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# ACDF Using Stand-Alone PEEK Cervical Cages in Management of Multilevel Cervical Spondylotic Myelopathy

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## Abstract

**Background:** When degenerative abnormalities in the cervical spine cause external compression on the spinal cord, it can impede the cord's ability to function and disrupt its blood supply. This condition is known as cervical spondylotic myelopathy or CSM.

**Aim and objectives:** In the treatment of multilayer degenerative cervical myelopathy, the objective is to evaluate standalone cervical cages, clinical and radiological outcomes, and quality of life.

**Patients and methods:** This is a prospective study carried out on a total number of twenty patients diagnosed with multi-level cervical disc disease (more than 2 levels) Between October 2021 and September 2023, patients at Al-Hussein and Sayed Galal University Hospitals had anterior cervical discectomy and fusion using standalone PEEK cages.

**Results:** To rule out cervical spondylotic myelopathy, a thorough neurological examination must be performed on any elderly patient presenting with walking difficulties. The gold standard for diagnosing CSM is an MRI or a simple X-ray. Early diagnosis, which results in low grade myelopathy and short symptom duration, is essential for excellent to good outcome. Age, myelomalacia, and the presence of bladder symptoms are all variables that can be used to predict a patient's outcome. High rates of symptomatic relief and clinical and functional outcomes are expected after ACDF using standalone PEEK cages (mean recovery rate of 60.09% and 80% excellent to good functional outcome). The good end plate preparation and use of stand-alone PEEK cages filled with graft give the optimal condition for fusion and successful outcome.

**Conclusion:** A thorough neurological examination is necessary for any elderly patient experiencing difficulty walking in order to rule out cervical spondylotic myelopathy. The gold standard for diagnosing CSM is an MRI, CT scan, and plain X-ray.

**Keywords:** Cervical cages; PEEK; Degenerative cervical myelopathy

## 1. Introduction

CSM is defined as a degenerative illness of the cervical spine that causes malfunction of the spinal cord due to either or both of the cord's vascular supply or extrinsic compression. This type of spinal cord impairment is the most common in adults over fifty.<sup>1</sup>

Patients with myelopathy are commonly characterized by spasticity and hyperreflexia. Spondylotic cervical cord compression detected by imaging methods, mostly MRI, is a prerequisite for the clinical diagnosis of CSM.<sup>2</sup>

To accomplish the greatest amount of decompression without sacrificing spinal stability is the aim of surgical treatment.<sup>3</sup>

With the anterior approach, decompression is accomplished more directly, allowing for the

fusion of levels two, three, and four to stabilize and repair abnormalities. Conversely, when more than four levels are impacted, the posterior approach—an indirect decompression technique—is usually employed. It depends on the spinal cord's capacity to move posteriorly inside a wider canal. For this reason, those who have preoperative kyphosis are not good candidates for a posterior technique.<sup>4</sup>

Maximal decompression without sacrificing spinal stability is the aim of surgical treatment. Due to the wide range of clinical and radiological presentations, developing a surgical protocol in CSM has been negatively impacted.<sup>3</sup>

The ductile, thermoplastic polyether ketone (PEEK) spacer has a modulus that is similar to cortical bones, which may have advantages in load sharing and stress distribution. This could also reduce the loss of long-term cervical lordosis. PEEK cages also have a high degree of biocompatibility. Most individuals who get appropriate operational management recover satisfactorily from myelopathy; patients who receive operative treatment early in the course of the disease and those with fewer comorbidities are more likely to see improvement.<sup>5</sup>

The work's objective is to assess the standalone cervical cages in management of multilevel degenerative cervical myelopathy as regard clinical and radiological outcomes and quality of life.

## 2. Patients and methods

This is a prospective study was conducted on twenty patients with multi-level cervical disc disease (more than two levels) underwent anterior cervical discectomy and fusion using standalone PEEK cages at the Al-Hussein and Sayed Galal university hospitals, Faculty of Medicine, Al-Azhar University, between October 2021 and September 2023.

