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Research Paper
ACDF Instead of Anterior Cervical Discectomy and Fusion

Mohammadreza Chehrassan[1], Farshad Nikouei[1], Mohammadreza Shakeri[1], Javad Moeini[1*], Ebrahim Ameri Mahabadi[1], Hasan Ghandhari[1]

1. Bone and Joint Reconstruction Research Center, Shafayahyaeian Hospital, Iran University of Medical Sciences, Tehran, Iran.

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ABSTRACT

Background: Reciprocal alterations in cervical and global spine alignment are widely acknowledged. However, there is limited evidence of the changes in global spine alignment that occur after cervical lordosis is restored following anterior cervical discectomy and fusion (ACDF).

Objectives: This study aims to investigate the effect of ACDF on global spine alignment.

Methods: This retrospective study comprised 32 patients (mean age 46±10 years) who underwent ACDF for cervical disc herniation. Cervical alignment, local and global spine alignment, and pelvic parameters were measured on the preoperative and three-month postoperative EOS® images.

Results: All spinal indices were altered after the operation, and this difference was statistically significant in all cases except for thoracic kyphosis. Three months after the surgery, total cervical lordosis correction was greater in patients with a single fusion level (P<0.001); however, local cervical lordosis correction was significantly higher in patients with more than one fusion level (P<0.001). Pelvic tilt change was significantly higher in cases with multiple fusion levels (P=0.043).

Conclusion: Regarding the number of fusion levels in patients undergoing ACDF, restoration of global and local cervical lordosis changes global spinal alignment.

*** Corresponding Author:**
Javad Moeini, MD.
Address: *Bone and Joint Reconstruction Research Center, Shafayahyaeian Hospital, Iran University of Medical Sciences, Tehran, Iran.*
Phone: *+98 (21) 33542001*
E-mail: *saeenmedicine@gmail.com*

Introduction

Cervical lordosis is a vital physiological curvature of the human spine. Normal cervical curvature is necessary for maintaining balance and various human activities, such as motor functions, mastication, breathing, vocal production, and eye movement. It also acts as a shock-absorbing mechanism in ambulatory functions [1, 2]. In a bilateral connection, malalignment in the cervical curvature also has a detrimental effect on the alignment of the spine in other parts, including thoracolumbar angle and pelvic alignment [3-5].

Along with the increasingly sedentary lifestyle in recent years, a higher incidence of abnormal cervical curvature is reported in the literature [6, 7]. Cervical disc herniation is one of the leading causes of abnormal cervical curvature [8]. Anterior cervical discectomy and fusion (ACDF) combines spinal decompression and fusion surgery to treat herniated cervical discs and correct cervical lordosis [9].

Considering the direct relationship between cervical and global spine alignment, correction of cervical lordosis improves whole-spine and pelvic sagittal alignment [3-5]. However, due to the small number of studies, the impact of ACDF on global spinal alignment is not clearly understood. This study was conducted to evaluate spinal alignment changes following correction of cervical lordosis in a series of patients with cervical disc herniation who underwent ACDF.

Methods

The medical profiles of patients who underwent ACDF at our hospital between January 2017 and December 2022 were retrospectively reviewed. The inclusion criteria included patients with degenerative cervical disc herniation who underwent ACDF if they underwent preoperative and postoperative EOS® imaging. The exclusion criteria included patients with other medical conditions, such as trauma, tumor, or infection, as well as those with a history of previous spine surgery or tandem spinal stenosis. Finally, 32 patients who met the study criteria were included. Table 1 presents the patient demographics and surgical features.

Radiographic assessments

Radiographic evaluations were conducted on whole-spine EOS® images obtained preoperatively and three months postoperatively. The assessments included measurement of cervical local lordosis at the level of ACDF, global cervical lordosis, thoracic kyphosis, lumbar lordosis, and whole-spine alignment by measuring the C7-S1 sagittal vertical axis (SVA) and spino-pelvic parameters. Global cervical lordosis was assessed by calculating the Cobb angle between distal endplates C2 and C7. Local cervical lordosis was measured as lordosis of the involved cervical vertebrae in patients who underwent ACDF. Spino-pelvic variables were evaluated by measuring the pelvic tilt and sacral slope (Figures 1 and 2).

