

Four Levels Anterior Cervical Discectomy and Fusion by Stand Alone PEEK Cages

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Abstract

Background: cervical spondylotic myelopathy is a common health problem that neurosurgeons face in Egypt. The aim of this study is to evaluate the efficacy of PEEK cage only in 4 levels anterior cervical discectomy as one of surgical option other than anterior cervical corpectomy, fixation by plat or posterior approach for cervical laminectomy, and assessment of post spinal surgery pain. **Methods:** this prospective study on 28 patients with cervical spondylotic myelopathy (CSM) over a period of 3 years (between April 2012 and April 2015) with mean period of follow up 30 months. We have done anterior cervical discectomy with fixation by cage only for all cases with perioperative assessment and scoring clinically and radiologically (Japanese Orthopaedic Association [JOA] scores, Visual Analogue Scale [VAS] scores for assessment of neck and arm pain, perioperative parameters (hospital stay, blood loss, operative time), the European Myelopathy Scoring (EMS) and Odom's criteria, and the incidence of complication, post spinal surgery pain assessment). **Results:** clinical outcome was excellent (28.55), good (50%) and fair (21.5) according to Odom criteria. The European Myelopathy Scoring (EMS), improved from 10 to 16. The mean JOA score improved from 10.1 ± 2.1 to 14.2 ± 2.3 . Fusion failure had been seen in 4 patients in one level for each secondary to anterior displacement of the cage with no other major complications. **Conclusion:** 4 levels anterior cervical discectomy with PEEK cage only is an effective, save and less costly with less post operative complication and hospital stay and less post spinal surgery pain.

Keywords

Four Levels Cervical Disc, Peek Cage Fusion, Cervical Spondylotic Myelopathy

1. Introduction

Cervical spondylotic myelopathy (CSM) is a common clinical degenerative disease particularly for the old population. The aim of surgery is to decompress spinal cord and preserve the stability of the spinal column and assessment of post spinal surgery pain [1].

The selection of optimal surgical treatment for CSM, especially for multilevel cervical spondylotic myelopathy (mCSM), remains controversial [2]. Surgeries mainly involved anterior and posterior approaches, including anterior cervical discectomy and fusion (ACDF), anterior cervical corpectomy and fusion (ACCF), laminoplasty, laminectomy, and laminectomy with fusion [3]. ACDF for treating CSM was firstly introduced by Smith and Robinson and Cloward; the anterior procedure has become the most widely used surgical choice [4].

However, controversy remains regarding the selection of surgical procedures for the treatment of multilevel CSM. Surgeries using both anterior and posterior approaches have been developed with the goal of decompressing the spinal cord and restoring the stability of the cervical spine [5].

The posterior approach involves laminectomy with or without fusion, or laminoplasty. laminectomy and laminoplasty have been found to be effective treatment for multilevel CSM but are hindered by the complications of progressive cervical kyphosis, C5 nerve root palsy, axial neck pain, segmental instability, and associated postoperative neurological deterioration [6]. While the anterior approach surgery directly decompresses the spinal cord and nerve root, improves cervical alignment, and reduces the incidence of complications [7]. As post spinal surgery pain that frequently observed troublesome disease entity for both patients and surgeons, that type of pain is frequently not matched with the dermatome and is characterized by its severity and continuity, many patients continue experiencing intolerable pain and functional disability, leading to psychological disturbances such as depression or insomnia [8]. Several studies have confirmed the safety and efficacy of treating multi segmental (2 or 3 levels) CSM using an anterior approach [8].

The decision to treat multilevel CSM especially 4-level CSM with multilevel anterior cervical discectomy and fusion (ACDF) remains controversial, and few studies have investigated the treatment of 4-level CSM [9]. ACDF results in very low morbidity and almost no mortality. Nonetheless, studies on 4 levels ACDF are few, particularly long term follow-up studies [10].

The purpose of this study is to review the efficacy, safety and the outcome of 28 patients who underwent 4-level ACDF with peek cages only, with follow up and assessment of post spinal surgery pain.

