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Dynamic Cervical Implant versus Cervical Interbody Cage Fusion in Management of Degenerative Cervical Disc Disease

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ABSTRACT

Background: Anterior cervical discectomy and fusion (ACDF) is the most widely used method for the surgical treatment of cervical degenerative disc disease (CDDD) because of its positive fusion rate and patient self-assessment outcomes.

Objectives: To compare clinical and radiological outcomes following dynamic cervical implant and cervical interbody cage fusion in management of single degenerative cervical disc disease.

Patients and Methods: This study included 30 randomized consecutive prospective patients suffering from degenerative cervical disc who were surgically treated by anterior cervical discectomy. Fifteen patients were treated with anterior cervical discectomy and cage interbody fusion and fifteen patients were treated with anterior cervical discectomy and dynamic cervical implant at the Neurosurgery Department, Faculty of Medicine, Menoufia University and Neurosurgery Department of Alexandria Police Hospital.

Results: Mean symptom duration was 9.20±15.0 months in the dynamic cervical implant (DCI) group and 14.20±13.36 months in the cervical cage fusion group. Preoperative scores in the DCI group were moderate in 11 patients (73.3%) and severe in 4 patients (26.7%), while postoperative scores were zero in 6 patients (40.0%), mild in 8 patients (53.3%), and moderate in 1 patient (6.7%). Both groups' improvements in mJOA score and decreases in pain as measured by the VAS were statistically significant.

Conclusions: Dynamic cervical implant appears promising as an alternative to anterior cervical cage fusion, both DCI and cervical cage fusion groups showed similar results, and both appear to be viable options for the treatment of single-level degenerative cervical disc disease.

Keywords: Cervical Interbody Cage, Degenerative Cervical Disc**,** Dynamic Cervical Implant.

INTRODUCTION

Herniated neucleus pulposus (HNP), degenerative disc disease (DDD), and internal disc disruption are cervical disc disorders (IDD). A limited displacement of the nucleus, cartilage, apophyseal bone fragments, or anular tissue fragments outside the intervertebral disc area is known as HNP [1]. Using magnetic resonance imaging (MRI), 10% of asymptomatic people under the age of 40 and 5% of people over the age of 40 can be found to have frequency in the United States HNP [2].

With the help of an MRI, degenerative disc disease can be detected in 25% of asymptomatic people under the age of 40 and 60% of people over the age of 40. Cervical radiculopathy's exact frequency and prevalence are unknown, although studies have revealed that 51-67% of individuals have neck and arm pain occasionally [2]. Degenerative annular rips, disc height loss, and nuclear deterioration are all factors in DDD. IDD refers to disc annular fissuring without disc external deformation. Cervical radiculopathy, which can cause sensory, motor, or reflex problems in the affected nerve root distribution, can be caused by nerve root damage in the presence of disc herniation [3].

Due to its minimal morbidity, magnetic resonance imaging (MRI) continues to be the preferred imaging technique for assessing cervical HNP. Advantages include the ability to define soft tissues (such as cervical discs and the spinal cord), sees cerebrospinal fluid, is noninvasive, and doesn't expose patients to radiation. In trauma cases, computed tomography (CT) scans are frequently utilised to identify cervical spine fractures [4].

Plain cervical spine radiographs are used to assess stability, spinal deformity, infection, and persistent degenerative changes [4]. Muscles may be relaxed, and discomfort relieved by using hot packs, massage, and electrical stimulation. To temporarily reduce pain, a soft cervical collar is advised (not to exceed 3-4 days continuous use). Although there isn't a well-defined treatment mechanism of action, spinal manipulation and mobilization may return the patient to their normal range of motion (ROM) and reduce discomfort [5].

Injections into the cervical epidural, spinal nerve (or root), and Z-joint serve both therapeutic and diagnostic purposes. These techniques can be utilized to identify the anatomical source of discomfort (nerve root, facet), and they can also offer conservative treatment [6]. Studies show that conservative management is effective for cervical HNP with radiculopathy. Intractable radicular or discogenic neck discomfort, decreasing neurologic function, or neurogenic bowel or bladder dysfunction all call for surgery. In particular, radicular pain, spinal instability, progressive myelopathy, or upper extremity weakness are the conditions where cervical spine surgery results are best [5].

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The standard anterior cervical discectomy and fusion approach developed by Cloward and Smith is where surgical care of DDD started. One of the most frequent operations performed by spine surgeons is anterior cervical discectomy and fusion (ACDF) [7]. Dynamic cervical implants were developed as a result of the prospect of achieving anterior cervical decompression and fusion (ACDF) goals while preserving motion in surrounding segments. Utilizing dynamic ventral systems enables controlled sinking and improves the spine's ability to distribute stress. The primary pressures acting on these implants, which are often inserted to restore the spine's axial load-bearing capacity, are distraction and compression [7].

Therefore, the purpose of this study was to compare the clinical and radiological results of cervical interbody cage fusion and dynamic cervical implant in the treatment of a single degenerative cervical disc condition.

PATIENTS AND METHODS

Study Design and Patient Enrolment

In this study, 30 randomized consecutive prospective patients with degenerative cervical disc disease who underwent anterior cervical discectomy were included. At the Neurosurgery Department, Faculty of Medicine, Menoufia University, and Neurosurgery Department of Alexandria Police Hospital, fifteen patients underwent anterior cervical discectomy and cage interbody fusion, and fifteen patients underwent anterior cervical discectomy and dynamic cervical implant.

We included in this study the intervertebral disc herniation from C3 to C7, single level degenerative disc disease, and both sexes with age groups spanning from 20 to 50 years. While we excluded acute or persistent systemic, spinal, or localised infections; severe mechanical instability; osteoporosis; numerous levels; vertebral fractures; vertebral tumours; prior cervical disc surgery.

Preoperative evaluation

The following tests were administered to all patients**:**

Detailed medical history taking with emphasis on age, sex, kind of employment, history of the current condition, and history of systemic illnesses such diabetes mellitus, renal or hepatic insufficiency, osteoporosis, etc.

Comprehensive physical examination included a general check-up, vital signs (such as pulse, blood pressure, temperature, and respiration rate), and examinations of the chest, heart, abdomen, and urogenital system.

Comprehensive neurological examination examining the motor system involved grading the strength, tone, and condition of the muscles using a Medical Research Council (MRC) scale [8]. Grades 0 (total paralysis) to 5 (normal power). Assessment of the sensory system; the four limbs have two types of reflexes: shallow reflexes and deep reflexes. Sphincters: bowel or bladder irregularities. Visual analogue scale (VAS) modified Japanese Orthopedic Association (mJOA) score, and Neck Disability Index (NDI) were used for pre- and postoperative evaluation on the second day of surgery, as well as at the third, sixth-, and twelfth months following surgery [9].

Visual Analogue Scale (VAS) calculated by taking a millimeter-long measurement from the line's left end to the patient's marked location [9].

The modified Japanese Orthopedic Association (mJOA) Score: The total rating of modified Japanese Orthopedic Association was 0 to 18. The deficits are more serious the lower the score. Normal performance is 17+18, 12–16 in Grade 1, 8–11 in Grade 2, and 0–7 in Grade 3 [9]**.**

Neck Disability Index (NDI): Scores range of NDI from 0 to 5 for each of the 10 items. Thus, 50 is the highest possible score. To create a percentage score, multiply the resulting score by 2. On rare occasions, a respondent will omit answering a particular question. The finished things are then multiplied by the average of all the other items [10].

Interpretation: No disability was classified as 0 to 4, mild disability is classified as 5 to 14, moderate disability is classified as 15 to 24, severe disability is classified as 25 to 34, and complete disability is classified as 35 and beyond [10].

Routine laboratory investigations**:** Prothrombin time and activity, fasting blood sugar, urea, creatinine, SGOT, and SGPT were all included in the full blood picture. Additional unique tests: When necessary, tumour markers were used to rule out tumours, whereas ESR and CRP could rule out infection.

Radiological investigations: Examination of the cervical spine using magnetic resonance imaging (MRI) included measuring the size of the spinal canal, the size of the spinal cord, and the intervertebral discs, ligamentum flavum hypertrophy, and the vertebral ligaments. Antero-posterior, lateral, and flexion-extension dynamic studies on a plain X-ray of the cervical spine were used to identify small subluxations between the vertebrae and show aberrant movement.

Postoperative evaluation

A. ***Surgical data:*** Directly from the surgeons' dictated operative notes, anaesthetic notes, and operating room records were collected as objective surgical data. This included the duration of the procedure, the size of the incision made in the skin, the projected blood loss, the number of blood units that had to be transfused, the degree of exposure, and any intraoperative difficulties.

B. *Perioperative data:* The charts of the patients were used to collect perioperative hospital data. This included the amount of blood transfused, the number of transfusions required, the length of hospital stays, the requirement for care in a transitional facility, and postoperative problems.

C. *Postoperative care:* The day following surgery, the patients were mobilized postoperatively. Before discharge, radiographic pictures were taken.

D. *Postoperative follow-up:* To evaluate the clinical and radiological results, as well as for immediate and long-term problems associated to the surgical strategy, all patients were monitored for a year following surgery.

