

FUNCTIONAL OUTCOME OF ANTERIOR CERVICAL DISCECTOMY WITH FUSION IN SINGLE OR MULTIPLE LEVELS USING STAND-ALONE CAGE OR CAGE WITH PLATE – A PROSPECTIVE STUDY

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Abstract

Background: Cervical spondylosis and disc herniation frequently lead to radiculopathy and myelopathy caused by progressive narrowing of the foramina or central spinal canal (stenosis). Anterior Cervical Discectomy and Fusion (ACDF), first introduced as a surgical technique, is now the most commonly used approach for treating symptomatic cervical disc herniations. This study aims to evaluate the functional outcomes of single- or multi-level ACDF using either a cage with a plate or a stand-alone cage and to assess the technique's effectiveness, postoperative complications, and overall patient satisfaction. **Materials and Methods:** In this prospective study, data was collected from those diagnosed with cervical radiculopathy, myelopathy & myelo-radiculopathy both clinically and radiologically in our hospital between August 2022 and January 2024. **Result:** A total of 36 patients were included. The mean of the study participants was 50.25 + 10.25 years. Out of these, 22 (61.1%) were males, and 14 (38.9%) were females. Radicular pain is the most prevalent symptom. The most common fusion level is C5-C6 (30.6%), followed by C6-C7 (25%) and C4-C5 (19.4%). Modified JOA Score before treatment: 83.3% of individuals experienced moderate to high functional impairment. After treatment, none remained in this range, and 88.9% demonstrated substantial improvement in functional outcomes. Nurick score showed that 69.4% of individuals had mild symptoms before treatment, and 19.4% had very severe symptoms. After treatment, 77.8% reported no symptoms, and 19.4% had mild symptoms, with no individuals experiencing moderate symptoms. **Conclusion:** One or two-level anterior cervical discectomy and fusion, whether using a stand-alone cage or a cage with a plate, is a safe and effective surgical option for cervical spondylotic myelopathy and radiculopathy, enabling patients to resume their normal activities quickly.

INTRODUCTION

Cervical spondylosis and disc herniation frequently lead to radiculopathy and myelopathy caused by progressive narrowing of the foramina or central spinal canal (stenosis). While most patients with radiculopathy improve with conservative treatment, some may require surgery if their symptoms persist or worsen. Anterior Cervical Discectomy and Fusion (ACDF), first introduced by Robinson and Cloward, is the most widely used surgical approach for symptomatic cervical disc herniations. It has a proven

track record of successful outcomes, effectively relieving symptoms and stabilizing the spine in cases where non-surgical treatments fail.^[1,2]

Cervical radiculopathy, often caused by disc herniation or spondylosis (commonly affecting the C6-C7 nerve roots), is associated with poorer outcomes when symptoms persist for more than six months or when high pain levels and radicular signs are present. Cervical spondylotic myelopathy (CSM), a leading cause of cervical spinal cord dysfunction, results from spinal cord compression due to degenerative changes like vertebral bulging and

ligament ossification. To mitigate risks associated with traditional ACDF procedures, such as screw loosening and dysphagia, stand-alone cage concepts have been introduced, offering positive outcomes and fewer complications, making them a safer alternative to anterior cervical plating.^[3-6]

ACDF is commonly performed for conditions like spondylosis, disc herniation, and ossification of the posterior longitudinal ligament (OPLL), though its indications can vary and are sometimes debated. In cases of multilevel disease, a posterior approach may be more suitable. While the ACDF procedure is well-established, surgeons can choose from various cage and bone graft types and anterior plate options, each with unique pros and cons. Stand-alone cages, which offer a less invasive alternative with lower donor-site morbidity, are frequently used. However, cage subsidence is a common complication, potentially leading to foraminal stenosis and the recurrence of radiculopathy and axial neck pain post-surgery.^[7-9]

Stand-alone interbody cages were developed to stabilize and promote the fusion of cervical vertebrae without needing an anterior plate. However, this approach is not without complications, which include cage subsidence, cervical dislocation, and cervical kyphosis.^[10]

The objective is to evaluate the functional outcomes of single- or multi-level anterior cervical discectomy and fusion (ACDF) using a cage with a plate or a stand-alone cage. The study assesses the technique's effectiveness, postoperative complications, and overall patient satisfaction.

