

Complications of Peek Cage Following Single Level Anterior Cervical Discectomy and Fusion

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Abstract

Background: Prospective study of complications related to PEEK cage in fusion following single level anterior cervical discectomy.

Aim of Study: To assess the complications related to PEEK cage following single level anterior cervical discectomy and fusion.

Patients and Methods: A total of 127 case have been operated, 12 of them developed complications after using PEEK cage after anterior cervical discectomy and fusion. Follow-up at Cairo University Hospital between 2011 to 2013. Outcome assessment was done using visual analogue score (VAS), forearm pain, neck pain as well as neurological assessment and radiological follow-up with cervical X-rays.

Results: 12 patients from a total of 127 patients following single level anterior cervical discectomy and fusion using PEEK cage had cage related complications. Follow-up ranged from 12 to 27 months, with a mean follow-up of 15 month. There were five cases of cage migration, three cases with subsidence, two cases with adjacent level degeneration, one case with kyphotic deformity and one case pseudoarthrosis.

Conclusion: Use of PEEK cage in cervical fusion following single level Anterior Cervical Discectomy is widely used and provide satisfactory results. Complications related to PEEK cage use is relatively low and avoidable through careful attention to technically steps in graft site and choosing an appropriate sized cage.

Key Words: PEEK – Anterior cervical discectomy – Fusion.

Introduction

ANTERIOR cervical discectomy is performed for degenerative disc changes, causing radiculopathy and/or myelopathy or both [1,2].

Fusion was carried out in the past by using an autologous bone graft taken mostly from the iliac crest. Recently there has been an advance in new

treatments for degenerative disease of the cervical spine [3,4].

New types of implants are being developed to decrease complications of bone grafting such as infections, hematomas, and pain at the donor site, allowing for shortening the duration of operation, and achieve better bio-mechanical results [5,6].

The use of cages in fusion following anterior cervical discectomy accepted by most of the surgeons.

There are many types of cages developed for anterior cervical discectomy and fusion like carbon fiber, titanium, and PEEK cages. PEEK cages were widely used in the last few years to provide stabilization and fusion after anterior cervical discectomy in the management of cervical degenerative changes. which would provide immediate Structural support and stability, has not yet been identified [7,8].

The aim of the work to assess the complications related to the use of PEEK cages and fusion following anterior cervical discectomy in the cases of degenerative cervical disc changes.

Patients and Methods

This is a prospective Study done at the Neurosurgery Department of Cairo University starting from 2011 to 2013. During that time frame 127 patients with single level degenerative cervical disc changes were operated upon using the standard anterior cervical discectomy (ACD) and fusion using a PEEK cage were included into the study. Patients were followed-up prospectively for radiological and clinical evidence of complications. The mean follow up period = 15 months (range 12-27 months). During this period only ten patients

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with clinical or radiographic evidence of cage related complications were detected and included in our study.

All 127 patients had single level cervical degenerative changes, with clinical evidence of either cervical radiculopathy or myelopathy or both. Patients with cervical radiculopathy were operated for discectomy and fusion after 3 months of ineffective conservative treatment, along with radiological evidence of neural compression.

All patients in our study had only one level ACDF with PEEK cage fusion.

Preoperative evaluation:

All patients had general and neurological examination. Preoperative examination includes plain X-rays of the cervical spine (A-P, lateral and dynamic films (flexion/extension); magnetic resonance imaging (MRI) and CT of the cervical spine. Neck and arm pain were graded according to the visual analogue scale. Routine preoperative laboratory investigations were also done.

Surgical technique and approach:

After premedication and taking general anesthesia, patients were putted in supine position on the operating table and the neck slightly hyperextended. A roll is placed between the shoulders, to allow moderate extension [9].

Under lateral fluoroscopic control, The surgical procedures were performed using a standard anterior cervical technique [10].

A total discectomy was performed using the operating microscope after insertion of a vertebral body distractor, to avoid any damage to the bony end plates. Posterior osteophytectomy was performed. In all cases the posterior longitudinal ligament was opened and excised to ensure no subligamentous disc fragments. We select the size of the cage based on preoperative radiological studies and intraoperative measurements.

We prepare the upper and lower end plates by preserving the subchondral bone and removing the overlying cartilage. After completion of discectomy and end plate preparation the optimum PEEK cage size was selected. We filled the inner cavity of the PEEK cage with either autologous cancellous bone from the patient's iliac crest, or with artificial bone in other cases. After adequate distraction with the use of Casper distractor the PEEK cage was impacted into the disc space for fusion. The PEEK cage is implant made from a polymer matrix of polyetherether-ketone and a radio transparent trap-

ezoidal-shaped and slightly wedged. It has two radio-opaque lines in the external walls (vertical white lines on X-rays) and two pins on the superior and inferior borders and a hollow inner space. These marks helps in the accurate positioning of the PEEK cage with the use of intraoperative fluoroscopy. After insertion of a subcutaneous suction drain closure was then done in a routine fashion.

