Original Article

Stand-alone Cage for Three-level and Four-level Anterior Cervical Discectomy

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ABSTRACT

Background: Anterior cervical discectomy and Polyetheretherketone cage fusion (ACDF) without fixation has proven to be safe and effective procedure for the treatment of single and double-level degenerative disc disease (DDD). Three and four-level ACDF without fixation did not yet gain equal consensus. Objectives: This study aimed to evaluate the safety and effectiveness of three, and four-level PEEK cage fusion without fixation. Patients & Methods: This study was conducted at Cairo University Hospitals, included eighteen patients suffering from myelopathy due to cervical DDD operated upon by three-level (twelve patients) or four-level ACDF (six patients) without fixation from 2010 to 2012. Modified Japanese Orthopedic Association (mJOA) scoring was used for neurological assessment. Radiological assessment was done preoperative and postoperative with a minimum of six months. Results: sixteen patients showed clinical improvement, two patients showed no change, none of patients showed clinical deterioration, complications occurred in one patient in the form of transient bilateral C5 motor affection with subsequent improvement. Asymptomatic cage subsidence occurred with three cages shortly postoperatively, with no further progression, and reoperation not necessary. Conclusion: PEEK cage alone is a safe and effective surgical option in the treatment of three and four-level cervical DDD.

INTRODUCTION

Cervical spondylotic myelopathy is a progressive degenerative disease of the intervertebral discs and adjacent vertebrae. Multilevel affection of the cervical spine represents a challenging problem. A variety of anterior, posterior, and combined approaches with and without instrumentation has been advocated. Anterior approach allows direct decompression of the spinal cord, restoring the sagittal alignment, and avoiding kyphosis5,17. PEEK cages and other spacers like autologus bone graft, bone cement and artificial disc have all been applied4,6. However the choices become limited in three- and four-level discectomies, stand-alone cages have been widely applied in single- and double-level discectomies10,18. Controversy remains regarding a high incidence of complications, such as cage subsidence, kyphotic deformity, and pseudarthrosis in three- and four-level stand-alone cage22,11,15. Anterior cervical discectomy and fusion (ACDF) with plate fixation have been reported to reduce the above-mentioned complications23,21. Plate-related complications such as screw breakage, screw pullout, dysphagia, and esophageal perforation still exist though not very high. Furthermore, the necessity of adding anterior and/or posterior instrumentation in multilevel disease is still debatable8,9,12,19. The aim of this study is to evaluate the safety and efficacy of three, and four-level PEEK cage fusion without additional fixation.

PATIENTS AND METHODS

This retrospective study conducted eighteen (twelve males, six females) patients underwent ACDF with stand-alone cage for degenerative cervical disc disease affecting three or more levels from the year 2010 to 2012. PEEK cages were used in all patients at 60 levels. All patients were followed up for at least six months. The mean age of these patients at operation was 55 years (ranged 42–74 years). Indications for surgery included progressive myelopathy resulting from three- to four-level cervical degenerative disc disease after failed conservative treatment. Patients with trauma, ossification of posterior longitudinal ligament (OPLL), infections, or tumors were excluded from the study. Twelve patients had a three-level, and six patients had four-level ACDF. The mean follow-up period was 9 months (range 6-18 months).
Surgical technique:

The patient was placed supine with mild neck extension after induction of general endotracheal anesthesia. A right-sided approach was performed via a transverse incision in twelve patients (three-level) or longitudinal incision in six patients (four-level). The platysma was split in line with its longitudinal incision in six patients (four-level). The prevertebral fascia and longus coli muscles were mobilized to visualize the uncovertebral joints. The operative levels were confirmed using fluoroscopy. Caspar pins were used to apply distraction as needed. Microscopic discectomy was performed, and the posterior longitudinal ligament was excised in all cases, followed by removal of the posterior osteophytes to decompress the spinal cord. The nerve roots were decompressed with meticulous foraminotomies. The cartilage end-plates were removed with curetage while the bony end-plates were protected in order to provide a stable hard bed for the cage avoiding its subsidence in the subchondral bone. After adequate decompression, proper size cage packed with synthetic bone granules was placed in the distracted intervertebral space. After verification of the cage position with fluoroscopy, the caspar distractor was released and the stability of the cage was confirmed. Postoperatively, the patients were encouraged to resume their normal activities as soon as possible with a Philadelphia cervical collar for 6 weeks.