Clinical follow up

Following the initial postoperative visit, patients were checked on at an outpatient clinic on the second day of surgery, three months after the procedure, six months after the procedure, and one year after the procedure. Clinical symptoms were noted after each office visit, a physical examination was performed, and patients were assessed for any improvement or deterioration in symptoms or clinical signs. According to the mJOA score, each patient's postoperative neurological condition was assessed on the second day of surgery, three months, six months, and a year after the operation. The VAS score was used to calculate postoperative pain, and comparisons between the two groups were made on the second day after surgery, three months later, six months later, and one year later.

Radiological follow up

Radiographic evaluations were performed using cervical X-rays in the AP, LAT, and dynamic views on the second postoperative day, three, six, and one year after the operation. Additionally, MRI was performed a year following the procedure to assess the spinal cord, recurrent discs, adjacent segment disorder, and signal intensity changes on T2 weighted MRI scans at the level of the operation. The results of the two groups were then compared.

Ethical approval

The trial was registered with the local Ethics Council of the Faculty of Medicine, Menoufia University (IRB approval number: 2/2023NEUS8) and the study's reporting complied with the criteria. All participants signed an informing consent after a thorough explanation of the goals of the study. The Helsinki Declaration was followed throughout the study's conduct.

Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0**.** **(**Armonk, NY: IBM Corp, USA**).** Qualitative data were described using number and percent and were compared by Chi-square test, Fisher's Exact or Monte Carlo correction. The Kolmogorov-Smirnov test was used to verify the normality of distribution of quantitative data, which were described using range (minimum and maximum), mean, standard deviation and median. Comparison of quantitative data between 2 groups or between pre-and postoperative data in the same group, or between more than 2 groups was done using Student t-test, Paired t-test, or one-way ANOVA test respectively for normally distributed data and by Mann Whitney test, Wilcoxon signed ranks test, or Kruskal-Wallis test respectively for abnormally distributed data. The significance of the obtained results was judged at the 5% level.

RESULTS

Figure 1 displays the study population's flowchart. 44 patients with a verified diagnosis of degenerative cervical disc disease were seen. 30 patients participated in the study and gave their agreement, whereas 14 patients were excluded from it. The participants were separated into two groups as Group I, consisting of 15 patients with DCI, and Group II, included of 15 patients with cages. Preoperative and postoperative data of each group were also calculated (Figure 1).

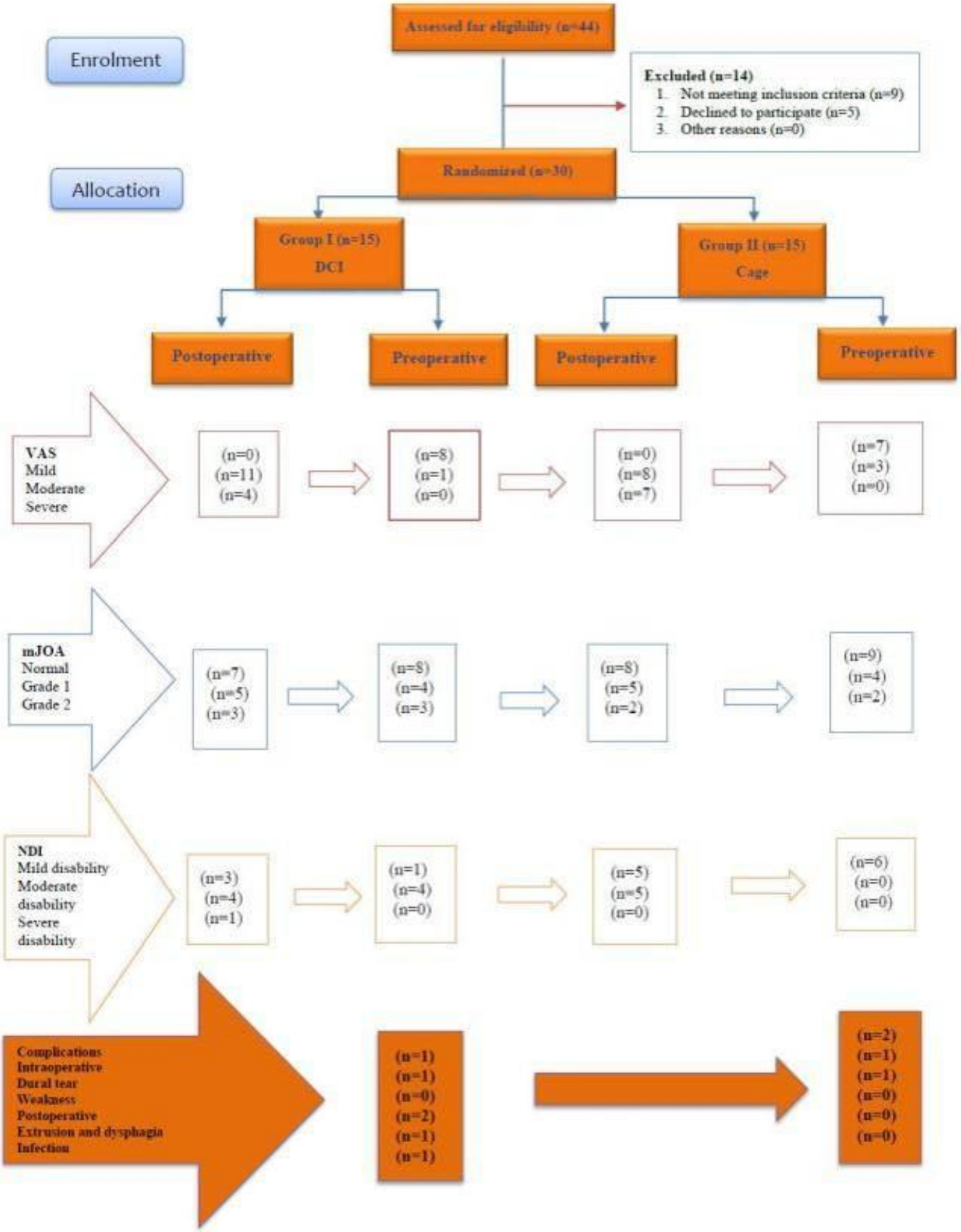

Figure (1): Flowchart of the studied groups

In the present research, there was no significant difference between the 2 studied groups regarding sex, age, past history, complaint, motor and sensory examination, and reflexes (Table 1).

Table (1): Distribution of the studied cases according to sex, age, history, complaint, motor examination, sensory examination, and reflexes (n= 30)

	DCI (n = 15)		Cage (n = 15)		Total (n = 30)		*P value*
	No.	**%**	**No.**	**%**	**No.**	**%**	
Sex							
Male	7	46.7	6	40	13	43.3	0.713
Female	8	53.3	9	60	17	56.7	
Age (years)							
Min. – Max.	28.0 – 50.0		28.0 – 50.0		28.0 – 50.0		0.384
Mean ± SD	42 ± 6.48		44 ± 5.88		41.47 ± 5.86		
Past history							
No past history	5	33.3	6	40	11	36.7	
HTN	4	26.7	4	26	8	26.7	
DM	5	33.3	1	6.7	6	20.0	^{FE}**p**=0.083
DM, HTN	0	0	4	6.7	4	13.3	
Rheumatoid arthritis	1	6.7	0	0	1	3.3	
Complaint							
Neck pain	15	100.0	15	100.0	30	100.0	
Radiculopathy	10	66.7	9	60	19	63.3	
Myelopathy	3	20.0	6	40.0	9	30.0	^{FE}**p**=0.487
Radiculopathy and myelopathy	2	13.3	0	0.0	2	6.7	
Motor examination							
No weakness	8	53.3	7	47.4	15	50.0	
Weakness	2	13.3	2	13.3	4	13.3	
Hemiparesis	2	13.3	1	6.7	3	10.0	^{FE}**p**=0.895
Quadriparesis	2	13.3	4	26.6	6	20.0	
Diparesis	1	6.7	1	6.7	2	6.7	
Sensory examination							
No sensory loss	8	53.3	9	60.0	17	56.7	0.713
Sensory loss	7	46.7	6	40.0	13	43.3	
Reflexes							
Normal							
Hyporeflexia							
Hyperreflexia and	8	53.3	7	46.7	15	50.0	^{FE}**p**=0.875
Hoffman	2	13.3	2	13.3	4	13.3	
Hyperreflexia and	4	26.7	5	33.3	9	30.0	
Babinski	1	6.7	1	6.7	2	6.7	

MC: **Monte Carlo** test, FE: Fisher exact test.

In our study, the mean±SD symptom duration was 9.20±15.0 months in the DCI group and 14.20±13.36 months in the cervical cage fusion group (Table 2).

Table (2): Comparison between the two studied groups according to duration of symptoms.

