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ORIGINAL ARTICLE

Comparative Study of Dynamic Cervical Implant Versus Cervical Interbody Cage Fusion in the Management of Degenerative Cervical Disc Disease

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Abstract

Background: **Cervical radiculopathy occurs when a herniated disc causes pressure on a nerve root, resulting in dysfunction of the sensory, motor, or reflex pathways served by that nerve root. This trial aimed to evaluate the effectiveness of a dynamic cervical implant (DCI) against a cervical interbody cage fusion for the treatment of a single degenerative disc in the cervical spine.**

Methods: **This prospective randomized trial was carried out on 30 patients aged from 30 to 50 years old, both sexes, suffering from single degenerative cervical discs, who were surgically treated by anterior cervical discectomy and intervertebral disc herniation from C3 to C7. Participants were split into two groups of equal size: those who would have a DCI also received an anterior cervical discectomy and cage interbody fusion. In addition, those who would receive a cervical cage fusion also received an anterior cervical discectomy and a DCI.**

Results: **Postoperative radiography showed no adjacent segment disorder in 14 (93.3%) patients in the DCI group and 13 (86.7%) patients in the cervical cage fusion group without a statistically significant difference between groups. In the DCI and cervical cage fusion groups, the prognosis was 46.7%, 46.7% good, 40% and 26.7% excellent, 13.7% poor, 20% poor, and 0, 6.7% fair, respectively.**

Conclusion: **In the treatment of cervical disc disease, the DCI shows promise as a potential alternative to total disc replacement and anterior cervical discectomy and fusion. The DCI has the ability to maintain device-level motion as well as minimize the development of adjacent segment disease. Additionally, the DCI protects the facet joints from the excessive stresses that are observed with other motion-preserving devices during lateral bending, axial rotation, and extension.**

Keywords: Cervical interbody cage fusion, Degenerative cervical disc disease, Dynamic cervical implant

1. Introduction

A herniated nucleus pulposus, degenerative disc disease, or internal disc disruption are all examples of illnesses affecting the cervical spine.[1]

The intervertebral disc is a functional unit that separates and cushions the bones of adjacent vertebrae in the spine. The disc cushions the spine, allows for motion, gives structure, as well as separates the vertebral bodies to raise the height of the intervertebral foramen. The disc separating the C2−T1 vertebrae has three main parts: an eccentrically placed nucleus pulposus, an annulus fibrosus made of lamellae, and two cartilaginous endplates. Since there is no disc in this area, only ligaments and joint capsules limit motion in C1 as well as C2.[2]

In order to assess cervical herniated nucleus pulposus, magnetic resonance imaging (MRI) is still the

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gold standard. Magnetic resonance imaging has many benefits, including the ability to clearly define soft tissues (such as the cervical discs and spinal cord) and see cerebrospinal fluid without exposing a person to radiation or requiring any invasive procedures.[3]

Computed tomography (CT) scans are often employed in trauma situations due to their ability to clearly outline cervical spine fractures. Chronic degenerative changes, metastatic illness, infection, spinal deformity, and spinal stability can all be assessed using a plain radiograph of the cervical spine, and electrodiagnostic studies in order to assess the level of neurologic function in the cervical spine.[1]

If conservative treatment fails to treat the symptoms, surgical intervention is indicated. The types of surgical intervention include anterior discectomy or posterior decompression. The target of the operation is to alleviate compression on both nerve roots and the spinal cord with preservation of the stability of the cervical spine, hence the concept of doing fusion following anterior cervical discectomy.[3]

The development of the dynamic cervical implant (DCI) was spurred on by the idea that it could be possible to achieve the objectives of anterior cervical decompression and fusion while still preserving motion in the neighboring segment.[2]

The aim of this work was to compare clinical and radiological outcomes following DCI and cervical interbody cage fusion in the management of single degenerative cervical disc disease.

2. Patients and methods

This randomized consecutive prospective study was carried out on 30 cases aged from 30 to 50 years old, both sexes, suffering from single degenerative cervical discs, who were surgically treated by anterior cervical discectomy and intervertebral disc herniation from C3 to C7.

