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Original Research Article

Anterior cervical discectomy & fusion using only cage: An institutional experiences

Poonia Nemi Chand[1], Surendra Jain[2]*, Hardika Poonia[3]

[1]Neuro Care Hospital & Research Centre Pvt. Ltd., Jaipur, Rajasthan, India
[2]Sawai Man Singh Medical College, Jaipur, Rajasthan, India
[3]JNU Hospital, Jaipur, Rajasthan, India

Abstract

Background: Anterior Cervical Discectomy and Fusion (ACDF) using a standalone cage represents a pivotal advancement in the surgical management of cervical degenerative disc disease. This study evaluates the efficacy, safety, and clinical outcomes of ACDF performed with a standalone cage without using plate, aiming to substantiate its utility in clinical practice.

Materials and Methods: A retrospective analysis of 440 patients who underwent ACDF with a standalone cage from 2013 to 2023 was conducted at Neuro Care Hospital and Research Centre in Jaipur, India. Clinical outcomes were assessed using the Nurick grade, Visual Analog Scale (VAS) for neck and arm pain, and the Modified Japanese Orthopedic Association (mJOA) scoring system at the 6-month follow-up. Complications were also recorded.

Results: Significant improvements were observed postoperatively: Nurick grade improved from 1.46 ± 0.90 to 0.40 ± 0.59 ($p<0.001$), neck VAS scores from 4.04 ± 0.77 to 1.66 ± 0.93, and arm VAS scores from 7.25 ± 1.19 to 1.63 ± 0.86 (both $p<0.001$). The mJOA score enhanced from 11.6 ± 1.42 to 15.9 ± 1.76 ($p<0.001$). Complication rates were low, with cage subsidence being the most notable.

Conclusion: ACDF with a standalone cage is effective and safe, significantly improving patient outcomes at 6 months post-surgery with minimal complications, thereby supporting its application as a standard procedure for cervical degenerative disc disease.

Keywords: ACDF, Standalone cage, Cervical degenerative disc disease, Clinical outcomes, Safety.

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1. Introduction

ACDF represents a cornerstone surgical intervention for patients suffering from symptomatic cervical disc disease that is unresponsive to conservative management. The procedure involves the exclusion of the problematic disc, followed by the fusion of the adjacent vertebrae to stabilize the cervical spine.[1] This method entails the removal of the afflicted disc, facilitating the fusion of the adjacent vertebral segments to secure the cervical spine's stability. Innovations in techniques and the development of various implants have progressively improved the safety and effectiveness of ACDF, notably through the introduction of intervertebral cages. These devices are crucial for preserving the alignment of the cervical spine and the height of the disc space while fostering bone fusion between vertebrae.[2,3] The adoption of cages has been associated with favorable outcomes in treating degenerative disc disease surgically.[3]

Historical data reveal an evolution in preferences toward cage materials, from titanium and carbon fiber to poly ether ether ketone (PEEK), each offering distinct advantages.[4] Moreover, the practice of augmenting fusion with an anterior plate to bolster stabilization has gained traction due to its perceived benefits in enhancing fusion rates. However, the emergence of complications from combining interbody cages with anterior plating has prompted a shift towards investigating alternative solutions to mitigate such issues.[5]

In response to these challenges, a novel variant of the PEEK cage and titanium cage has been developed. These stand-alone, self-locking cage features anti-migration teeth, obviating the need for plates and screws by providing immediate stabilization akin to traditional stabilization

*Corresponding author: Surendra Jain
Email: neurocare2013@gmail.com

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methods. Furthermore, these cages have been shown to aid in the restoration of cervical lordosis while avoiding the complications typically associated with anterior plating.[6]

Given this background, our study aims to scrutinize the effectiveness, safety, and patient outcomes of utilizing a standalone cage in ACDF procedures for the treatment of cervical degenerative disc disease, without resorting to additional stabilizing hardware.

2. Materials and Methods

2.1. Study design and participants

This retrospective study analysed the outcomes of anterior cervical discectomy and fusion (ACDF) surgeries performed between 2013 to 2023 at Neuro Care Hospital and Research Centre in Jaipur, India. A overall of 440 patients were involved, comprising 326 males & 114 females. The contributors were stratified based on their age and the level of ACDF surgery (single, double, or triple level). Titanium cage used in each cases and using autologus bone graft filled in to cage.

2.2. Criteria for inclusion

All individuals over 18 years old who showed symptoms of cervical myelopathy /radiculopathy or both, supported by Magnetic Resonance Imaging (MRI) results and clinical features.