	DCI (n=15)	Cage (n=15)	U	*P value*
Duration of symptoms (months)				
Min. – Max.	3.0 – 60.0	3.0 – 48.0	67.0	0.054
Mean ± SD.	9.20 ± 15.0	14.20 ± 13.36		
Median	4.0	9.0		

Regarding preoperative VAS scores in the DCI group, they were moderate in 11 patients (73.3%) and severe in 4 patients (26.7%), while postoperative scores were zero in 6 patients (40.0%), mild in 8 patients (53.3%), and moderate in 1 patient (6.7%). The median preoperative score for the DCI group of mJOA patients 16. However, the preoperative scores in the cervical cage fusion group were mild in 8 patients (53.3%), severe in 7 patients (46.7%), and no pain in 5 patients (33.3%), mild pain in 7 patients (46.7%), and moderate pain in 3 patients (20.0%). In contrast, the cervical cage fusion preoperative mJOA median was 16 as the median. The mJOA score improved in both groups at three, six-, and twelve-months following surgery. Both groups' improvements in mJOA score and decreases VAS were statistically significant (Table 3).

Table (3): Comparison between the two studied groups according to VAS and mJOA.

	DCI (n = 15)		**Cage (n = 15)**		**x^2**	**MCp**
	No.	**%**	**No.**	**%**		
VAS						
Preoperative						
No	0	0.0	0	0.0		
Mild	0	0.0	0	0.0	1.142	0.771
Moderate	11	73.3	8	53.3		
Severe	4	26.7	7	46.7		
Postoperative						
No	6	40.0	5	33.3		
Mild	8	53.3	7	46.7	2.342	0.368
Moderate	1	6.7	3	20.0		
Severe	0	0.0	0	0.0		
P1	**0.013***		**0.021***			
mJOA						
Preoperative						
Normal	7	46.7	8	53.3	0.394	**^{MC}p=** 1.000
Grade 1	5	33.3	5	33.3		
Grade 2	3	20.0	2	13.3		
Postoperative						
Normal	8	53.3	9	60.0	0.396	**MCp=** 1.000
Grade 1	4	26.7	4	26.7		
Grade 2	3	20.0	2	13.3		
P1	**0.317**		**0.317**			
Preoperative						
Min. – Max.	10.0 – 18.0		9.0 – 18.0			
Mean ± SD.	15.0 ± 2.80		14.67 ± 3.18			
Median	16.0		16.0			
Postoperative						
Min. – Max.	12.0 – 18.0		10.0 – 18.0			
Mean ± SD.	15.93 ± 2.37		15.60 ± 2.92			
Median	17.0		17.0			
P1	**0.001***		**<0.001***			

x^2, p: x^2 and p values for Chi square test for comparing between the two groups ^{MCp}: p value for Monte Carlo for Chi square test for comparing between the two groups. p_1: p value for Wilcoxon signed ranks test for comparing between preoperative and post-operative in each group t, p: t and p values for Student t-test for comparing between the two groups p: p value for Paired t-test for comparing between preoperative and post-operative *: Statistically significant at $p \leq 0.05$.

In the current study, the afflicted levels in the DCI group were C5C6 in 8 patients (53.3%), C6-C7 in 5 patients (33.3%), and C3-C4 in 2 patients (13.6%), in decreasing order of frequency. In the cervical cage fusion group, the afflicted levels were C5-C6 in 7 patients (46.7%), C6-C7 in 6 patients (40.0%), and C4-C5 in 2 patients (13.3%), (Figure 2).

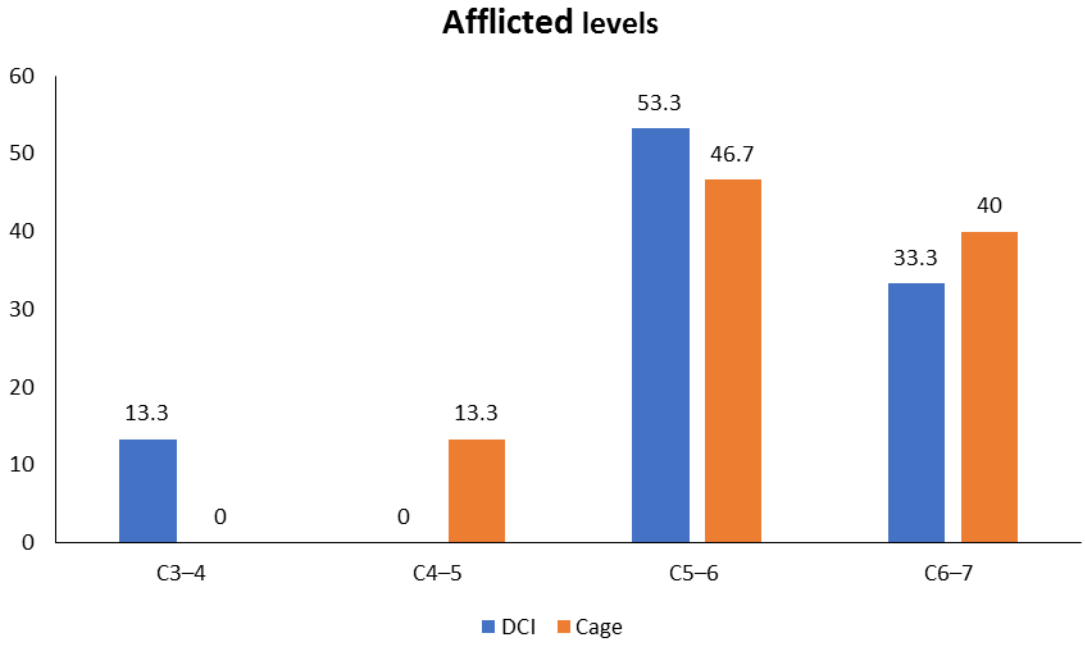

Figure (2): Comparison between the two studied groups according to the afflicted levels.

There was no significant difference between the studied groups according to preoperative and postoperative MRI results and postoperative X-ray findings (Table 4).

Table (4): Comparison between the two studied groups according to MRI and postoperative x-ray.

	DCI (n = 15)		Cage (n = 15)		x^2	MCp
	No.	%	No.	%		
MRI						
Preoperative						
Foraminal disc	10	66.7	9	60.0	0.144	0.705
Central disc and cord signal	5	33.3	6	40.0		
Postoperative						
Decompression of the affected root						
Decompression of the cord, no cord signal	10	66.7	9	60.0	0.983	0.764
Decompression of the cord, cord signal	2	13.3	4	26.7		
	3	20.0	2	13.3		
Postoperative x-ray	14	93.3	0	0.0		
No instability	14	93.3	13	86.7		
No adjacent segment disorder.	0	0	0	0.0	33.869	0.723
Migration of the implant Fusion	1	6.7	0	0		
Adjacent segment disorder	0	0.0	2	13.3		

x^2, x^2 and p values for Chi square test for comparing between the two groups.
^{MC}p: p value for Monte Carlo for Chi square test for comparing between the two groups.

According to our research, the median blood loss in the DCI group was 40 CC versus 50 CC in cervical cage fusion group (Figure 3).

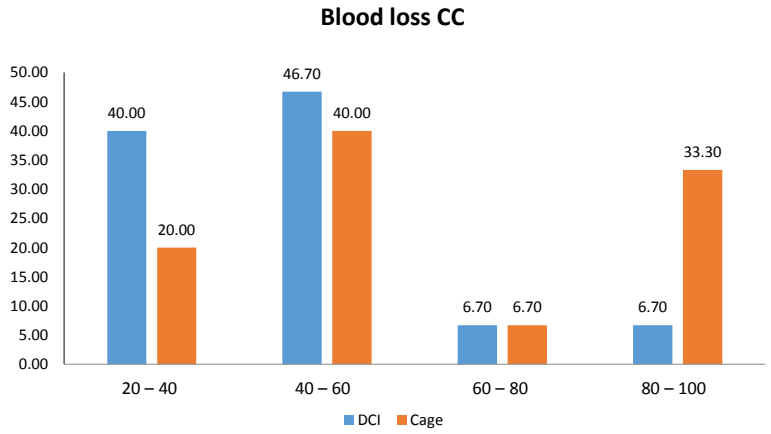

Figure (3): Comparison between the two studied groups according to blood loss CC.

There were no significant side effects such neurovascular injuries, CSF leaks, esophageal perforations, or deep infections in the current trial. Complications affected 3 individuals (20%) in the DCI group and two patients (13.3%) in the cervical cage fusion group (Table 5).

Table (5): Comparison between the two studied groups according to complications.

Complication	DCI (n=15)		Cage (n=15)		X^2	P value
	No.	%	No.	%		
No	12	80.0	13	86.7	86.7	**MCp**=0.599
Intraoperative	1	6.7	2	13.3	13.3	**MCp**=0.599
Dural tear	1	6.7	1	6.7	6.7	**FEp**=1.000
Weakness (post-operative)	0	0.0	1	6.7	6.7	**FEp**=1.000
Postoperative	2	13.3	0	0.0	0.0	**MCp**=0.599
Extrusion and dysphagia	1	6.7	0	0.0	0.0	**FEp**=1.000
Infection	1	6.7	0	0.0	0.0	**FEp**=1.000

x^2, p: x^2 and p values for Chi square test for comparing between the two groups.
^{MC}p: p value for Monte Carlo for Chi square test for comparing between the two groups
^{FE}p: p value for Fisher Exact for Chi square test for comparing between the two groups.