The study was done after approval from the Ethical Committee at Al-Azhar University Hospitals.

Exclusion criteria were severe mechanical instability, osteoporosis, multiple levels, vertebral fractures and tumors, previous cervical disc surgery, and acute or chronic systemic, spinal, or localized infections.

Participants were distributed into two groups: those with DCI and those with cervical cage fusion.

All patients were subjected to complete medical history-taking, complete physical examination, routine laboratory investigations, and a complete neurological examination.

2.1. Radiological investigations

Plain radiography of the cervical spine, including antero-posterior, lateral views, and flexion and extension dynamic studies to determine minor subluxations between the cervical vertebrae and demonstrate abnormal mobility. Also, CT and MRI of the cervical spine are requested.

2.2. Technique of anterior cervical discectomy

An incision done at the level of Adam's apple is suitable for exposure to C5, and the incision can be placed above or below this level depending on the level to be exposed.

2.2.1. Dissection

The platysma is also incised in the same line, and the middle layer of the fascial plane between the sternomastoid and the strap muscles is split open with blunt and, occasionally, sharp dissection. The deep cervical fascia overlying the longus colli muscles and the anterior longitudinal ligament of the cervical spine are then visible. The prevertebral fascia is then incised in the midline and the longus colli muscles are exposed. The muscles are then dissected on both sides with sharp dissection well above and below the required area to ensure that the blades of the self-retaining retractors can be placed underneath to maintain proper exposure during the entire procedure. Either Cloward or Caspar self-retaining retractors are then applied vertically.

2.2.2. Leveling

Once the prevertebral fascia is reached, a needle is inserted into the probable diseased disc space, and the level is confirmed using the C-arm. A vertebral spreader is then inserted into the disc space. The operating microscope is brought in at this stage. Discectomy: the annulus is then incised, and the nucleus is entered. Anterior osteophytic ridges, especially of the upper body, may obscure the view in the presence of gross spondylotic changes and can be removed by small nibblers or Kerrison punches or burred away with a high-speed drill, facilitating entry into the disc space. The nucleus is then removed with curettes and rongeurs.

The posterior longitudinal ligament is then inspected for any tears, as the disc can sequester through the ligament into the spinal canal. Both foramina can be probed with a blunt microhook for disc fragments. In the presence of a hard disc protrusion with gross posterior osteophytic ridges, it is necessary to curette them or preferably remove them with high-speed burrs after removal of the hyaline cartilage attached to the vertebral body endplates. This is important for proper decompression, and frequently soft disc protrusion under these osteophytic ridges is observed, it is also necessary to create space for the graft to fit precisely.

Further disc removal is then performed, and a complete disc excision can then be done in most cases of soft disc protrusion until the posterior longitudinal ligament is completely exposed.[2]

Postoperatively, the patients were mobilized on the day of surgery. Most patients were able to be discharged a few days postoperatively. Radiographic images were obtained before discharge.

All patients were observed for 1 year after surgery to assess the clinical and radiological outcome, as well as acute and delayed complications related to the surgical approach. Patients were evaluated at each visit for any improvement or deterioration in symptoms or clinical postoperative pain was calculated according to the visual analog scale (VAS) score, and comparisons between the two groups were done on the second day of surgery, after 3 months of surgery, after 6 months of surgery, and after one year of the operation. The prognosis was calculated according to Odom's criteria, which were defined as.

Good outcome was defined as intermittent discomfort related to cervical disc disease that did not significantly interfere with work, fair outcome was defined as subjective improvement but limited physical activities, and poor outcome included patients who did not improve. Excellent was defined as having no complaints related to cervical disc disease and being able to carry out routine daily activities without impairment.[1]

3. Results

Table 1 showed patient characteristics, examination and reflexes of the studied patients. Table 2 showed that VAS and mJOA were statistically significant in that both groups decreased pain and improved MJOA scores. In the DCI group, in descending order of frequency, the affected level was C5–C6, and in the cervical cage fusion group, it was C5–C6. MRI, postoperative x-ray, and Blood loss CC were statistically insignificant in both groups. Table 3 showed relations between prognosis and different parameters in cage group. (Figs 1 and 2).