**Inclusion Criteria:** Patients with symptomatic multilevel cervical spondylotic myelopathy affecting more than 2 levels, age 25–70 years old, and failed conservative treatment for 6 weeks.

**Exclusion Criteria:** Individuals with systemic or local infections, patients under 25 years of age, patients with single or double levels cervical disc disease, individuals with active rheumatoid arthritis or any other illnesses like COPD or ischemic heart disease that would raise the risk of surgery or interfere with natural healing.

**Methods:** Consist of preoperative evaluation, operative technique, postoperative complications, and postoperative follow-up. Proper informed written consent was obtained from the patients preoperatively, indicating that they would be a part of the study.

**Preoperative Evaluation:** All patients were subjected to:

**Clinical Evaluation:** Consists of history taking, general, local, neurological examination, and assessment of the severity of myelopathy by mJOA score, Visual Analogue Score (VAS), and neck disability index (NDI). The patient's most disturbing issue overall was the one that was presented. The current history assessed the condition's beginning, progression, and duration.

**Neurological symptoms:** 13 patients (65.0%) complaining of axial neck pain, 18 patients (90.0%) with difficult walking and heaviness in lower limbs, 19(95.0%) patients with difficulty in performing fine hand movement (clumsy hand), 18 patients (90.0%) with sensory symptoms in the form of paresthesia of both upper limbs, 2 patients (10.0%) with bladder disturbance symptoms (frequency, incontinence or retention), and 13 patients (65.0%) with brachialgia.

**Examinations:**

**Inspection of patient's gait:** In line with Nurick's disability categorization<sup>6</sup>, we noticed that 18 (90.0%) patients have abnormal shuffling gait.

**Examination of the neck ROM:** the presence of positive L'hermitte sign in 8(40.0%) patients.

**Motor system examination of the lower and upper limbs:**

Inspection of muscles, whether normal or wasted, if it is wasted, whether it is unilateral or bilateral, symmetrical or asymmetrical. Inspection for the presence of muscle fasciculation. Examination of muscle tone is done by passive flexion and extension of all joints and shaking of wrist, ankle, and leg. Examination of motor power in the upper limb (shoulder, elbow, wrist, and hand) and lower limb (hip, knee, and ankle), Based on the muscle grading system established by the British Medical Research Council (MRC).

**Examination of sensation in the upper and lower limbs:**

**Examination of superficial sensations (to pain and touch sensation):** For pain, use a pin, and for touch, use a piece of cotton. Examination of deep sensations (Joint position and movement and vibration sensation) was done to determine posterior column affection. Examining the great toes with a tuning fork or assessing the perception of toe or ankle position might identify the loss of vibratory sensation. Romberg's sign: a test for position sense was done for all cases and was positive in 5 (25.0%) patients. Examining the Upper Limb's Reflexes: Below the compression level, there is an increase in upper extremity reflexes. Because of nerve root compression, they could be reduced or nonexistent at or above the degree of compression.

**Examination of Reflexes in the Lower Limb:**

Lower extremity reflexes, such as those in the knee and ankle, are stronger when there is no spinal disease.

### 3. Results

Table 1. Comparison between mJOA pre and 3,6,12 months post operative among the studied patients.

MJOA	PRE	3	6	12	GAIN	RR	TEST VALUE	P-VALUE	SIG.
		MONTHS	MONTHS	MONTHS					
MEA±	7.70±	12.28±	13.0±	13.2±	5.55±	61.08±	-17.798*	0.000	HS
SD	1.66	2.0	1.1	1.59	1.39	14.13			
RANGE	6-12	11-16	11-18	6-13	4-9	40-81.81			

P-value: Probability value, P-value>0.05: Non significant; P-value < 0.05: Significant; P-value<0.01: Highly significant, \*: Paired t-test

The mean pre-operative mJOA score was 7.70 SD±1.66 while the mean post-operative mJAO score at 3 months follow up 12.28±2.0, then 13.0±1.1 at 6 month and significant improvement at 12 month follow up 13.25±1.59 in comparison to preoperative score, Tables 1 and 2.

