

Anterior Cervical Discectomy with Stand Alone PEEK Cage for Management of 3 and 4 Level Degenerative Cervical Disc Disease*

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ABSTRACT

AIM: The aim of this study was to evaluate the efficacy of cage-assisted fusion in three and four level cervical arthrodesis without additional anterior plating in patients with normal BMD. We hypothesized that omitting the use of long anterior cervical plate in multi-level ACDF will simplify the surgery, reduce the surgical time, avoid excessive and prolonged retraction on esophagus and carotids, and will also reduce the potential complications of application of long anterior cervical plate in selected patients. We also thought that the success of stand-alone cage would reduce the cost of the surgery, which is crucial in low-income countries.

MATERIAL AND METHODS: This prospective case series study included 30 patients diagnosed and treated for multilevel (at least 3 levels) cervical disc prolapse presented by either radiculopathy and/or myelopathy operated by anterior cervical micro-discectomy and stand-alone cage fusion. These cases were treated at Ain Shams University hospitals and Arab Contractors Medical Center between 2008 and 2011.

RESULTS: This study included 30 patients; 27 were males (90%) and 3 were females (10%). The presenting symptoms in order of frequency were neck pain (100%) of the cases, followed by radicular pains (70%) and Myelopathy (40%). The mean age of the patients at the time of surgery was 52.23 (minimum 42 and maximum 70 years). 28 patients in our series we operated for three levels (93.4%), and 2 cases we operated for four levels (6.6%). There has been no operative related mortality or morbidity in our series. All the cases were discharged on the first or second postoperative day. We had statistically significant reduction of VAS of arm pains in the immediate postoperative periods. This statistically significant reduction was maintained through the follow up period. There has not been significant correlation between the VAS preoperatively and immediately post-operatively. There has been statistically significant reduction in the VAS of neck pain starting from the third month postoperatively. We had statistically significant reduction of the Nurick score for patients presenting with myelopathy postoperatively. We had solid fusion in 28 patients (93.3 %), and there was no fusion in 2 patients (6.7%). Three cases (10%) needed reoperation. One case operated originally for C3-4, 4-5 and 5-6 disc disease needed reoperation for adjacent segment degeneration at C6-7. Another case developed postoperative discitis after C4-5, 5-6, 6-7 ACDF. A third case developed cage subsidence due to excess removal of the endplate and needed reoperation for corpectomy and fusion and fixation.

CONCLUSIONS: We recommend that ACDF with stand-alone cage fusion is a safe and effective measure in treatment of 3 or 4 level disc disease with no need of cervical plating in selected patients. We believe that BMD assessment should be added to the routine investigations of patients undergoing fusion surgery as it may change surgical planning.

KEY WORDS: ACDF, multilevel fusion, normal BMD, nurik score, stand-alone cages, VAS

BACKGROUND

Cervical spondylosis 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. As advanced cervical spondylosis most typically involves compression of the cord by anterior structures, the anterior approach allows for direct decompression of the spinal cord and excision of these pathologic elements. The aim of surgery is to achieve an adequate decompression of the spinal cord, restore or maintain sagittal alignment, achieve solid fusion and avoid kyphosis (15).

Reconstruction of the defect after discectomy is still a matter of debate among spine surgeons. Autogenous tricortical iliac graft, artificial disc, PEEK cages and titanium cages, with and without plate application, have all been applied (15).

The use of autologous iliac crest bone grafts for fusion has been largely superseded by polyetheretherketone (PEEK) and titanium cages due to the complications associated with donor site pain, blood loss and relatively high levels of graft collapse and kyphosis (14).

Anterior cervical discectomy and fusion (ACDF) with plate fixation have been reported to reduce complications of stand-alone cages as subsidence and pseudoarthrosis. Unfortunately, plate related complications rates, ranging from 2.2 to 24%, such as screw breakage, screw pullout, injury of recurrent laryngeal nerve, dysphagia and esophagus perforation still exist (12).

