Original article

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Clinical study of management and outcomes in patients with degenerative cervical myelopathy treated with anterior cervical discectomy and fusion: an institutional experience and review of literature

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Aim: This prospective observational study was done to evaluate the outcomes and management of patients with degenerative cervical myelopathy (DCM) treated with anterior cervical discectomy and fusion (ACDF).

Materials and methods: Our study included 80 patients with DCM admitted to a neurosurgical department between August 2013 and February 2023. Patients underwent ACDF surgery for single- or multi-level spinal canal stenosis. Demographic data, clinical features, and neurological examinations including assessments of limb power using the Medical Research Council Scale, sensory system function, and sphincter disturbance pre- and post-operatively were assessed. Pre- and post-operative neurological function was evaluated using the Nurick score, while post-operative outcomes were assessed using the Odom's criteria. The study population consisted mainly of males aged 51-60 years. Myelopathy was the most frequent presentation, with C5-C6 level being the most common level of fusion.

Results: ACDF surgery significantly improved neurological function, as evidenced by reduced pre-operative weakness and sensory dysfunction, and increased post-operative muscle strength. Minimal postoperative complications were observed.

Conclusions: These findings align with previous research, demonstrating ACDF as a safe and effective procedure for improving neurological function and quality of life in DCM patients. Limitations include sample size and study design, necessitating further research.

Key words: *degenerative cervical myelopathy; anterior cervical discectomy and fusion; myeloradiculopathy; Nurick score; Odom's criteria*

Introduction

Degenerative cervical myelopathy (DCM) represents the most prevalent cause of spinal cord impairment among adults globally [1]. This clinicopathological entity encompasses a broad spectrum of acquired and congenital conditions, including degenerative changes, hypertrophy, and calcification of the intervertebral discs, ligaments, and bony structures of the cervical spine. Notable examples include cervical spondylosis and ossification of the posterior longitudinal ligament (OPLL) [2,3]. These pathological processes result in stenosis of the cervical spinal canal, leading to chronic compression of the spinal cord and subsequent neurological and functional disabilities [4]. Cervical degenerative disc disease can be particularly debilitating, significantly compromising the quality of life. Magnetic Resonance Imaging (MRI) studies have demonstrated that many adults may present with cervical degenerative disc disease without exhibiting any clinical symptoms [5,6]. For symptomatic patients, conservative management is generally the initial preferred approach, with the majority responding positively to such treatment [7]. However, anterior cervical discectomy and fusion (ACDF) is recommended for patients who do not respond to conservative management [8-12]. In a well-selected cohort of patients characterized by younger age, a single-level soft disc, male gender, non-smokers, congruent radiological and clinical findings, and well-preserved neurological function, ACDF has been associated with favourable outcomes [13,14]. In this study, we evaluated the clinical presentations and outcomes following ACDF in patients with cervical degenerative disc disease across various age groups.

Aim and objectives

Aim:

To evaluate the outcomes and management of patients with degenerative cervical myelopathy treated with ACDF.

Objectives:

1. To determine the age- and sex-specific incidence of cervical degenerative disease in the study population.
2. To assess the clinical features, outcomes, and complications associated with cervical degenerative disease in patients treated with ACDF.
3. To compare pre-operative and post-operative Nurick scores and postoperative Odom's criteria outcomes.