Regarding the motor examination, reflexes, VAS postoperative, mJOA postoperative, and NDI preoperative, there were significant differences between the analysed groups. Complaint, sensory examination, VAS preoperative, mJOA preoperative, NDI postoperative, MRI preoperative, and postoperative blood loss complication did not differ significantly between the analyzed groups (Table 6).

Table (6): Relations between prognosis and different parameters in DCI group.

		Prognosis						Test of sig.	p
		Poor (n = 2)		Good (n = 7)		Excellent (n = 6)			
		No.	%	No.	%	No.	%		
Complaint	Radiculopathy	1	50.0	3	42.9	6	100.0	X^2 = 5.802	^{MC}p= 0.176
	Myelopathy	1	50.0	2	28.6	0	0.0		
	Radiculopathy and myelopathy	0	0.0	2	28.6	0	0.0		
Motor examination	No weakness	1	50.0	1	14.3	6	100.0	X^2 = 11.935*	^{MC}p= 0.046*
	Weakness	0	0.0	2	28.6	0	0.0		
	Hemiparesis	1	50.0	1	14.3	0	0.0		
	Quadriparesis	0	0.0	2	28.6	0	0.0		
	Biparesis	0	0.0	1	14.3	0	0.0		
Sensory examination	No sensory loss	1	50.0	3	42.9	4	66.7	X^2 = 1.009	^{MC}p= 0.786
	Sensory loss	1	50.0	4	57.1	2	33.3		
Reflexes	Normal	1	50.0	1	14.3	6	100.0	X^2 = 10.531*	^{MC}p= 0.026*
	Hyporeflexia	0	0.0	2	28.6	0	0.0		
	Hyperreflexia and hofman	1	50.0	3	42.9	0	0.0		
	Hyperreflexia and Babinski	0	0.0	1	14.3	0	0.0		
	VAS								
Preoperative	No	0	0.0	0	0.0	0	0.0	X^2 = 0.798	^{MC}p= 1.000
	Mild	0	0.0	0	0.0	0	0.0		
	Moderate	2	100.0	5	71.4	4	66.7		
	Severe	0	0.0	2	28.6	2	33.3		
Postoperative	No	1	50.0	0	0.0	5	83.3	X^2 = 14.170*	^{MC}p= 0.001*
	Mild	0	0.0	7	100.0	1	16.7		
	Moderate	1	50.0	0	0.0	0	0.0		
	Severe	0	0.0	0	0.0	0	0.0		
	mJOA								
Preoperative	Normal	1	50.0	1	14.3	5	83.3	X^2 = 7.455	^{MC}p= 0.071
	Grade 1	0	0.0	4	57.1	1	16.7		
	Grade 2	1	50.0	2	28.6	0	0.0		
	Min. – Max.	11.0 – 18.0		10.0 – 17.0		16.0 – 18.0		F= 3.675	0.057
	Mean ± SD.	14.50 ± 4.95		13.43 ± 2.64		17.0 ± 0.63			
	Median	14.50		13.0		17.0			
Postoperative	Normal	1	50.0	1	14.3	6	100.0	X^2 = 10.278*	^{MC}p= 0.007*
	Grade 1	0	0.0	4	57.1	0	0.0		
	Grade 2	1	50.0	2	28.6	0	0.0		
	Min. – Max.	12.0 – 17.0		12.0 – 17.0		18.0 – 18.0		F= 7.078*	0.009*
	Mean ± SD.	14.50 ± 3.54		14.57 ± 1.99		18.0 ± 0.0			
	Median	14.50		15.0		18.0			
	NDI								
Preoperative	No disability	0	0.0	1	14.3	6	100.0	X^2 = 11.949*	^{MC}p= 0.010*
	Mild disability	1	50.0	2	28.6	0	0.0		
	Moderate disability	1	50.0	3	42.9	0	0.0		
	Severe disability	0	0.0	1	14.3	0	0.0		
Postoperative	No disability	1	50.0	3	42.9	6	100.0	X^2 = 6.038	^{MC}p= 0.201
	Mild disability	0	0.0	1	14.3	0	0.0		
	Moderate disability	1	50.0	3	42.9	0	0.0		
	Severe disability	0	0.0	0	0.0	0	0.0		
	MRI								
Preoperative	Foramina disc Central disc and cord	1	50.0	3	42.9	6	100.0	X^2 = 5.127	^{MC}p= 0.062
	signal	1	50.0	4	57.1	0	0.0		
Postoperative	Decompression of the affected root	1	50.0	3	42.9	6	100.0	X^2 = 5.802	^{MC}p= 0.173
	Decompression of the cord, no cord signal	0	0.0	2	28.6	0	0.0		
	Decompression of the cord, cord signal	1	50.0	2	28.6	0	0.0		
Blood loss	20 – 40	0	0.0	2	28.6	4	66.7	X^2 = 9.305	^{MC}p= 0.085
CC	40 – 60	1	50.0	5	71.4	1	16.7		
	60 – 80	1	50.0	0	0.0	0	0.0		
	80 – 100	0	0.0	0	0.0	1	16.7		
Complication	No	1	50.0	5	71.4	6	100.0	X^2 = 3.032	^{MC}p= 0.305
	Yes	1	50.0	2	28.6	0	0.0		

x^2, p: x^2 and p values for Chi square test ^{MC}p: p value for **Monte Carlo** for Chi square test H, p: H and p values for **Kruskal Wallis test** *: Statistically significant at $p \leq 0.05$

The duration of symptoms, sensory examination, reflexes, VAS postoperative, mJOA, and MRI all showed significant differences between the study groups. As for the motor examination, VAS preoperative, NDI preoperative, NDI postoperative, NDI postoperative, postoperative X-ray, and complications, there were no significant differences between the analyzed groups (Table 7).

Table (7): Relations between prognosis and different parameters in Cage group.

	Prognosis								Test of sig.	p
	Poor (n=1)		Fair (n=3)		Good (n=7)		Excellent (n=4)			
	No.	%	No.	%	No.	%	No.	%		
Duration of symptoms (months)										
Min. – Max.			16.0 – 36.0				3.0 – 3.0		H= 9.767*	0.008*
Mean ± SD.			25.33 ± 10.07		7.0 – 48.0		3.0 ± 0.0			
Median	24.0#		24.0		14.43 ±14.86		3.0			
Motor examination										
No weakness	0	0.0	0	0.0	5	71.4	2	50.0		
Weakness	0	0.0	0	0.0	1	25.3	1	25.0	X^2 =	0.206
Hemiparesis	0	0.0	1	33.3	0	0.0	0	0.0	14.576	
Quadriparesis	1	100.0	1	33.3	1	14.3	1	25.0		
Biparesis	0	0.0	1	33.3	0	0.0	0	0.0		
Sensory examination		0.0							X^2 =	0.033*
No sensory loss	0	100	0	0.0	6	85.7	3	75.0	7.417*	
Sensory loss	1	.0	3	100.0	1	14.3	1	25.0		
Reflexes										
Normal										
Hyporeflexia		0.0								0.048*
Hyperreflexia and	0	0.0	0	0.0	5	17.4	2	50.0	X^2= 13.384*	
hofman	0	0.0	0	0.0	1	14.3	1	25.0		
Hyperreflexia and	0	100	3	100.0	1	14.3	1	25.0		
Babinski	1	.0	0	0.0	0	0.0	0	0.0		
Vas										
Preoperative		0.0								
No	0	0.0	0	0.0	0	0.0	0	0.0	X^2 =	^{MC}p=
Mild	0	0.0	0	0.0	0	0.0	0	0.0		1.000
Moderate	0	100	2	66.7	4	57.1	2	50.0	1.583	
Severe	1	.0	1	33.3	3	42.9	2	50.0		
Postoperative		0.0								
No	0	0.0	1	33.3	0	0.0	4	100.0	X^2 =	^{MC}p=
Mild	0	100	0	0.0	7	100.0	0	0.0	19.330*	<0.001*
Moderate	1	.0	2	66.7	0	0.0	0	0.0		
Severe	0	0.0	0	0.0	0	0.0	0	0.0		
JOA										
Preoperative		0.0								
Normal	0	0.0	0	0.0	6	85.7	2	50.0	X^2 =	^{MC}p=
Grade 1	0	100	2	66.7	0	14.3	2	50.0	10.709*	0.031*
Grade 2	1	.0	1	33.3	1	0.0	0	0.0		
Min. – Max.	9.0#		9.0 – 13.0		12.0 – 18.0		12.0 – 17.0		F= 5.946*	0.018*
Mean ± SD.			11.33 ± 2.08		16.43 ± 2.07		15.50 ± 2.38			
Median			12.0		17.0		16.50			
Postoperative										
Normal	0	0.0	0	0.0	6	85.7	3	75.0	X^2 =	^{MC}p=
Grade 1	0	0.0	2	66.7	1	14.3	1	25.0	10.661*	0.028*
Grade 2	1	100.0	1	33.3	0	0.0	0	0.0		
Min. – Max.	11.0#		10.0 – 14.0		13.0 – 18.0		13.0 – 18.0		F= 5.743*	0.020*
Mean ± SD.			12.33 ± 2.08		17.0 ±1.83		16.75 ± 2.50			
Median			13.0		18.0		18.0			
NDI										
Preoperative										
No disability	0	0.0	0	0.0	3	42.9	2	50.0	X^2 =	^{MC}p=
Mild disability	0	0.0	1	33.3	3	42.9	1	25.0	5.438	0.631
Moderate disability	1	100.0	2	66.7	1	14.3	1	25.0		
Severe disability	0	0.0	0	0.0	0	0.0	0	0.0		