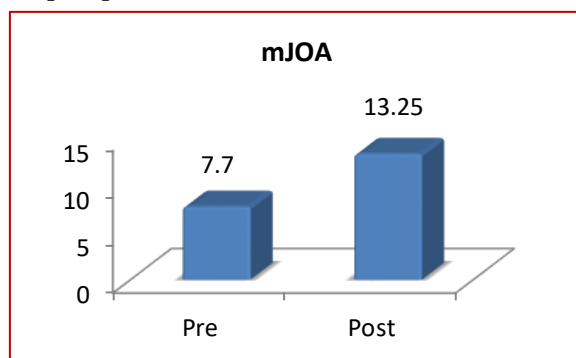


Figure 1. Comparison between mJOA pre and 12 months post operative among the studied patients.

Table 2. Comparison between pre and post operative gait function and pain scoring among the studied patients.

SCORE TYPE	PREOPERATIVE	POSTOPERATIVE	SHORT TERM POST-OP	LONG TERM POST OP	P-VALUE
VAS NECK	6.08±2.14	3.48±1.81	1.01±1.01	0.3±0.57	<0.001
VAS UL	8.72±0.99	4.08±1.85	2.38±1.47	0.23±0.43	<0.001
NDI	35.16±4.84	30.78±5.28	19.02±3.81	8.2±4.44	<0.001
NURICK	2.9±0.6	1.8±0.7	1.6±0.87	1.1±0.6	<0.002

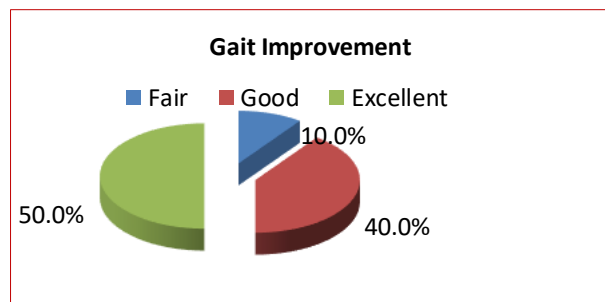


Figure 2. Postoperative clinical outcome (gait improvement) of the studied patients.

Table 3. Postoperative clinical outcome of the studied patients.

	NO.=20
MOTOR WEAKNESS IMPROVEMENT	G2/5-G4/5 7(35.0%) G3/5-G4/5 11(55.0%) G3/5-G5/5 2(10.0%)
GAIT IMPROVEMENT	Good 8(40.0%) Excellent 10(50.0%)
SPHINCTERIC IMPROVEMENT	Positive 2(10.0%)

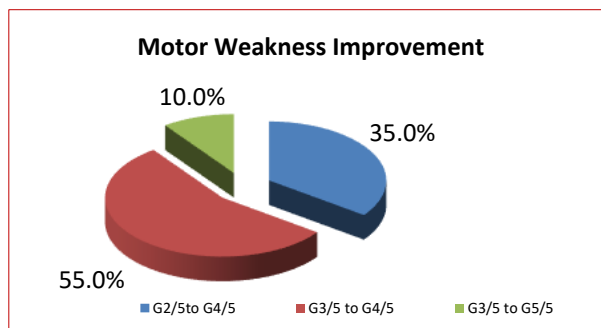


Figure 3. Postoperative clinical outcome (motor weakness improvement) of the studied patients.

Table 4. Relation between outcome of the studied patients with radiological findings and IMHSI.