Materials and methods

This prospective observational study was conducted at a single tertiary care hospital, focusing on patients admitted with degenerative cervical myelopathy to the Department of Neurosurgery from August 2013 to February 2023. Consent was obtained from all participants. A total of 80 patients were included in the study. The inclusion criteria encompassed patients presenting with cervical compressive myelopathy and myeloradiculopathy, affected at spinal levels between C3 and C7, with myelopathy secondary to cervical spinal canal stenosis involving the disc, patients experiencing persistent complaints unresponsive to conservative management for a minimum of three months, and those diagnosed with posterior osteophyte complex disease. Exclusion criteria included patients with cervical trauma, age less than 18 years, ongoing cervical infection and inflammation, and those presenting solely with radiculopathy. Baseline demographic data including age, sex, and medical history were collected. Clinical features, presenting symptoms, duration of symptoms, and neurological examination findings were documented. Pre-operative imaging studies, including X-ray of cervical spine antero-posterior and lateral views, MRI of cervical spine with whole spine screening were done. All surgeries were performed by experienced neurosurgeons using standardized techniques for ACDF. Intraoperative data, including the level of fusion, number of fusions and any intraoperative complications, were recorded. Clinical examinations were conducted at periodic intervals post-surgery (during the hospital stay, at the first follow-up during suture removal, and at three, six, and twelve months). During these examinations patients were asked whether their symptoms were the same, better, or worse post-surgery. At the six-month follow-up, patients were assessed based on Odom's criteria (excellent: no complaints and able to carry out physical activities; good: minimal persistence of preoperative symptoms but physical activities possible without significant interference; fair: relief of some preoperative symptoms with significant limitation in physical activities; poor: worsened or unchanged symptoms and signs) Patients were also assessed using the Nurick score (Grade 0: no root or cord symptoms; Grade I: root signs or symptoms with no cord involvement; Grade II: signs of cord involvement with normal gait; Grade III: gait abnormality but able to be employed; Grade IV: gait abnormality prevents employment; Grade V: able to ambulate only with assistance; Grade VI: chair-bound or bedridden). There were no cases of loss to follow-up.

Results

Table 1 summarises demographic details (age and gender distribution) and clinical characteristics of patients (clinical symptoms and duration of symptoms) diagnosed with cervical degenerative myelopathy.

The age distribution of patients reveals a predominant occurrence in the age group of 51-60 years, comprising 37 patients (46.25%) of the study population, followed by those aged 41-50 years with 28 patients (35%). Gender distribution shows a higher prevalence among males, accounting for 66 patients (82.50%). The duration of symptoms varied, with a notable proportion of patients, 42 (52.5%) reporting symptom durations between 6 to 12 months. Clinical symptoms observed in the patients include myelopathy, affecting 63 patients (78.75%) of the study population, and myeloradiculopathy, observed in 17 patients (21.25%).

Table 2 summarises the level of ACDF and the number of fusion procedures performed. It reveals that the majority of patients underwent single-level ACDF fusion surgery, with 67 patients receiving this intervention. Twelve patients underwent double-level fusion, and one patient underwent a three-level fusion in a single sitting.

Table 3 shows neurological examination preoperatively and postoperatively in the form of an assessment of limb power on the Medical Research Council (MRC) scale, sensory system examination, sphincter disturbances and surgical complications. Pre-operative power grades varied, with the majority, 39 patients (48.75%) falling into grade 4-, while post-operative assessments showed significant improvements, particularly in grades 4 and 4+. Sensory system evaluations revealed sensory affection in 28 patients (35%) pre-operatively, with a significant improvement noted post-operatively. Sphincter disturbance, specifically bladder involvement, was present in ten patients (12.50%) pre-operatively, of which two patients had improved sphincter control while the remaining eight patients (10%) showed no change post-operatively. Regarding complications, no intraoperative complications were reported, while three patients (6.3%) experienced immediate postoperative complications, primarily characterized by limb weakness and five patients (6.25%) experienced delayed postoperative complications in the form of non-improvement of symptoms of pain and spasticity. Complications such as severe blood loss, dysphagia, oesophageal perforation, infections, vocal cord palsy, and kyphosis, were not observed in this study.

Table 4 summarises Nurick score evaluation conducted pre-operatively and post-operatively and the outcome assessment based on Odom's criteria. Nurick score evaluation indicates improvements in neurological function following surgical intervention. The distribution of Nurick score post-operatively shows a decrease in scores compared to pre-operative assessments. Outcome assessment based on Odom's criteria demonstrates that the majority of patients, 31 (38.75%) achieved excellent outcomes, followed by a good outcome in 27 patients (33.75%), a fair outcome in 17 patients (21.25%) and a poor outcome in 05 patients (6.25%), reflecting positive outcomes in terms of neurological improvement post-surgery.