Table 1. Distribution of the studied cases according to age, sex, and history (n = 30).

	Patients ($N = 30$) [n (%)]
Age (y)	30–50
Sex	
Male	13 (43.3)
Female	17 (56.7)
History	
No past history	11 (36.7)
HTN	8 (26.7)
DM	6 (20.0)
DM and HTN	4 (13.3)
Rheumatoid arthritis	1 (3.3)
Complaint	
Neck pain	30 (100.0)
Radiculopathy	19 (63.3)
Myelopathy	9 (30.0)
Radiculopathy and myelopathy	2 (6.7)
Motor examination	
No weakness	15 (50.0)
Weakness	4 (13.3)
Hemiparesis	3 (10.0)
Quadriparesis	6 (20.0)
Biparesis	2 (6.7)
Sensory examination	
No sensory loss	17 (56.7)
Sensory loss	13 (43.3)
Reflexes	
Normal	15 (50.0)
Hyporeflexia	4 (13.3)
Hyperreflexia and Hofman	9 (30.0)
Hyperreflexia and Babiniski	2 (6.7)

4. Discussion

Spinal fusion has been studied as a means to treat pathology related to the spine for more than a century.

In the DCI group of the current study regarding prognosis, motor examination was a statistically significant factor, while sensory examination was not a statistically significant factor for prognosis. This was in contrast to Jackson[4] who did not find a statistically significant relation between motor examination and prognosis.

And in agreement with McAfee[5] and in contrast to Heller who reported sensory examination as one of the statistically significant factors affecting prognosis. Also, reflex examination was a statistically significant factor for prognosis: this was in

Table 2. Comparison among the two studied groups according to duration of symptoms, visual analog scale, level, MRI, and blood loss CC (n = 30).

	DCI (*N* = 15) [*n* (%)]	Cage (*N* = 15) [*n* (%)]	X^2	MCp
Duration of symptoms (months)	9.20 ± 15.0	14.20 ± 13.36	67.0	0.054
VAS				
Preoperative				
No	0	0	1.142	0.771
Mild	0	0		
Moderate	11 (73.3)	8 (53.3)		
Severe	4 (26.7)	7 (46.7)		
Postoperative				
No	6 (40)	5 (33.3)	2.342	0.368
Mild	8 (53.3)	7 (46.7)		
Moderate	1 (6.7)	3 (20)		
Severe	0	0		
P_1	0.013*	0.021*		
Level				
C3–4	2 (13.3)	0	3.463	0.378
C4–5	0	2 (13.3)		
C5–6	8 (53.3)	7 (46.7)		
C6–7	5 (33.3)	6 (40.0)		
MRI				
Preoperative				
Foraminal disc	10 (66.7)	9 (60)	0.144	0.705
Central disc and cord signal	5 (33.3)	6 (40)		
Postoperative				
Decompression of the affected root	10 (66.7)	9 (60)	0.983	0.764
Decompression of the cord, no cord signal	2 (13.3)	4 (26.7)		
Decompression of the cord, cord signal	3 (20.0)	2 (13.3)		
Blood loss CC	43.20 ± 14.19	58.67 ± 26.56	U = 71.50	0.087
Postoperative radiography				
No instability	(93.3)	0	33.869	0.723
No adjacent segment disorder	(93.3)	(86.7)		
Migration of the implant	(6.7)	0		
Fusion	0	(100)		
Adjacent segment disorder	0	(13.3)		

Table 3. Relations between prognosis and different parameters in the dynamic cervical implant group.