	Prognosis								Test of sig.	p
	Poor (n=1)		Fair (n=3)		Good (n=7)		Excellent (n=4)			
	No.	%	No.	%	No.	%	No.	%		
Postoperative										
No disability	0	0.0	1	33.3	6	85.7	2	50.0	X^2 = 4.409	^{MC}p= 0.232
Mild disability	1	100.0	2	66.7	1	14.3	2	50.0		
Moderate disability	0	0.0	0	0.0	0	0.0	0	0.0		
Severe disability	0	0.0	0	0.0	0	0.0	0	0.0		
MRI										
Preoperative										
Foramina disc	0	0.0	0	0.0	6	85.7	3	75.0	X^2= 7.417*	^{MC}p= 0.033*
Central disc and cord signal	1	100.0	3	100.0	1	14.3	1	25.0		
Postoperative									X^2= 10.661*	^{MC}p= 0.028*
Decompression of the affected root	0	0.0	0	0.0	6	85.7	3	75.0		
Decompression of the cord, no cord signal	0	0.0	2	66.7	1	14.3	1	25.0		
Decompression of the cord, cord signal	1	100.0	1	33.3	0	0.0	0	0.0		
Postoperative x-ray									X^2= 1.881	^{MC}p= 1.000
No instability, no adjacent segment disorder	0	0.0	0	0.0	0	0.0	0	0.0		
Migration of the implant Fusion	0	0.0	0	0.0	0	0.0	0	0.0		
no adjacent segment disorder	0	100.0	3	100.0	6	85.7	3	75.0		
Fusion, adjacent segment disorder	1	0.0	0	0.0	1	14.3	1	25.0		
Complication	1	100.0	1	100.0	6	85.7	3	75.0	X^2= 1.881	^{MC}p= 1.000
No	0	0.0	0	0.0	1	14.3	1	25.0		
Yes										

#: one cases was excluded from the comparison
x^2, p: x^2 and p values for Chi square test ^{MC}p: p value for Monte Carlo for Chi square test
F, p: F and p values for ANOVA test H, p: H and p values for Kruskal Wallis test *: Statistically significant at $p \leq 0.05$

In case (1) in our study, A 35-year-old female patient was seen with neck pain radiating to the left shoulder and tingling in the right index and thumb that had been present for five months and was not improving with medical care. Clinical testing revealed no motor weakness, a successful Spurling manoeuvre, and healthy reflexes. Preoperative mJOA score was 17/18, preoperative NDI was 4/50, and preoperative VAS was moderate (no disability). Radiological tests revealed a prolapsed C5-C6 disc. DCI implantation was performed along with an anterior cervical C5–6 discectomy. Patient postoperative VAS improved to "no pain," "mJOA improved to "18/18," and "NDI improved to "0/50" (No disability). The prognosis was very good (Figure 4a, b, c).

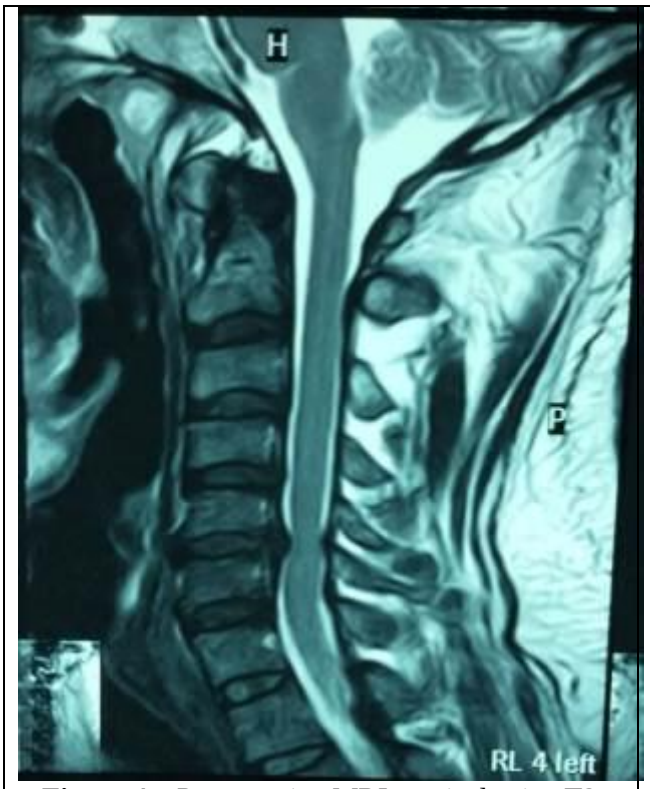

Figure 4a. Preoperative MRI cervical spine T2 sagittal view showed C5-6 disc prolapse.

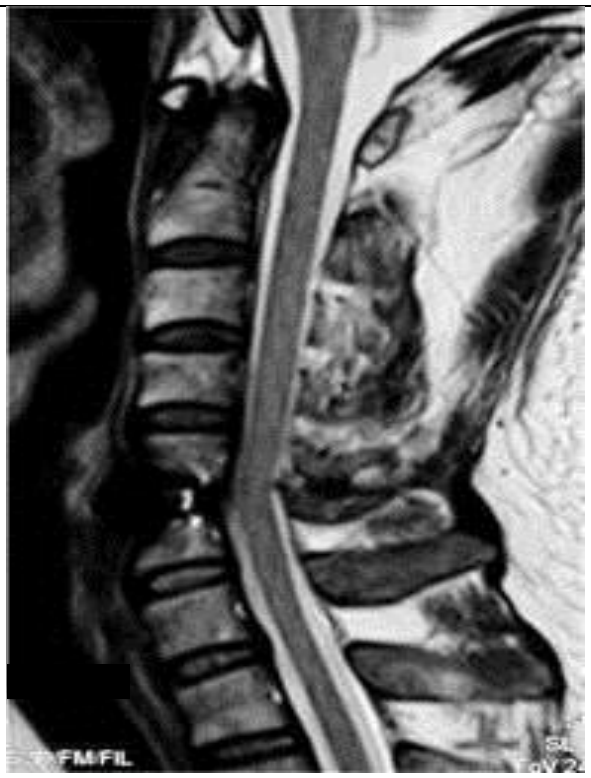

Figure 4b. Postoperative MRI cervical spine T2 sagittal view showed excision of the herniated disc and decompression of cord.

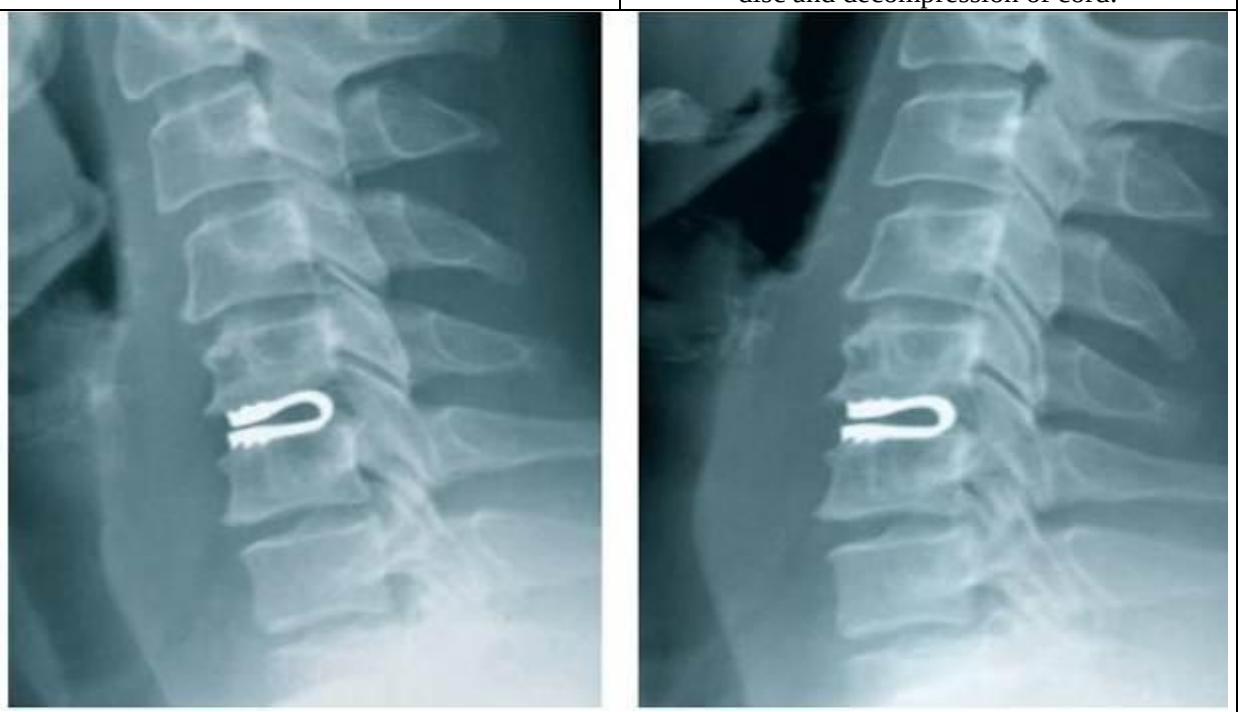

Figure 4c. Postoperative plain x-ray of cervical spine dynamic view showed stability of cervical spine, no heterotopic ossification and in place DCI.