Figures 1-4 show pre-operative and post-operative radiological images in few of our patients.

This article contains some figures that are displayed in color online but in black and white in the print edition.

Table 1. Demographic and clinical characteristics of patients with cervical degenerative myelopathy

Characteristic	Number of patients	Percentage
Age distribution (years)		
21-30	2	2.5%
31-40	9	11.25%
41-50	28	35%
51-60	37	46.25%
61-70	4	5%
Gender distribution		
Male	66	82.50%
Female	14	17.50%
Duration of symptoms		
<6 months	29	36.25%
6-12 months	42	52.5%
>12 months	9	11.25%
Clinical symptoms		
Myelopathy	63	78.75%
Myeloradiculopathy	17	21.25%

Table 2. Surgical intervention details

Level of ACDF fusion	Number of patients
C3-C4	22
C4-C5	22
C5-C6	38
C6-C7	12
Number of fusions	
Single-level ACDF fusion	67
Double-level ACDF fusion	12
Three-level ACDF fusion	1

Note: ACDF - Anterior cervical discectomy and fusion

Table 3. Neurological examination pre- and post-operatively and complications

Evaluation	Number of patients (percentage)	
	Preoperative	Postoperative
Limb Power (MRC Scale)		
Grade 3	12 (15%)	6 (7.50%)
Grade 4-	39 (48.75%)	8 (10%)
Grade 4	29 (36.25%)	40 (50%)
Grade 4+	0	26 (32.50%)
Sensory system examination		
Affected	28 (35%)	16 (20%)
Non-affected	52 (65%)	64 (80%)
Sphincter disturbance		
Present	10 (12.50%)	8 (10%)
Absent	70 (87.50%)	72 (90%)
Surgical complications		
Intraoperative	0	
Immediate postoperative	3 (3.75%)	
Delayed postoperative	5 (6.25%)	

Note: MRC - Medical Research Council

Table 4. Nurick score evaluation preoperatively and postoperatively and Odom's criteria outcome assessment

Evaluation	Number of patients	
	Preoperative	Postoperative
Nurick score		
0	0	16
1	0	29
2	30	21
3	35	9
4	9	5
5	6	0
Odom's criteria outcome	Number of patients	
Excellent	31 (38.75%)	
Good	27 (33.75%)	
Fair	17 (21.25%)	
Poor	5 (6.25%)	

Fig. 1. A - Preoperative magnetic resonance imaging study of the cervical spine, (T2 weighted image, sagittal view) showing narrowing of central canal with cervical compressive myelopathy; B - Preoperative computed tomography imaging study of the cervical spine (sagittal view) showing osteophytes with narrowing of the central canal and straitening of the cervical lordosis; C - Postoperative radiographic imaging study of the cervical spine (sagittal view) showing the cage with screw *in situ*; D - Postoperative radiographic imaging study of the cervical spine (coronal view) showing the cage with screw *in situ*