There has been a rapid increase in the use of cervical spine interbody fusion cages in view of their theoretical ability to prevent graft collapse, with the potential advantage of indirect foraminal decompression by restoration and preservation of intervertebral height and lordosis (7).

An element of clinical equipoise therefore remains in plating as an adjunct to ACDF. In addition, many of the clinical studies looking at anterior plating were in the context of autologous bone grafting and thus the necessity for anterior instrumentation in the context of PEEK cages has not been fully evaluated (14).

Recent series have established the safety and efficacy of multilevel ACDF with PEEK cages with and without plating, but superiority of either procedure has not been definitively established (14). Cage subsidence is still an issue with

stand-alone cages. Subsidence is defined as the sinking of an object with a greater elasticity modulus (e.g., cage or spacer) into an object with a lower elasticity modulus (e.g., vertebral body) (8). The subsidence rate of stand-alone PEEK cages of the cervical spine was from 5.4% to 19.1% in different studies (3,5,8,17,19).

The effect of bone mineral density (BMD) on lumbar cage subsidence have been studied and low BMD have been shown to increase the rate of lumbar cage subsidence (13). The effect of BMD on cervical cage subsidence have not been studied.

The aim of this study was to evaluate the efficacy of cage-assisted fusion in three and four level cervical arthrodesis without additional anterior plating in patients with normal BMD. We hypothesized that omitting the use of long anterior cervical plate in multi-level ACDF will simplify the surgery, reduce the surgical time, avoid excessive and prolonged retraction on esophagus and carotids, and will also reduce the potential complications of application of long anterior cervical plate in selected patients. We also thought that the success of stand-alone cage would reduce the cost of the surgery, which is crucial in low-income countries.

PATIENTS and METHODS

This prospective case series study included 30 patients diagnosed and treated for multilevel (at least 3 levels) cervical disc prolapse presented by either radiculopathy and/or myelopathy operated by anterior cervical micro-discectomy and stand-alone cage fusion. These cases were treated at Ain Shams University hospitals and Arab Contractors Medical Center between 2008 and 2011.

All patients were evaluated by preoperative complete general and neurological examination. Preoperative investigations included; MRI of the cervical spine, and plain x-rays of the cervical spine (anteroposterior, lateral and dynamic views). Bone densitometry for BMD was done using Dual Energy X-Ray Absorptiometry (DEXA). All cases have been assessed for pain using Visual Analogue Scores (VAS) for neck and arm pains preoperatively and at follow up visits. The patients were assessed for myelopathy and their functional outcome using Nurick grades (20).

The exclusion criteria were cervical instability or subluxation, patients with kyphotic deformity, and patients with abnormal bone density.

All cases had standard approach to the cervical spine with slight distraction using Casper retractor and microscopic discectomy with osteophyte removal. We avoided in all cases

excess curettage of the cartilaginous end plate and removal of the subchondral bone to avoid cage subsidence. In all cases, fusion was done by using stand-alone PEEK cages filled with bone graft substitute. We placed the cages after finishing the discectomy in at every level in order to avoid over distraction and placing over-sized cages.

External orthosis using hard neck collar with chin support for 4 weeks followed by soft neck collar for another 2 weeks was prescribed for all patients.

All patients had plain x-ray of the cervical spine AP and lateral views on the first postoperative day in order to assess sagittal and lateral alignment, and lateral x-ray at three months interval until full fusion. We used a reduction in the disc height by 4 mm per level in the lateral x-ray film between immediate and late post-operative x-ray films per level as an evidence of cage subsidence and loss of reduction.

MRI was only indicated in case of any symptomatic deterioration. Patients were followed up for at least one year postoperatively.

Statistical relationship between the variables was studied with the Pearson correlation coefficient using SPSS 16 software.

RESULTS

This study included 30 patients; 27 were male (90%) and 3 were female (10%). The presenting symptoms in order of frequency were neck pain (100%) of the cases, followed by radicular pain (70%) and myelopathy (40%).

