.05$ ). Similarly, when the comparison between the preoperative time and at the postoperative 3 months was made, the increase of the lordosis angle was statistically significant ( $p < 0.01$ ).

There was no cage subsidence observed at 3rd month postoperatively. Fusion rate at the 3rd postoperative month was 55% ( $n=11$ ).

## *2. Disc Heights*

### *2.1. Operated Segment*

The mean disc heights of operated segment measured preoperatively and at postoperative first day, and at 3 months were 2.37 ( $\pm 0.56$ ), 5.52 ( $\pm 0.73$ ), and 5.45 ( $\pm 0.72$ ) millimetres respectively. There was a statistically significant increase,

when the comparison was made on the measured disc height of the operated segment between the preoperative period and the postoperative first day ( $p < 0.01$ ). Similarly, when the comparison between the preoperative time and at the postoperative 3 months was made, the increase in the disc height of the operated segment was statistically significant ( $p < 0.01$ ).

### *2.2. Upper adjacent segment*

The mean disc height of the upper adjacent segment measured preoperatively and at postoperative first day, and at 3 months were 2.83 ( $\pm 0.45$ ), 2.72 ( $\pm 0.46$ ), and 2.74 ( $\pm 0.46$ ) millimetres respectively. There was no statistically significant change, when the comparison made on the measured disc height of the upper adjacent segment between the preoperative period and the postoperative first day ( $p = 0.524$ ). Similarly, when the comparison between the preoperative time and at the postoperative 3 months was made, the result was not statistically significant ( $p = 0.585$ ).

### *2.3. Lower adjacent segment*

The mean disc height of the lower adjacent segment measured preoperatively and at postoperative first day, and at 3 months were 3.09 ( $\pm 0.49$ ), 2.82 ( $\pm 0.51$ ), and 2.85 ( $\pm 0.52$ ) millimetres respectively. There was no statistically significant change, when the comparison made on the measured disc height of the lower adjacent segment between the preoperative period and the postoperative first day ( $p = 0.1$ ). Similarly, when the comparison between the preoperative time and at the postoperative 3 months was made, the result was not statistically significant ( $p = 0.14$ ).

## *3. Foramen Heights*

### *3.1. Operated segment*

The mean height of the right neural foramina of the operated segment measured preoperatively and at

postoperative first day, and at 3 months were 8.86 ( $\pm 1.09$ ), 9.70 ( $\pm 0.98$ ), and 9.69 ( $\pm 0.96$ ) millimetres respectively. There was a statistically significant increase, when the height of the right neural foramina of the operated segment compared between the preoperative period and the postoperative first day ( $p < 0.05$ ). Similarly, when the comparison between the preoperative time and at the postoperative 3 months was made, the increase in the height of the right neural foramina of the operated segment was statistically significant ( $p < 0.05$ ).

The mean height of the left neural foramina of the operated segment measured preoperatively and at postoperative first day, and at 3 months were 8.70 ( $\pm 1.06$ ), 10.11 ( $\pm 1.43$ ), and 10.08 ( $\pm 1.45$ ) millimetres respectively. There was a statistically significant increase, when the height of the left neural foramina of the operated segment compared between the preoperative period and the postoperative first day ( $p < 0.05$ ). Similarly, when the comparison between the preoperative time, and at the postoperative 3 months was made, the increase in the height of the left neural foramina of the operated segment was statistically significant ( $p < 0.05$ ).

### 3.2. Upper Adjacent Segment

The mean height of the right neural foramina of the upper adjacent segment measured at preoperatively and at postoperative first day and at 3 months were 9.04 ( $\pm 1.03$ ), 8.97 ( $\pm 0.98$ ), and 9.02 ( $\pm 1.01$ ) millimetres respectively. There was no statistically significant change when the height of the right neural foramina of the upper adjacent segment compared between the preoperative period and the postoperative first day ( $p = 0.827$ ). Similarly, when the comparison between the preoperative time and at the postoperative 3 months was made, the result was not statistically significant ( $p = 0.939$ ).

