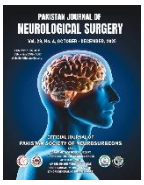

PAKISTAN JOURNAL OF NEUROLOGICAL SURGERY (QUARTERLY) – OFFICIAL JOURNAL OF PAKISTAN SOCIETY OF NEUROSURGEONS

Original Research

Surgical Outcomes of Single-Level Stand-Alone Cage Use in Anterior Cervical Discectomy and Fusion (ACDF)

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ABSTRACT

Objective: To test clinical and radiological outcomes of single-level anterior cervical discectomy and fusion (ACDF) without anterior plating using polyetheretherketone (PEEK) cage as a stand-alone cage.

Materials and Methods: This retrospective study included 24 patients who underwent single-level ACDF between May 2024 and July 2025, with 12 12-month follow-up. All the surgeries were anterior, and PEEK cages were autologous bone-filled. They employed a team that measured the functional outcome of Neck Disability Index (NDI), the Visual Analog Scale (VAS), and Swallowing Quality of Life (SWAL-QOL). Fusion, subsidence, and alignment were the radiological results. An analysis involving 22.0 SPSS was used, and $p < 0.05$ was the cutoff point.

Results: A complete population was maintained for a period of 12 months. At radiograph- 100 percent in fusion. The NDI and VAS scores improved significantly (21.05, 8.10, and 2.25, 1.12, respectively). The assessment of the level of SWAL-QOL was low, and its expression was through dysphagia during follow-up. Subsidence >2 mm with clinical significance was observed in two patients (8.3%). One case (4.2%) of pseudarthrosis and two cases (8.3%) of transient adjacent level radiculopathy were recorded, and no infections were registered, with no reoperations being observed.

Conclusion: Single-level ACDF with the use of standalone cages gives good fusion, improved clinical results, and a low complication rate. Morbidity can subsequently be reduced after the surgery by foregoing anterior plating.

Keywords: Anterior cervical discectomy, stand-alone cage, cervical fusion, postoperative outcomes.

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Date of Submission: 04-07-2025
Date of Revision: 25-11-2025
Date of Acceptance: 28-11-2025
Date of Online Publishing: 01-12-2025

Date of Print: 31-12-2025

DOI: 10.36552/pjns.v29i4.1180

INTRODUCTION

It is not rare to have cervical degenerative disc disease leading to radiculopathy, myelopathy, or

neck axial pain, because of compression of nerve roots or the spinal cord.[1] Anterior cervical discectomy and fusion (ACDF) has always been regarded as the gold-standard surgical treatment of such pathologies.[2] This treatment will relieve neural anatomy, restore disc height, and result in long-term spinal stability via effective interbody fusion.[3]

Historically, ACDF entails the use of an interbody spacer and an anterior cervical plate to offer added stability and encourage fusion. Although anterior plating is successful, there are possible complications that have been correlated to this procedure that include difficulty swallowing, degeneration of the adjacent segment, longer time of operation, and irritation of the soft tissues.[4] Two things have become clear in light of these concerns, though, it has become of interest to conduct stand-alone interbody cages to alleviate the morbidity of anterior plating.[5]

Stand-alone cages, usually made of polyetheretherketone (PEEK) or titanium, are made to produce the segmental stability by use of an interference fit and in-built fixation characteristics in the form of spikes, screws, or ridges.[6] The benefit of these devices is that they provide less amount of surgical exposure, less soft tissue disruption, and possibly a lower complication rate. Nevertheless, concern continues to be exhibited towards cage subsidence, spinal lordosis loss, pseudarthrosis, and the long-term process of keeping an alignment without anterior plate reinforcement.[7]

Although there has been an increasing use of stand-alone cages in ACDF, the literature is inconclusive on the long-term outcome of the procedure, especially in single-level interventional procedures.[8] Others show similar results as the conventional methods, and others document increased potential of subsidence and delayed fusing. In addition, one should add that it has few data on functional outcomes, radiological changes, and complication profile at a standardized follow-up.[9]

Based on these assumptions, this paper seeks to analyze the clinical and radiological outcome of single-level ACDF procedures done with the use of a stand-alone cage with respect to functional improvement, degree of fusion, alignment, and complications in the postoperative period at 12 months follow-up. This study compares subjective and objective measures of outcome to add to the emerging literature supporting the use of stand-alone cages in anterior cervical spine surgery.