Follow-up:

After surgery, all patients wear a suitable hard cervical collar for 3 months. A normal activity level of neck movement was progressively resumed. Plain antero-posterior and lateral cervical spine radiographs were taken at 3, 6, and 12 months postoperatively. Radiographs with the neck in lateral flexion and extension were obtained at 12 months to evaluate fusion results.

The mean hospitalization duration was 2.9 days. Three patients had prolonged hospital stay, one patient was admitted for 14-days for physiotherapy, 2nd patient who was admitted on wheel chair and discharged after 7 days walking with crutches and the third patient who developed deep venous thrombosis had prolonged admission for 10 days. In our study we have no graft donor-site related complications. Postoperatively, two patients reported pain related to graft harvest. The postoperative pain seen in these two patients related to graft harvesting was mild and transient (less than 14 days).

Late follow-up and outcome:

The mean follow-up was 15 months. All patients were followed up clinically and radiographically by plain X-ray of the cervical spine. Plain X-rays was a quite an informative tool in the follow-up of cervical spine surgery as regard assessment of alignment, curvature, fusion, and stability. magnetic resonance image (MRI) cervical spine and CT of the cervical spine were done for all complicated and symptomatic patients.

At one year follow-up, fusion was defined as no radiolucent line between the cage and end plate and any translation or angular changes seen on lateral flexion and extension radiographs [11].

Results

Pre-operative clinical state:

There was male predominance (7 males and 5 females) and ages of patients ranged from 23 to 67 years. Mean age for all patients was 44 years. Duration of the symptoms before presentation ranged from 3 months to 3 years with mean 10 months.

Table (1): Age, sex and duration of symptoms.

	Range	Mean
Age (years)	23-67	44
Sex	7 males	5 females
Duration of symptoms	3 to 36 months	10 months

The number of smoker patients were eight while the non-smoker patients were four. Considering each presentation the most common presentation was radiculomyelopathy in six cases, followed by radiculopathy in four patients and myelopathy in two patients. Neck pain was seen in three out of 12 patients. The visual analogue score for arm pain ranged from 7 to 10 (mean = 7.4) while for neck pain from 2 to 9 (mean = 3.7). Pre-operative imaging studies: The number of individual levels operated upon is shown in Table (2).

Table (2): Number of individual levels operated.

Level	Number	Percent
C3-4	1	8.3
C4-5	2	16.7
C5-6	6	50
C6-7	3	25

As regards complications, they can be classified as those related to the graft site preparation, or PEEK cage inserted or graft donor site. We found that there were five cases of cage migration (three with anterior displacement, one patient with posterior displacement and one with lateral displacement that fractured the uncus). Three patients had cage subsidence; two patients developed adjacent level degeneration; one patient with kyphotic deformity; and one patient with pseudoarthrosis.

The complicated PEEK cages were asymptomatic in four patients (one with adjacent segment disc degeneration, one with a local kyphosis at the fused level, one with pseudoarthrosis, and one with minimally anteriorly migrated yet fused cage). However, in the other eight patients, four patients had developed recurrent neck pain (three patients with cage subsidence and one patient with adjacent level degeneration), two patients developed swallowing difficulties had anterior cage migration two patients had recurrence of neurological symptoms (one patient with posterior cage migration and excessive bone formation with posterior osteophytes leading to secondary canal stenosis, and the other patient had lateral cage migration with uncus fracture).

Neurological outcome:

In our study, after 6-8 months post-operatively we have seen recurrence of neck pain in three patients with cage subsidence and after 16 months there was recurrent neck pain in one patient with adjacent segment disease. Recurrence of arm pain occurred in four patients (one patient with a laterally displaced cage and uncus fracture (at 4 months), and in the three patients with cage subsidence and neural foramina compromise causing root compression).

Two patients had developed swallowing difficulties at 3 and 4 months postoperatively due to anterior migration of the cage and one patient had progressive myelopathy at 5-months postoperatively due to posteriorly displaced cage (Table 3).

Table (3): Time of occurrence of symptomatic PEEK cage complications and clinical status of the patients.