Regarding ***case 2,*** male patient, 40 years old, appeared with sphincteric abnormalities, neck pain, limited neck movement, difficulties with fine hand movements, inability to walk unassisted, and neck pain that had persisted despite four months of medical treatment. A clinical examination revealed stiffness, hyperreflexia, weakness in both the upper and lower limbs, and a positive planter reflex. Preoperative mJOA score was 12/18, preoperative NDI was 15/50, and preoperative VAS was moderate (moderate disability). Studies using radiology revealed C6-C7 disc prolapse and cord signal. A cage fusion and anterior cervical C6-7 discectomy were performed. Postoperative VAS for the patient improved to light pain, postoperative mJOA improved to 14/18, and postoperative NDI improved to 7/50 (Mild disability). A favorable prognosis (Figure 5a, b, c).

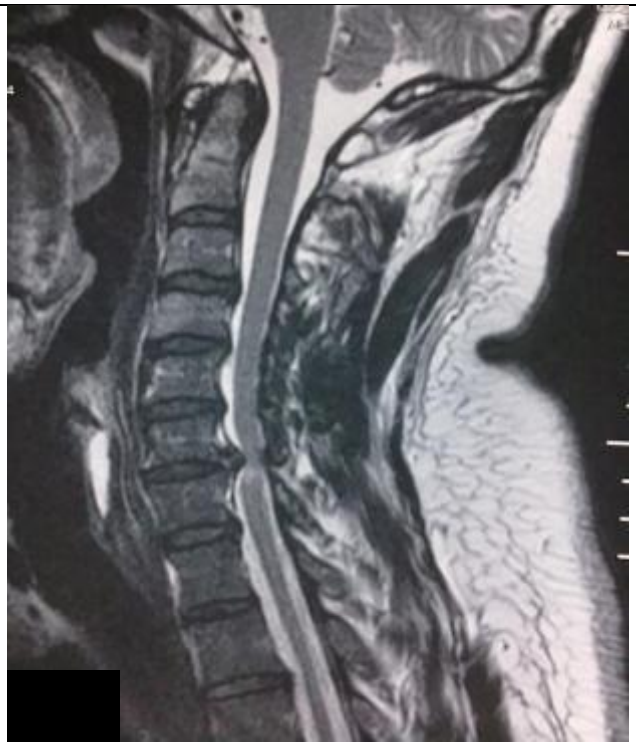

Figure 5a. Preoperative MRI cervical spine T2 sagittal view showed C6-7 disc prolapse with cord signal.

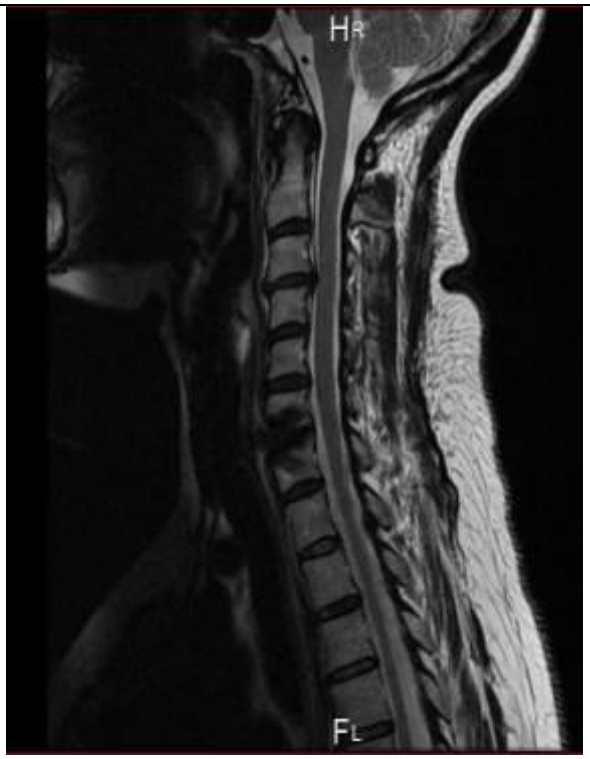

Figure 5b. Postoperative MRI cervical spine T2 sagittal view showed excision of the herniated disc, decompression of cord, no cord signal and adjacent segment disease at C3-4

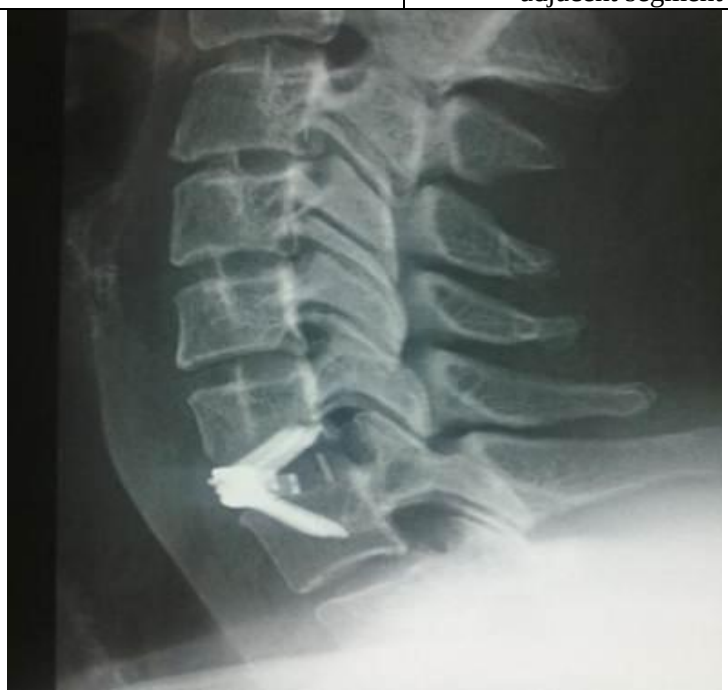

Figure 5c. Postoperative plain X-ray of cervical spine lateral view showed stability of cervical spine, fusion and in place cervical cage.

In case 3, A 37-year-old male patient presented with neck pain radiating to the left shoulder and forearm, along with numbness in the left index and middle fingers that had persisted for 7 months despite medical treatment. Clinical testing revealed positive Spurling's manoeuvre and left triceps jerk hyporeflexia. Preoperative VAS was severe, preoperative mJOA score was 15/18 and preoperative NDI was 5/50 (mild disability). Radiological scans showed C6C7 disc prolapse. Anterior cervical C6-7 discectomy with DCI insertion was done. Patient postoperative VAS improved to "no pain," "mJOA improved to "18/18," and "NDI improved to "2/50" (No disability). The prognosis was very good (Figure 6a, b, and c).

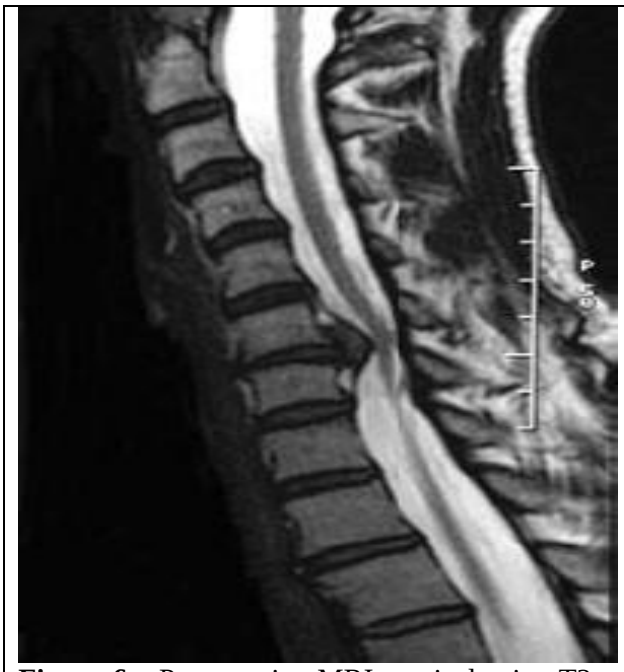

Figure 6a. Preoperative MRI cervical spine T2 sagittal view showed C6-7 disc prolapse.