		UN COMPLICATED	COMPLICATED	TEST VALUE	P-VALUE	SIG.
		No.=14	No.=6			
STENOTIC LEVELS	C3-4	5(35.7%)	0(0.0%)	2.857*	0.091	NS
	C4-5	9(64.3%)	6(100.0%)	2.857*	0.091	NS
	C5-6	14(100.0%)	6(100.0%)	-	-	-
	C6-7	9(64.3%)	6(100.0%)	2.857*	0.091	NS
IMHSI	Negative	9(64.3%)	1(16.7%)	3.810*	0.051	NS
	Positive	5(35.7%)	5(83.3%)			
MOTOR WEAKNESS IMPROVEMENT	G2/5-G4/5	5(35.7%)	2(33.3%)	1.076	0.584	NS
	G3/5-G4/5	7(50.0%)	4(66.7%)			
	G3/5-G5/5	2(14.3%)	0(0.0%)			
GAIT IMPROVEMENT	Fair	0(0.0%)	2(33.3%)	10.476	0.005	HS
	Good	4(28.6%)	4(66.7%)			
	Excellent	10(71.4%)	0(0.0%)			

P-value>0.05: Non-significant; P-value<0.05: Significant; P-value<0.01: Highly significant, \*:Chi-square test

There was no statistically significant difference found between uncomplicated and complicated groups regarding stenotic levels. Also, while the percentage of IMHSI was higher in complicated group (83.3%) than non-complicated group (35.7%) but did not reach statistically significant with p-value=0.051 Perhaps because there are fewer patients, Table 4.

Table 5. Distribution of numbers of fused cervical levels by radiological findings among the studied patients.

SPINAL LEVEL	TOTAL NO.=20
C3-4	10(50.0%)
C4-5	15(75.0%)
C5-6	20(100.0%)
C6-7	15(75.0%)

In this study a total number of 60 cervical levels were decompressed and fused with C5-6 level being the most commonly level affected in 20 patient (100%) followed by C4-5 level in 15



patients (75%) then C6-7 level account 15 patient (75%) and C3-4 level was affected in 10 patients (50%).

On plain radiographs, sagittal alignment was assessed using the lateral C2-C7 Cobb's angle. Cobb's angle, which measures the distance between the inferior end plates of the C2 and C7 bodies, is used to determine the alignment of the cervical spine. The C2-C7 Cobb' angle was used in our investigation to detect postoperative lordotic alterations in cervical global alignment. During the first surgical follow-up period, Cobb's angle increased. Subsequently, there were no statistically significant changes in cervical lordosis at the 6-month follow-up. Compared to the value at six months, there was a small decrease of lordosis of the mean C2-C7 angle at the 12-month follow-up, [Table 5](#).

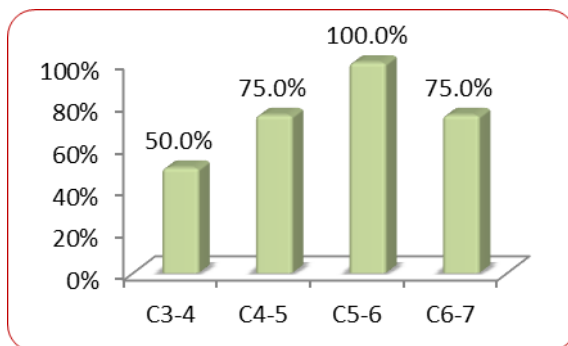


Figure 4. Distribution of numbers of fused cervical levels.

#### Case Presentation

A male patient 56 years old with axial neck pain (broad based gait) radiating to right shoulder 6 months ago suffering from difficulty in walking and performing fine hand movements, numbness and clumsiness of both hands more at right side. Neurological Examination of upper limb represented by motor exam on the right sided weakness of hand grip with weak elbow flexion and wrist extension (grade 2/5) and (grade 4/5) on left side. Sensory exam is intact and Reflexes in the form of exaggerated biceps and triceps reflexes bilaterally more at Rt side. Pathological reflexes resulted by, +ve Inverted radial reflex on Rt side, +ve Grip & release sign on both hands, +ve Finger escape sign on Rt side, and +ve Hoffman's sign on both side