No. of patients	Type of cage complication	Clinical status	Time of occurrence post-operative
3	Subsidence	Recurrence of neck pain and radiculopathy	6-8 months
1	Adjacent level degeneration	Recurrence of neck pain	16 months
2	Cage migration (anterior)	Swallowing difficulties	3 months, 4 months
1	Cage migration (posterior)	Progressive myelopathy	5 months
1	Cage migration (anterolateral with uncus fracture)	Recurrence radiculopathy	4 months

Stabilization and fusion:

Fusion was assessed radiologically based on analysis of plain radiographs. The operated segments were deemed fused if there was a lack of motion between the vertebral bodies defined as less than 2 degrees of segmental motion on lateral flexion-extension radiographic views or in the presence of body bridges surrounding the cage. Non union occurred in two cases which had anteriorly displaced cages.

Subsidence:

Subsidence was defined as a disc height/cage height ratio of less than 0.7mm. Subsidence occurred in three patients all of whom developed recurrent neck pain and radiculopathy within 6-8 months of surgery. Measurements of the disc height as a percentage of adjacent vertebral body height was also done preoperatively and post-operatively

to demonstrate any relation between the disc height changes and the various complications.

Discussion

The cervical spine, due to the complexity of anatomical structures and biomechanical properties pose a specific challenge to the surgeon. Neuroimaging and dynamic development of diverse instrumentation for spinal stabilization allow for precise evaluation aid-ultimately for an efficient and complex solution of the problem, creating the chalice for early rehabilitation [12,13,14]. The anterior cervical discectomy with inter body fusion is an effective method for treating patients with cervical disc disease [15,11]. There are numerous types of cages developed for anterior cervical discectomy with fusion including titanium, carbon fiber, and PEEK cages. PEEK is a semi-crystalline aromatic linear polymer that provides a good combination of strength, stiffness, toughness, and environmental resistance [16,17].

Although, the PEEK cages are considered one of the effective methods in anterior discectomy and fusion complications of PEEK cages should be clarified to have a reasonable judgment on the clinical efficacy of the PEEK cage.

This study include 12 patients with clinically and radiologically documented cervical degenerative disc disease who performed surgery, this include 7 males and 5 females. Mean age is 44 years (range from 23-67 year's). The commonest presentation is radiculomyelopathy seen in 6 cases followed by radiculopathy in four patients and wry myelopathy in two patients. Neck pain is in three patients. Mean duration of complications diagnosis 6.6 months.

Godlewski et al., [14] reported in their series with the PEEK cages, 2 cases of complications of PEEK cages. with a slightly older mean age, longer mean duration for complication diagnosis The standard anterior cervical microscopic discectomy was performed for all patients. Godlewski et al., [14]; Liao et al., [11] and others use a right-sided approach as standard.

After complete decompression, end plate preparation was done. End plate preparation is a critical step to help fusion. To prevent subsidence it is important to leave subchondral bone. This is also recommended by Cho et al., [16], Godlewski et al., [14] and others.

In our study products of osteophytectomy were not suitable as regards quality to use it to fill the

cages as grafts and we used autologous iliac crest graft in same cases and artificial bone graft in other cases. Liao et al., [11] reported that in their study that, PEEK cages were filled with freeze-dried cancellous allograft bone. This kind of bone graft was made from femoral condyle that was harvested during total knee arthroplasty.

Godlewski et al., [14] reported in their study that PEEK cages were filled with only a small amount of bone tissue typically fallen from the iliac crest and the internal part of the implant may also be replaced with commercially available synthetic bone substitutes to avoid an additional bone harvesting procedure. Cho et al., [16] reported in their study that, PEEK cages were filled with autologous graft harvested from the right iliac crest.

All our patients were kept in hard neck collar for 3-months post-operatively. Liao et al., [11] used a Miami brace for 3-months. However, use of neck collar helps to decrease neck movements which proved to increase subsidence in all fusion devices as reported by both Wilke et al., [18] and Kettler et al., [19] in their in vivo investigation.

In our study, the mean follow-up is 15 months. All patients were followed-up clinically and radiologically. Plain X-rays were quite informative in the follow-up of cervical spine surgery as regard assessment of alignment, curvature, PEEK cage location and stability. Magnetic resonance imaging (MRI) and CT of the cervical spine was done in all complicated and symptomatic cases.

Cho et al., [16] stated in their study that, all patients were followed-up to 6 months post-operatively with X-ray examination to assess the fusion rate, the cervical lordosis and height of cervical discs, and the cross sectional area of the foramina at each fusion level. Follow-up with magnetic resonance imaging (MRI) for evaluation of either spinal cord or root compression was also done.

Godlewski et al., [14] reported in their study that, all patients had clinical assessment and radiological evaluation four times: (1) Before the surgical procedure; (2) One day after the surgery; (3) One month after the surgery (4) Three months after the surgery.

In this study, there were 12 patients with PEEK cage complications (9.4%). Five patients with cage migration, 3 of which had an anterior cage displacement, one with posterior cage displacement and 3 patients with anterolateral displacement and

fracture of the uncus. Cage related subsidence occurred in three patients and adjacent level degeneration was in two patients, pseudoarthrosis in one patient, and one patient has suffered from kyphosis.