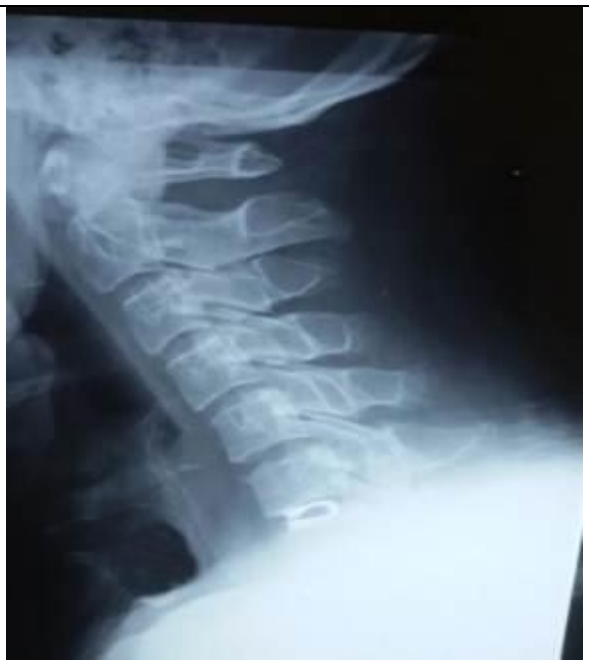

Figure 6b. Postoperative plain X-ray of cervical spine lateral view showed stability of cervical spine, no heterotopic ossifications and in place C6-7 DCI**.**

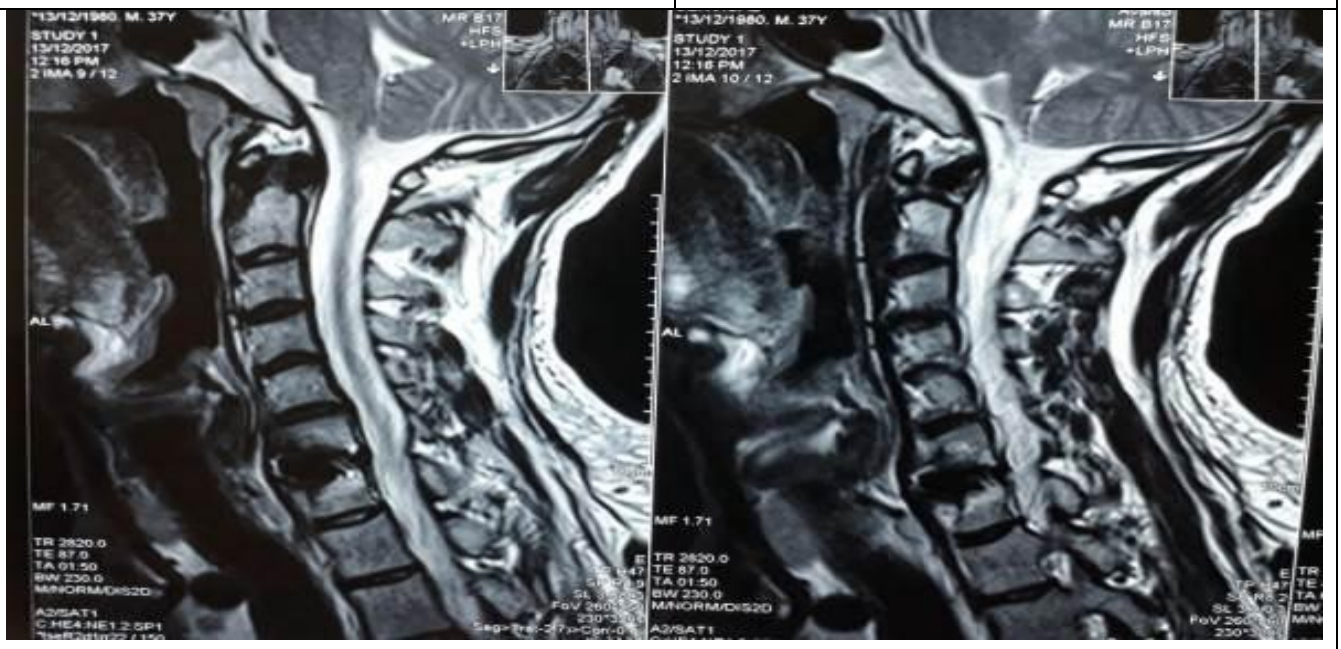

Figure 6c. Postoperative MRI cervical spine T2 sagittal view showed excision of the herniated disc and decompression of cord**.**

DISCUSSION

For more than a century, spinal fusion has been researched to address spine-related pathology. Although there isn't a proven cure for adjacent segment disease (ASD), there are ways to manage its symptoms. Numerous investigations have demonstrated that decompression of neural components combined with potential fusion extension may be used to address symptoms [11]. In the current study, there was a predominance of female sex in the DCI and cervical cage fusion groups (53.3% vs. 60% respectively). 2, 1 patient's prognosis was bad; 3, 4 patient's prognosis was good; and 3, 3 patient's prognosis was great. Representation of men (46.7% vs. 40%) 1 patient out of 3 had a great prognosis, while 4 patients out of 4 had a good prognosis, which was close to **Auerbach *et al.*** [12] where most of the patients were females (55,6%) in contrast to **Chang *et al.*** [13], when there were more men (58,8%).

In DCI group, 33.3%, and 40% of cases with no past medical history, 1 had poor prognosis, 1 had fair prognosis, 3, 2 had good prognosis and 2, 2 had excellent prognosis, respectively. 26.7% of cases in DCI group with history of hypertension; 1 had poor prognosis, 1 had good prognosis and 1 had excellent prognosis, 33.3% of cases with history of diabetes mellitus; 1 had poor prognosis, 3 had good prognosis and 1 had excellent prognosis and 6.7% of cases with history rheumatoid arthritis who had excellent prognosis. These results were close to **Guerin *et al.*** [14] 38% of cases had no prior medical history, 30% had hypertension-related histories, 30% had histories of diabetes mellitus, and 2% had histories including rheumatoid arthritis, lumbar disc, and migraines. Past history was not statistically significant predictor of outcome in either group. This agreed with **Hilibrand *et al.*** [15] who found no statistically significant correlation between prior history and prognosis.

Neck pain was the primary presenting complaint in both the cervical cage fusion and DCI groups of individuals. Radiculopathy was the most common symptom, occurring in 9 out of 10 patients. One patient had a poor prognosis, three patients had a good prognosis, six patients had a good prognosis, and three patients had an excellent prognosis. 3 and 6 patients had myelopathy (20% and 40%), which causes difficulty with fine hand movements, heaviness in the lower limbs, gait disturbances, and sphincter disturbances. In the cervical cage fusion group alone, 1, 1, and 2, 1, respectively, had bad and good prognoses, while 3, 3, and 1 had acceptable and excellent prognoses. These results were close to **Boden *et al.*** [16] who noticed that all the patients reported neck pain, and 71% of those instances also reported radiculopathy, 17% reported myelopathy, and 12% had both radiculopathy and myelopathy. In the cervical cage and DCI groups, the presenting symptoms had no statistically significant impact on the outcome. This agreed with **Boden *et al.*** [16] who failed to discover a statistically meaningful link between symptoms and prognosis. In contrast to **Guerin *et al.*** [14] **and Lopez-Espina *et al.*** [17] who cited symptoms as one of the statistically important elements influencing prognosis.

In the current study, the motor examination of the DCI and cervical cage fusion groups revealed that no weakness was present in 8 and 7 patients respectively; five patients had a good prognosis, and six patients had an excellent prognosis; weakness along the affected nerve root was present in 2, 2 patients. In the DCI group, one patient had a poor or good prognosis; however, the cervical cage fusion group had a fair prognosis in quadriparesis in two and four patients, respectively; in the DCI group, two patients had a good prognosis and diparesis in one patient. However, in the cervical cage fusion group, diparesis occurred in 6.7% of cases; 1 had a poor or fair or good prognosis, and excellent prognosis. These results were close to **Hilibrand *et al.*** [15] **and Heller *et al.*** [18] who discovered that weakness was absent in 50% of cases, present along the affected root in 20% of cases, hemiparesis was present in 10% of cases, quadriparesis was present in 10% of cases, and diparesis was present in 10% of cases. Motor examination was statistically meaningful prognostic indicator since it was absent in 100% of cases with favourable prognosis, 50% of cases with poor prognosis, and 50% of instances with quadriparesis. **Heller *et al.*** [18] reported that one of the statistically important elements impacting prognosis is motor examination. In contrast to **Jackson and Johnson** [19] who failed to discover a statistically significant link between the motor examination and prognosis.

In the current investigation, the DCI group's sensory examination revealed that 8 patients had normal sensory examinations, whereas 7 patients had sensory loss that ranged from hyposthesia to total sensory loss. As opposed to this, the cervical cage fusion group's sensory examination revealed normal sensory examination in 9 patients, and sensory loss in 6 patients, ranging from hyposthesia to total sensory loss. These results were close to **McAfee *et al.*** [20] where the sensory test revealed no sensory loss in (59%) of the cases and sensory loss in (41%), both of which had identical prognostic percentages. Similarly, **Lopez-Espina *et al.*** [17] found sixty-four percent of individuals with sensory examinations had no sensory loss, while 35.7% of cases had sensory loss.

In DCI group, sensory examination was not statistically significant factor for prognosis. This agreed with **McAfee *et al.*** [20] and in contrast to **Heller *et al.*** [18] who reported that one of the statistically significant parameters influencing prognosis is sensory examination. In the cervical cage fusion group, sensory assessment was statistically significant determinant for prognosis, with no sensory

loss in 75% of cases with great prognosis and 100% of cases with bad prognosis. This agreed with **Lopez-Espina *et al.*** [17] and in contrast to **Matsumoto *et al.*** [21] who failed to find a statistically significant link between the sensory evaluation and prognosis.