2.3. Exclusion criteria

Excluded from the study were patients with a history of trauma, patients with previous cervical surgery, and cervical Ossified Posterior Longitudinal Ligament (OPLL).

2.4. Age distribution

Participants were divided into 6 age groups: 0-10, 11-20, 21-30, 31-40, 41-50, 51-60, and over 60 years as provided in Table 1.

2.5. Surgical groups

The patients were categorized into three groups based on the surgery type:

1. Group A (Single-level ACDF),
2. Group B (Double-level ACDF
3. Group C (Triple-level ACDF)

The specific cervical levels involved in the surgeries are detailed for each group given in **Table 2**.

2.6. Operative time

The operative time varied by group, with single-level ACDF procedures (**Figure 1**) averaging 90-100 minutes, and double-level procedures (**Figure 2**) ranging between 120-139 minutes. The operative time for triple-level ACDF surgeries (**Figure 3**) were 160-180 minutes.

2.7. Outcome measures

The effectiveness of the surgeries was evaluated using several metrics:

1. Visual Analog Scale (VAS): The VAS is a commonly used tool to measure pain intensity. Clinically, VAS ratings can be categorized as follows: 0 to 4 mm: No pain, 5 to 44 mm: Mild pain, 45 to 74 mm: Moderate pain, 75 to 100 mm: Severe pain
2. Nurick Grade to assess the severity of myelopathy. It uses a 6-grade scale:
   Grade 0: "Root symptoms only or normal"
   Grade 1: "Signs of cord compression; normal gait"
   Grade 2: "Gait difficulties but fully employed"
   Grade 3: "Gait difficulties prevent employment; walks unassisted"
   Grade 4: "Unable to walk without assistance"
   Grade 5: "Wheelchair or bed-bound"
3. Modified Japanese Orthopaedic Association (mJOA): The mJOA assesses functional status in patients with degenerative cervical myelopathy (DCM).
   Mild myelopathy: mJOA from 15 to 17
   Moderate myelopathy: mJOA from 12 to 14
   Severe myelopathy: mJOA from 0 to 11

Subsidence and complications, including cage subsidence, transient dysphagia, and transient hoarseness were recorded. The incidence of these complications was compared across the three groups.

2.8. Statistical analysis

The changes in VAS scores, Nurick Grade, and mJOA scores from preoperative to 6-months postoperative periods were analyzed via paired t-tests, with P-values less than 0.05 considered statistically significant using SPSS version. Z-values were also calculated to measure the effect sizes of the interventions. The incidence of subsidence and complications was reported descriptively

3. Results

The majority of ACDF surgeries were performed on patients aged 41-50 (148 cases), with a male predominance across all age groups. No surgeries were reported for patients aged 0-20.(**Table 1**)

Table 1: Distribution of ACDF patients (N=440) by age and gender

Age	Male	Female	Total
0 to-10	-	-	-
11-20	-	-	-
21-30	10	4	14
31-40	62	18	80
41-50	110	38	148
51-60	90	32	122
>60	54	22	76

Table 2: Distribution of ACDF surgeries by cervical level and gender

Single level ACDF (Group A N=290 Cases)	**Level**	**Male**	**Female**
	C2-C3	16	5
	C3-C4	26	9
	C4-C5	62	22
	C5-C6	48	13
	C6-C7	35	9
Double-Level ACDF Surgeries (Group B, N=127 cases)	**Level**	**Male**	**Female**
	C3-C4 & C5-C6	19	7
	C3-C4&C6-C7	28	12
	C5-C6&C6-C7	23	9
	C4-C5 &C5-C6	21	8
Triple-Level ACDF Surgeries (Group C, N=68 cases)	**Level**	**Male**	**Female**
	C3-C4, C4-C5, C5-C6	48	20

Table 3: Assesement of pain before and after surgery through VAS scores, nurick grade, modified japenese orthopedics (mJOA) scores

	Time	Mean	SD	P-value	Z-value
VAS Scores for Neck Pain	Pre op	4.06	0.77	<0.001	12.90
	6 months post-operative	1.67	0.93		
VAS Scores for arm Pain	Pre op	7.15	1.19	<0.001	12.1761
	6 months post-operative	1.53	0.86		
Nurick Grade Outcomes	Pre op	1.46	0.90	<0.001	11.9843
	6 months post-operative	0.40	0.59		
Modified Japenese Orthopedics (mJOA) Scores	Pre op	11.9	1.42	<0.001	11.880
	6 months post-operative	15.6	1.76		

In our study **Table 2** showed that the most common level for single-level ACDF was C4-C5 (84 cases), with a higher male incidence across all levels. Operative time averaged 90-100 minutes. This table also show C3-C4 & C6-C7 combination was the most frequent for double-level ACDF (40 cases), showcasing a consistent male predominance. Operative time was longer, averaging 120-139 minutes. Triple-level ACDF surgeries predominantly involved the C3-C4, C4-C5, & C5-C6 levels, with a significant male majority (48 cases).