2. Materials and Methods

We have operated upon 28 patients with 4 level cervical disc over a period of 3 years from April 2012 to April 2015. All patients have signed an informed consent. There were 20 patient over 50 years and 8 below 50 years with mean age 56

years. Males were 22 and only 6 females. patients who met the selection criteria of this study and agreed with participation according to **the inclusion criteria:** 1) symptoms of cervical myelopathy and/or brachialgia; 2) the cervical spine MRI showed disc herniation; 3) cervical pathology in four levels, and those who presented with significant segmental instability, cervical anatomic deformity, ossification of the posterior longitudinal ligament (OPLL), as well as symptomatic disorders at the other spinal region. There were 16 patient presented by myelopathy and radiculopathy and 12 patient with only myelopathy. The duration of symptoms was from 6 months to 2 years.

The surgical technique was a standard Smith-Robinson right approach to expose the symptomatic levels (**Table 1**). After appropriate exposure and localization of the disc, a discectomy was performed. Besides, a local decompression was accomplished via resection of osteophytes and the posterior longitudinal ligament if necessary. After decompression, an appropriate sized cage packed with local decompression bone harvested from the anterior hypertrophic osteophyte and potential decompression of the posterior border of vertebral body was implanted as a stand-alone devices. Postoperatively, the patients were encouraged to resume their normal activities as soon as possible with a neck collar to avoid over-extension for 6 weeks.

2.1. Clinical and Radiological Evaluation

Clinical and radiologic follow-ups were performed immediately after operation, at 6 weeks, 3, 6, 9, 12, 18, and 24 months after surgery, and annually thereafter. **Clinical outcomes** (Japanese Orthopaedic Association) [JOA] scores, neck and arm pain Visual Analogue Scale [VAS] scores, perioperative parameters (hospital stay, blood loss, operative time), the European Myelopathy Scoring (EMS) and Odom's criteria, and the incidence of complications (ALD, hardware-related complications, hoarseness, pseudoarthrosis, dysphagia, dural tears) were recorded (**Table 2**).

Table 1. Demographic feature.

Age	20 (71%) patients over 50 ys
	8 (29%), patients below 50 ys, mean 52 y \pm 12.0
Gender	Male 22 (78.5%) patients
	Female (21.5%) 6 patients
Duration of symptoms	Less than 6 months, 6 patients (21.4%)
	6 - 12 months, 10 patients (35.7%)
	6 - 12 months, 10 patients (35.7%) More than 12 months, 12 patients (42.8%)
Clinical	16 patient with myelopathy + radiculopathy
	12 patient with only myelopathy
Follow up	2 - 3 years mean 30 months \pm 6.0

2.2. Radiologic Assessment

All patients underwent MR using the 1.5T or 3.0T, T1- and T2-weighted sagittal and axial imaging of the cervical spine (preoperative). The presence or absence of bone fusion, and radiological parameters were examined using anteroposterior (AP), lateral, and flexion/extension lateral plain radiographs), radiologic parameters (fusion rate, segmental height, cervical lordosis).

The cervical lordosis was assessed using *the Cobb angles* of C2 - C7, which is formed by lines along the inferior endplate of C2 to inferior endplate of C7 in a neutral position (**Figure 1**). *The intervertebral height* was calculated as the mean value of the height of the anterior border (AH) and posterior border (PH). Cage subsidence was recorded when the loss of intervertebral height was over 3 mm. *Fusion* was considered according to the following accepted criteria: 1) absence of motion between the spinous processes at dynamic lateral radiographs, 2) absence of a radiolucent gap between the graft and endplates, 3) presence of

Table 2. Odom criteria.

Grade	Definition
Excellent	All preoperative symptoms relieved, able to carry out daily occupations without impairment.
Good	Minimum persistence of preoperative symptoms, able to carry out daily occupations without significant interference.
Fair	Relief of some preoperative symptoms, but whose physical activities were significantly limited.
Poor	Symptoms and signs unchanged or worse.