	Prognosis			Test of significance	*P*
	Poor (*N* = 2) [n (%)]	Good (*N* = 7) [n (%)]	Excellent (*N* = 6) [n (%)]		
Sex					
Male	0	4 (57.1)	3 (50)	χ^2 = 1.820	^{MC}p = 0.624
Female	2 (100)	3 (42.9)	3 (50)		
Age (y)					
30–35	0	0	1 (16.7)	χ^2 = 4.545	^{MC}p = 0.385
36–42	0	4 (57.1)	1 (16.7)		
42–50	2 (100)	3 (42.9)	4 (66.7)		
Complaint					
Radiculopathy	1 (50)	3 (42.9)	6 (100)	χ^2 = 5.802	^{MC}p = 0.176
Myelopathy	1 (50)	2 (28.6)	0		
Radiculopathy and myelopathy	0	2 (28.6)	0		
History					
No past history	0	3 (42.9)	2 (33.3)	χ^2 = 4.895	^{MC}p = 0.797
HTN	1 (50)	1 (14.3)	2 (33.3)		
DM	1 (50)	3 (42.9)	1 (16.7)		

(*continued on next page*)

Table 3. (continued)

	Prognosis			Test of significance	*P*
	Poor ($N = 2$) [n (%)]	Good ($N = 7$) [n (%)]	Excellent ($N = 6$) [n (%)]		
DM, HTN	0	0	0		
Rheumatoid arthritis	0	0	1 (16.7)		
Duration of symptoms (months)	42.0 ± 25.46	5.14 ± 0.90	3.0 ± 0.0	H = 12.624*	0.002*
Motor examination					
No weakness	1 (50)	1 (14.3)	6 (100)	χ^2 = 11.935*	^{MC}p = 0.046*
Weakness	0	2 (28.6)	0		
Hemiparesis	1 (50)	1 (14.3)	0		
Quadriparesis	0	2 (28.6)	0		
Biparesis	0	1 (14.3)	0		
Sensory examination					
No sensory loss	1 (50)	3 (42.9)	4 (66.7)	χ^2 = 1.009	^{MC}p = 0.786
Sensory loss	1 (50)	4 (57.1)	2 (33.3)		
Reflexes					
Normal	1 (50)	1 (14.3)	6 (100)	χ^2 = 10.531*	^{MC}p = 0.026*
Hyporeflexia	0	2 (28.6)	0		
Hyperreflexia and Hofman	1 (50)	3 (42.9)	0		
Hyperreflexia and Babinski	0	1 (14.3)	0		
Vas					
Preoperative					
No	0	0	0	χ^2 = 0.798	^{MC}p = 1.000
Mild	0	0	0		
Moderate	2 (100)	5 (71.4)	4 (66.7)		
Severe	0	2 (28.6)	2 (33.3)		
Postoperative					
No	1 (50)	0	5 (83.3)		
Mild	0	7 (100)	1 (16.7)	χ^2 = 14.170*	^{MC}p = 0.001*
Moderate	1 (50)	0	0		
Severe	0	0	0		
Mean ± SD.	14.50 ± 4.95	13.43 ± 2.64	17.0 ± 0.63	F = 3.675	0.057
Postoperative					
Normal	1 (50)	1 (14.3)	6 (100)	χ^2 = 10.278*	^{MC}p = 0.007*
Grade 1	0	4 (57.1)	0		
Grade 2	1 (50)	2 (28.6)	0		
Mean ± SD.	14.50 ± 3.54	14.57 ± 1.99	18.0 ± 0.0	F = 7.078*	0.009*
NDI					
Preoperative					
No disability	0	1 (14.3)	6 (100)	2 χ = 11.949*	MC *P* = 0.010*
Mild disability	1 (50)	2 (28.6)	0		
Moderate disability	1 (50)	3 (42.9)	0		
Severe disability	0	1 (14.3)	0		
Postoperative					
No disability	1 (50)	3 (42.9)	6 (100)		
Mild	0	1 (14.3)	0	2 χ = 6.038	MC *P* = 0.201
Moderate disability	1 (50)	3 (42.9)	0		
Severe disability	0	0	0		
MRI					
Preoperative					
Foramina disc	1 (50)	3 (42.9)	6 (100)	2 χ = 5.127	MC *P* = 0.062
Central disc and cord signal	1 (50)	4 (57.1)	0		
Postoperative					
Decompression of the affected root	1 (50)	3 (42.9)	6 (100)	2 χ = 5.802	MC *P* = 0.173
Decompression of the cord, no cord signal	0	2 (28.6)	0		
Decompression of the cord, cord signal	1 (50)	2 (28.6)	0	χ^2 = 4.223	^{MC}p = 1.000
Level					
C3–4	0	0	1 (16.7)		
C4–5	0	1 (14.3)	0		

