PRELIMINARY EXPERIENCE USING A POLYETHERETHERKETONE (PEEK) CAGE IN THE TREATMENT OF CERVICAL DISC DISEASE

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OBJECTIVE: We investigated the effectiveness of a new material, polyetheretherketone (PEEK), in a spinal cage used in performing cervical spinal fusion for the correction of cervical kyphosis.

METHODS: A total of 80 patients with various cervical diseases were divided into two groups. Patients in Group A (40 patients) underwent microdiscectomy and PEEK cage fusion, and patients in Group B (40 patients) were treated with microdisectomy and autogenous iliac crest graft (AICG) fusion. We evaluated the patients for cervical lordosis, the height of the foramina, the cross sectional area of the foramina, and fusion status on the basis of x-rays. The patients' neurological and functional outcomes were assessed on the basis of the Prolo scale. Magnetic resonance imaging was also performed for spinal cord evaluation.

RESULTS: The use of the PEEK cage in patients who undergo spinal fusion may increase cervical lordosis (mean, 2.33 ± 3.00 mm; $P = 0.03$), whereas AICG fusion may not (mean, −0.84 ± 6.69 mm; $P = 0.49$). The use of the PEEK cage was found to increase the height of the foramina (mean, 2.54 ± 1.40 mm; $P = 0.00$) and increase its cross sectional area (mean, 40.36 ± 23.53 mm^2; $P = 0.00$). The height of the foramina increased only in the PEEK group postoperatively. The cross sectional area of the foramina increased in both groups postoperatively. The complication rate in patients who underwent fusion procedures with the PEEK cage was less than that in patients who underwent fusion with AICG fusion (2.50 versus 17.50%; $P = 0.03$). Both groups had a satisfactory fusion rate (100 versus 93.1%). The patients' postoperative Prolo scale scores were statistically better in the PEEK group (8.50 ± 1.49 versus 7.17 ± 2.13; $P = 0.00$), and more patients in the PEEK group than in the AICG group achieved excellent outcomes (66.63 versus 28.57%; $P = 0.00$). Because PEEK is radiotransparent on x-rays and few artifacts are seen on magnetic resonance imaging scans, it is better suited than autogenous iliac crest donor material for postoperative radiographic evaluation.

CONCLUSION: The PEEK cage provides solid fusion, increased cervical lordosis, and increased height and cross sectional area of the foramina. There are few complications associated with the use of this cage, and the functional and neurological outcomes are satisfactory. It also facilitates postoperative x-ray and magnetic resonance imaging evaluation. The PEEK cage is therefore a good substitute for AICG fusion in patients with cervical disc disease.

KEY WORDS: Autogenous iliac crest graft, Cage, Cervical disc disease, Interbody fusion, Microdisectomy, Polyetheretherketone

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The use of spinal cages for spinal fusion in patients with cervical disc disease is popular not only because cages aid in increasing cervical foramina height (2) but also because they help correct cervical kyphosis (9, 19). Although some authors have supported performing a discectomy without grafting because it achieves good results in 85 to 92% of cases (18, 23), it is known that patients with postoperative kyphosis experience more frequent cervical pain in nongrafted cases (32). The cage has been shown to reduce the complication rate by 22% in comparison with autogenous iliac crest

graft (AICG) fusion (6). Many new interbody fusion cages have been developed, but clinical studies of this fusion procedure are still scarce (4, 7, 10, 24, 26, 31). To date, no perfect cage has been produced. Subsidence (5, 12), migration (16), and structural failure of the cage (27) have occurred. With the use of a titanium cage, vertebral body collapse may occur if the endplate is degraded too much. In addition, radiological metallic artifacts may complicate follow-up evaluation with the use of magnetic resonance imaging (MRI) and computed tomographic scanning of bony fusion. Furthermore, radiotransparent carbon fiber cages have been used widely, but synovitis and the lymphatic spread of fiber debris may be found after intra-articular procedures (21). A new radiotransparent polyetheretherketone (PEEK) cage (Solis; Stryker Instruments, Kalamazoo, MI) is commercially available, but, to our knowledge, clinically reliable reports of the PEEK cage are rare in the literature. In this study, we describe our preliminary experience with the use of anterior cervical microdiscectomy and interbody PEEK cage fusion to treat patients with cervical disc disease.