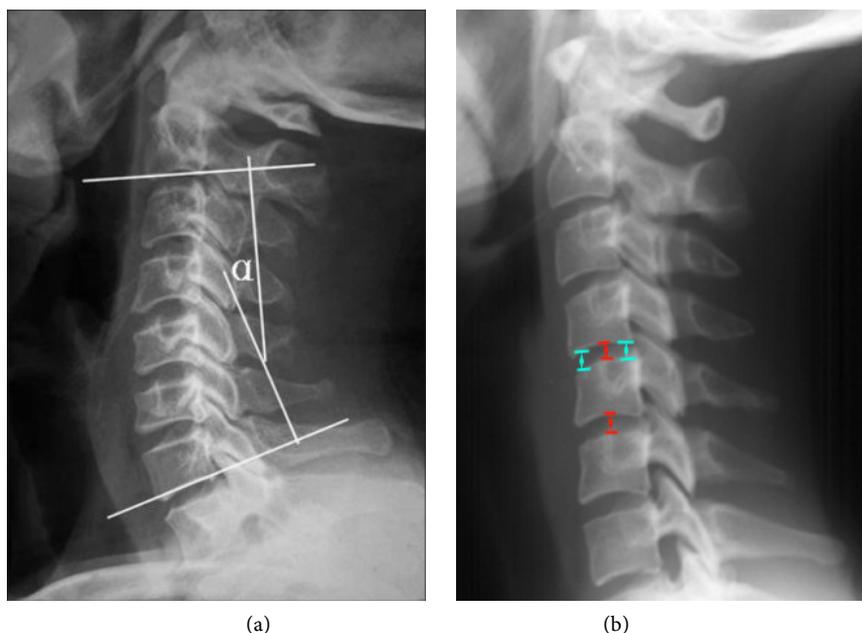


Figure 1. (a) The diagram of cervical lordotic angle which was measured according to Cobb's method; (b) The intervertebral height was calculated as the mean value of the height of the anterior border (AH) and posterior border (PH).

continuous bridging bony trabeculae at the graft-endplate interface. Assessment of postspinal surgery pain; Clinical follow-up were performed immediately after operation, at 6 weeks, 3, 6, 9, 12, 18, and 24 months after surgery, by using visual analogue scale (VAS).

3. Results

All 28 participants underwent 4 levels anterior cervical discectomy and fusion using peek cages only. The mean operating time was 125 minutes. The mean intra-operative blood loss was 180 cc. The mean length of hospital stay was 2 days. The mean follow-up was 30 months. All patients had been followed up regularly at 3, 6, 12, and 24 months apart of 2 patients (one died from cardiac cause after 11 months and one had got RTA and developed paraplegia due to dorsal spine fracture) (Figures 2-6).



Figure 2. MRI T2 sagittal cuts showing 4 levels cervical disc with cord indentation.

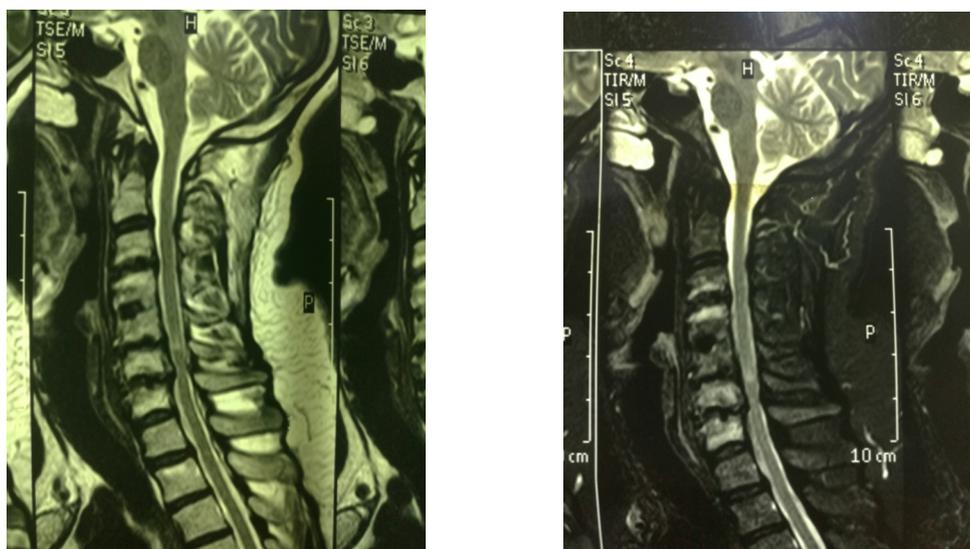


Figure 3. Post operative MRI T2 sagittal with 4 cervical cages.