Outcomes assessment

Clinical and radiographic follow-up was maintained for a mean period of 9 months (range 6–18 months). Clinical outcome was determined according to the modified Japanese Orthopedic Association (mJOA) scoring for neurological assessment immediately before and after surgery and at the final follow-up. The recovery rate was calculated using the formula suggested by Hirabayashi. It was considered excellent (100–75%), good (74–50%), fair (49–25%), unchanged (24–0%) and worsened (score less than 0%)\(^{11}\). An anteroposterior and lateral cervical spine X-rays were done to all patients in the immediate and late postoperative period. Postoperative MRI cervical spine was done whenever needed.

Fusion was defined by the presence of trabecular bone across the interfaces without lucencies between the cage and vertebral endplates, and bony bridging formation between superior and inferior endplates\(^{2}\). Cage subsidence was defined as ≥2 mm decrease of the segmental height at the final follow-up compared to that measured at the immediate postoperative period\(^{16}\).

RESULTS

A retrospective study of eighteen patients receiving polyetheretherketone (PEEK) cage fusion for three levels or more without fixation. All patients were followed-up for an average period of 9 months (ranged from 6 to 18 months). Age of patients ranged between 42 yrs and 74 yrs, with mean of 55 yrs. There were 12 males (66.6%), and 6 females (33.4%). Total number of levels operated were 60 levels, six patients (33.4%) underwent four-level operations (all C3 to C7), while the remaining twelve (66.6%) underwent three-level ACDF. Of the twelve patients who had three level ACDF, seven (38.9%) had cervical discs removed between C4 and C7, and five (27.8%) between C3 and C6.

Clinical outcome: Pre-operative mJOA scores ranged from 5 to 14, with a mean of 10.4., and post-operative mJOA scores ranged from 7 to 18, with a mean of 14.7. Recovery rate ranged from 15% to 100%, with a mean of 62.94% for all patients. It was 64.4% in patients underwent 3 level and 60% in patients underwent 4 level ACDF (Fig. 3). There were no major intraoperative or postoperative complications. One patient underwent 4 levels operation had a transient bilateral C5 root dysfunction (Fig. 1 a-c), noticed immediately postoperative, in the form of partial weakness of bilateral shoulder abduction, with spontaneous total recovery over two weeks. Two patients showed no post-operative improvement, one of them underwent 3 level ACDF (Fig. 2 a-c), and the other underwent 4 level ACDF. None of our cases showed permanent neurological worsening.

Radiological outcome: fusion was achieved after 6 months in all patients. Subsidence occurred with 3 cages, two of them in one patient underwent 3 level ACF for degenerative disc disease between C4 and C7 vertebrae. In this patient C5-6 cage subsided in the superior end plate of C6, while C6-7 cage subsided in the inferior end plate of C6. This patient had 83% recovery rate. The third subsided cage occurred in C5-6 disc level where the cage pierced the superior endplate of C6 of a patient underwent 4 level ACDF. This patient had 63% recovery rate. All subsided cages were of less than 3 mm. They were discovered in the first month postoperative, with no further progression over 6, and 12 months follow-up period for both patients respectively. No anterior or posterior cage migration was detected in any patient. The difference in recovery rate between the three and four level ACDF being better in the former is shown in Fig. 3.
Fig. 1 a-c: A 46 years male underwent 4-level ACDF with transient post-operative bilateral C5 root dysfunction. a. Preoperative plain x-ray lateral view showing multisegment degeneration. b. Preoperative T2W1 MRI revealing spinal cord compression. c. post-operative plain x-ray lateral view 8 months after surgery demonstrating good fusion, adequate lordosis, and no cage subsidence. Recovery rate was excellent.

Fig. 2 a-c: 74 years male underwent 3 level ACDF (C3-6) ACDF. a. Preoperative radiograph with advanced spondylosis. b. Preoperative T2W1 MRI showing severe cord compression with signal opposite C3-4. c One year postoperative demonstrating good fusion, with no cage subsidence, adequate decompression, with persistence of the cord signal in. Patient showed no clinical improvement.
**DISCUSSION**