Neurological Examination of lower limb was done represented by, Motor exam: weakness of hip flexors and knee extensors bilaterally (grade 4/5), Sensory exam: intact superficial and deep sensation bilaterally, reflexes: exaggerated knee and ankle jerk, and finally, pathological reflexes give positive Babinski's sign bilaterally and the preoperative mJOA score was 9.

lateral and AP radiographs A plain x-ray showed posterior osteophytes more clearly visible at C5-6 and C6-7 levels, a straightening of the

cervical curvature, and small disc gaps at C4-5, C5-6, and C6-7. Multi-level disc prolapse at C4-5, C5-6, and C6-7 was seen on the cervical spine MRI, along with anterior cord compression at C5-6. Rear osteophytes are particularly noticeable at levels C5-6 and C6-7 on a CT scan.

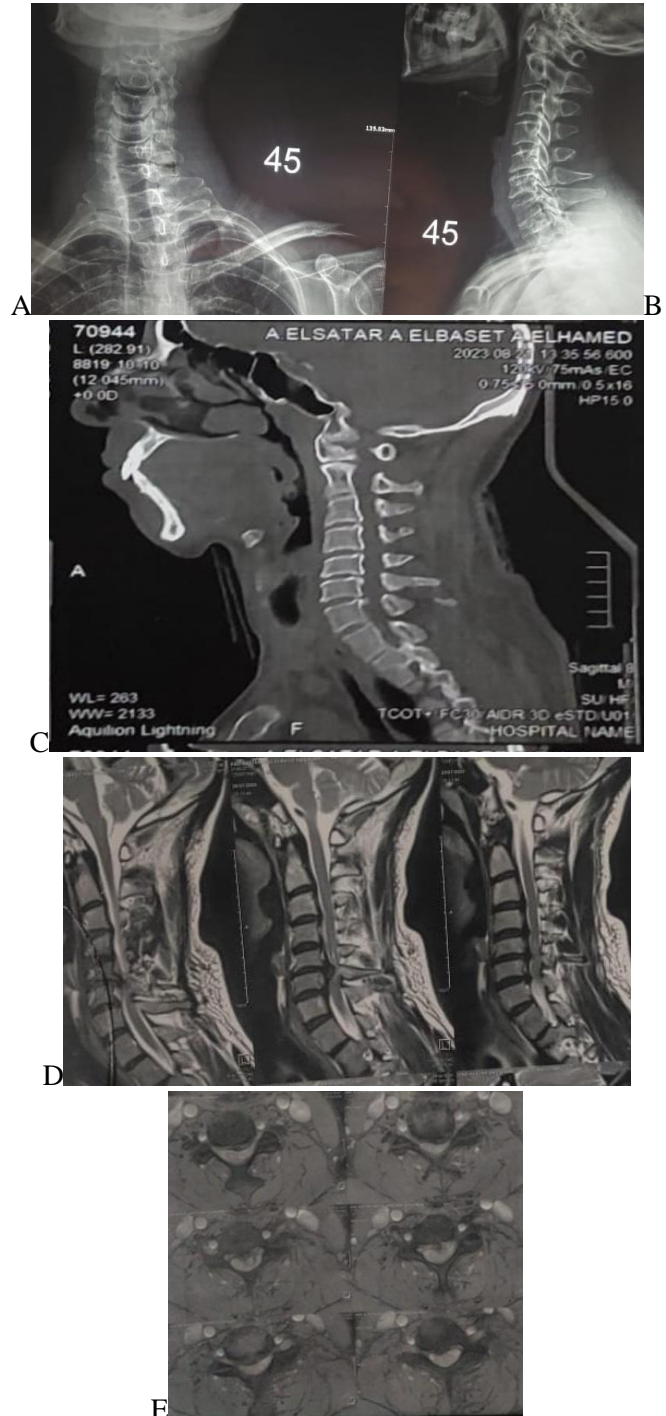


Figure 5. Preoperative X-ray: (A) AP view and Lateral view showing kyphotic sagittal alignment with narrowing of disc spaces C4-5, C5-6, C6-7, (C) CT scan show posterior osteophytes (D, E) MRI: Sagittal and axial views showing C4-5&C5-6 &C6-7 disc prolapses.