Figure 4. MRI T 2 axial cuts post operative 4 levels anterior cervical discectomy.



Figure 5. X rays A-P & lateral post operative 4 levels anterior cervical discectomy with cages.



Figure 6. X rays cervical spine (dynamic) showing proper fusion with widening of disc space.

3.1. Clinical Outcomes

JOA score: The mean JOA score improved from 10.1 ± 2.1 to 14.2 ± 2.3 at 3 months postoperatively and was maintained at 13.6 ± 2.2 points at the final follow up. **VAS and NDI score:** the mean NDI improved from 30.33 ± 1.6 to 14.22 ± 1.8 at the final follow up.

Neurological outcomes: There were 22 patient with quadriparesis grade 3 (power) in 4 limbs and 6 patients with weakness of both lower limbs grade 4 (power). Sphincteric affection was in 18 patients in the form of precipitancy. Post operative and at the end of follow up, 8 patients regain full power, 14 patients have got improvement in lower limbs and 6 patients remain stationary.

According to The European Myelopathy Scoring (EMS), the mean pre-operative EMS was 10 points, and improved to 16 at the end of follow up. As regard the duration of symptoms, we can classify into 3 groups, less than 6 months (6 patients), from 6 to 12 months (10 patients) and more than 12 months (12 patients). The difference between the groups pre-operative EMS was statistically none significant ($P\{0.001}$) while was statistically significant post operative ($p\{0.542}$). That means, EMS is directly related to the duration of symptoms (**Table 3**).

3.2. Radiologic Outcomes

The mean Cobb angle improved from 10° to 2.8° . The mean disc height improved from 4 to 5.9. The fusion has been achieved in 22 patients within 11 months in all levels and in 3 levels in 4 patients due to cage displacement, (2 out of follow up) (**Table 4**, **Table 5**).

Horseness of voice has been seen in 18 patients post operative, recovery has been achieved within 1st week in 15 patients and the other 3 patient improved after 1 month. 14 patients had got dysphasia that improved within 72 hours post operative. Fusion failure had been seen in 4 patients in one level for each secondary to anterior displacement of the cage with no other major complications. One case developed post operative CSF leakage the stopped on 3rd day.

Table 3. Odom criteria.

EXCELLENT	8 PATIENTS (28.5%)
GOOD	14 PATIENTS (50%)
FAIR	6 PATIENTS (21.5%)
POOR	0

Table 4. Pain score: VAS showed gradual improvement, only two cases had chronic pain.

Table : Visual analogue Scale	
Time	VAS
6 weeks	4.2 ± 0.91
3 months	3.6 ± 0.98
6 months	3.14 ± 1.007
9 months	2.57 ± 0.92
12 months	2.03 ± 1.10
18 months	1.46 ± 0.98
24 months	0.80 ± 1.32

Table 5. Complications.

Complications	Number of patients	Incidence
Temporary hoarseness	18	64.2%
Temporary dysphagia	14	50%
Graft displacement	4	14.2%
Failure of fusion	4 levels in 4 patients	0.03% (as 112 levels)
Cerebrospinalfluid	1	0.03%
Epidural hematoma	0	0%
C5 palsy	0	0%
Infection	0	0%

4. Discussion

Some studies reported on the surgical plan for multilevel CSM; however, the option of surgical approach remains debated. But recently the anterior approaches are extensively applied for surgical treatment of multilevel CSM, which can directly decompress the spinal cord and nerve root due to discs herniation or ossification [11]. The decision to perform a surgical operation for CSM must take into consideration the patients' age, symptom severity, baseline function, and the patient's overall health [12]. In a meta-analysis, the anterior approach achieves slightly better recovery of neural function than the posterior approach in patients with multilevel cervical spondylotic myelopathy [13]. Cage assisted ACDF is safe and effective because it prevents graft collapse and enables indirect foraminal decompression by restoring intervertebral height and lordosis [14].