MATERIALS AND METHODS

Study Design

This is a retrospective observational study developed in Nasir Teaching Hospital, Peshawar, and took place between May 2024 and July 2025, and it's a follow-up 12 months. The purpose of the study was to evaluate the clinical and radiological rate of single-level anterior cervical discectomy and fusion (ACDF) and their use of stand-alone interbody cages in patients with cervical degenerative disc disease. The Institutional Review Board gave its ethical approval to the study before data gathering, and all the patients signed their informed consent before surgery.

Study Population

This study comprised 24 patients who had single-level ACDF using a stand-alone cage during the study period. The patients included had radiculopathy or myelopathy caused by the degeneration of cervical discs made evident by MRI procedures. The experienced spine surgeons conducted all the procedures through the standardized protocol of an operation.

Inclusion Criteria

Inclusion criteria consisted of adult patients with:

Cervical disc disease (C3 -C7), Non-responsive to non-operative treatment during at least six weeks, Radiological evidence of disc herniation or disc degeneration, Readiness to undergo follow-up assessment

Exclusion Criteria

Multilevel cervical pathology, Prior surgery of the cervical spine, History of infection, tumor, or trauma specific to the level of surgery, and difficulty obtaining all data or noncompletion of 12-month follow-up. Patients with significant comorbidities known to affect fusion outcomes, such as uncontrolled diabetes, osteoporosis, or active smoking, were excluded.

Surgical Technique

General anesthesia in a supine position with the standard Smith-Robinson anterior approach was used in carrying out the surgery on all patients. Following the decompression of the target level, decompaction was achieved by a discectomy procedure, and the neuro elements were extracted. Endplates were dissected indeed with great care not to over-damage. An autologous local bone graft obtained from endplate/disc space shavings was packed into the PEEK cage was subsequently placed in the disc space and positioned fluoroscopically. There was no anterior cervical plate or supplemental fixation.

Postoperative treatment was the same as for any other normal pain management, early mobilization, and a neck collar, with a preference, depending on the surgeon, of 2-4 weeks. Clinical stabilization was attained, and patients were discharged and encouraged to observe early recovery activity restrictions.

Outcome Measures

Patients were Clinically Evaluated Using:

Neck Disability Index (NDI), Visual Analog Scale (VAS) of neck pain, and Swallowing Quality of Life questionnaire (SWAL-QOL) after 6 weeks, 6 months, and 12 months.

Lateral and flexion-extension cervical spine X-rays were used to carry out a radiological assessment. Radiographic fusion was characterized by the lack of motion at the level where the surgery had been performed, and bridging trabecular bone was described. Subsidence was measured by the change in intervertebral height and was analyzed individually in the superior and inferior endplates. The parameters of sagittal alignment, such as cervical lordosis and C2-C7 SVA, were measured before and after the operation.

Follow-Up Protocol

Follow-ups of the patients were made at 6 weeks, 6 months, and 12 months after the operation. Clinical symptoms, functional outcomes, and radiological parameters were measured at every visit. To determine postoperative swallowing function, SWAL-QOL scores were obtained. All complications, such as pseudarthrosis, adjacent level radiculopathy, or infection, have been noted.

Statistical Analysis

The demographic data, clinical scores, and radiographic measurements were summed up by the use of descriptive statistics. The continuous variables were expressed as mean (SD), and categorical variables as the frequency (%) value. Any statistical calculations were made on SPSS version 22.0, and p- p-values <0.05 were found to be statistically significant.

RESULTS SECTION

Demographic and Clinical Characteristics

This study consisted of 24 patients who underwent single-level anterior cervical discectomy and fusion (ACDF) with stand-alone interbody cages. As the study population, there were 16 males (66.7%) and 8 females (33.3%), with an average age of 57.18+-12.97 years. The average follow-up period was 12 months, and no patients were lost at the 1-year benchmark.