The mean height of the left neural foramina of the upper adjacent segment measured preoperatively and at postoperative first day, and at 3 months were 8.93 ( $\pm 1.04$ ), 8.92 ( $\pm 1.03$ ), and 8.92 ( $\pm 1.01$ ) millimetres respectively. There was no statistically significant change when the height of the left neural foramina of the upper adjacent segment compared between the preoperative period, and the postoperative first day ( $p = 0.976$ ). Similarly, when the comparison between the preoperative time, and at the postoperative 3 months was made, the result was not statistically significant ( $p = 0.976$ ).

### 3.3. Lower Adjacent Segment

The mean height of the right neural foramina of the lower adjacent segment measured preoperatively, and at postoperative first day, and at 3 months were 9.18 ( $\pm 0.90$ ), 9.15 ( $\pm 0.92$ ), and 9.14 ( $\pm 0.91$ ) millimetres respectively. There was no statistically significant change, when the height of the right neural foramina of the lower adjacent segment compared between the preoperative period, and the postoperative first day ( $p = 0.918$ ). Similarly, when the comparison between the preoperative time, and at the postoperative 3 months was made, the result was not statistically significant ( $p = 0.904$ ).

The mean height of the left neural foramina of the lower adjacent segment measured preoperatively, and at postoperative first day, and at 3 months were 9.26 ( $\pm 0.88$ ), 9.22 ( $\pm 0.9$ ), and 9.22 ( $\pm 0.9$ ) millimetres respectively. There was no statistically significant change, when the height of the left neural foramina of the lower adjacent segment compared between the preoperative period and the postoperative first day ( $p = 0.888$ ). Similarly, when the comparison between the preoperative time and at the postoperative 3 months was made, the result was not statistically significant ( $p = 0.902$ ).

#### 4. Cross-sectional Area of the Foramen

##### 4.1. Operated segment

The mean cross-sectional area of the right neural foramina of the operated segment measured preoperatively, and at postoperative first day, and at 3 months were 42.25 ( $\pm 7.35$ ), 50.15 ( $\pm 8.14$ ), and 49.95 ( $\pm 8.14$ ) square millimetres respectively. There was a statistically significant increase when the cross-sectional area of the right neural foramina of the operated segment compared between the preoperative period and the postoperative first day ( $p < 0.05$ ). Similarly, when the comparison between the preoperative time and at the postoperative 3 months was made, the increase in the cross-sectional area of the right neural foramina of the operated segment was statistically significant ( $p < 0.05$ ).

The mean cross-sectional area of the left neural foramina of the operated segment measured preoperatively, and at postoperative first day, and at 3 months were 41.8 ( $\pm 8.29$ ), 53.4 ( $\pm 9.17$ ), and 53.05 ( $\pm 9.13$ ) square millimetres respectively. There was a statistically significant increase, when the cross-sectional area of the left neural foramina of the operated segment compared between the preoperative period and the postoperative first day ( $p < 0.05$ ). Similarly, when the comparison between the preoperative time and at the postoperative 3 months was made, the increase in the cross-sectional area of the right neural foramina of the operated segment was statistically significant ( $p < 0.05$ ).

##### 4.2. Upper adjacent segment

The mean cross-sectional area of the right neural foramina of the upper adjacent segment measured preoperatively, and at postoperative first day, and at 3 months were 45.6 ( $\pm 8.4$ ), 44.6 ( $\pm 7.7$ ), and 45.3 ( $\pm 8.11$ ) square millimetres respectively. There was no statistically significant change, when the cross-sectional area of the right neural foramina of the upper

adjacent segment compared between the preoperative period and the postoperative first day ( $p = 0.697$ ). Similarly, when the comparison between the preoperative time and at the postoperative 3 months was made, the result was not statistically significant ( $p = 0.909$ ).