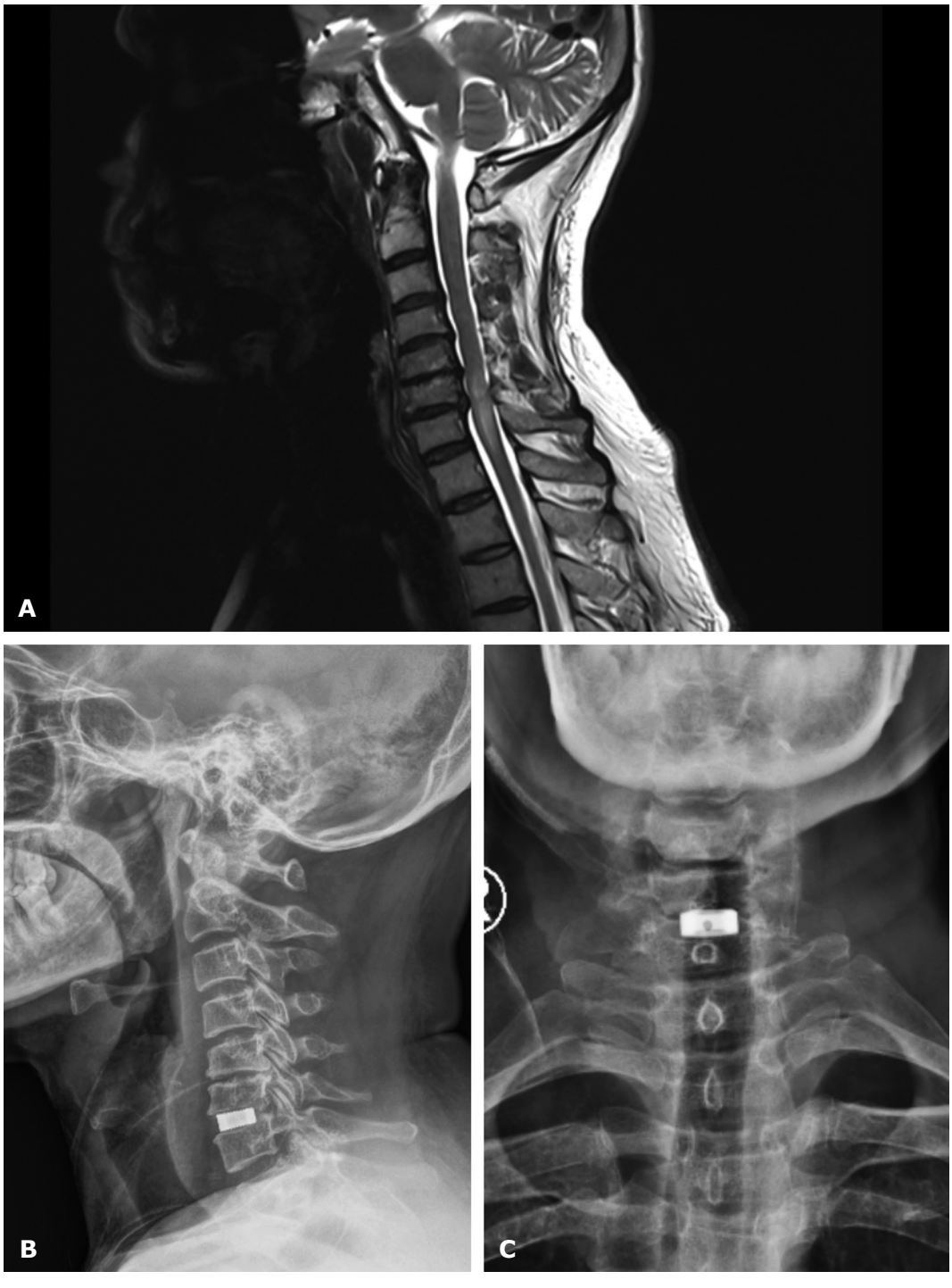

Fig. 2. A - Preoperative magnetic resonance imaging study of the cervical spine (T2 weighted image, sagittal view) showing cervical compressive myelopathy with disc osteophyte complex; B - Postoperative radiographic imaging study of the cervical spine (sagittal view) showing the cage *in situ*; C - Postoperative radiographic imaging study of the cervical spine (coronal view) showing the cage *in situ*