(*continued on next page*)

Table 3. (continued)

	Prognosis			Test of significance	*P*
	Poor (*N* = 2) [n (%)]	Good (*N* = 7) [n (%)]	Excellent (*N* = 6) [n (%)]		
C5–6	1 (50)	4 (57.1)	3 (50)		
C6–7	1 (50)	2 (28.6)	2 (33.3)		
Blood loss CC					
20–40	0	2 (28.6)	4 (66.7)	$\chi^2 = 9.305$	$^{MC}p = 0.085$
40–60	1 (50)	5 (71.4)	1 (16.7)		
60–80	1 (50)	0	0		
80–100	0	0	1 (16.7)		
Mean ± SD.	55.0 ± 21.21	41.29 ± 5.77	41.50 ± 19.22	H = 2.683	0.262
Postoperative X-ray					
No instability, no adjacent segment disorder	2 (100)	6 (85.7)	6 (100)	$^{2}\chi = 1.680$	MC *P* = 1.000
Migration of the implant	0	1 (14.3)	0		
Fusion, no adjacent segment disorder	0	0	0		
Fusion, adjacent segment disorder	0	0	0		
Complication					
NO	1 (50)	5 (71.4)	6 (100)	$\chi^2 = 3.032$	$^{MC}p = 0.305$
YES	1 (50)	2 (28.6)	0		