In the present study, reflexes were normal in 8 patients in the DCI group, hyperreflexia, and positive Hoffman's reflex in 4 patients, hyporeflexia in 2 patients, and hyperreflexia and positive Bapiniski's sign in 1 patient. In the cervical cage fusion group, they were normal in 7, hyperreflexia and positive Hoffman's reflex in 5, hyporeflexia in 2, and hyperreflexia and positive Bapiniski's sign in 1 patient. These results were close to **Maiman *et al.*** [22] where in DCI and cervical cage fusion groups 55%, 53.7% had normal reflexes, 15%, 16.3% had hyporeflexia, 25%, 23.5% had hyperreflexia and positive Hoffman's sign, and 5%, 6.5% had hyperreflexia and positive Babiniski's sign respectively. In both the DCI and cervical cage fusion groups, the prognosis percentage was the same. The examination of reflexes was statistically significant factor in prognosis. This agreed with **Maiman *et al.*** [22] and in contrast to **Harrop *et al.*** [23] who did not report reflex examination among statistically significant prognostic factors.

The preoperative VAS in the DCI and cervical cage fusion groups in the current study was 73.3%, 53.3% moderate degree and 26.7%, 46.7% were severe degree, respectively. While the postoperative VAS score was zero in 40.0%, mild pain in 53.3%, and moderate pain in 6.7%, 20.0%, respectively. VAS Score improvement was statistically significant. This came in agreement with **Botelho *et al.*** [24] who concluded that anterior cervical discectomy and DCI improved VAS. However, this was in contrast to **Anakwenze *et al.*** [25] who reported that the increase in VAS was not statistically significant.

In the DCI and cervical cage fusion groups, postoperative VAS was statistically significant factor for prognosis, with 83.3%, 100% of excellent prognosis having no pain, 50%, 0% of poor prognosis having no pain, and 50%, 100% of poor prognosis having moderate pain respectively. This agreed with **Botelho *et al.*** [24] and in contrast to **Harrod *et al.*** [9] where postoperative VAS was not statistically significant factor in prognosis, respectively.

Both the DCI and cervical cage fusion groups improved VAS and mJOA statistically significantly, which came in agreement with **Cunningham *et al.*** [26] and in contrast to **Anakwenze *et al.*** [25] who find improvement in DCI group only and **Boselie *et al.*** [27] who find improvement in the cervical arthroplasty group only.

In the current DCI study and cervical cage fusion groups preoperative mJOA was normal in 7 and 8 patients (46.7% and 53.3%), grade 1 in 33.3% and 33.3%, and grade in 20.0% and 13.3% respectively. While postoperative mJOA in both groups was normal in 53.3% and 60.0%, grade 1 in 26.7% and 26.7%, grade 2 in 20.0% and 13.3% respectively. The increase in mJOA was statistically significant. This came in agreement with **Wigfield *et al.*** [28] who concluded that anterior cervical discectomy and DCI improved JOA. While another study found the improvement in JOA was not statistically significant [25].

In the DCI and cervical cage fusion groups, postoperative mJOA was statistically significant factor for prognosis, as (100% and 75%) of excellent prognosis cases had normal mJOA, (50% and 0%) of poor prognosis cases had normal mJOA, and (50% and 100%) of poor prognosis cases had grade 2 mJOA respectively. This agreed with **Wigfield *et al.*** [28] who concluded that postoperative mJOA was statistically significant prognostic factor. This contrasted with other studies that found no statistically significant link between postoperative mJOA and prognosis [25].

In the current study in DCI and cervical cage fusion group in a decreasing order of frequency the operated level C5-6 was in 53% and 46.7% of cases, C6-7 in 33.3% and 40.0% of cases and C3-4 in 13.3 % and 13.3% respectively. This was like **Pool *et al.*** [29], where C5-6 was the most used operating level in the study and in contrast to **Wigfield *et al.*** [28] where C6-7 was the most used operating level. The operated level had no statistically significant relationship.

Complications occurred at a rate of 20% in the current study's DCI group. It was decreased at intraoperative (6.7%) and postoperative complications (13.3%). **Matgé** [30] reported complications occurred at a 5% rate and were postoperative in the form of implant migration and dysphonia. The rate of complications in the cervical cage fusion group was 13.3%. They were of the intraoperative complications' variety, with transient weakness that improved with physiotherapy and a dural tear that was sutured intraoperatively. **Lawrence *et al.*** [31] reported complications in the form of intraoperative complications occurred at a rate of 17%, 7% due to a dural tear, a cage break, esophageal injury, and postoperative complications pseudoarthrosis and cage migration accounted for 10% of cases.

In the DCI and cervical cage groups, 100% and 75% of patients with excellent prognosis had no complications, 50% and 100% of patients with poor prognosis had complications, and 50% and 0% of patients with poor prognosis had no complications, respectively. Complication and prognosis had no statistically significant relationship. This agreed with **Matgé** [30] **and Lawrence *et al.*** [31] who found no statistically significant link between complication and prognosis. However, this was in contrast to **Pool *et al.*** [29] who concluded that complications were found to have a statistically significant relationship with prognosis.

In the current study, the average blood loss in the DCI and cervical cage fusion groups was 40, 50 cc. This was close to **Matgé** [30] who reported 60 cc average blood loss. Also, **Pool *et al.*** [29] who reported 70 cc average blood loss while **Auerbach *et al.*** [12] reported the average blood loss is 80 cc. Blood loss had no statistically significant relationship with prognosis. This agreed with **Auerbach *et al.*** [12] and in contrast to **Coric *et al.*** [32] who discovered a statistically significant link between blood loss and mortality.

Preoperative MRI in the DCI and cervical cage fusion groups revealed foraminal disc (66.7% and 60.0%), central disc, and cord signal (33.3% and 40%) of cases respectively. It was statistically significant that preoperative MRI affects prognosis, as 75% of excellent prognosis cases (75% and 75%) had foraminal disc, 85% of good prognosis cases (85%, 85.7%) had foraminal disc, and 100% of fair and poor prognosis cases had central disc with cord signal, respectively. This was close to **Phillips *et al.*** [33] **and Chang *et al.*** [13] who reported that postoperative MRI revealed decompression of the affected root in (66.7% and 60.0%), cord decompression with cord signal in (20% and 26.7%), and cord decompression with cord signal disappearance in (13.3% and 13.3%) respectively. Postoperative MRI had a statistically significant effect on prognosis, with (100% and 75%) of excellent prognosis having decompression of the affected root, (0.00% and 85.7%) of good prognosis having persistent cord signal, and (50% and 100%) of poor prognosis having persistent cord signal respectively.

On the other hand, in DCI group **Phillips *et al.*** [33] reported 60% of cases had decompression of the affected root, 6.7% had inadequate decompression of the affected root, 20% had decompression of the affected cord without cord signal, and 13.3% had inadequate decompression of the affected cord with cord signal. While, in cervical cage fusion group **Chang *et al.*** [13] reported in 67.7% of cases, the affected root was decompressed; in 5.0% of cases, the affected cord was decompressed without a cord signal; and in 13.3% of cases, the affected cord was decompressed with a persistent cord signal.

In the current research, postoperative X-rays in the DCI and cervical cage fusion groups revealed no instability in 14 and 15 patients (93.3% and 100%), no adjacent segment disorder in 14 and 2 patients (93.3%, 13.3%) respectively, and implant migration in 1 patient (6.7%) in the DCI group only. Only the cervical cage fusion group had fusion in 15 patients (100%), and no adjacent segment disease in 13 patients (86.7%). **Botelho *et al.*** [24] reported in 92.6% of cases that there was no instability and no adjacent segment disorder, while 1.6% had migration and 4.4% had ossification.

In the current study in DCI group the median duration of symptoms was 4 months while in cervical cage fusion group was 9 months. Duration of symptoms was statistically significant factor affecting prognosis in both DCI and cervical cage fusion group. **Park *et al.*** [34] also reported one of the factors influencing the prognosis of anterior cervical discectomy, whether followed by cervical cage fusion or DCI, is the duration of symptoms.

CONCLUSIONS

The DCI appears to be a promising alternative to TDR and ACDF in the treatment of cervical discs based on preliminary clinical and radiographic results. The DCI allows for maximum neurological improvement while maintaining excellent clinical outcomes. The ability to maintain device-level motion and minimize the development of ASD while protecting the facet joints from excessive stresses noted with other motion preserving devices during lateral bending, axial rotation, and extension is one of the potential biomechanical advantages of DCI over ACDF and TDRC. The use of serrated teeth to secure the device to the bone eliminates the need for a central keel or flanges, which reduces the mechanical competency of the endplate and may protect against subsidence or fracture.

There was no statistically significant difference in adjacent segment disease between the DCI and cervical cage fusion groups. Both the DCI and cervical cage fusion groups achieved comparable results, and both appear to be viable treatment options for single-level degenerative cervical disc disease. Long-term follow-up is required to confirm efficacy and refine ideal DCI indications. Long-term effects will necessitate further research.

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