Our study suggested significant improvement in neck pain and arm pain was observed postoperatively (Pre-op: 4.06 ± 0.77, Post-op: 1.66 ± 0.93, p value <0.001), with a notable reduction in pain scores. (Pre-op: 7.15 ± 1.19, Post-op: 1.53 ± 0.86, p<0.001) respectively. Nurick grade also showed significant improvement in outcome postoperatively which indicate enhanced neurological function (Pre-op: 1.46 ± 0.90, Post-op: 0.40 ± 0.59, p <0.001). Significant improvements were also observed in mJOA scores post-surgery (Pre-op: 11.9 ± 1.42, Post-op: 15.6 ± 1.76, p<0.001), reflecting recovery in spinal cord function.(**Table 3**)

Following the results 'observation, it is also suggested that subsidence were observed in total of 11 patients across all groups, with the distribution being 6 patients in Group A (5.2% of Group A), 2 patients in Group B (1.7% of Group B), and 3 patients in Group C (4.4% of Group C). Regarding complications, cage subsidence was noted as a specific issue. Additionally, transient dysphagia and transient hoarseness were identified, with both conditions being more commonly

reported in Group C compared to Group B which recovered within 1- 2 months.

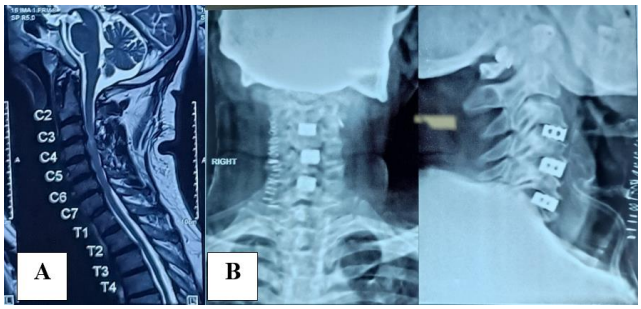

Figure 1: A: Sagittal view of cervical spine MRI suggestive of C3-C4, C4-C5, C5-C6 PIVD; **B:** Post-Operative X-ray (AP and Lateral view) of 3 level ACDF

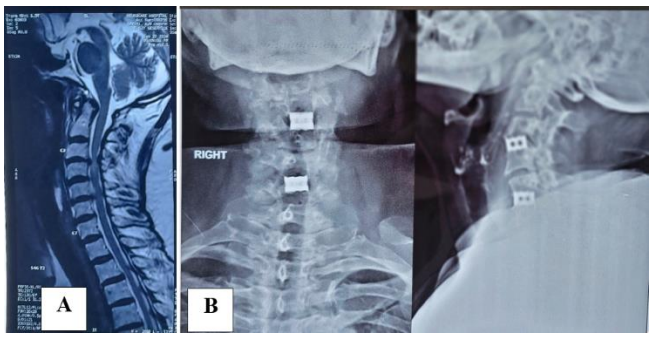

Figure 2: A: Sagittal view of cervical spine MRI suggestive of C3-C4 & C5-C6 Diffuse disc bulge and Hyperintense signal intensity at C3-C4 level; **B:** Post-Operative X-ray of 2 level ACDF

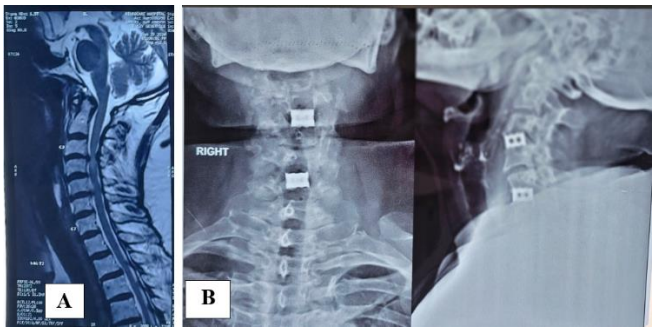

Figure 3: A: Sagittal view of cervical spine MRI suggestive of C4-C5 diffuse disc bulge and Hyperintense signal intensity at C4-C5 level; **B:** Post-operative x-ray of 1 level ACDF