Table 1: *Demographic Profile of Patients who Have Single-Level Stand-Alone Cage ACDF.*

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	16	66.7%
	Female	8	33.3%
Age (Years)	Mean ± SD	57.18 ± 12.97	–
	Range	35 – 75	–
Follow-up (Months)	Mean ± SD	12.00 ± 0.00	–

Table 2: *Descriptive Functional Outcomes Stats.*

Variable	Mean ± SD	Range
Neck Disability Index (NDI)	21.05 ± 8.10	8 – 38
VAS Neck Pain Score (out of 10)	2.25 ± 1.12	0 – 4
SWAL-QOL at 6 Weeks	87.86 ± 11.13	68 – 100
SWAL-QOL at 6 Months	92.05 ± 7.89	77 – 100
SWAL-QOL at 12 Months	85.78 ± 14.21	60 – 100
Radiological Fusion Rate (%)	100%	–
Follow-up Duration (Months)	12.00 ± 0.00	12 – 12

Functional and Clinical Outcomes

Patients were assessed using standard outcome measures: Neck Disability Index (NDI), Visual Analog Scale (VAS) for neck pain, and Swallowing Quality of Life (SWAL-QOL). At 1 year, all patients observed substantial improvement in their functional status, while radiographic assessment had a 100% fusion rate.

Table 3: *Radiographic Parameters, Birth and Subsidence.*

Variable	Mean ± SD	Range
Superior Endplate Subsidence (mm)	0.85 ± 0.63	0 – 2.2
Inferior Endplate Subsidence (mm)	0.96 ± 0.67	0 – 2.6
Subsidence > 2 mm (cases)	2	8.3%
Cervical Lordosis (°) Change	+1.51 ± 6.10	-8 – +10
Segmental Fusion Segment Lordosis	+1.12 ± 3.51	-3 – +7
C2–C7 SVA (mm)	2.18 ± 2.82	0 – 6.5

Radiological and Alignment Outcomes

Radiological evaluation involved the measurements of interbody cage subsidence, disc height preservation, and cervical alignment parameters. A slight amount of subsidence was measured in a couple of patients, but no patient needed revision surgery or any demonstration of clinical deterioration.

Table 4: *Complication Profile.*

Complication Type	Frequency (n)	Percentage (%)
No Complication	21	87.5%
Adjacent Level Radiculopathy	2	8.3%
Pseudarthrosis	1	4.2%
Reoperation	0	0%
Infection	0	0%

Postoperative Complications

Of 24 patients, 21 (87.5%) had an undisturbed recovery. One patient (4.2%) developed pseudarthrosis, and 2 patients (8.3%) complained of transient adjacent level radiculopathy; all cases were treated successfully conservatively. No reported any infections or re-operations.

DISCUSSION

The study reviewed the surgical outcome of single-level anterior cervical discectomy and

fusion (ACDF) with stand-alone cages with a 12-month follow-up period, both in clinical and radiographic aspects. The outcomes were not only good fusion rates but a significant reduction in pain and functional disability, maintenance of cervical alignment, and a low variety of postoperative complications. These results are in line with an existing bulk of evidence that stand-alone cages are really good in single-level ACDF procedures, serving as a worthy alternative to conventional plating structures.

The overall follow-up Neck Disability Index (NDI) mean score of 21.05 + 8.10 showed a moderate degree of disability; however, demonstrated a considerable alleviating level in the functional area over the earlier symptoms registered during the surgery. Neck pain in the Visual Analog Scale (VAS) also resulted in a significant reduction, with a mean of 2.25 +/-1.12 at 12-month follow-up. Such results can be compared with other study reviews by Virkar et al, (2022)[10] and Zaccaria et al, (2023),[11] who also found similar results in terms of improvement in both NDI and VAS in a similar stand-alone cage ACDF. The steadily increasing clinical outcomes exemplify the idea that direct decompression of neural elements through ACDF is very effective in relieving such symptoms.