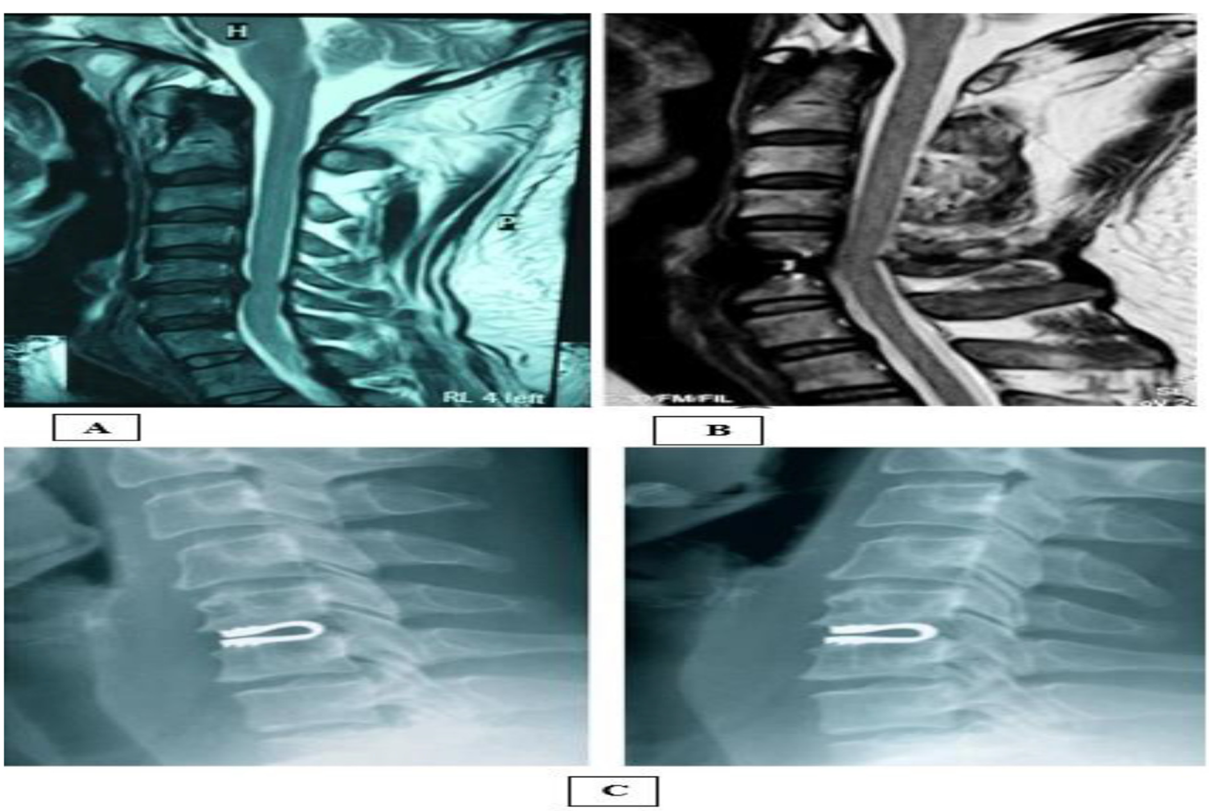

Fig. 1. (A) Preoperative MRI cervical spine T2 sagittal view showed C5–6 disc prolapse. Postoperative (B) MRI cervical spine T2 sagittal view showed excision of the herniated disc and decompression of cord; (C) plain radiography of cervical spine dynamic view showed stability of cervical spine, no heterotopic ossifications, and in-place dynamic cervical implant.