PATIENTS AND METHODS

This prospective study was conducted in our department of neurosurgery from January 2001 to May 2002. We analyzed the clinical outcomes of patients who underwent treatment with interbody PEEK cage (Group A, 40 patients) and patients who were treated with AICG fusion (Group B, 40 patients). In Group A, we enrolled 22 men and 18 women (age range, 25–78 yr; mean age, 53.6 yr); in Group B, we enrolled 28 men and 12 women (age range, 18–72 yr; mean age, 44.8 yr). The demographic data and levels of discectomy are shown in *Table 1*.

TABLE 1. Demographic data of cervical disc diseases

Characteristic	Group A (n = 40)	Group B (n = 40)
Men/women	24/16	28/12
Radiculopathy	18	18
Myelopathy	12	10
Myeloradioculopathy	10	12
One level	22	20
Two levels	10	12
Three levels	8	8
C2–C3	1	0
C3–C4	9	8
C4–C5	18	18
C5–C6	26	24
C6–C7	12	8

Clinical cervical disc disease is defined as intractable radiculopathy or myelopathy or a combination of the two due to nerve root or spinal cord compression. The operative procedure was performed with the use of the method described by Smith and Robinson (25). Under the microscope, the protruded disc or spur compressing the roots or cord was totally resected with the use of a high-speed burr, a Cavitron ultrasonic surgical aspirator (CUSA; Valleylab, Boulder, CO), or curettes. The PEEK cage is a hollow frame with retentive teeth on the top and bottom, which improve the fixation of the cage to the bone. The two associated titanium pins are placed vertically in the medial plane and inserted 1 mm into adjacent vertebral bodies. The hollow PEEK cage was impacted with autogenous bone graft harvested from the right iliac crest, as shown in *Figure 1*. We then drilled out the bony marrow from the iliac crest with a T-shaped driver. The bone marrow tissue was harvested from the cortex of the iliac crest to 1.5 to 2 cm in depth by twisting the inner tube of the T-shaped driver. Usually, each harvesting procedure offers sufficient bone marrow to fill a cage cavity. By harvesting along the iliac crest, the surgeon is able to accumulate sufficient bone marrow for at least three cages. The skin wound of the harvest site over the iliac crest in the PEEK group was as small as 1 cm in length. In Group B, the skin wound size was usually approximately 3 to 5 cm, and the graft was obtained with the use of chisels, although in later procedures we used an oscillating saw to prevent microfracture. The endplate of the vertebral body was prepared by removing the cortical cartilaginous layers. After achieving distraction with the use of Caspar screws, the cage or autogenous tricortical iliac graft was impacted into the disc space for fusion.

We followed the patients 6 months postoperatively with x-ray examinations to assess the fusion rate, the spinal curve and height, and the cross sectional area of the foramina in each fusion level. The last operation was performed in November 2001. Patients were also followed up with MRI for evaluation of either spinal cord or root compression. A straight line from the posterior border of the dens to the posterior border of C7 was drawn. Another line was drawn from the posterior border of C4 perpendicular to the first line, whose intersected length was measured in millimeters as the degree of spinal curvature (19). A positive intersected length indicates the degree of lordosis. If the intersected length is negative, it indicates kyphosis. When the intersected length is zero, the spinal curve is referred to as *straight*. The cross sectional area of the foramina was measured on an x-ray oriented in the oblique (45-

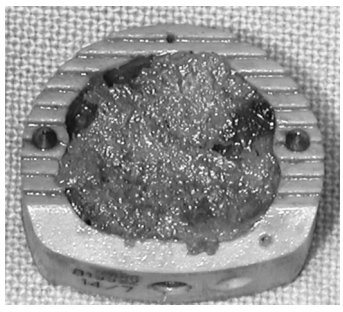

FIGURE 1. *Photograph of a PEEK cage with halo frame and titanium spurs impacted with iliac bone marrow.*

degree) direction and calculated with the use of a computer digitizer. Patients' function and working ability were measured according to the Prolo scale (8, 22). The Prolo scale is suitable for evaluating the outcomes of patients with regard to radiculopathy, myelopathy, or a combination of the two. Prolo scale scores ranged from 10 (perfect) to 2 (incapacitated), and the clinical outcomes were excellent (9–10), good (7–8), fair (5–6), and poor (2–4). The follow-up period ranged from 6 to 16 months (mean, 10 mo).