The 100 radiographic fusion rates at 12 months in the total 24 patients was one of the most significant observations in the study. Such an outcome is comparable to those of Barbagallo et al, (2013), who achieved a fusion success of 94.5 percent with single-level ACDF using zero-profile or stand-alone cage-based approaches.[12] It was concluded by Epstein et al, (2022) that stand-alone PEEK cages packed with autologous iliac crest bone graft have the potential to achieve comparable fusion rates to cage-plus-plate constructs, with success rates of 92% at 12 months (improving to 96 % at 24 months).[13] Cage subsidence is frequently quoted as a major concern when using stand-alone cages, due to the lack of anterior plating to distribute loading sharing and stabilize the constructIn our study only 2 patients (8.3%) had Such rates are relatively low, in comparison with the previous observations made by Ha et al, (2008) and Satake et al, (2017) who noted subsidence rates (17.1-19.7%) but the majority of cases were asymptomatic.[14,15]

The relatively low rate, in our series, could be attributed to both proper attention to ensuring the cage is not over-distractive and the maintenance of as much subchondral bone as possible when preparing endplates. Additionally, the high-quality PEEK cages with an optimal footprint should have been used, which could have evenly distributed the load, reducing the endplate penetration. Long-term spinal health is dependent upon cervical alignment and sagittal balance. We achieved a mean posterior change of +1.51 and 6.10 degrees in cervical lordosis and + 1.12 and 3.51 degrees in segmental lordosis after the surgery, as well as a mean C2-C7 SVA of 2.18 and 2.82 mm. With such values, we imply saving sagittal alignment and sustaining local curvature, which is most essential in the prevention of adjoining segment degeneration. In comparison to the case presented by Zhao et al, (2020) that stand-alone ACDF maintains cervical alignment to a similar extent as plated constructs in single-level disease, our results are similar.[16]

A major issue is postoperative swallowing difficulty (dysphagia) that can be common with anterior plates in place. The analysis of the quality of swallowing was done at 3 time points in our research study through the SWAL-QOL tool.

Interestingly, SWAL-QOL scores were highest at 6 months and were slightly lower at 12 months. This may be due to patient adaptation, recall bias, or a low-trauma latent onset of discomfort of swallowing, but none had clinically significant persistent dysphagia.

Notably, clinically significant or lasting dysphagia was not developed in a single patient. The results of the study are in line with the previous research conducted by Dong et al,

(2015), who managed to show that the removal of anterior plates decreases retraction pressure to the esophagus and leads to minimal development of postoperative swallowing challenges. Their meta-analysis, comparing zero-profile spacers and traditional anterior plate in cervical fusion, results showed significantly less dysphagia both early and late post-surgery in the zero-profile group, confirming the hypothesis that anterior plating is one of the main causes of esophagus irritation and discomfort during swallowing.[17]

As far as complications are concerned, only one patient presented with pseudarthrosis (4.2 %), which was treated conservatively. There were 2 patients (8.3%) who had experienced adjacent-level transient radiculopathy that healed after no additional care. There were no infections and no hardware failures/reoperations. Such rates are also quite low compared to the studies by Shriver et al, (2015) and colleagues, who identified higher rates of the adjacent level disease and pseudarthrosis in multi-level or plated structures to be slightly higher. The lack of anterior plating in our series could have led to the reduction of mechanical stress at the adjacent segments, which other studies have found.[18]

The current results are promising, though not unlimited. The relatively small sample size (n=24) is an important limitation in that it imposes significant limitations on the generalisability of our findings. Another limitation is the lack of consistent MRI, CT, or intraoperative photographic documentation, given that this was a retrospective review based on available records. Therefore, we could not include representative images of pre- and postoperative. While parameters of radiographic measurements were measured and reported, the lack of visual documentation may limit the ability to fully demonstrate the radiological outcomes. Second, retrospective design has built-in selection bias and restricted control over the variables that may confound the results. Third, the lack of a comparative group of patients who underwent ACDF with anterior plating does not allow direct evaluation of the comparative advantages of the two methods. Fourth, the 12-month follow-up period, although adequate in evaluating fusion, may not be adequate in identifying long-term consequences of adjacent segment degeneration or delayed pseudarthrosis.