A stand alone cervical cage has been used for 1st time by Bag by in 1988, then it became widely used worldwide [15]. ACDF using a standalone cage without plating has achieved favourable outcome. The use of multiple standalone PEEK cages for multilevel cervical spondylotic myelopathy has achieved good mid-term outcome at 4 years [16].

Adjacent-level degeneration is associated with disease progression rather than surgery. Greater strain is placed above 3 to 4 levels of fused segment [17]. Nonetheless, the 5-year incidence of adjacent-level degeneration is 8.7% after 3-level ACDF and 0% after 4-level ACDF [18].

Cervical corpectomy was initially used for the treatment of 4-level CSM [19]. However, a study comparing three reconstructive techniques demonstrated that anterior cervical corpectomy and fusion (ACCF) was associated with high blood-loss, low fusion rate, a high incidence of postoperative complications, and relatively poor cervical lordosis restoration. On the basis of these findings ACCF is no longer considered the correct choice for treating multilevel CSM [20].

Hwang *et al.* revealed that stand alone cage for 3 and 4 levels are better than plate fixation with the lower post operative complications and hospital stay [21].

This result has been confirmed by **Bucceiro *et al.***, Who applied stand alone PEEK cages in 4 levels cervical discs and concluded that this method is an effective procedure for 4 levels cervical spondylotic myelopathy [22].

4.1. Clinical Outcomes

In this study, the mean pre-operative EMS was 10 points, and improved to 16 at the end of follow up, comparing to **Chiles *et al.***, they reported that the mean EMS preoperative was 9 and raised to 16 post operative at the end of follow up period (7 years) [23].

As regard postspinal surgery pain the study showed marked improvement of the cases, only two patients continue suffering of pain which had various causes as Rigoard P, Blond S, *et al.* [24] explained that may be due to residual stenosis, epidural fibrosis, instability, a synovial cyst, a pseudomeningocele, arachnoiditis, internal disk disruption, e, reflex sympathetic dystrophy, and psychological problems have been suggested as possible etiologies of neuropathic pain after spinal surgery [25].

4.2. Postoperative Complications

A previous study compared the incidence of complications (including graft subsidence, graft dislocation, hoarseness, dysphagia, C5 nerve root palsy, cerebrospinal fluid leakage, and incision infection) following the repair of 4-level CSM with three different reconstructive techniques using an anterior approach. The results suggested that ACDF was associated with the lowest incidence of pseudarthrosis and the zXZ highest incidence of laryngeal nerve-related complications. However, the highest overall incidence of complications was been found in Cervical corpectomy and fusion group [26].

4.3. Adjacent Segment Degeneration

For patients with multilevel CSM, the incidence of postoperative adjacent segment degeneration (ASD) after anterior cervical fusion has been estimated at about 9% [27]. Previous studies suggest that the biomechanical changes of the cervical spine involved in the fusion of multiple segments may increase the mobility of adjacent segments, which in turn, increases compression on the intervertebral discs and accelerates disc degeneration. However, other research suggests that ASD is caused by the dual action of natural and accelerated degeneration of adjacent segments [28]. Other studies have shown that the incidence of ASD is significantly lower after anterior cervical fusion undertaken for multilevel disease than for single-level disease [29]. In our series of patients there was no evidence of ASD after a follow-up of 2.5 years.

4.4. Fusion Failure

In our study, there were only 0.03% incidence of fusion failure over 112 levels but Maughan *et al.* reported 0.04 fusion failure over 440 levels [30].

5. Conclusions

Multilevel ACD and Fusion by standing alone PEEK cages are safe and effective for multilevel cervical spondylotic myelopathy and achieve satisfactory mid-term clinical and radiological outcome with minimal intra-operative and post-operative complications.

There were **some limitations** to this study. It was a small number of patients. Bone fusion was assessed using radiography; computed tomography was not routinely used. Comparison with other reconstructive procedures was not made. The patients' lifestyles and occupations were not considered, numeric rating scale (NRS) better to be used for assessment of pain instead of VAS score.

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