The mean cross-sectional area of the left neural foramina of the upper adjacent segment measured preoperatively, and at postoperative first day, and at 3 months were 44.55 ( $\pm 9.12$ ), 44.7 ( $\pm 9.32$ ), and 44.6 ( $\pm 8.94$ ) square millimetres respectively. There was no statistically significant change, when the cross-sectional area of the left neural foramina of the upper adjacent segment compared between the preoperative period and the postoperative first day ( $p = 0.959$ ). Similarly, when the comparison between the preoperative time and at the postoperative 3 months was made, the result was not statistically significant ( $p = 0.986$ ).

##### 4.3. Lower adjacent segment

The mean cross-sectional area of the right neural foramina of the lower adjacent segment measured preoperatively, and at postoperative first day, and at 3 months were 47.55 ( $\pm 6.6$ ), 47.05 ( $\pm 6.32$ ), and 46.95 ( $\pm 6.01$ ) square millimetres respectively. There was no statistically significant change, when the cross-sectional area of the right neural foramina of the lower adjacent segment compared between the preoperative period and the postoperative first day ( $p = 0.808$ ). Similarly, when the comparison between the preoperative time and at the postoperative 3 months was made, the result was not statistically significant ( $p = 0.766$ ).

The mean cross-sectional area of the left neural foramina of the lower adjacent segment measured at preoperatively, and at postoperative first day, and at 3 months were 47.6 ( $\pm 6.03$ ), 46.95 ( $\pm 6.28$ ), and 47.05 ( $\pm 6.2$ ) square millimetres respectively. There was no statistically significant change, when the cross-

sectional area of the left neural foramina of the lower adjacent segment compared between the preoperative period and the postoperative first day (p=0.741). Similarly, when the comparison between the preoperative time and the at the

postoperative 3 months was made, the result was not statistically significant (p=0.778).

All measured data were summarized in Table-2.

**Table-2.** Measurements of 20 patients preoperatively, 1 day postoperatively and 3 months postoperatively

	Preop	Postop 1st Day	Postop 3rd Month
Ischiara Lordosis Angle	15.45 (±8.57)	24.15 (±7.65)	25.80 (±8.18)
Disc Heights (mm)			
Operated Segment	2.37 (±0.56)	5.52 (±0.73)	5.45 (±0.72)
Upper Adjacent Segment	2.83 (±0.45)	2.72 (±0.46)	2.74 (±0.46)
Lower Adjacent Segment	3.09 (±0.49)	2.82 (±0.51)	2.85 (±0.52)
Foramen Heights (mm)			
Operated Segment			
Right	8.86 (±1.09)	9.70 (±0.98)	9.69 (±0.96)
Left	8.70 (±1.06)	10.11 (±1.43)	10.08 (±1.45)
Upper Adjacent Segment			
Right	9.04 (±1.03)	8.97 (±0.98)	9.02 (±1.01)
Left	8.93 (±1.04)	8.92 (±1.03)	8.92 (±1.01)
Lower Adjacent Segment			
Right	9.18 (±0.90)	9.15 (±0.92)	9.14 (±0.91)
Left	9.26 (±0.88)	9.22 (±0.90)	9.22 (±0.90)
Foramen Areas (mm <sup>2</sup> )			
Operated Segment			
Right	42.25 (±7.35)	50.15 (±8.14)	49.95 (±8.14)
Left	41.8 (±8.29)	53.4 (±9.17)	53.05 (±9.13)
Upper Adjacent Segment			
Right	45.60 (±8.40)	44.60 (±7.70)	45.3 (±8.11)
Left	44.55 (±9.12)	44.70 (±9.32)	44.6 (±8.94)
Lower Adjacent Segment			
Right	47.55 (±6.60)	47.05 (±6.32)	46.95 (±6.01)
Left	47.6 (±6.03)	46.95 (±6.28)	47.05 (±6.20)



## DISCUSSION

Cloward, Smith and Robinson first described anterior discectomy combined with bone graft placement in cervical disc disease<sup>(4,10)</sup>. There is no doubt that anterior discectomy with interbody fusion removes the source of compression and immediately relieves pain by restoring neural foraminal height. The segmental distraction eliminates abnormal stimuli coming from stretch receptors in the muscles, joint capsules and skeletal structures of the cervical spine, which produce an increase in muscle tone involving adjacent segments. The removal of this stimulation decreases the muscle tone and re-establishes the cervical lordosis<sup>(8)</sup>.