The mean age of the patients at the time of surgery was 52.23 (minimum 42 and maximum 70 years).

Regarding the operated levels, 28 patients in our series we operated for three levels (93.4%), and 2 cases we operated for four levels (6.6%).

There has been no operative related mortality or morbidity in our series. All the cases were discharged on the first or second postoperative day.

We had statistically significant reduction of VAS of arm pains in the immediate postoperative periods. This statistically significant reduction was maintained through the follow up period. There has not been significant correlation between the VAS preoperatively and immediately postoperatively. There has been statistically significant reduction in the VAS of neck pain starting from the third month postoperatively. We had statistically significant reduction of the Nurick score for patients presenting with myelopathy postoperatively.

We had solid fusion in 28 patients (93.3 %) (Figure 1), and there was no fusion in 2 patients (6.7%).

One patient had asymptomatic pseudo-arthritis at C5-6 level in dynamic lateral x-ray film. The other case was a 43-year-old diabetic male who had initial postoperative X ray with straight spine (Figure 2A) but developed post-operative discitis one month after surgery (Figure 2B, C) and was re-operated with corpectomy, pyramesh placement and anterior cervical plating (Figure 2D).

In our series we had 2 cases of adjacent segment degeneration (ASD) (6.6%). One patient, 3 months after being operated upon for C4-5, C5-6 and C6-7 ACDF, developed C3-4 disease. The patient was informed but since he was asymptomatic we opted for follow up (Figure 3). The other case was a 56-year-old female who developed clinical and radiological C6-7 disc disease one year after C3-4, C4-5, and C5-6 ACDF. She was operated with total disc replacement with dynamic cervical implant (Discocerv



Figure 1. Plain x-ray cervical spine lateral view 3 months postoperative for a case operated for C4-5, C5-6, C6-7 ACDF showing acceptable lordosis.



Figure 2: A) Immediate post-operative showing straight spine and unacceptable lordosis. This patient had been complicated by discitis Figure 2B, C and D. B) 30 days postoperative x-ray film with kyphosis due to discitis. C) Postoperative MRI showing discitis with cord compression. D, E) Post-operative anteroposterior and lateral x-rays following corpectomy, body replacement by pyramesh and plate fixation.



Figure 3: A case presented with ASD at the C3-4 level following three levels ACDF with stand-alone cages at C4-5, 5-6, 6-7. The patient was symptomatic and did not accept surgery.

Scient'x, France) with addition of cervical plate at the upper 3 levels.

We considered subsidence as loss of more than 4 mm per level in the lateral X-ray films compared to the immediate postoperative x-ray as radiological loss of reduction. Subsidence was considered positive in our series with reduction of the disc height with more than 4mm between immediate and late postoperative X-rays. The rate of subsidence in our series was (3%). We had one case with loss of reduction (3.3%)

OUTCOME

26 cases (86.7%) had favorable outcome (solid fusion, resolution of all symptoms and maintenance of cervical lordosis) after at least 12 months follow up. One case presented by neck pain (3.3%), plain X ray showed pseudoarthrosis. The patient refused redo surgery as the pain was tolerable with analgesics on irregular basis.

Three cases (10%) needed reoperation. One case operated originally for C3-4, 4-5 and 5-6 disc disease needed reoperation for adjacent segment degeneration at C6-7. Another case developed postoperative discitis after C4-5, 5-6, 6-7 ACDF. A third case developed cage subsidence due to excess removal of the endplate and needed reoperation for corpectomy and fusion and fixation.