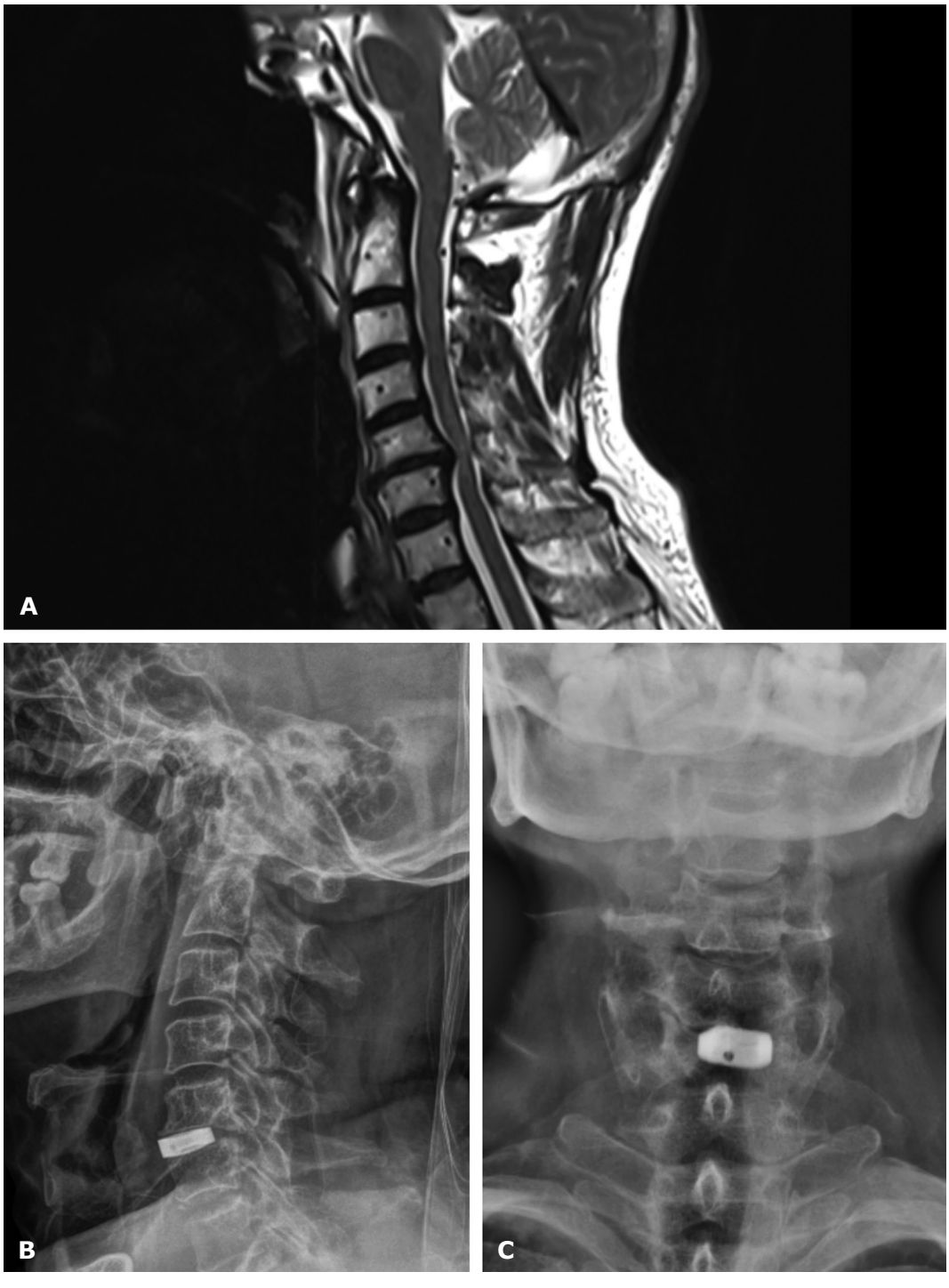

Fig. 3. A - Preoperative magnetic resonance imaging study of the cervical spine (T2 weighted image, sagittal view) showing cervical compressive myelopathy with disc osteophyte complex; B - Postoperative radiographic imaging study of the cervical spine (sagittal view) showing the cage *in situ*; C - Postoperative radiographic imaging study of the cervical spine (coronal view) showing the cage *in situ*