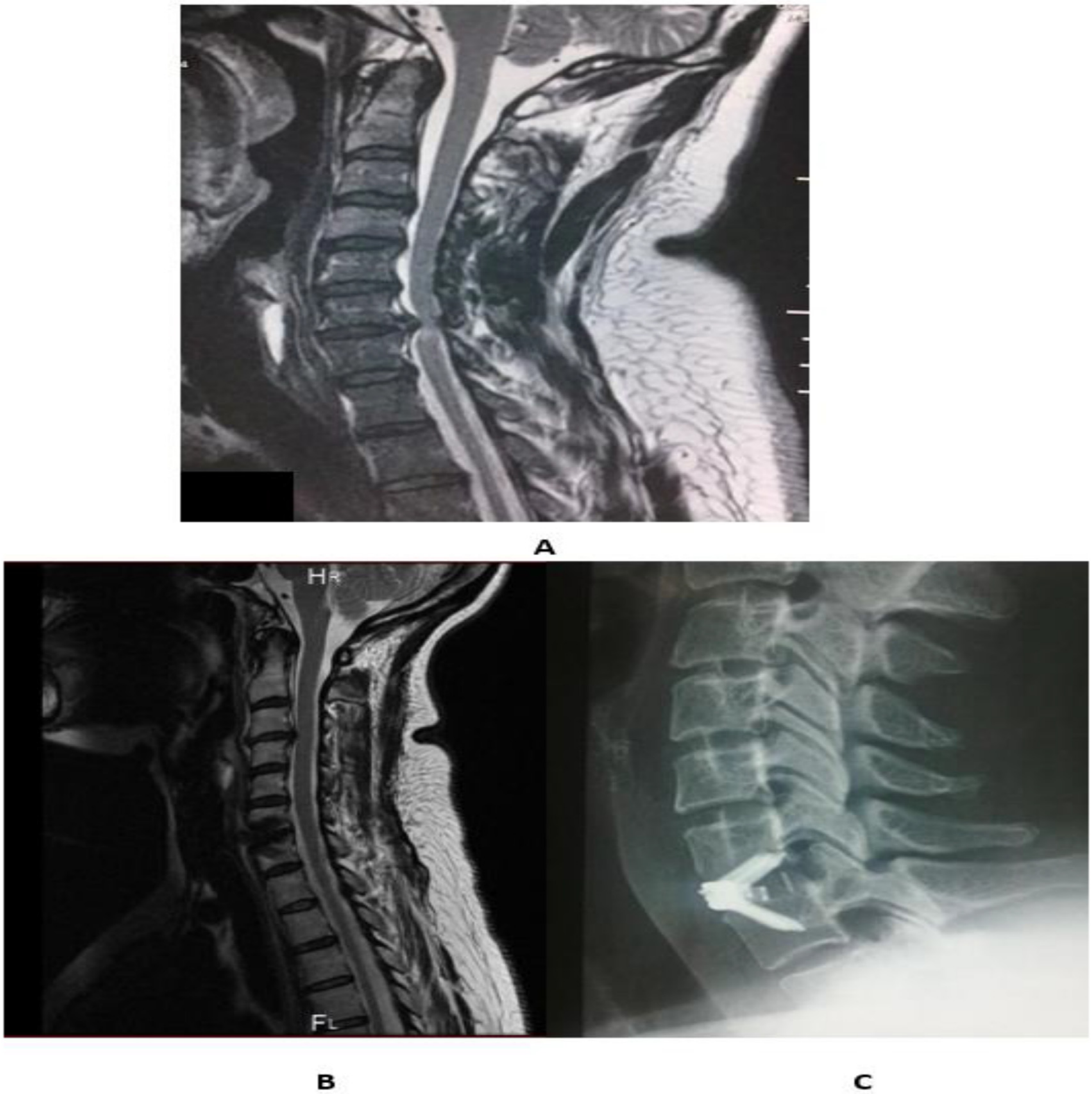

Fig. 2. (A) Preoperative MRI cervical spine T2 sagittal view showed C6—7 disc prolapse with cord signal; (B) postoperative MRI cervical spine T2 sagittal view showed excision of the herniated disc, decompression of cord, and no cord signal; (C) plain radiography of cervical spine lateral view showed stability of cervical spine, fusion, and in-place cervical cage.

agreement with Mummaneni[6] and in contrast to Harrop[7] who did not report reflex examination as a statistically significant factor affecting prognosis.

In the cervical cage fusion group of the current study presenting symptoms, motor examination was not a statistically significant factor for prognosis. This was in agreement with Ishihara[8] who did not found a statistically significant relationship between symptoms and prognosis. This was also in contrast to Lopez-Espina[9] who reported symptoms as one of the statistically significant factors affecting prognosis. This was in agreement with Hilibrand[10] who did not found a statistically significant relationship between motor examination and prognosis. In contrast to Kim[11] who reported motor examination as one of the statistically significant factors affecting prognosis. Sensory and reflex examinations were statistically significant factors for prognosis. This was in agreement with Lopez-Espina[9] and in contrast to Matsumoto [12] who did not report any statistically significant relation between sensory examination and prognosis. Also, in agreement with Maiman[13] and in contrast to Kim[11] who did not report reflex examination from statistically significant factors affecting prognosis.

In the current study, in both groups, improvement in VAS score was statistically significant, this came in agreement with Botelho[14] who concluded that VAS was improved following anterior cervical discectomy and DCI. Also, this came in agreement with Ishihara[8] who concluded that VAS was improved following anterior cervical discectomy and fusion. In contrast to Anakwenze[15] where improvement in VAS was not a statistically significant factor.

Postoperative VAS was a statistically significant factor for prognosis in the DCI group, this was in agreement with Botelho[14] and also in agreement with Sasso.[16]

In the current study, in both groups, there was no statistically significant relationship between complications and prognosis. This agreed with Matgé,[17] who did not find a statistically significant relationship between complications and prognosis.

In the current study, in both groups, there was no statistically significant relationship between blood loss and prognosis. This agreed with Auerbach[18] and in contrast to Coric[19] who found a statistically significant relation between blood loss and prognosis in the DCI group.

In the current study in the DCI group, excellent prognosis occurs in 40% of cases. This was close to Parkinson[20] who reported excellent prognosis in 45% of cases. In cervical cage fusion group, excellent prognosis occurs in 26.7% of cases. This was close to Gore[21] who reported excellent prognosis in 35% of cases.

4.1. Conclusion

In the treatment of cervical disc disease, DCI indicates promise as an alternative to total disc replacement and anterior cervical discectomy as well as fusion due to its ability to preserve device-level motion and reduce the occurrence of adjacent segment disease.

Conflicts of interest

There are no conflicts of interest.

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