RESULTS

In Group A, the total discectomies performed with cages comprised 66 levels. According to Student's *t* test, mean preoperative cervical lordosis was 3.75 ± 4.54 mm, and mean postoperative cervical lordosis was 6.19 ± 5.53 mm. The mean increase in lordosis was 2.33 ± 3.00 mm ($P = 0.04$). The mean preoperative height of the cervical foramina was 8.78 ± 1.83 mm, and the mean postoperative height of cervical foramina was 11.66 ± 1.77 mm. The mean increase in the height of the foramina was 2.54 ± 1.40 mm ($P = 0.00$). The mean preoperative cross sectional area of the foramina was 46.25 ± 25.91 mm^2, and the mean postoperative cross sectional area of the foramina was 85.00 ± 30.45 mm^2. The mean increase in the cross sectional area of the foramina was 40.36 ± 23.53 mm^2 ($P = 0.000$, Student's *t* test). The mean postoperative Prolo scale score was 8.50 ± 1.49. Excellent outcomes were reported for 66.7% of patients, and good outcomes were recorded for 25% of patients. The mean hospital stay was 6.35 days. The fusion rate was 100%. The complication rate was 2.5% (1 of 40 patients), which included 1 patient with postoperative pharyngitis. There were no patients with cage failure, dislodgement, or pseudoarthrosis. An imaging study of a patient with postoperatively increased foramina height and an increased cross sectional area of the foramina is shown in *Figure 2*. In one patient with three-level disc disease who was treated with cage fusion, the postoperative artifacts were minimal, and increased lordosis with evident solid bone fusion was noted at the 1-year follow-up examination (*Fig. 3*).

In Group B, the total discectomies performed with AICG fusion comprised 58 levels. The mean preoperative cervical lordosis was 5.88 ± 5.85 mm, and the mean postoperative cervical lordosis was 4.78 ± 6.69 mm. The mean altered lordosis was −0.84 ± 6.69 mm ($P = 0.49$, Student's *t* test). The mean preoperative height of the cervical foramina was 10.09 ± 2.17 mm, and the mean postoperative height of the cervical foramina was 10.93 ± 2.61 mm. There were no statistically significant differences in the increase in foramina height postoperatively in Group B ($P = 0.16$, Student's *t* test). The mean preoperative cross sectional area of the foramina was 39.40 ± 14.20 mm^2, and the mean postoperative cross sectional area of the foramina was 68.68 ± 26.49 mm^2. The mean increase in the cross sectional area of the foramina was 26.68 ± 30.40 mm^2 ($P = 0.00$, Student's *t* test). The mean postoperative Prolo scale score was 7.17 ± 2.13. Excellent results were reported in 29% of patients, and 29% of patients demonstrated good outcomes.

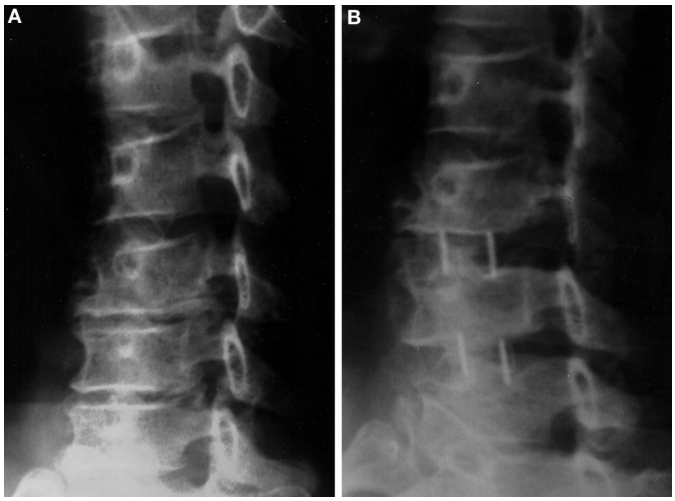

FIGURE 2. *Imaging studies of a patient with C5–C6 and C6–C7 radiculopathy.* A, *the preoperative height of the C5–C6 foramen was 9 mm, and the cross sectional area of the C5–C6 foramen was 27 mm^2. The preoperative height of the C6–C7 foramen was 11 mm, and the cross sectional area of the C6–C7 foramen was 33 mm^2.* B, *the postoperative height of the C5–C6 foramen was 15 mm, and the cross sectional area of the C5–C6 foramen was 90 mm^2. The postoperative height of the C6–C7 foramen was 14 mm, and the cross sectional area of the C6–C7 foramen was 84 mm^2.*