Results

All parameters were altered 3 months postoperatively. While global and local cervical lordosis, thoracic kyphosis, lumbar lordosis, and sacral slope increased, the C7-S1 SVA and pelvic tilt decreased. These results were statistically significant, except for thoracic kyphosis (Table 2).

Considering the number of fused levels by ACDF, three months postoperatively, global cervical lordosis, local lordosis, and pelvic tilt were significantly different between patients with one fusion level and those with two or three fusion levels. In this respect, the global cervical lordosis correction was greater in cases with a single fusion level (P<0.001); however, the local cervical lordosis correction was significantly higher in patients with two

Table 1. Demographic and surgical characteristics of the patients undergoing ACDF for cervical disc herniation

Variables		Mean±SD/No.(%)
Age (y)		46±10
Sex	Male	8(25)
	Female	24(75)
Involvement Level	One level	26(81.3)
	> One level	6(18.7)

ACDF: Anterior cervical discectomy and fusion.

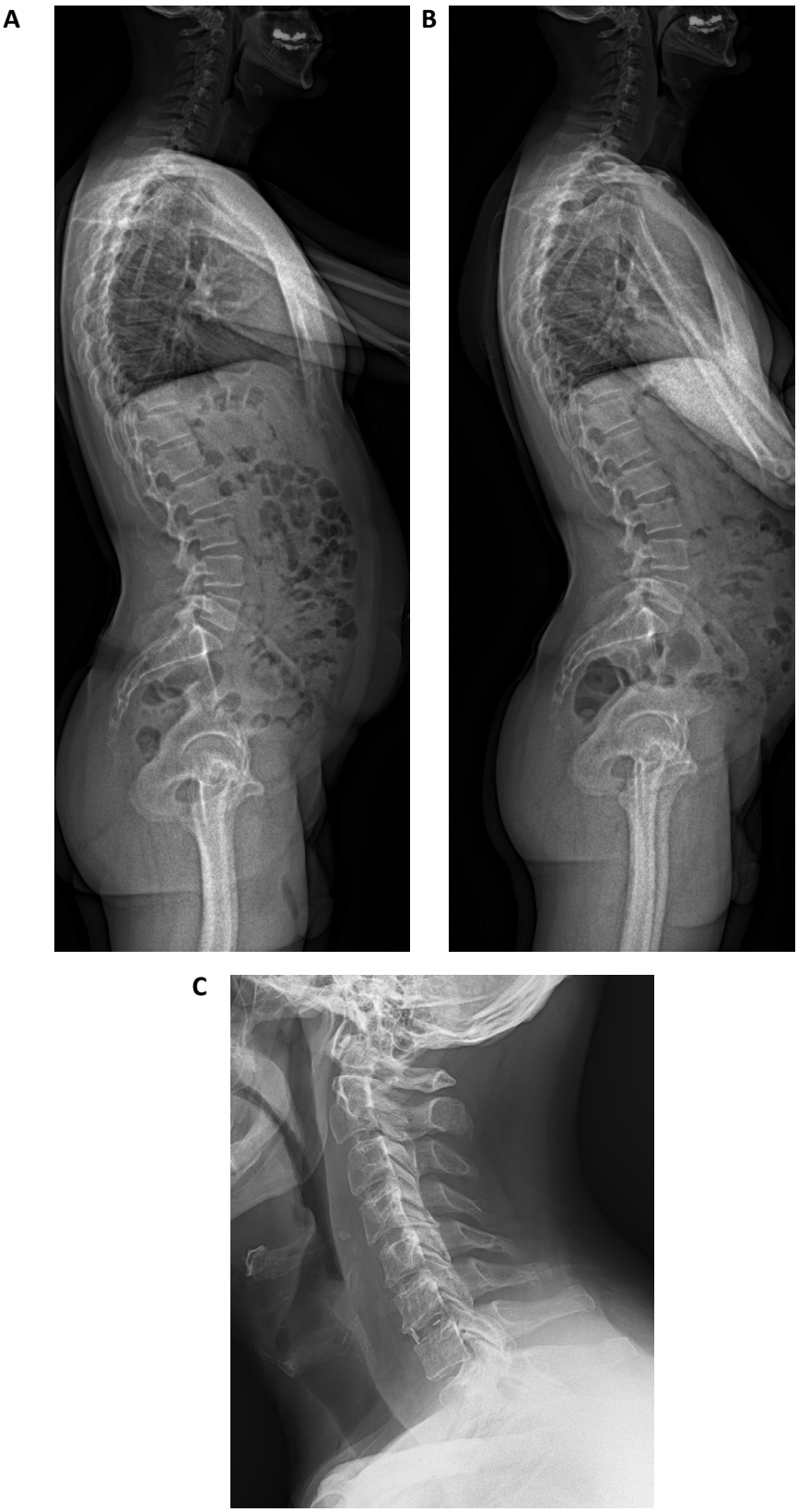

Figure 1. EOS® images of patient with single level ACDF
a) Preoperative lateral standing EOS, b) Postoperative EOS, c) Postoperative lateral cervical x-ray
ACDF: Anterior cervical discectomy and fusion.