Using cages in the management of ACDF has proven to be a safe and effective procedure. Good clinical and radiographic results had been reported regarding PEEK cages alone for the treatment of one- or two-level ACDF. However, augmentation with plate fixation is usually needed, especially for multilevel ACDF. The main reason for additional plate fixation in cage-assisted ACDF was the high cage subsidence rate in studies using cages, specially the studies included metal cages which had very different elasticity with bone and, consequently, led to high rate of cage subsidence. Furthermore, another cause of cage subsidence might be the intraoperative overdistraction of the disc space and cage oversizing. Plate fixation has been found to increase the fusion rate and thus maintaining cervical lordosis, but its hardware complications like screw pullout, screw breakage, dysphagia, and injury of esophagus still exist though not high. In an attempt to avoid the above-mentioned problems, PEEK cages for three, and four-level ACDF were used alone. The use of the cage without plate for anterior cervical arthrodesis, which includes distraction and compression, was introduced by Bagby, Cho, and Boakye et al. who reported a fusion rate of 100% with PEEK cage.

The aim of this clinical and radiographic study was to provide follow-up data on the surgical success and patient outcome of polyetherehterketone (PEEK) cage-assisted anterior cervical discectomy and fusion (ACDF) in three or four levels without plating. The literature on that topic is scanty, and the reported series are not entirely comparable because of differences in patient characteristics, types of spinal arthrodesis, and methods for quantitating outcome.

Eighteen patients with cervical spondylotic myelopathy underwent multilevel ACDF, three- level in twelve, and four-level in six patients. PEEK is a nonresorbable polyaromatic polymer with similar elasticity to bone. The close match in the elastic modulus aids in minimizing cage subsidence and optimizing fusion rate.

The graft used was mineralized bone matrix with cage filling. The surgeries were carried out by two different surgeons using standardized techniques. One of the points to prevent cage subsidence in our study was the avoidance of bony endplates removal. The mean age was 55 years. Twelve (66%) were males. Clinical outcome showed significant improvement as there was increase in the mean mJOA score from 10.4 preoperatively to 14.7 postoperatively. These figures coincide with Hwang et al study where 56 patients underwent 3, and 4-level ACDF with and without plate fixation, the mean mJOA score before surgery was 10.7, and at the final follow-up was 14.1. Our results showed better recovery rate in 3-level (64.4%), compared to 4-level (60%) ACDF. Complications happened in one patient (5.5%) who underwent 4-level ACDF, in the form of immediate postoperative C5 bilateral root affection. This weakness improved during the first 2 weeks of the postoperative period. Tethering effect on the nerve root following shifting of the spinal cord after decompression and restoration of the lordosis could be the underlying etiology. This can also happen with posterior decompression in cervical myelopathy. Yonenobu et al reported 3.4% (13/384) incidence of postoperative C5 nerve root palsy in a series of patients who underwent either anterior or posterior decompressive surgery for cervical myelopathy.
Radiological outcome regarding fusion, and cage subsidence in this study showed good fusion in all cases (100%). In the 6 months follow-up, it was detected by the presence of trabecular bone across the interfaces without lucencies between the cage and vertebral endplates, and bony bridging formation between superior and inferior endplates. The result in this study is higher than the following results: 72% detected by Hong Liu in twenty-five patients underwent 3-level ACDF, 87.5% of sixteen patients underwent 4-level ACDF by Mootaz Shousha, and 97.5% of ten patients underwent 4-level ACDF by Bucciero et al. This difference could be attributed to the more strict radiological criteria of fusion adopted in their studies. They required lack of motion in the postoperative dynamic X-rays, which was not routinely done in our study.

There were no cases of collapse >3 mm in this study. The rate of cage subsidence in our study was 11% (2/18), all were in C6 body. Subsidence did not have any effect on the recovery rate, and showed no radiological progression during the follow-up period. This was a bit higher compared with Hong Liu who reported one case of cage subsidence (4%) in his 3-level series of twenty-five patients. It was not progressive, and reoperation was not necessary. In their study, Hwang et al reported 6.3% of cage subsidence. This did not cause any symptoms. It was discovered within the first 3 months following the operation, with no further progression in the follow-up period. They also reported that minimal settling of the cage may even be beneficial leading to faster healing.

CONCLUSION

Clinical and radiological outcome of the stand-alone PEEK cage for the surgical treatment of three- and four-level degenerative cervical disc disease is satisfactory. Furthermore the presence of subsidence as a postoperative radiological finding does not always reflect a bad clinical situation. Stand-alone PEEK cage is also a safe procedure with potentially less morbidity than anterior plating.

REFERENCES

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