The mean hospital stay was 7.82 ± 4.99 days. The fusion rate was 93.10% (54 of 58 levels). The complication rate was 17.50% (7 of 40 patients), including 4 patients with graft collapse, 2 patients with graft dislodgement, and 1 patient with donor site hematoma. The imaging study of one patient with graft collapse and kyphotic spine is shown in *Figure 4*.

We compare the results of Groups A and B in *Table 2* and *3*. Group A had a statistically significant increase in cervical lordosis as compared with Group B ($P = 0.01$). Only Group A showed a significant increase in the height of the foramina postoperatively. Both groups demonstrated an increase in the cross sectional area of the foramina. However, there were no statistically significant differences in the increase of the cross sectional area in either group ($P = 0.08$). Both groups had a good fusion rate, but the complication rate in Group A was significantly less than that in Group B ($P = 0.03$). The mean postoperative Prolo scale score in Group A was also significantly better than that in Group B ($P = 0.00$). More patients in Group A than in Group B had excellent outcomes ($P = 0.00$). The groups were not statistically different with regard to mean hospital stay.

DISCUSSION

Physical and Physiological Characteristics of the PEEK Cage

PEEK is a semicrystalline polyaromatic linear polymer that provides a good combination of strength, stiffness, toughness, and environmental resistance. As described in Wolff's law (28), bone grows in response to applied stress and is resorbed

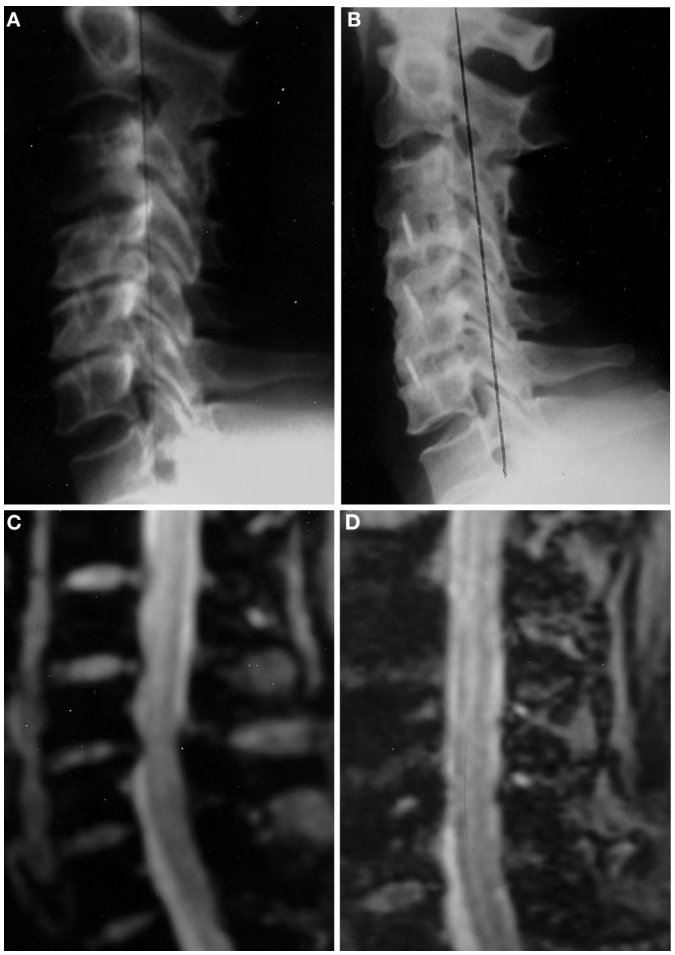

FIGURE 3. *Imaging studies of a patient with three-level cervical disc disease who underwent microdisectomy and PEEK fusion.* A, *the preoperative x-ray showed kyphosis (−1 mm).* B, *the postoperative x-ray showed lordosis (4 mm) and good bone fusion at the 1-year follow-up examination.* C, *the preoperative sagittal view MRI scan showed multiple compressions at C4–C5, C5–C6, and C6–C7.* D, *the postoperative sagittal view MRI study obtained at 1-year follow-up showed that most compression was relieved. The artifacts from the cage were minimal.*