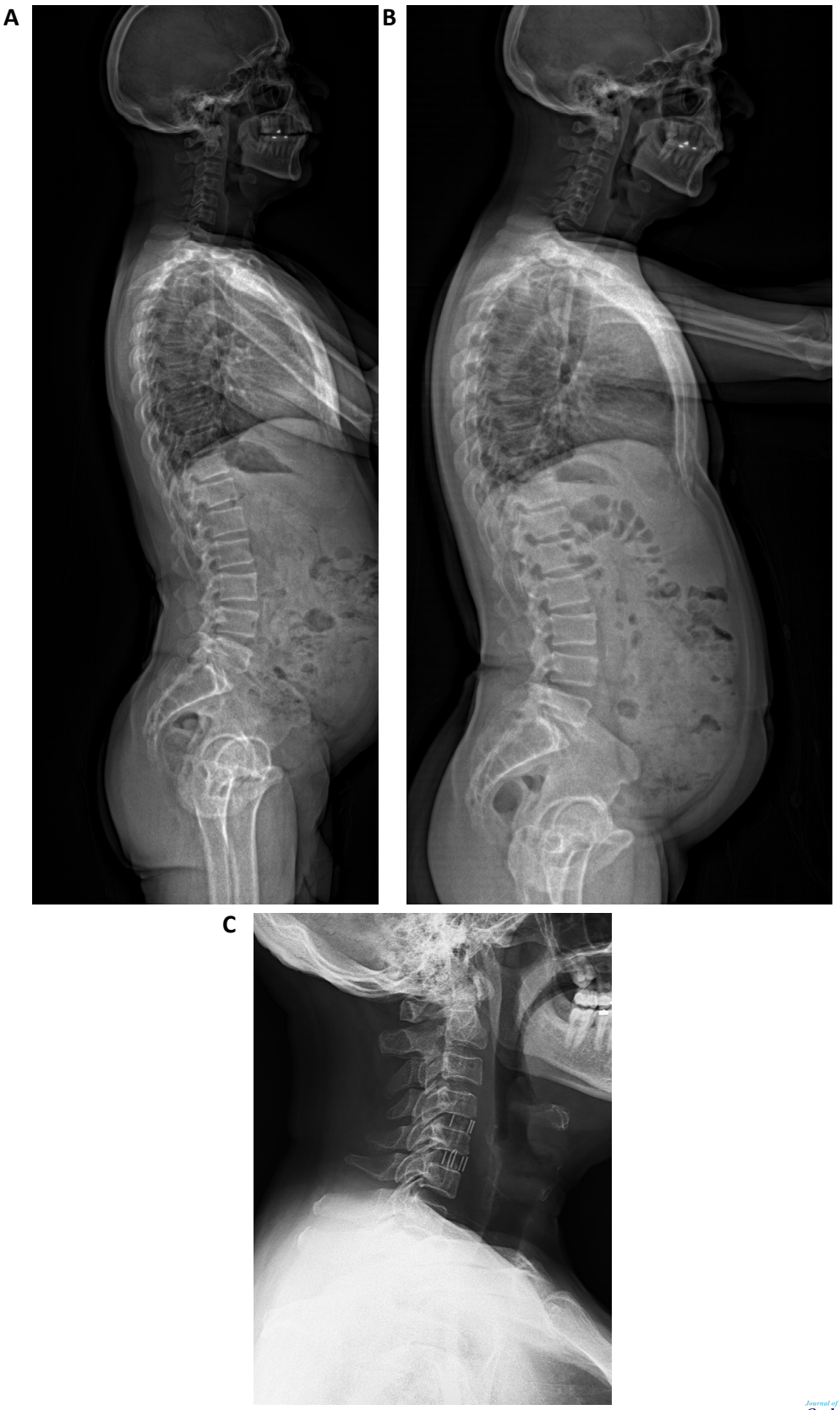

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Figure 2. EOS® images of patient with two level ACDF
a) Preoperative lateral standing EOS, b) Postoperative EOS, c) Postoperative lateral cervical x-ray
ACDF: Anterior cervical discectomy and fusion.

Table 2. Radiographic measures before, immediately after, and three months after ACDF

Radiographic Measure		Mean±SD	P
C2-C7 lordosis (º)	Before operation	6.19±3	<0.001
	3 months after operation	13.3±4	
Local cervical lordosis (º)	Before operation	-1.2±7.3	0.01
	3 months after operation	5.5±3.9	
Lumbar lordosis (º)	Before operation	47.1±7	0.041
	3 months after operation	48.8±6.6	
Thoracic kyphosis (º)	Before operation	33.1±4.9	0.061
	3 months after operation	34.1±7.9	
C7-S1 SVA (mm)	Before operation	14.9±15.1	0.047
	3 months after operation	12.9±8.6	
Sacral slope (º)	Before operation	34.0±4	0.034
	3 months after operation	36.7±3.9	
Pelvic tilt (º)	Before operation	15.6±2.8	0.023
	3 months after operation	13.7±2.6	

ACDF: Anterior cervical discectomy and fusion; SVA: Sagittal vertical axis.
Notes: P<0.05 is considered significant.