During the last several years, the harvesting of autograft has gradually decreased, mainly because of the high rate of graft site related side effects such as pain, hematoma, scarring, infection and visible iliac crest defect. Implantation of interbody fusion cages for this situation was introduced in the 1980s. Using a cage instead of bone graft after discectomy has offered advantages including the absence of complications at the donor site, easier implantation technique and good immediate and long-term stabilization. Additionally, ACDF using an intervertebral cage is credited with promoting instant stability, restoration of the neural foraminal height and interbody fusion by providing an environment for bone growth.

It is well known that PEEK cages are biologically inert, have high versatility and possess outstanding mechanical properties, including a high degree of strength in all directional planes and impact and fatigue resistance. They do not induce corrosive reaction in contiguous vertebral bodies and excellent results have been shown with regard to pulling out and compression<sup>(2)</sup>. The PEEK cages seem to possess adequate radiographic properties for evaluation with

magnetic resonance imaging and CT scanning.

PEEK is a semicrystalline polyaromatic linear polymer that provides a good combination of strength, stiffness, toughness and environmental resistance. The elastic modulus of the PEEK cage is close to that of bone, which helps to decrease stress shielding and increase bony fusion<sup>(12)</sup>. It is also more elastic than titanium in reducing the possibility of graft subsidence into the vertebral body. PEEK cages have retention teeth on the surfaces of the upper and lower frames to reduce cage dislodgement to offer a fixation mechanism, similar to the function of a plate and screw<sup>(3)</sup>. The PEEK cages also have surface pins on the upper and lower frames, which may enhance its anchoring to the endplate and reducing the possibility of graft dislodgement. The endplate must not be scraped too much to avoid degrading the cortical strength of the vertebral body<sup>(11)</sup>. In our patients, neither pseudoarthrosis nor cage migration was encountered; nor did the surface pins provide immediate, solid fixation between the cage and the adjacent vertebral bodies.

The maintenance of post-operative lordosis has been shown to be a key factor in decreasing adjacent level disc stress. Previous studies of the PEEK cage have used intervertebral bony fusion as the primary measure of surgical success; however, little is known about its effects on spinal curvature. Recently, Wilkinson et al.<sup>(13)</sup>, demonstrated that the PEEK cage is comparable to the anterior cervical plate in the maintenance of post-operative cervical lordosis.

In the present study, it is demonstrated that the cervical lordosis angle increased statistically significantly following ACDF surgery even at the first day and at the third month postoperatively. As a result of this, we concluded that PEEK cage implantation had affirmative effects on protecting cervical axis.

Our results showed that, implantation of PEEK cage at the operated level provided statistically significant increase in the intervertebral disc height, bilateral neural foramen heights and in the cross sectional area of bilateral neural foramina at first postoperative day and at postoperative 3 months. We resulted that; implantation of PEEK cage had obvious positive effects at the operated segment. On the other hand, the measurements of the adjacent segments showed no statistically significant change between preoperative and postoperative values. So, our study demonstrated that implantation of PEEK cage did not affect both the upper and lower adjacent segments.

Restoring of cervical lordosis angle, disc height, bilateral neural foramen heights and cross-sectional area of bilateral neural foramina were achieved at the very early postoperative period and even at the early post-fusion period. However, there was no negative effect on the disc heights and the neural foramina of the adjacent segments. Finally, further studies with larger groups and longer follow-up are needed.

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