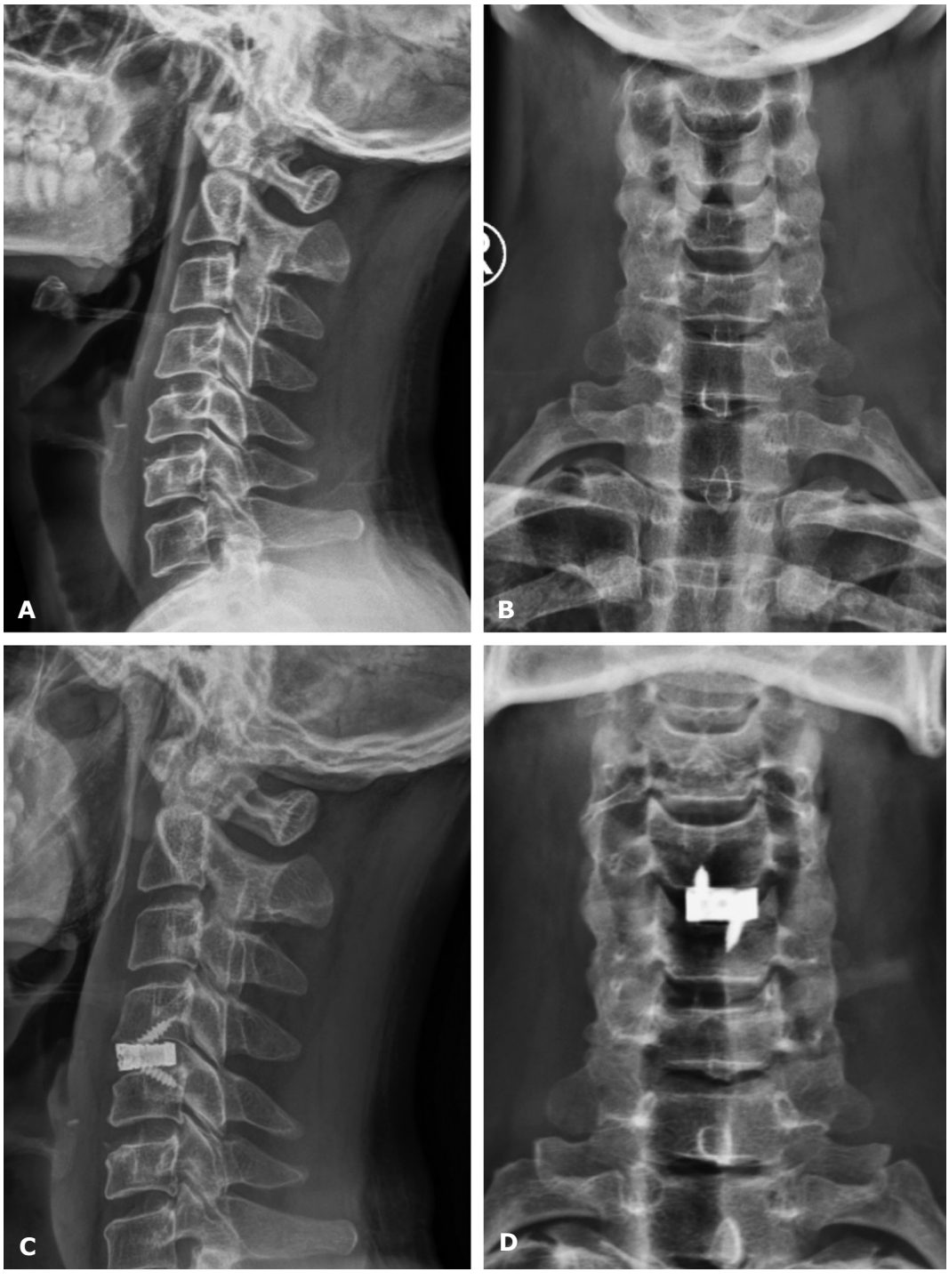

Fig. 4. A - Preoperative radiographic imaging study of the cervical spine (sagittal view) showing disc-osteophyte complex causing narrowing of the central canal; B - Preoperative radiographic imaging study of the cervical spine (coronal view); C - Postoperative radiographic imaging study of the cervical spine (sagittal view) showing the cage with screw *in situ*; D - Postoperative radiographic imaging study of the cervical spine (coronal view) showing the cage with screw *in situ*