if a mechanical stimulus is lacking. The elastic modulus of the PEEK cage is close to that of bone (approximately 17 GPa) (29), which helps to decrease stress shielding and increase bony fusion. The PEEK cage has been found to have a deleterious influence on cell attachment and growth (1). In one animal study, osteocalcin production, alkaline phosphatase activity, and the proliferation of fibroblasts were enhanced after the insertion of a PEEK cage (13). The cage was shown to exhibit a stimulatory effect on the protein content of osteoblasts (17). The in vitro and in vivo implantation of PEEK into rat and rabbit muscles has shown no biocompatibility problems (11, 29, 30). Halo cages that enable bone to be added have made intersomatic fusion possible. Fusion occurs approximately 3 to 6 months after surgery. The cage generally demonstrates excellent resistance to crushing (4170 N under static conditions

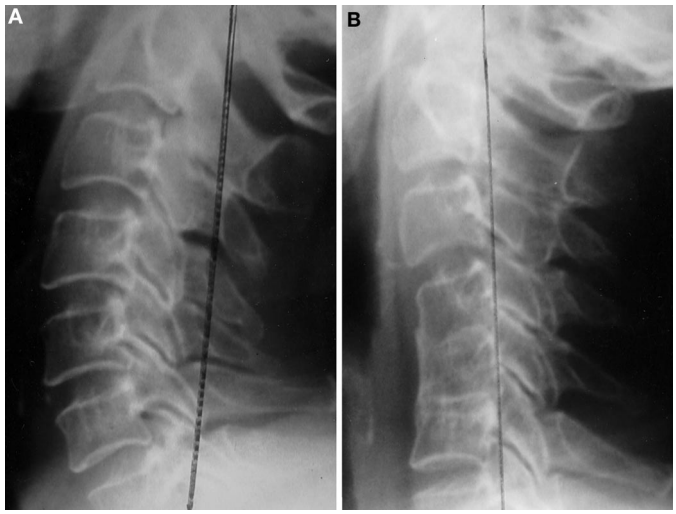

FIGURE 4. *Imaging studies of a patient with C5–C6 radiculopathy who underwent microdisectomy and autogenous right iliac bone graft.* A, *the preoperative spinal curve was lordotic.* B, *the postoperative curve was kyphotic due to collapse of the bone graft.*

and 5 million cycles at 2160 N). These values are much higher than the force applied to the cervical spine (20). The cage provides good, solid fusion to maintain spinal stability and correct cervical lordosis (19). The PEEK cage has a hard frame that resists spinal loading and maintains spinal alignment when the bone graft in the cage cavity is remolded. The resistance of the PEEK cage is close to the vertebral body. The PEEK cage is also more elastic than titanium, reducing the possibility of graft subsidence into the vertebral body. Furthermore, the surface pins of the PEEK cage may enhance its anchoring to the endplate, reducing the possibility of graft dislodgement. The endplate must not be scraped too much to avoid degrading the cortical strength of the vertebral body.

How the PEEK Cage Creates Foramina Height

Murphy et al. (18) reported that bone grafts distract the disc space, thereby increasing the size of the intervertebral foramina and preventing postoperative settling. Segmental distraction may eliminate abnormal stimuli coming from stretch receptors in the muscles, the joint capsules, and the skeletal structure of the cervical spine. Because of the wedge-shaped design of the PEEK cage, stimulation is minimized, the diameter of the spinal canal is increased, and lordosis is created. We used a PEEK cage with a thickness of 6 or 7 mm, which is larger than the degenerative disc space, to increase the postoperative foramina height. However, a 5-mm-thick cage was used if the height of the disc space was found to be narrowing. We used cages of two different widths (12 and 14 mm). A 14-mm-width cage was preferred because it increased the contact area of fusion. Bartels et al. (2) suggested that carbon fiber cages might effectively increase the height of the cervical foramina by approximately 1.3 mm after 1 year of follow-up. In our study, however, the mean increase in foramina height

TABLE 2. Functional outcome, hospital stay, and radiological data in both groups[a]