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or three fusion levels (P<0.001). Pelvic tilt change was significantly greater in cases with multiple fusion levels (P=0.043). Other spinal parameter changes, including lumbar lordosis, thoracic kyphosis, C7-S1 SVA, and sacral slope, were not significantly different between one, two, or three fusion levels (Table 3).

Discussion

Reciprocal changes in cervical spine alignment and thoracolumbar alignment have been considered in earlier studies [10-14]. Ha et al. evaluated cervical spine parameters after treating thoracolumbar deformity in 49 patients. Patients were divided into low and high C7 SVA groups. In the lower C7 SVA group, cervical lordosis significantly increased after thoracolumbar deformity correction, while in the high C7 SVA group, cervical lor-

Table 3. Effect of the fusion level on the alterations of spinal measures three months after ACDF

Spinal Measure	Mean±SD		P
	Single Fusion Level (n=26)	Two or Three Fusion Level (n=6)	
C2-C7 Lordosis change (º)	8.4±4.9	3.3±0.5	<0.001
Local cervical lordosis change (º)	5.7±5.9	7.3±5.5	<0.001
Lumbar lordosis change (º)	1.8±1.9	1.7±0.8	0.767
Thoracic kyphosis change (º)	1.1±1.3	0.5±0.33	0.160
C7-S1 SVA change (mm)	-2.6±7.8	0.33±9.52	0.561
Sacral slope change (º)	2.6±1.6	3.2±1	0.397
Pelvic tilt change (º)	-1.6±1.4	1.7±-3	0.043

ACDF: Anterior cervical discectomy and fusion; SVA: Sagittal vertical axis.
Notes: P<0.05 is considered significant.