Discussion

DCM is a significant condition that has garnered considerable research attention, with the aim of deepening our understanding of its pathophysiology and management. Key anatomical structures commonly affected by DCM include the vertebral body, intervertebral discs, posterior longitudinal ligament, ligamentum flavum, and uncovertebral joints. The clinical presentation of DCM may encompass motor, sensory, and/or sphincter dysfunction, often accompanied by notable signs such as Hoffman's sign and the inverted brachioradialis reflex. Diagnosis is primarily established through a clinical examination, supported by MRI evidence of cord compression [15]. The Nurick score remains a critical tool in evaluating neurological function both before and after surgical intervention. Surgical management is the cornerstone of DCM treatment, with approaches varying between anterior, posterior, or a combination of both. The anterior approach, including procedures such as corpectomy or ACDF, is generally preferred due to its association with fewer complications and a shorter hospital stay [3, 4]. Since the introduction of ACDF in 1958 [12] it has become one of the most frequently performed spinal surgeries [16]. ACDF is widely regarded as the gold standard for addressing degenerative cervical spine diseases due to its relatively low risk profile, reproducibility, and reliability [17]. A meta-analysis by Shahab Aldin Sattari et al. [18] found no significant differences between ACDF and posterior decompression in terms of functional outcomes at the one-year follow-up. However, ACDF was associated with less intraoperative bleeding, shorter hospital stays, and lower rates of surgical site infections and C5 palsy.

Our study focused on the outcomes of surgical interventions for degenerative cervical myelopathy/ myeloradiculopathy in 80 patients. The findings revealed a predominance of the condition in middle-aged males, with the most affected age group being 51-60 years, accounting for 46.25% of the cases, followed by the 41-50 years age group, representing 35% of the cases. Gender distribution demonstrated a higher prevalence among males (82.50%) compared to females (17.50%). These demographic details are consistent with the studies conducted by Shrikhande N.N. et al. [19] and Saravanan A et al. [20]. Several clinical syndromes are associated with cervical disc disease including cervical spondylotic myelopathy/ myeloradiculopathy, cervical radiculopathy, and neck pain syndromes. Our study excluded cases involving only radiculopathy or neck pain syndrome, focusing primarily on patients presenting with myelopathy (78.75%) or mixed symptoms of myeloradiculopathy (21.25%), aligning with the observations of Shrikhande N.N. et al. [19] and Hwang et al. [21]. Furthermore, approximately 52.5% of the patients reported symptoms lasting 6 to 12 months, similar to findings by Suri A. et al. [22]. However, Ramesh et al. [23] highlighted a significant proportion of patients experiencing symptoms for over 12 months, underscoring the importance of early detection and prompt intervention to optimize outcomes and prevent further neurological deterioration.

In terms of surgical procedures, the most frequently observed single-level of fusion was at C5-C6, occurring in 38 cases, consistent with Shrikhande N.N. et al. [19] and Saravanan A. et al. [20]. Double-level fusion surgery was performed on 12 patients, with only one patient undergoing three-level fusion in a single sitting, further aligning with the findings of Shrikhande N.N. et al. [19] and Saravanan A. et al. [20], indicating that three-level fusion is less frequently performed.

Our analysis revealed significant improvements in neurological function following surgery. Pre-operative weakness Grade 4- MRC scale decreased substantially from 48.75% to 10% postoperatively, accompanied by a notable increase in excellent muscle strength Grade 4+ MRC scale from 0% to 32.50%. Additionally, pre-operative sensory dysfunction decreased from 35% to 20% post-surgery. The rate of sphincter disturbances remained consistent at around 10% pre- and post-operatively, similar to the findings of Shrikhande N.N. et al. [19] who reported no significant improvement in this area. Although the study was limited by sample size and design, the minimal postoperative surgical complications (3.75% immediate, 6.25% delayed) suggest ACDF as a safe and effective procedure for improving neurological function in DCM patients. The postoperative weakness was also improved gradually in all the patients. In contrast, studies by Mastronardi L. et al. [24] and Choi S.H. et al. [25] reported various complications, including severe blood loss, dysphagia, oesophageal perforation, infections, vocal cord palsy, and kyphosis. None of these were observed in our study. This absence of severe complications suggests successful surgical management and perioperative care, contributing to favourable outcomes.