4. Discussion

The findings of this study, focusing on the outcomes of anterior cervical discectomy and fusion (ACDF) using only a cage without additional anterior plating, contribute to the ongoing discourse on the optimal surgical management of cervical degenerative disc disease. Our results indicate significant improvements in pain, neurological function, and a relatively low complication rate, which align with and extend the findings of previous research in this domain. ACDF using cage with plate has been widely performed to treat Multilevel cervical disc disease, including skip-level disease.[7] However, long-segment ACDF has resulted in complications that have been reported in the different literature.[8-14]

Swank et al[9] showed that the incidence of nonunion for ACDF varied depending on the number of disc levels involved: 10% in single-level fusion, 44% in 2-level fusion, and 54% in 3-level fusion. Lowery and McDonough[10] reported that the incidence of anterior plating failures was associated with the number of operated levels: 20% in single-level fusion, 36% in 2-level fusion, 71% in 3-level fusion, and 80% in 4-level fusion. Geisler et al[13] reported the reoperation rates after cervical plate stabilization increased as the number of operated levels increased: 5.8% in single-level fusion, 6.5% in 2-level fusion, 8% in 3-level fusion, and 16.8% in 4-level fusion. In a study by (Chen et al.,2020), a significant incidence of dysphagia was reported at various time points postoperatively.[15] So avoidance of these complication, self-locking stand-alone cervical cages were developed, leading to successful clinical outcomes reported in numerous studies.[5]

The efficacy of cage-only ACDF in reducing neck and arm pain, as evidenced by the marked improvement in Visual Analog Scale (VAS) scores, mirrors the outcomes reported in similar studies. For instance, a comparative analysis by Cheung et al.,(2019), highlighted that patients undergoing ACDF with a standalone cage experienced comparable pain relief and functional recovery to those receiving an additional anterior plate.[16] Another study by (Ahn et al.,2023) using a cage with a plate may lead to complications such as neck pain, hoarseness of voice, and difficulty in swallowing.[17] Contrast to our study, study of Seervi et al. 2023 concluded that anterior cervical plate with expandable cage is better than expandable cage alone in case of corpectomy.[18] In a study conducted by Elsayed & Sakr in 2019, it was found that patients experienced a decrease in neck pain and arm pain, while maintaining neck pain and disability scale over a 12-month period. There were no complications related to the implants, and radiological fusion was achieved within 3 months for all patients treated with a stand alone cage. All patients were free of swallowing difficulties when evaluated three months after the operation Similarly, a study conducted by Wang et al. in 2018, found that neck discomfort and arm pain showed a progressive and consistent improvement after surgery, with the highest ratings observed at the 12-month.[19]

Furthermore, the restoration of neurological function, as assessed by the Modified Japanese Orthopaedic Association (mJOA) score and Nurick grade, underscores the potential of cage only ACDF to effectively address neurological deficits associated with cervical disc disease. These findings are consistent with those of Chen et al.,(2022) who also reported significant neurological improvement post-ACDF with cages, underscoring the procedure's role in decompressing neural elements and stabilizing the cervical spine. In summary our study's findings reinforce the utility of cage-

only ACDF as a viable option for treating cervical degenerative disc disease, with outcomes comparable to those achieved with additional anterior plating. Nevertheless, the decision to use a standalone cage must be carefully considered, considering the specific clinical scenario, patient anatomy, and the surgeon's experience. Future research should focus on long-term outcomes, the evolution of cage technology, and refining patient selection criteria to optimize surgical results further. The limitations of our study was no comparison group with ACDF using plate and cage and short term follow up. Further studies required for establishment of ACDF without plate and need long term follow up.

5. Conclusion

In conclusion, our study conclusively supports the standalone cage method as an effective and safe approach for ACDF, showcasing marked clinical improvements at the 6-month follow-up, including better Nurick grades, and reduced VAS scores for neck and arm pain. This approach not only significantly aids in pain relief and neurological improvement but also reduces the risk of surgical complications, aligning closely with the gold standard for ACDF. Our findings advocate for the adoption of the standalone cage in treating cervical degenerative disc disease, highlighting the need for ongoing innovation and evidence-based advancements in spine surgery practices.

6. Source of Funding

None.

7. Conflict of Interest

None.

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