MATERIALS AND METHODS

Study Design, Sample Size and Source of Data:

This was a prospective study carried out on 36 patients were diagnosed with cervical radiculopathy, myelopathy & myelo-radiculopathy both clinically and radiologically in the department of Orthopaedics and Neurosurgery at BLDE (deemed to be university) Shri B. M. Patil Medical College, Hospital and Research Centre, Vijayapura over a period of two years from August 2022 to January 2024.

Inclusion Criteria

1. Patients of age 18-70 years.
2. A three-month period of significant persistent radicular pain that did not improve with conventional treatment
3. Progressive paresis associated with cervical radiculopathy
4. Specific instances of myelopathy brought on by spinal stenosis in the cervical canal
5. Neurological deficit
6. Traumatic disc herniation
7. Those who give written informed consent

Exclusion Criteria

1. Active cervical infection
2. Neoplasia and metastasis
3. Patients with failed previous cervical surgery
4. Neurovascular injury

5. Medically unfit for surgery

Method of Data Collection: After obtaining clearance from the Institutional Ethical Committee as per inclusion and exclusion criteria, all patients were included and after taking informed consent before participating in the study. The chief complaint of axial neck pain was the primary clinical symptom in most cases. A comprehensive neurological examination was performed on clinical examination to assess sensory and motor loss, reflex changes, and signs of myelopathy. Sensory symptoms, typically in the C6 and C7 dermatomes, were assessed as these generally precede motor symptoms. Deep tendon reflexes, emphasizing the Brachioradialis reflex, were tested, as these are often impaired in radiculopathy. Neck movement was evaluated, and any restriction caused by muscle spasms was noted. The aggravation of radiculopathy pain by coughing, sneezing, and lifting heavy objects was documented. A thorough history and clinical examination were conducted to rule out alternative diagnoses, including shoulder pathology, angina, and intra-spinal tumors. Relevant investigations were ordered as needed. The severity of cervical myelopathy was evaluated using the modified Japanese Orthopaedic Association (JOA) scale,^[11] preoperatively and postoperatively. Patient demographics, including age and duration of symptoms, were recorded. Pre-operative neurological disability was assessed using the Modified JOA scale. Imaging studies, particularly MRI, were reviewed to measure effective canal diameter and identify intramedullary hyperintense signal changes on T2-weighted images. The number of cervical compression levels was determined based on clinical and radiological findings.

Radiological imaging for suspected cervical spondylosis began with plain radiographs, including anteroposterior, lateral, and flexion-extension views, taken with the patient in a supine position. Lateral cervical spine X-rays had to include the occiput through the first thoracic vertebra to assess vertebral alignment, measured using the Pavlov-Torg ratio to evaluate cervical stenosis. Key findings indicating cervical spondylosis included anterior osteophytes, disc space narrowing, loss of lordosis, and foraminal spurs. CT scans were reserved for patients with MRI-suggested posterior longitudinal ligament ossification. At the same time, MRI C-spine with myelogram was standard for quantifying spinal canal dimensions, disc herniation, ligament hypertrophy, and the degree of root or cord compression.

Operative Procedure: The anterior approach was commonly used to visualize and remove the problematic disease without affecting the spinal cord, particularly in uncovertebral osteophytes, spondylotic bars, disc herniation, and posterior spurs compressing the spinal cord at one or two levels. In the study, Anterior Cervical Discectomy with Fusion (ACDF) was performed using either a stand-alone cage or a cage with a plate. Cage sizes ranged from 6mm to 8mm, while screw sizes used were between 14mm and 16mm.