The mean preoperative Nurick score, indicating the severity of impairment, was 2.57. However, this score improved significantly post-surgery, dropping to 1.12 on average. Consistent with these findings, studies by Gupta A. et al. [26] demonstrated significant reductions in Nurick scores after surgery, further supporting the notion that ACDF intervention can lead to reduced neurological impairment and enhanced functional abilities in DCM patients. The decrease in postoperative Nurick scores across these studies suggests that surgical treatment plays a crucial role in enhancing patients' quality of life and functional abilities. Furthermore, analysis using Odom's criteria at six months revealed positive outcomes for a substantial portion of patients. Nearly 40% (38.75%) achieved an excellent outcome, with good and fair outcomes were observed in an additional 55% of patients. These results are comparable to previous research by Hassan M. et al. [27] and Saravanan A. et al. [20], who also reported high rates of positive outcomes following ACDF surgery for DCM. While limitations including sample size and study design necessitate further research involving larger, controlled studies, the current findings provide promising evidence of the effectiveness of ACDF surgery in improving outcomes for DCM patients. Additionally, the study by Long Tang et al. [28] suggests that day-surgery ACDF may offer safety and early efficacy comparable to traditional inpatient procedures, presenting a promising alternative for eligible patients. This research highlights the potential of ACDF surgery to improve neurological function and functional abilities, ultimately enhancing patients' quality of life.

Conclusion

Our study investigated the effectiveness of ACDF surgery in managing DCM in 80 patients. Our analysis revealed a predominance of the condition in middle-aged males, with the most frequent surgical level being C5-C6. Significantly, ACDF surgery resulted in substantial improvements in neurological function, as evidenced by reductions in pre-operative weakness and sensory dysfunction, along with a notable increase in excellent muscle strength. Furthermore, the minimal postoperative complications observed suggest ACDF as a safe and effective procedure for patients with DCM. The study also highlights the importance of early intervention. These findings align with previous research demonstrating positive outcomes following ACDF surgery. The decrease in Nurick scores across our study and others highlights the potential of ACDF intervention to improve neurological function, functional abilities, and ultimately, patient quality of life in DCM patients. While limitations including sample size and study design necessitate further research with larger, controlled studies, the current results provide promising evidence for the effectiveness of ACDF surgery in managing DCM.

Declarations

Disclosure

Hereby it is stated that the manuscript has been read and approved by all the authors. Each author believes affirms that the manuscript represents honest work and confirms that the information has not been published or submitted elsewhere in any form.

Consent

Informed consent was obtained from all participants.

Conflict of interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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The authors report no involvement in the research by the sponsor that could have influenced the outcome of this work.

Author's contribution

All authors contributed equally to the manuscript and approved the final version of the manuscript.

Research ethics

This study was observational, focusing on patients with Degenerative cervical myelopathy (DCM). All participants received the same standard treatment. The study aimed to evaluate the outcomes and management of patients with degenerative cervical myelopathy treated with ACDF. Objectives were to determine the age- and sex-specific incidence of cervical degenerative disease in the study population, to assess the clinical features, outcomes, and complications associated with cervical degenerative disease in patients treated with ACDF and to compare pre-operative and post-operative Nurick scores as well as postoperative Odom's criteria outcomes without any deviation from standard clinical practice.

Given that the study was purely observational and did not involve any experimental procedures, manipulation of variables, or assignment of participants to different treatment groups, it was deemed to fall under the category of research that does not require IRB approval. All data were collected in a manner consistent with routine clinical practice, ensuring that patient care was not impacted in any way by the study. Patient confidentiality and ethical standards were strictly maintained throughout the study. No identifiable patient information was collected, and all data were anonymized to protect the privacy of the participants.

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