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dosis showed a significant reduction after the operation. In multilinear regression analysis, preoperative cervical parameters predicted postoperative cervical lordosis [10]. Yu et al. evaluated the relationship between the cervical spine and the global spine alignment. Cervical spine alignment significantly correlated with global spine alignment in asymptomatic subjects and those with cervical spondylosis. In the cervical spondylotic group, cervical angles were significantly different in patients with different Roussouly types [11].

Changes in spinopelvic parameters after ACDF have also been reported in previous studies. Huang et al. evaluated changes in spinopelvic sagittal alignment in 133 patients with cervical spondylosis who underwent ACDF. They observed several significant changes in global spinal alignment, including thoracic kyphosis, sacral slope, spinal sacral angles, and lumbar lordosis [15]. Kim et al. aimed to determine whole spine sagittal alignment and pelvic alignment changes in 48 patients after ACDF. Twelve months after the operation, the pelvic tilt significantly increased, while the sacral slope significantly reduced. A significant correlation was observed between cervical lordosis and SVA. In addition, the SVA was significantly associated with pelvic tilt and sacral slope. They concluded that ACDF impacts whole spine sagittal alignment, particularly in patients with high cervical lordosis. In these cases, restoration of cervical lordosis caused reciprocal changes in pelvic tilt and sacral slope, mediated by a shortened SVA [5]. Similarly, in the present study, restoration of lumbar lordosis following ACDF led to alterations in other spinal curvatures, including the whole-spine sagittal and pelvic alignment.

Patients who undergo multilevel cervical fusions restore greater amounts of cervical lordosis compared to patients with a single-level fusion [16]. Accordingly, multilevel fusion is expected to have a more significant effect on global spinal alignment. In the present study, segmental lordosis correction was significantly greater in patients with multilevel fusion. In addition, changes in global spinal alignment, specifically pelvic tilt correction, were more frequent in the multilevel fusion group. These observations reveal that cervical fusion levels are associated with post-ACDF alterations in global spinal alignment.

Altogether, the results of the current study confirmed the reciprocal correlation between cervical alignment and global spinal alignment in patients who underwent ACDF. Moreover, the present study reveals that while the number of fused levels affects local and global cervical lordosis, this entity has no role in global spine alignment and spino-pelvic parameters except for pelvic tilt. Future studies may use this information for personalized correction of global spine alignment during the ACDF procedure.

Conclusion

Alterations in cervical alignment affect global spinal alignment in patients with cervical disc herniation who undergo ACDF. While ACDF and local and global cervical restoration affect global spine alignment and spinopelvic parameters, the number of fusion levels does not affect these entities, except for pelvic tilt.

The present study has some limitations. The primary limitation was the small number of patients, which did not allow multivariate data analysis. Another limitation was the short follow-up period. Therefore, future studies with larger patient numbers and longer follow-up periods can help further understand the relationship between the cervical and global alignment of the spine and factors affecting the association among patients undergoing ACDF.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of Iran University of Medical Sciences, Tehran, Iran (Code: IR.IUMS.REC.1402.305). All procedures performed in this study involving human participants were by the ethical standards of the institutional and/or national research committee and the 1964 Helsinki Declaration and its subsequent amendments or comparable ethical standards. No information (names, initials, hospital identification numbers, or photographs) in the submitted manuscript could be used to identify patients.

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Authors' contributions

Conceptualization: Mohammadreza Chehrassan; Investigation: Hasan Ghandhari; Data collection and analysis: Javad Moeini; Supervision: Ebrahim Amerimahabadi; Writing: Farshad Nikoei, and Mohammadreza Shakeri.

Conflict of interest

The authors declared no conflict of interest.

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