

Assessment of Clinical and Radiological Results After Anterior Cervical Discectomy and Fusion

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Abstract

Objective: Anterior cervical discectomy and fusion (is one of the important options for the treatment of cervical disc herniation. The aim of this study was to examine the effects of anterior cervical discectomy and fusion on coronal balance, apart from the reduction in pain intensity, angle difference, and sagittal balance, which has been frequently studied before.

Methods: Clinical and radiological follow-up results after anterior cervical discectomy and fusion procedure were evaluated in 41 patients. Standard anterior cervical microdiscectomy, osteophyctectomy, and root decompression were performed by the same neurosurgeon. The pre- and postoperative sagittal balances of the patients, the effect of the angulation difference that will be created by the cage and the pain scores (visual analog scale) were determined. C1-C2 angle, C2-C7 lordosis angle, and T1 slope angle were measured on the lateral radiograph of the patients. Number Cruncher Statistical System program was used for statistical analysis.

Results: The lordotic increases in the postoperative C1-C2 and C2-C7 angles of the cases compared to the preoperative period were statistically significant ($P = .001$ and $P = .004$, respectively). The changes in the T1 slope angles and in the postoperative coronal balance measurements after the operation compared to the preoperative period were not significant ($P = .232$ and $P = .753$, respectively). The decrease in the postoperative visual analog scale scores of the cases compared to the preoperation was significant ($P = .001$).

Conclusion: While no significant change was found in the T1 slope angle for lordosis after surgery, significant increases in the C1-C2 and C2-C7 lordosis angles were accompanied by a significant decrease in pain.

Keywords: Cervical disc herniation, anterior cervical discectomy, sagittal balance

Introduction

In the surgical treatment of cervical disc herniation, anterior cervical discectomy and fusion (ACDF) with cage are the most commonly used and accepted methods today.¹ First described by Smith and Robinson, ACDF provides good clinical results by providing neural decompression and segmental stabilization.¹⁻⁴ The cage placed in the disc space maintains the height of the disc space and foramen while providing fusion.^{5,6} It has also been shown to be beneficial in the correction of some cervical deformities, especially focal kyphosis.⁷ Disorders and kyphotic changes in the alignment of the cervical spine cause an increase in the load on the anterior side of the spine, which accelerates the degeneration of the adjacent segment.⁸ Therefore, this situation is related to the neck pain of the patients in the postoperative period.⁹ Cervical sagittal balance is expressed as the shape of the spine that helps to keep the spine afloat with very little muscle power.¹⁰ Therefore, in addition to providing neural decompression, correction of spinal alignment is also important for the clinical outcome. In the available literature, there exists data on the association of postsurgical cervical sagittal alignment with clinical outcomes and patient satisfaction after ACDF.¹⁻⁴ However, we did not encounter significant

data regarding the association of coronal alignment with postsurgical outcomes and pain alleviation after ACDF. Hence, in our current study, we aimed to perform a more comprehensive analysis regarding postsurgical pain, angle differences, and both sagittal and coronal balance in patients surgically treated with ACDF. This study was retrospectively designed to evaluate 41 patients with single-level cervical disk herniation and operated with ACDF. Besides evaluating the pre- and postsurgical sagittal balances, we also assessed the coronal balance and compared all these values with pain scores determined with the visual analog scale (VAS). Further details on the study design are provided in the "Materials and Methods" section.

Methods

The study was conducted in the Neurosurgery Clinic of Memorial Hospital (Bahçelievler, İstanbul) between 2018 and 2020. Ethical Approval was obtained from the local ethics committee (Date: February 27, 2022, Number: 58) and the study was planned according to the principles of World Medical Association Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects" amended in October 2013. Due to the retrospective nature of the study, the local ethics committee did not request informed consent forms. We retrospectively determined patients who were surgically treated with ACDF to evaluate pre- and postsurgical sagittal and coronal balance and pain levels. We included patients above 18 years old and who did not previously undergo anterior or posterior cervical surgery, who did not have post-traumatic cervical dislocation or fracture and any accompanying neurological, infectious and malignant