The Smith-Robinson anterior cervical fusion technique involved placing the patient supine on the operating table with a small roll in the interscapular region and slightly tilting the head to the side opposite the planned incision. After marking the anterior cervical skin using a curved skin crease, dissection proceeded through the subcutaneous layer and the platysma, which was divided vertically. The sternocleidomastoid border and carotid sheath were exposed, and the omohyoid muscle was mobilized as needed. The pretracheal fascia was incised medially, and the prevertebral space was developed with blunt dissection. The longus colli muscles were exposed and elevated, and retractors were placed. The disc space was marked under fluoroscopic guidance, and the anterior annulus and disc material were removed using rongeurs and curets. The anterior lip of the vertebra was flattened using a high-speed burr, and any necessary foraminotomy or osteophyte removal was performed. The posterior longitudinal ligament was removed if needed. The adjacent endplates were prepared, ensuring subchondral bone preservation. The spacer was fashioned and inserted with traction, ensuring 2mm clearance from the spinal canal. The spacer was secured with screws, and intraoperative radiographs confirmed placement. The procedure was repeated for additional disc levels, and the platysmal layer was closed over a soft drain, followed by the closure of the skin and subcutaneous layers with a thin dressing applied.

Postoperative Care: The patient was moved out of bed. The drain was removed on the first postoperative day. Occasionally, a gentle collar was used for an additional week or two. Radiographs of the lateral cervical spine, taken in flexion and extension, were examined to ensure no signs of motion at the fusion site.

Statistical Analysis: The data collected was analyzed using IBM SPSS version 27. In the study analysis, the Shapiro-Wilk test was used to assess the normal distribution of the data. A p-value of less than 0.05 was considered statistically significant. Continuous variables were expressed as mean and standard deviation, while ordinal or categorical variables were presented as frequency (n) and percentage (%). The study included a total of 36 samples.

RESULTS

In this study, 36 patients were included. The mean of the study participants was 50.25 + 10.25 years. Among the participants, the majority, 18(50%) of them, belonged to the 51-60 years age group. The ages range from 27 to 68 years. 22 were males, representing 61.1% of the population, and 14 were females, accounting for 38.9%. [Table 1]

The distribution of clinical symptoms among the study participants shows that radicular pain is the most prevalent symptom, affecting two-thirds of the participants 24(66.7%). Myelopathic pain is present in 7(19.4%) participants, while axial neck pain is the

least common, experienced by 5(13.9%). This distribution indicates that degenerative changes are the predominant cause of the condition in the sample, with trauma being a less frequent cause. [Table 1]

According to Odom's Criteria, on the treatment outcomes, a significant majority, 27(75.0%), reported experiencing excellent results, indicating high satisfaction and effectiveness. This is followed by 7(19.4%) individuals who reported good outcomes and Only 2(5.6%) of the individuals who experienced fair outcomes, suggesting that the treatment was less effective for a very small segment of the sample.

Before treatment, most individuals reported severe 19(52.8%) or moderate pain 17(47.2%). After treatment, 33(91.7%) reported no pain, and 3(8.3%) reported mild pain, with no cases of moderate or severe pain. This reflected a significant reduction in pain levels, showing that the treatment was highly effective.



Figure 1: 45-year-old male with cervical myelopathy on X-ray and MRI showing disc bulge at C5-C6 level during pre-operative stage



Figure 2: Same operated patient on X-ray showing cage fixation at C5-C6 level during the post-operative stage



Figure 3: Follow-up evaluation of the patient for power of wrist extensors and power of finger flexion & extension

Before treatment, the majority of individuals, 30(83.3%), scored 10-11 on the Modified JOA Score, indicating moderate to high functional impairment. A small percentage of 4(5.6%) had scores in the 5-6 range, representing the lowest functional impairment, while 2(11.1%) had scores in the 12-13 range, showing slightly higher impairment. Post-treatment, there was a significant shift in scores. The majority,

32(88.9%), scored in the highest range of 16-17, indicating substantial improvement in functional outcomes. A small percentage of 4(11.1%) showed minimal to low functional impairment. Overall, the results demonstrated that the treatment had a profound positive impact on functional outcomes,

with most individuals showing notable improvement in their scores. The Nurick Score results reflect the changes in the severity of symptoms or functional status before and after treatment, as shown in [Table 2].