Table 1: Nuric Grades (20)

Grade	
0	Signs or symptoms of root involvement but without evidence of spinal cord disease
1	Signs of spinal cord disease but no difficulty in walking
2	Slight difficulty in walking which did not prevent full-time employment
3	Difficulty in walking which prevented full-time employment or the ability to do all housework, but which was not so severe as to require someone else's help to walk
4	Able to walk only with someone else's help or with the aid of a frame
5	Chair bound or bedridden

Table 2: Post-Operative Complications

Complication	Frequency	Percentage
Pseudoarthrosis	1	3.3%
Symptomatic Cage Subsidence	1	3.3%
Adjacent Level Disease (one of them was asymptomatic)	2	6.6%
Discitis	1	3.3%

The cervical lordosis was measured at preoperative lateral Xray, immediately postoperatively and at last follow up after fusion. The mean preoperative lordotic angle between C2 and C7 was 11.2 degrees. The mean postoperative lordotic angle was 33.4. The mean lordotic angle at 6 months was 28.6.

DISCUSSION

This study is a prospective study with a follow-up period of at least one year, and the results of our study show that cervical myelopathy and/or radiculopathy can be effectively treated by multi-level ACDF with the use of stand-alone PEEK cages for three and four levels of cervical disc prolapse in selected cases. We hypothesized that omitting the use of long anterior cervical plate in multi-level ACDF will simplify the surgery, reduce the surgical time, avoid excessive and prolonged retraction on oesophagus and carotids, and will

also prevent the potential above mentioned complications of application of long anterior cervical plate. This hypothesis had been supported by results of lower cage subsidence in patients with normal BMD in stand-alone lumbar cages.

Anterior cervical discectomy and interbody fusion (ACDF) is an efficient procedure and is considered the gold standard for surgical treatment of cervical spondylotic myelopathy and/or radiculopathy. The success of ACDF depends on adequate decompression of the neural structure and development of a solid osseous fusion (7).

Fusion with autologous iliac crest graft has been used for long time with various degrees of success (7). Placing an interbody bone graft can preserve disc height, widen the neural foramen, and normalize cervical spine alignment.¹³ However, the complications with the use of autologous iliac crest bone graft as pseudo-arthrosis, collapse, extrusion,

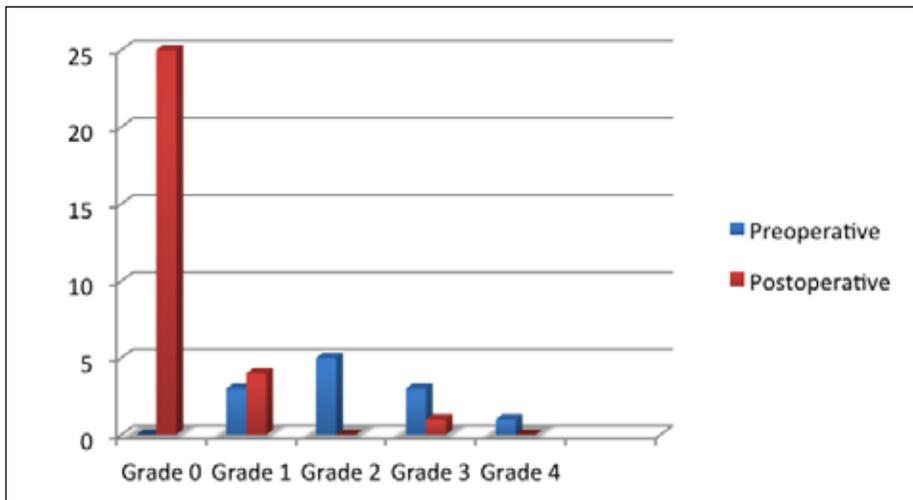


Figure 4: Nurik Grades Pre and 3 months Postoperatively. Cases presented with myelopathy (12 cases) showed improvement with exception of the case that developed discitis. This patient improved to grade 0 after the second surgery.