Godlewski et al., [14] founded that in a group of 30 surgically treated patients, two patients developed complications and one patient reoperated.

Liao et al., [11] reported no cases of PEEK cage complications as regards cage subsidence or migration but there were 3 cases having poor results, though there three patients achieved solid union at the final follow-up. Analysis of radiographical data of these patients showed that the immediate post operation segmental lordosis was 0.9 and regressed to 4.4. It was not possible to create the condition of local lordosis, which might have been due to the choice of a smaller sized cage, resulting in poor clinical results.

As regards to the levels operated, in our study, C5-6 level was the more common site for disc for surgery (55%). This is matching with Liao et al., [11] in their series. Godlewski et al., [14]. Stated that the most common level operated was also C5-6 (390a) and Cho et al., [16] reported that the C5-6 disc space was also the most common level operated upon (63%).

In our study, there were 3 cases with cage subsidence and recurrence of neck pain and radiculopathy. Two of these patients were operated upon. Cage extraction followed by inserting an iliac crest graft and fixation with anterior cervical plating and screws was done. The patient with antero-lateral cage migration and uncal fracture was also reoperated, requiring cage removal, insertion of an appropriately sized graft followed by anterior cervical plating with screws.

The patient with posterior cage migration also required cage extraction followed by bone graft insertion and anterior cervical plate fixation. In our study one patient had accelerated adjacent level degeneration after insertion of PEEK cage at C5-6 level. The patient developed a symptomatic C4-5 disc herniation which was removed and stabilized with another PEEK cage. The other patients with clinical or radiographic evidence of complications were followed-up and they responded to conservative treatment.

In our study, we filled the cages with either autologous iliac crest cancellous bone or artificial bone graft. We found no apparent relation between PEEK cage complications and the type of bone

material filling it. Liao et al., [16] stated that the combination of PEEK cage and cancellous allograft bone for anterior cervical discectomy and fusion can lead to a high union rate and satisfactory clinical results.

The complications occurring with PEEK cages should not be related only to the PEEK cages. There are multiple other reasons for these different complications (loss of lordosis, subsidence, diminution in foraminal height or others).

Conclusion:

Use of PEEK cages in spinal fusion after anterior cervical discectomy is widely used and provides satisfactory results. Complications with PEEK cages use is relatively low and avoidable through careful attention to technical steps in graft site preparation and choosing an appropriate sized cage, along with careful follow-up for fusion and adjacent segment disease.

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المضاعفات الناتجة عن استخدام الطريقة الأمامية لجراحة الغضروف العنقي باستخدام القفص الصناعي والالتحام العظمي

تصميم الدراسة: أجريت هذه الدراسة المستقبلية في قسم جراحة المخ والأعصاب بجامعة القاهرة.

المرضى والطرق: تم إجراء هذه الدراسة على مجموعة ١٢٧ حالة، ١٢ منهم أصيبوا بمضاعفات بعد استخدام القفص العنقي بعد استئصال الغضروف العنقي من الأمام والالتحام العظمي. المتابعة في مستشفى جامعة القاهرة بين عامي ٢٠١١ و ٢٠١٣ تم تقييم النتائج باستخدام الدرجة التناظرية البصرية (VAS) وآلام الساعد وآلام الرقبة وكذلك التقييم العصبي والمتابعة بالأشعة العادية على الفقرات العنقية.

النتائج: ١٢ مريضاً من إجمالي ١٢٧ مريضاً بعد استئصال الغضروف العنقي من الأمام أحادى المستوى والالتحام العظمي باستخدام القفص الصناعي، كان لديهم مضاعفات متعلقة بالقفص. تراوحت المتابعة من ١٢ إلى ٢٧ شهراً، بمتوسط متابعة لمدة ١٥ شهراً. كانت هناك خمس حالات هجرة في الأقفاص، وثلاث حالات هبوط، وحالتان مع تنكس المستوى المجاور، وحالة واحدة مع تشوه حدابي وحالة واحدة مع التهاب مفصل كاذب.

وقد أظهرت نتائج هذه الدراسة أن :

- يستخدم الأقفاص الصناعية والالتحام العظمي على نطاق واسع بعد استئصال الغضروف العنقي من الأمام ويقدم نتائج مرضية.
- تعد مضاعفات استخدام الأقفاص الصناعية منخفضة نسبياً.
- يمكن تجنب هذه المضاعفات من خلال الاهتمام الدقيق بالخطوات الفنية في إعداد موقع القفص واختيار قفص بحجم مناسب، إلى جانب المتابعة الدقيقة للالتحام العظمي وأمراض المستوى المجاور.