Future research must focus on large, prospective, randomized cohorts with the ability to compare stand-alone posterior cervical fusion (ACDF) to plated ACDF. In particular, the target should be multilevel disease, as well as cost-effectiveness evaluations and long-term biomechanical performance. Simultaneous application of modern imaging modalities, patient-reported outcomes, and full cost-benefit analysis will be essential in perfecting clinical decision-making.

CONCLUSION

The current retrospective case series affirms that single-level ACDF using stand-alone interbody cages is a safe and effective surgical approach to patients with cervical degenerative disc disease. The procedure provided strong clinical outcomes, including significant pain and functional disability scores, high rates of radiographic fusion, and low complication rates at 12 months of follow-up. Radiological alignment and subsidence rates were kept at a minimum, and this did not harm clinical outcomes. In addition, the lack of anterior plating seemed to produce a positive postoperative swallowing outcome and decreased adjacent segment load. Although these results are promising, several limitations, such as small sample size and lack of a control group, need to be overcome in prospective, randomized studies in the future. However, the research provides the growing place of stand-alone cage constructs as a reliable alternative to conventional plated constructs in limited instances of single-level ACDF.

REFERENCES

1. Todd AG. Cervical spine: degenerative conditions. Current reviews in musculoskeletal medicine. 2011;4(4):168-74. Doi: 10.1007/s12178-011-9099-2
2. Song KJ, Choi BY. Current concepts of anterior cervical discectomy and fusion: a review of the literature. Asian spine journal. 2014;8(4):531. Doi: 10.4184/asj.2014.8.4.531
3. Gould H, Sohail OA, Haines CM. Anterior cervical discectomy and fusion: Techniques, complications, and future directives. In Seminars in Spine Surgery 2020 Mar 1 (Vol. 32, No. 1, p. 100772). WB Saunders. Doi: 10.1016/j.semss.2019.100772
4. Sever C, Kilinc BE, Akpolat AO, Bozkaya T, Kurtan A, Misir A. A retrospective comparative analysis of anterior cervical discectomy and fusion using stand-alone titanium cage versus cage and plate fixation in two-level cervical disc herniation. Journal of Orthopaedic Surgery and Research. 2025;20(1):256. Doi: 10.1186/s13018-025-05654-x
5. Overley SC, Merrill RK, Leven DM, Meaike JJ, Kumar A, Qureshi SA. A matched cohort analysis comparing stand-alone cages and anterior cervical plates used for anterior cervical discectomy and fusion. Global Spine Journal. 2017;7(5):394-9. Doi: 10.1177/2192568217699211
6. Mobbs RJ, Amin T, Phan K, Al Khawaja D, Choy WJ, Parr WC, Lovric V, Walsh WR. Standalone titanium/polyetheretherketone interbody cage for anterior lumbar interbody fusion: Clinical and radiological results at 24 months. Journal of Craniovertebral Junction and Spine. 2022;13(1):42-7. Doi: 10.4103/jcvjs.jcvjs_133_21
7. Al-Mohammadi Y, Al-Abduljabbar A, Al-Mosa A, Al-Alwani Y, Abdulshakur A, Al-Zuwayhiri R, Alenezi A, Azzam AY, Abduljabbar A. Comparing Lumbar Spine Cages and Bone Grafts in Spinal Arthrodesis: A Meta-Analysis of Clinical Outcomes. Cureus. 2025;17(1). Doi: 10.7759/cureus.77017
8. Kim WB, Hyun SJ, Choi H, Kim KJ, Jahng TA, Kim HJ. Long-term follow-up results of anterior cervical inter-body fusion with stand-alone cages. Journal of Korean Neurosurgical Society. 2016;59(4):385-91. Doi: 10.3340/jkns.2016.59.4.385
9. Lechtholz-Zey EA, Ayad M, Gettleman BS, Mills ES, Shelby H, Ton A, Shin JJ, Wang JC, Hah RJ, Alluri RK. Systematic review and meta-analysis of the effect of osteoporosis on fusion rates and complications following surgery for degenerative cervical spine pathology. International Journal of Spine Surgery. 2024;18(3):277-86. Doi: 10.14444/8568
10. Virkar N, Bhilare P, Hadgaonkar S, Kothari A, Sancheti P, Aiyer S. Standalone cage versus anchored cage for anterior cervical discectomy and fusion: a comparative analysis of clinical and radiological outcomes. International Orthopaedics. 2022;46(10):23. Doi: 10.1007/s00264-022-05493-z
11. Zaccaria R, Cacciola F, Caruso G, Ferri S, Caffo M, Curcio A, Ghetti I, Germanò A. Correlation Between Cervical Spine Sagittal Alignment and Clinical Outcome After Standalone Intersomatic Titanium Cage CeSPACE for Cervical Anterior Discectomy and Fusion in Cervical Degenerative Disk Diseases. In The Funnel: From the Skull Base to the Sacrum: New Trends, Technologies and Strategies 2023 Dec 29 (pp. 361-366). Cham: Springer International Publishing. Doi: 10.1007/978-3-031-36084-8_55
12. Barbagallo GM, Romano D, Certo F, Milone P, Albanese V. Zero-P: a new zero-profile cage-plate device for single and multilevel ACDF. A single institution series with four years maximum follow-up and review of the literature on zero-profile devices. European Spine Journal. 2013;22(Suppl 6):868-78. Doi: 10.1007/s00586-013-3005-0
13. Epstein NE, Agulnick MA. Review of anterior cervical diskectomy/fusion (ACDF) using different polyetheretherketone (PEEK) cages. Surgical Neurology International. 2022;13:556. Doi: 10.25259/SNI_992_2022
14. Ha SK, Park JY, Kim SH, Lim DJ, Kim SD, Lee SK. Radiologic assessment of subsidence in stand-alone cervical polyetheretherketone (PEEK) cage. Journal of Korean Neurosurgical Society. 2008;44(6):370. Doi: 10.3340/jkns.2008.44.6.370
15. Satake K, Kanemura T, Nakashima H, Yamaguchi H, Segi N, Ouchida J. Cage subsidence in lateral interbody fusion with transpsoas approach: intraoperative endplate injury or late-onset settling. Spine Surgery and Related Research. 2017;1(4):203-10. Doi: 10.22603/ssrr.1.2017-0004
16. Zhao Y, Yang S, Huo Y, Li Z, Yang D, Ding W. Locking stand-alone cage versus anterior plate construct in anterior cervical discectomy and fusion: a systematic review and meta-analysis based on randomized controlled trials. European