Table 1: Descriptive characteristics of the study participants (n=36)

Characteristics	Frequency (n)	Percent (%)
Age group (in years)		
21-30	2	5.6%
31-40	6	16.7%
41-50	7	19.4%
51-60	18	50.0%
61-70	3	8.3%
Mean age (Mean+SD) = 50.25 + 10.25 years		
Gender		
Male	22	61.1%
Female	14	38.9%
Clinical symptoms		
Axial neck pain	5	13.9
Myelopathic pain	7	19.4
Radicular pain	24	66.7
Etiology		
Degenerative	28	77.8
Trauma	8	22.2
Level of fusion		
C2-C3	1	2.8
C3-C4	4	11.1
C4-C5	7	19.4
C4-C5, C5-C6	2	5.6
C5-C6	11	30.6
C5-C6, C6-C7	2	5.6
C6-C7	9	25.0
Odom's criteria		
Fair	2	5.6
Good	7	19.4
Excellent	27	75.0

Table 2: Frequency distribution of Wong baker's score, Modified Joe score and Nurick score in the pre-operative and post-operative period among study participants

SCORE	Pre-operative period n (%)	Post-operative period n (%)
WONG BAKER'S SCORE		
Grade 1	0 (0)	33 (91.0%)
Grade 2	0 (0)	3 (8.3%)
Grade 3	17 (47.2%)	0 (0)
Grade 4	19 (52.8%)	0 (0)
MODIFIED JOA SCORE		
5-6	2 (5.6%)	0 (0)
10-11	30 (83.3%)	0 (0)
12-13	4 (11.1%)	0 (0)
13-14	0 (0)	1 (2.8%)
14-15	0 (0)	2 (5.6%)
15-16	0 (0)	1 (2.8%)
16-17	0 (0)	32 (88.9%)
NURICK SCORE		
Grade 0	1 (2.8%)	28 (77.8%)
Grade 1	25 (69.4%)	7 (19.4%)
Grade 2	2 (5.6%)	0 (0)
Grade 3	0 (0)	1 (2.8%)
Grade 4	7 (19.4%)	2 (5.6%)
Grade 5	1 (2.8%)	1 (2.8%)

DISCUSSION

Cervical radiculopathy typically presents with unilateral neck and arm pain, often with sensory or motor deficits. It is essential to differentiate it from conditions like shoulder pathology or peripheral nerve entrapment. Most cases resolve naturally and

can be managed conservatively unless neurological symptoms worsen. Conservative treatments do not alter the natural progression of the disease. Surgery, such as ACDF, cervical disc arthroplasty (CDA), or posterior cervical foraminotomy (PCF), may be considered if symptoms persist after six months of

conservative treatment, depending on the pathology and surgeon's preference.^[12]

In this study, the individuals were aged between 27 and 68 years (mean age 50.25 ± 10.25 years), 61.1% were male, and 38.9% were female, with the largest age group being 51-60 years (50%). Comparatively, Elsayed A et al,^[13] studied 33 patients, divided into Group A (19 patients, ACDF) and Group B (14 patients, ACDF with plate fixation). Kumar R et al,^[14] studied 283 patients (201 males, 82 females, mean age 48.4 years), with most patients between 36 and 50 years. Kamani MM et al,^[3] studied 19 patients (17 males, two females) aged 40-50 years, while Rostami M et al,^[15] reported a mean age of 45.9 years, with 37 females and 23 males.

In this study, radicular pain is the most common symptom (66.7%), followed by myelopathic pain (19.4%) and axial neck pain (13.9%). Degenerative causes are the leading etiology (77.8%), with trauma accounting for 22.2%. In the Rostami M et al,^[15] study, 41 patients experienced radicular or axial pain, with a mean symptom duration of 4.2 months. Elsayed A et al,^[13] compared clinical symptoms between groups, finding higher rates of neck pain, brachialgia, motor deficits, and numbness in Group A (multiple-level discectomies). Kumar R et al,^[14] reported 90% of patients with compressive myelopathy from degenerative causes.