Parameter	Group A (n = 40)			Group B (n = 40)			*P* value[b]
	Mean		SD	Mean		SD	
Prolo scale score	8.50		1.49	7.17		2.13	0.00
Hospital stay (d)	6.35		3.77	7.82		4.99	0.48
Lordosis (in mm)							
Preoperative	3.75	$P = 0.03$	4.54	5.88	$P = 0.49$	5.85	0.12
Postoperative	6.19		5.53	4.78		6.69	0.28
Difference in lordosis	2.33		3.00	−0.84		6.36	0.01
Height of foramina (in mm)							
Preoperative	8.78	$P = 0.00$	1.83	10.09	$P = 0.16$	2.17	0.27
Postoperative	11.66		1.77	10.93		2.16	0.02
Difference in height	2.54		1.40	0.91		2.30	0.00
Cross sectional area of foramina (in mm^2)							
Preoperative	46.25	$P = 0.00$	25.91	39.40	$P = 0.00$	14.20	0.16
Postoperative	85.00		30.45	68.68		26.49	0.01
Difference in cross area	40.36		23.53	28.68		30.40	0.08

[a] SD, standard deviation.
[b] Student's *t* test.

TABLE 3. Fusion, complication, and excellent outcome rates in both groups

Parameter	Group A		Group B		*P* value
	No. of patients/total	%	No. of patients/total	%	
Fusion rate	66/66	100	54/58	93.10	0.18[a]
Complication rate	1/40	2.5	7/40	17.50	0.03[b]
Excellent outcome rate	20/30	66.67	10/35	28.57	0.000[b]

[a] χ^2 test.
[b] Fisher's exact test.

with the PEEK cage was approximately 2.54 mm. The difference may be due to distraction and the size of the cage.

Benefits of the PEEK Cage in Increasing Foramina Height, Foramina Cross Sectional Area, and Lordotic Curve

Murphy et al.'s study (18) showed that foramina height was not different in clinical presentation among patients who underwent graft (AICG) or nongraft fusion procedures. The number of cases that Murphy et al. studied was small (Group A, 7 cases; Group B, 12 cases), and they did not mention graft complications (e.g., collapse, kyphosis), which may have resulted in a negative influence on the clinical presentation in their AICG group. Bartels et al. (2) reported that the cervical cage effectively increased foramina height even after 1 year postoperatively, which contributed to the decompression of the nerve root. In the patients in our study who underwent AICG fusion, the height of the foramina may be reduced when the graft is resorbed. Cervical lordosis in a healthy person is 11.8 ± 5 mm (range, 6–16 mm) (3). In our PEEK cage group, mean lordosis was 6.19 ± 5.53 mm. The postoperative cross sectional area of the foramina in the PEEK cage group was larger than that in the AICG group, which may be due to the larger mean postoperative height of the foramina in the PEEK cage group (11.66 versus 10.93 mm). When the cross sectional area of the foramina is increased, nerve root compression is reduced. In the AICG group in our study, mean postoperative cervical lordosis did not increase; in fact, kyphotic deformity occurred. The same finding was noted in Savolainen et al.'s study (23). In their study, 40% of the patients who underwent fusion with AICG with or without plates had postoperative kyphosis.

High Fusion Rate and Lower Graft Complication Rate in the PEEK Cage Group

The fusion rates in the PEEK and AICG groups were satisfactory. Brown et al. (5) reviewed serial x-rays after anterior cervical fusion was performed in an aggregate total of 139 levels in 98 patients and found arthodesis in 97% of patients who underwent autograft procedures. Savolainen et al. (23) found a 98% fusion rate in patients who underwent procedures with autograft but reported donor site complications in 16% of the patients. Majd et al. (14) reviewed anterior cervical reconstruction with the use of titanium cages and anterior plates and reported that radiographic evidence of fusion in 97% of the patients and that 83% of patients did not experience any complications (i.e., neither cage dislodgement nor hardware failure). In our study, graft collapse and dislodgement were prevented in the PEEK group because the grafted bone marrow was protected in the cage cavity.