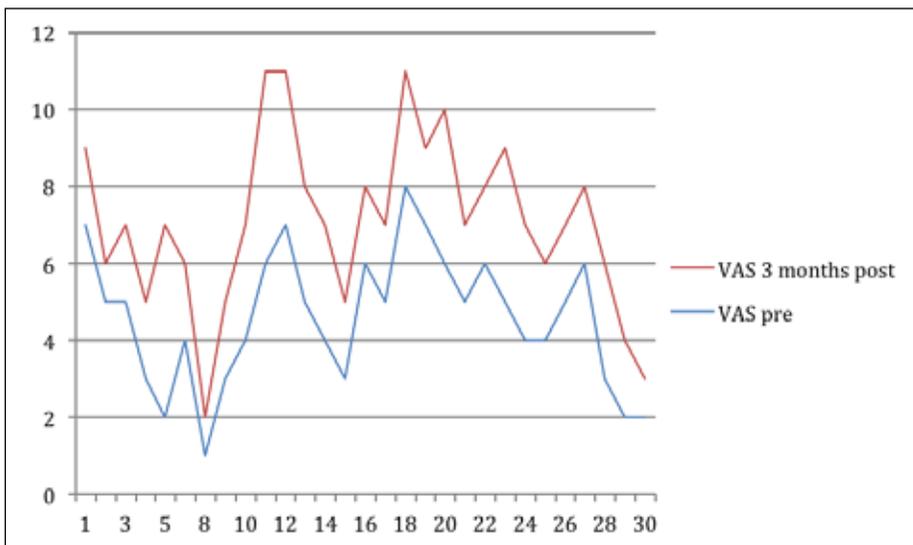


Figure 5: VAS preoperative and three months postoperative.

subsidence and resorption have limited its use. Various methods have been employed such as cage augmentation, bone substitutes, allograft, artificial replacement, and bone morphogenetic protein in an effort to avoid these complications (16). So far, cage-assisted ACDF has proven to be a safe and effective procedure for the treatment of cervical degenerative disc disease (12).

Multilevel anterior cervical discectomy and fusion remains a difficult problem. The rate of cage subsidence has proven to be higher in multiple levels ACDF than in single level (9).

Because of the high complication rate in multilevel ACDF procedures, augmentation of fusion with plate fixation has been suggested. Plate fixation may decrease the micro-movement of the cervical spine, enhance the fusion rate, and correct spinal curve to physiologic lordosis. In ACDF, additional plate fixation has been reported to result in a higher fusion rate, lower reoperation rate, and better pain relief (7). However, the use of an anterior plate system is associated with various intraoperative and postoperative complications. The application of long ACPs, particularly during multilevel cervical discectomy and fusion, is a time-consuming procedure, and can lead to various complications such as screw pullout, screw breakage specially with subsidence, injury of the laryngeal nerves, dysphagia or even injury of the oesophagus, and wound infection (20).

Potential problems with stand-alone cages include late kyphosis due to subsidence and pseudoarthrosis. Recent data suggests that subsidence usually happens within the first 3 months after surgery (14). Some authors suggested that subsidence has been a natural process during fusion (1).

The main reason for additional plate fixation in cage-assisted ACDF was the high cage subsidence rate in studies using cages without plating (2,11,14). However, most of the studies included metal cages, which had very different elasticity with bone and, consequently, led to high rate of cage subsidence (2,7,20). Furthermore, another cause of cage subsidence might be the intraoperative over distraction of the disc space and cage oversizing (10,12,15).

In their retrospective study, Das et al. studied 38 patients who had arthrodesis with cylindrical titanium cages and screw-plate fixation, and they reported the rate of pseudoarthrosis was 6–8% for one-level and 15–46% for treatment of multiple levels (7).

In this study we used PEEK cages for fusion. We preferred the use of PEEK cage because of its established

characteristics. The PEEK cage has a hard frame to resist the cervical loading and is more rigid than iliac bone graft. In laboratory studies, the PEEK cage has good stiffness in compression and rotation tests. It is also safe regarding histocompatibility. These unique structures offer a fixation mechanism, which is thought to be similar to the function of plate and screw. The PEEK cage is wedge shaped, which facilitates the creation of lordotic spinal curvature when put into the distracted disc space. Furthermore, the PEEK cage is made with radiotransparent material, which allows for x-ray follow-up. In addition, a very important feature is that the PEEK cage is more elastic than the other cages that are made of metal, reducing the possibility of graft subsidence into the vertebral body (6).