### Surgical procedure:

The patient was treated by multilevel ACDF of C4-5 & C5-6 and C6-7 discs, followed by insertion of PEEK cages filled with autogenous graft. (Figure 6).

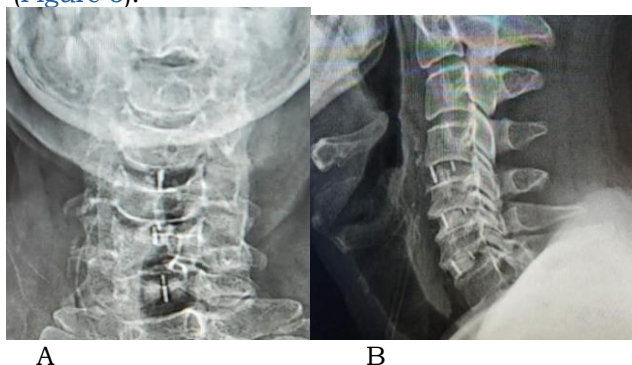


Figure (6): Immediate Post-Operative X-ray, A) AP view, B) Lateral view.

### Outcome:

Dramatic improvement of gait, hand function, sensory and bladder symptoms was noted within few days. Follow up after 6 months there was good bony fusion Figure 7 and final follow up 12 months later showing excellent fusion Figure 8 with excellent functional outcome. The mean increase in the mJOA score was 6, the recovery rate (RR) was 75%, and the final postoperative mJOA score was 15.

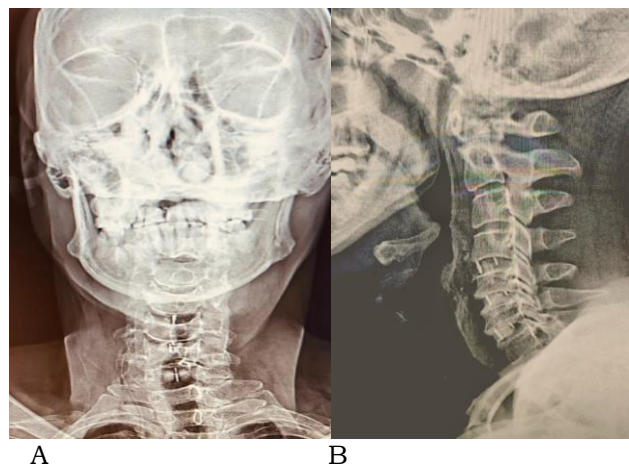


Figure 7. Follow up x-ray (6 months), A) AP view, B) Lateral view showing good fusion.

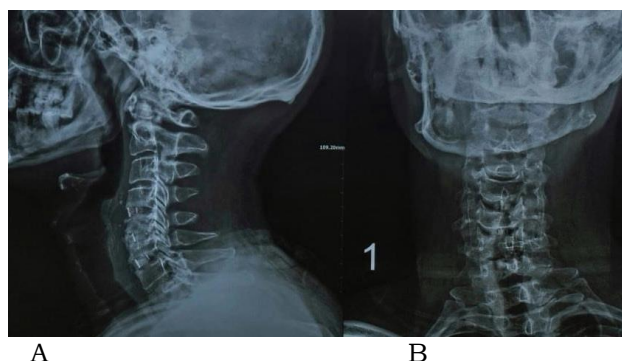


Figure 8. Follow up x-ray (12 months), A) AP view, B) Lateral view showing excellent fusion.