Spine Journal. 2020;29(11):2734-44. Doi: 10.1007/s00586-020-06561-x
17. Dong J, Lu M, Lu T, Liang B, Xu J, Zhou J, Lv H, Qin J, Cai X, Huang S, Li H. Meta-analysis comparing zero-profile spacer and anterior plate in anterior cervical fusion. PLoS One. 2015;10(6):e0130223. Doi: 10.1371/journal.pone.0130223
18. Shriver MF, Lewis DJ, Kshettry VR, Rosenbaum BP, Benzel EC, Mroz TE. Pseudoarthrosis rates in anterior cervical discectomy and fusion: a meta-analysis. The Spine Journal. 2015;15(9):2016-27. Doi: 10.1016/j.spinee.2015.05.010

Additional Information

Disclosure: The Authors report no conflict of interest.
Ethical Review Board Approval: This study was approved by the Institutional Review Board IREB of Hayatabad Medical Complex, Peshawar, Approval number:2568
Human Subjects: Informed consent was obtained from all participants included in the study.
Conflicts of Interest: The authors declare no conflicts of interest in accordance with the ICMJE uniform disclosure form.
Financial Disclosures: The authors have no financial relationships to disclose relevant to this study.
Funding: This study received no external funding.
Data Availability: Data supporting the findings of this study are available from the corresponding author upon reasonable request.

AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to the Paper in Terms of
1.	Ayaz Ahmed	Data Analysis, statistical analysis, and result interpretation.
2.	Sajid Razaq	Data collection and referencing.
3.	Atif Aman	Study concept and methodology design.
4.	Sohaib Ali	Critical reading and Revision.