In this study, the most common fusion level is C5-C6 (30.6%), followed by C6-C7 (25%) and C4-C5 (19.4%). Multiple-level fusions and C3-C4 affect smaller portions, with C2-C3 being the least common (2.8%). In comparison, Chen Y et al,^[16] reported C3-C6 and C4-C7 fusions, finding no significant difference between groups. Hegde D et al,^[17] found C5-C6 intervertebral disc prolapse (IVDP) most common, particularly in the neutral and kyphosis groups. Kumar R et al,^[14] also found C5-C6 as the most frequent fusion level (33.6%), followed by C4-C5 (29.7%), with C7-T1 and C2-C3 being the least common.

In this study, based on Odom's Criteria, 75% of patients reported excellent outcomes, 19.4% had good outcomes, and 5.6% had fair outcomes, indicating highly favorable results overall. In Chen Y et al,^[16] studies, both groups had similar excellent outcomes (19 in Group A and 20 in Group B) and good outcomes (9 in Group A, 6 in Group B), with no fair or poor outcomes. Elsayed A et al,^[13] found that in Group A, 36.8% had excellent outcomes, 31.6% good, 15.8% fair, and 15.8% poor. In Group B, 42.9% had excellent outcomes, 21.4% good, 14.3% fair, and 21.4% poor. Neither study showed a statistically significant difference between groups.

Modified JOA Score: In this study, before treatment, 83.3% of individuals had Modified JOA Scores between 10-11, indicating moderate to high functional impairment. After treatment, no individuals remained in this range, and 88.9% scored between 16-17, showing substantial improvement in functional outcomes. In contrast, Chen Y et al,^[16] reported significant improvements in NDI and JOA

scores across all time points (up to 24 months) post-surgery, although there were no significant differences between the two groups. Yang L et al,^[18] found no significant differences in JOA scores between Group A (anchored spacer) and Group B (anterior cervical plate) pre-and post-operatively. Kamani MM et al,^[3] noted that on admission, 13 out of 19 patients had moderate JOA scores, and by six months, all had mild scores. Overall, while our study profoundly impacts functional outcomes after treatment, other studies demonstrate significant improvements without substantial differences between surgical methods.

Nurick Score: In this study, before treatment, most individuals had mild (Grade 1, 69.4%) or very severe (Grade 4, 19.4%) symptoms, while a few had no symptoms (Grade 0, 2.8%) or extremely severe symptoms (Grade 5, 2.8%). After treatment, 77.8% reported no symptoms (Grade 0), 19.4% had mild symptoms (Grade 1), and there were no moderate symptoms (Grade 2). Severe (Grade 3) symptoms were reported by 2.8%, very severe (Grade 4) symptoms decreased to 5.6%, and extremely severe symptoms (Grade 5) remained at 2.8%. This indicates a significant reduction in symptom severity. In contrast, Kumar R et al,^[14] reported a wider distribution of preoperative functional grades among their patients, with varying proportions across all Nurick grades, highlighting the diversity in symptom severity before treatment.

Overall, this study's findings align with the broader literature on anterior cervical discectomy and fusion, showing functional outcomes and complication rates that are comparable to those in recent studies. This consistency reinforces the reliability of the present study's results within the context of existing research.

Limitation: To determine the long-term durability of the results from this prospective research, further randomized controlled studies with extended follow-up periods are necessary. Additionally, fusion rates between the groups have not been analyzed, and potential complications from using a stand-alone cage in multi-level ACDF, such as neighboring segment degeneration, non-union, and corrective loss, must also be considered. Another limitation of the study is that participants were not screened for their level of physical activity, which may significantly influence pain intensity and the level of disability among subjects.

CONCLUSION

The results indicate that one or two-level anterior cervical discectomy and fusion, whether utilizing a stand-alone cage or a cage with a plate, is a safe and effective surgical option for treating cervical spondylotic myelopathy and radiculopathy, facilitating a rapid return to normal activities for patients.

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