### 4. Discussion

In current study; 97.4% of patient in this study showed neurological improvement using mJOA as patients improved from preoperative  $7.70 \pm 1.66$  to 6-month postoperative mJOA score  $13.0 \pm 1.1$ . Also, much improvement with long term follows up until reached  $13.25 \pm 1.59$  after 1 year.

In the series of Bapat et al.<sup>3</sup> the average mJOA score was  $10.75 \pm 3.44$  and the postoperative one is  $16.01 \pm 1.4$ .

The mean preoperative mJOA among the study group was this is lower than the study of Fehling et al.<sup>7</sup> which included cases with mean mJOA of 12.85.

Misalignment has the potential to exacerbate the biomechanical strain on nearby segments and encourage degenerative alterations in those segments. The C2-C7 sagittal Cobb's angle was used in this investigation whenever it was practical.

As determined by the C2-C7 Cobb's angle, we observed a lordotic shift in cervical global alignment in our study, indicating that a rise in Cobb angle was attained in the early postoperative follow-up period. The observed change did not approach statistical significance six months after ACDF. In comparison to the data at 6m, we observed a minor reduction of lordosis of the mean C2-C7 angle at 1 year. Han et al.<sup>8</sup> observed a mean shift in lordosis of  $1.08^\circ$  at the 12-month mark.

Eugene Pak-Lin Ng<sup>9</sup> said that the average C2-7 angle before surgery was  $8.19 \pm 13.2$ , the average angle after surgery was  $11.5 \pm 14.1$  after six months, and the average angle after a year was  $10.9 \pm 14.5$ . Up to a year following ACDF, there was a lordotic change in the mean C2-7 angle, but the difference did not become statistically significant.

Pedro Joachin-Hernández<sup>10</sup> It was noted that in instances with pre-surgical global lordosis with a median value of 22 degrees (ranging from  $-16^\circ$  to  $52^\circ$ ), significant alterations were observed after 1 year, with a median value of 20 degrees (ranging from  $-6^\circ$  to  $40^\circ$ ).

In our study at 12 month 57 of 60 levels were graded as fused. This resulted in a fusion rate of 95%. two patients show delayed fusion at 9 months and one patient shows delayed fusion 1 year without significant complain.

Li et al.<sup>11</sup> showed that although none of the 11.1% of patients who had standalone four-level ACDF employing polyetheretherketone (PEEK) cages had symptoms, revision was not necessary.

De la Garza-Ramos et al.<sup>12</sup> found that after completing instrumented ACDF for four-level illness, the pseudoarthrosis rate was roughly 15.4%.

Twenty participants in this study had three different compression levels. Two patients (10%)

had a fair outcome, and eighteen patients (90%) had good results.

As such, the outcome and the number of fused levels have no discernible correlation.

Furlan et al.<sup>13</sup> imply that the number of impacted levels and the result are not well correlated.

In the study of Bapat et al.<sup>3</sup> the outcome in 79 cases with two levels of CSM was superior to the outcome in 20 cases with multilevel CSM undergoing anterior surgery (96% versus 80% respectively, excellent to good clinical outcomes).

Cabraja et al.<sup>14</sup> Treatment of 154 patients with degenerative cervical disc degeneration with ACDF revealed a 14.3% subsidence rate with PEEK cages; the fusion rates were unaffected by the subsidence rate. While higher disc height change (a relatively large cage) was linked with subsidence, postoperative alignment change was not.

In the study of Fehlings et al.<sup>7</sup> Three out of thirty-two patients had cage migration.

Our study indicates a statistically significant relationship between cervical lordosis and neck pain; the long-term clinical prognosis of ACDF is influenced by the restoration or maintenance of appropriate cervical lordosis.

Using the anatomical PEEK cages allowed us to maintain preoperative lordosis or enhance the cervical spine shape in the great majority of patients, which improved the overall treatment outcomes as measured by VAS neck and VAS UL.