In our study the incidence of cage subsidence was 3.3%, one of the main factors to reduce the incidence of cage subsidence in our study is avoiding excess curetting of the bony end plate of the vertebrae, as well as avoiding over distraction of the operated levels by selecting appropriate size of the placed cages. We also believe that the patient selection criteria in our study have led to this better result.

A support of our results came from the study by Cho et al. In their series of 180 cases of multilevel cervical degenerative disease, they randomized the patients into three groups: Group A (60 patients) underwent anterior discectomy and polyetheretherketone (PEEK) fusion, Group B (50 patients) underwent anterior discectomy, autogenous iliac crest graft (AICG) fusion and plate fixation, and Group C (70 patients) underwent anterior discectomy and AICG only. They concluded that both PEEK cage without plating and AICG with plating are good methods for interbody fusion in multilevel cervical degenerative diseases. They increase spinal lordosis and graft fusion rate, and cause fewer surgical complications. However, the PEEK cage was more preferred for multilevel fusion, because it has the fewest complication rates and the least amount of blood loss (6).

Adjacent segment disease may be associated with disease progression rather than surgery and one could therefore hypothesize that the incidence of adjacent segment disease would be higher in this series due to the propensity for degenerative damage in this cohort of patients who already have three or four affected cervical levels. Greater strain placed above three to four levels of fused segment would also be predicted biomechanically (14). In our study we had 2 cases of adjacent segment disease (6.6%), one had asymptomatic adjacent segment degeneration at C3-4 level after C4-5, 5-6 & 6-7 ACDF and was followed up as

he was asymptomatic. Another patient had adjacent level degeneration at C6-7 that was symptomatic and was treated by placement of artificial disc prosthesis at that level.

In short, the complications encountered in our study were adjacent level degeneration in 6.6%, cage subsidence in 3.3%, pseudoarthrosis in 3.3%, and post-operative discitis 3.3%.

The results are comparable to Periera et al (14) who reported 6.7% adjacent level degeneration and 3.3% cage subsidence. While Demircan et al (12) reported 4% subsidence.

Solid fusion was achieved in 26 patients (87%), and there was no fusion in 1 case (3.3%) while 3 cases needed reoperation. This is comparable to Demircan et al (12), who had 90.5% fusion and 9.5% non-fusion rates. While Liu et al had fusion rate of 72% and pseudoarthrosis rate of 28% although it was asymptomatic (7).

Song et al in their study on 43 patients treated for three and four level degenerative cervical disc disease, which underwent three- or four-level anterior cervical discectomy and fusion with a PEEK cage and plate construct, reported 100% fusion. However, they reported three cases of respiratory difficulty, four cases of dysphagia and one case of hoarseness (16).

Chang et al in their study on 29 patients who underwent anterior cervical discectomy and fusion with plating at four levels, reported fusion rate of 92.6% and 2 cases of cage subsidence (4).

In our series, 26 cases (87%) had a favorable outcome (solid fusion, resolution of all symptoms and maintenance of cervical lordosis) after at least 12 months of follow up, while, three cases (10%) needed reoperation. One case was operated upon for postoperative discitis, another patient operated upon for symptomatic adjacent level disease, and a third case for cage subsidence and local neck kyphosis, and one patient had pseudoarthrosis but did not undergo another surgery.

In conclusion we recommend ACDF with stand-alone cage fusion as a safe and effective measure in the treatment of 3- or 4-level disc disease with no need of cervical plating in selected patients. We believe that BMD assessment should be added to the routine investigations of patients undergoing fusion surgery as it may change surgical planning.

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