Donor Site Complication Rate Was Minimized in the PEEK Cage Group

Matge (15) reviewed patients who had undergone AICG fusion procedures and found that there were many graft-related complications, including migration (2.1–4.6%), kyphosis (3–10%), pseudoarthrosis (1–3%), and donor site hematoma, pain, or infection (10–18%). Castro et al. (6) reported a donor site complication rate of 22% in their series. In our study, the wound incision at the donor site in the PEEK cage group was small. The harvest of bone marrow through a small, T-shaped bone graft harvesting set was simple and produced less trauma than other methods, therefore minimizing donor site complications in our PEEK cage group. In our study, no pseudoarthrosis or cage migration was encountered, even in patients who underwent fusion at more than two levels. The upper and bottom titanium pins anchoring the vertebral body provide immediate, solid fixation between the cage and the adjacent vertebral bodies.

Radiotransparency of the PEEK Cage

Bone fusion can be evaluated easily by examining x-rays, because the PEEK cage is radiotransparent. Two small titanium pin markers are sufficient to identify the cage position during the postoperative x-ray follow-up examination. It is also possible to evaluate the patient's postoperative cord and root condition on the basis of MRI or computed tomographic scans.

Comparison of Hospital Stay

Castro et al. (6) reported that hospital stay and operative time were significantly reduced with the use of the two-level cage. In our study, there was no difference between the groups in terms of hospital stay. In Taiwan, 90% of the cost of hospital stays is paid by government health insurance, and the hospital fee was as low as one-fifth of that in the United States. Patients in Taiwan have less economic pressure with regard to hospital charges; therefore, the hospital stay was longer in both groups than they would be in the United States.

CONCLUSIONS

In our study, the surgical outcomes in the AICG group were inferior to those in the PEEK cage group. The postoperative change of lordosis, the change in the height of the foramina, and the occurrence of graft failure were the three major factors that differed between the two groups. Based on the degree of spinal decompression, the correction of spinal curvatures, and the relatively few complications encountered in patients in the PEEK cage group, the postoperative functional and neurological outcomes (according to Prolo scale scores) in that group were determined to be satisfactory. Therefore, we conclude that the use of the PEEK cage is a good substitute for fusion in patients with cervical disc disease, because it creates lordosis, provides more space for cord and root decompression, facilitates radiological follow-up, causes few complications, and leads to satisfactory outcomes.

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COMMENTS

Cho et al. present a timely and thoughtful article on the use of an aromatic polymer as an anterior cervical spine disc spacer. This particular family of aromatic (benzene ring) polymers is polyetheralylketone, a nonresorbable, "bioinert" material that closely mimics the tensile properties of bone. The most common polymer from this family that is used in clinical medicine is polyetheretherketone (PEEK). Although these are very similar in terms of their material properties and biocompatibilities, there are some slight differences in flexural modulus and fatigue strength. PEEK applications have included hip stems, in which they have a relatively good clinical record. To my knowledge, this article is one of the first reports of the use of polymers in interbody spinal applications. To date, these polymers have exhibited minimal inflammatory properties and do not seem to affect fusion in a positive or negative manner. They are radiolucent, thus allowing the surgeon to better assess fusion on plain radiographs, magnetic resonance imaging scans, and computed tomographic scans because artifacts appear to be negligible.

In spinal surgery, this material seems well suited for use in interbody implants with autograft bone packed both intra- and extracompartmentally. An important realization is that these polymers are neither osteoconductive nor osteoinductive. It should be noted that in the hip stems, a porous titanium mesh was incorporated to enhance bony ingrowth. Thus, any polymer intervertebral body implant should be used only in conjunction with bone graft. Although autograft is superior from a biological perspective, it is possible that allograft may be successful. Further studies are necessary to determine arthrodesis rates. It is certainly feasible that aromatic polymers might be an ideal structural substrate to use with bone morphogenetic proteins, although this work is preliminary. To date, my colleagues and I have performed six anterior cervical fusions with a slightly different PEEK spacer. We have used autograft bone (iliac crest or local vertebral body bone) and an anterior hybrid cervical plate. The follow-up period in our patients thus far is 4 months, and all patients seem to be experiencing solid arthrodesis. Bone has been placed both intracompartmentally (inside the spacer) and extracompartmentally (outside the spacer).