The restoration of cervical lordosis in our study resulted in a significant reduction in pain intensity, as reported on the VAS neck scale, from an average of  $6.08 \pm 2.14$  to  $0.03 \pm 0.057$  at the final follow-up. Additionally, there was an improvement in radicular pain. This decrease in pain can be attributed to the careful decompression of neural structures.

The findings of the present investigation were assessed during an average follow-up duration of 12 months. Patients resumed their employment activities during a period of around 3 to 6 months. The final result was as follows: Out of the total of 10 patients, 50% experienced an excellent outcome, 40% had a good outcome, and 10% had a fair outcome.

Accordingly, ACDF give a better functional outcome, restored function in most of cases, thus enabling them to return to their pre-operative level of functionality.

It has been demonstrated that ACDF with an anterior cervical plate is a successful fusion technique, with lower reported rates of pseudoarthrosis than with the cage-only approach.<sup>15</sup> But there's been increasing interest in using methods like standalone cages that don't require plate fixation because of the

postoperative problems linked to having an anterior plate.

When ACDF was performed using a cage-only technique instead of a traditional cage-plate technique, there was a lower incidence of postoperative dysphagia, intraoperative blood loss, and ASD. However, it was discovered that a cage-only approach resulted in lower postoperative disc height, higher rates of cage sinking, and less cervical lordosis restoration.<sup>15</sup>

After ACDF surgery, postoperative dysphagia is the most frequent side effect. Although the precise cause of dysphagia after ACDF is uncertain, a number of theories have been put forth.

According to Fountas et al., adhesion formation around the front cervical plate, hematoma, soft tissue edema, and esophageal damage may all play a role in the development of dysphagia.<sup>16</sup>

Lee et al. observed a direct association between the thickness of the plate and the incidence of postoperative dysphagia.<sup>17</sup>

According to Fogel and McDonnell's meta-analysis, patients who had previously had ACDF had much lower rates of both acute and long-term postoperative dysphagia when an anterior plate was removed and related esophageal adhesions were dissolved.<sup>18</sup>

Regarding the incidence of ASD, it was discovered that ACDF, using a cage-only strategy, outperformed the traditional cage-plate technique. The mechanical characteristics of intervertebral disks at levels near the fusion are impacted by ACDF using a traditional cage-plate approach, as shown by biomechanical investigations. Adjacent segments experience higher stress and motion following fusion, which may hasten the onset of ASD.<sup>19</sup>

A primary apprehension of ACDF regarding a standalone cage is the possible escalation in the cage sinking rate.

According to studies, cage subsidence may result in hypermobility in the posterior cervical region and localized cervical kyphosis. It is noteworthy to mention, nonetheless, that a comprehensive evaluation that was previously published concluded that cage subsidence after ACDF had no effect on fusion rates or clinical outcomes.<sup>20</sup> A systematic review that was previously published indicated that cage subsidence after ACDF had no effect on fusion rates or clinical outcomes.<sup>20</sup>

One of the current study's shortcomings is the tiny patient population. Computed tomography was not frequently employed; instead, radiography was used to evaluate bone fusion. No comparison with alternative reconstructive techniques was conducted. The lives and occupations of the patients were not taken into account; the VAS score should be replaced with



the numeric rating scale (NRS) for measuring pain.

#### 4. Conclusion

It is necessary to do a comprehensive neurological examination on any elderly patient who complains of difficulty walking in order to rule out the presence of cervical spondylotic myelopathy. Plain X-ray, CT, and MRI are considered the most reliable and accurate methods for diagnosing CSM. Early diagnosis is crucial for achieving a favorable outcome, since it can result in a lower grade of myelopathy and a shorter duration of symptoms. Bladder symptoms, myelomalacia, and patient age can all serve as prognostic markers.

#### Disclosure

The authors have no financial interest to declare in relation to the content of this article.

#### Authorship

All authors have a substantial contribution to the article

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#### Conflicts of interest

There are no conflicts of interest.

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