This article makes some excellent points but some clarification is needed. The authors focus on lordosis, foraminal height, and so forth. These issues are secondary to carpentry, not the material. There are multiple reasons for loss of lordosis, subsidence, and diminution in foraminal height. Among these are inappropriate distraction (either over- or underdistraction), mismatch of donor bone (or PEEK spacer) with the patient's vertebral body density, excessive removal of densely woven bone endplate, placement of a small intervertebral body spacer in the middle of the endplate (thus not contacting the stronger ring apophysis at the periphery of the endplate), and inadequate external bracing or internal plate fixation. Although the authors clearly make the points that PEEK is strong enough to withstand cervical axial loads and that the material is unlikely to fail, multiple considerations must be kept in mind when considering restoration of sagittal balance and maintenance of foraminal height. It seems that, on the basis of this preliminary study, PEEK may be a good alternative to allograft or autograft as a structural spacer. I recommend the use of cancellous autograft supplementation until future studies are completed.

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Cho et al. present their experience with using the PEEK cage for the treatment of patients with cervical disc disease. They compared a group of patients who underwent autogenous iliac crest graft interbody fusion with a group

treated with the PEEK cage with autogenous crest graft. The PEEK cage group had fewer complications, and spinal deformity was seen less frequently in the PEEK group than in the autogenous iliac crest graft group postoperatively. This finding emphasizes the need for structural support in the interbody region (i.e., the disc interspace). The cortical bone of an autograft in some cases may not provide this support adequately. That the PEEK material is absorbed with time is potentially an additional advantage of this surgical adjunct. The surgical results presented by Cho et al. are encouraging and provide an impetus to use interbody absorbable materials such as the PEEK cage instead of a ventral cervical plate for structural support. Further studies are most certainly needed.

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The authors describe two groups of patients with cervical disc disease. Group A comprised 40 patients who underwent microdiscectomy and PEEK cage fusion. Group B comprised 40 patients who were treated with microdiscectomy and autogenous iliac crest fusion. The authors conclude that the use of the PEEK cage was superior to autogenous iliac crest fusion with respect to postoperative lordosis, the change in the height of the foramina, and the recurrence of graft failure. The postoperative Prolo scale scores also were better in the PEEK group, although the length of hospitalization was the same in both groups. The follow-up period (range, 6–16 mo; mean, 10 mo) is short but acceptable. This particular material (PEEK) seems to be a reasonable alternative to other substitutes, and in the authors' experience, it seems to have been quite advantageous for the patients. It will be interesting to learn the long-term effects of these substitutes in terms of pseudarthrosis and rejection rates. Nevertheless, this preliminary report indicates that this particular substitute seems to work very well.

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Cho et al. describe the novel use of the PEEK cage as a method of anterior cervical arthrodesis. In this series, patients with various degenerative diseases underwent decompression with the use of the Smith-Robinson technique followed by interbody fusion with either the PEEK cage or autologous tricortical iliac crest. Patients were evaluated regarding disc interspace dimensions, fusion status, and clinical outcome. Patients who received the PEEK cage demonstrated higher postoperative Prolo scale scores, improved cervical lordosis, greater foraminal height, and fewer postoperative complications. On the basis of these results and the reduced imaging artifact, the authors conclude that the PEEK cage is an acceptable alternative method of cervical interbody fusion.

The preliminary results observed in patients who received the PEEK cage are encouraging; however, this article is simply a technical description of a new construct for anterior cervical arthrodesis. Despite the authors' attempt to demonstrate improved outcomes with the use of the PEEK cage, the study design prohibits any meaningful comparisons with alternative methods of anterior cervical arthrodesis. A comparison of the PEEK cage with more contemporary methods of anterior cervical arthrodesis would be more appropriate. Many of the complications associated with autologous tricortical iliac crest, which are observed in the present study, have been reduced significantly with anterior cervical plate stabilization and allograft bone. The osteotome harvesting technique that the authors initially used may also have compromised the graft's structural integrity. The significance of the higher Prolo scores observed in the PEEK group is questionable, because preoperative scores are not disclosed. Demonstration of a greater interval change between the preoperative and postoperative Prolo scores would be more clinically relevant. The lack of dynamic imaging to assess fusion status is also a concern.

Although the clinical efficacy of the PEEK cage compared with contemporary alternatives for anterior cervical arthrodesis remains undetermined, it is unlikely that one method of arthrodesis will prove to be significantly superior to another. Despite these criticisms, the concept of the PEEK cage is intriguing and should be considered as a possible alternative to the numerous methods of anterior cervical arthrodesis. The remaining challenge may not be to develop alternative methods of arthrodesis but to develop methods to eliminate the need for arthrodesis.

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