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diseases which would influence pain outcomes. After the data of these patients were evaluated retrospectively, 41 patients were found to be eligible for the study inclusion who underwent single-level ACDF with the diagnosis of cervical disc herniation. Patients postoperative follow-ups up to 12 months were retrospectively evaluated. Surgery was performed at the C6-C7 level in 23 of the patients and at the C5-C6 level in 18 of them. Preoperative neurologic examination information, radiology examinations, and surgery reports of all patients included in this study were reviewed. The sagittal plane was used alone in studies on the alignment of the cervical vertebrae after ACDF in the literature. The preoperative and postoperative sagittal balance measurement parameters of the patients were examined. In addition, the effect of the angulation difference that will be created by the position of the cage placed in the right or left paramedian, not in the midline, on the coronal balance was examined and compared with neck pain scores assessed with the VAS. Among all, ACDF patients who met the study criteria and were operated at a single level, only those that were not in the midline of the placed cage but were placed in the right or left paramedian on the Anteroposterior (AP) cervical radiograph were selected. Thus, a sample patient group was formed for the evaluation of the coronal balance measurements (Table 1).

Surgical Technique and Clinical Evaluation

Surgical procedures were performed by a single surgeon. Standard anterior cervical microdiscectomy, osteophylectomy, and root decompression were performed under general anesthesia. A PEEK (polyether ether ketone) locked cage (Procs®, Tial-Med, İzmir, Turkey) was placed at the disc distance for all patients. The patients used a neck brace for 15 days after surgery. An independent surgeon not involved in patient care analyzed the data. In the pre- and postoperative follow-up of the patients, VAS values for neck pain, cervical sagittal parameter data, and coronal balance measurements were evaluated at 12th month after surgery.

Table 1. Distribution of Demographic Features

		n	%
Age (years)	Minimum–maximum (median)	25-68 (44)	
	Mean \pm SD	44.83 \pm 9.12	
Sex	Female	19	46.3
	Male	22	53.7
Complaint	Pain in neck and right arm	13	31.7
	Pain in neck and left arm	25	61.0
	Pain in neck	3	7.3
Clinical examination	Right radiculopathy	13	31.7
	Left radiculopathy	22	53.7
	Left radiculopathy and myelopathy	3	7.3
	Myelopathy	3	7.3
Level of surgery	C5-C6	17	41.5
	C6-C7	24	58.5

Radiological Evaluation

Pre- and postoperative bilateral cervical radiographs of the patients were used in the radiological evaluation. C1-C2 angle, C2-C7 lordosis angle, and T1 slope angle were measured on the lateral radiograph of the patients. On the AP x-ray, segmental coronal balance was measured for the distance of the non-midline cage. While the radiographs were selected, those who were not in the neutral position were not included in the study. In each of the radiograph measurements, radiographs in which the spinous processes were in the midline and the distance between the line passing through the spinous processes, and the vertebral body–transverse process junction line on both laterals were the same. The most commonly used method for cervical sagittal parameters is the Cobb angle method.¹¹ Measurements were made and analyzed by the Cobbs method on the lateral radiograph. The angle between C1 and C2 is the angle between the line passing inferiorly of the ventral and dorsal arch of the C1 vertebra and the line passing inferiorly of the corpus of the C2 vertebra. The cervical lordosis angle between C2 and C7 is the angle between the inferior end plate of the C2 vertebra and the inferior end plate of the C7 vertebra. The T1 slope angle is defined as the angle between the T1 superior end plate of the vertebra and the horizontal line. In the measurements, lordosis was expressed as a positive value and kyphosis as a negative value. In the measurement of coronal balance, the angle was used between the upper vertebral corpus end plate and the lower vertebral corpus end plate of the distance where the cage was placed on the anterior–posterior radiograph.

Statistical Analysis

Number Cruncher Statistical System (NCSS; Kaysville, Utah, USA) program was used for statistical analysis. Descriptive statistical methods (mean, SD, median, frequency, ratio, minimum, maximum) were used while evaluating the study data. The conformity of quantitative data to normal distribution is presented by Kolmogorov–Smirnov, Shapiro–Wilk test, and graphical evaluations. Paired sample *t*-test was used for the comparison of normally distributed parameters before and after the operation, and Wilcoxon signed ranks test was used for the comparisons of the parameters that did not show normal distribution. Significance was evaluated at the $P < .05$ level at least.

Results

The study was conducted with a total of 41 patients, 46.3% ($n = 19$) female and 53.7% ($n = 22$) male (Table 1). The ages of the cases ranged from 25 to 68 years, with a mean of 44.83 ± 9.12 years. When the admission complaints were examined; it was determined that 31.7% ($n = 13$) had neck and right arm pain, 61.0% ($n = 25$) neck and left arm pain, and 7.3% ($n = 3$) neck pain. When the physical examination results were examined; it was revealed that 31.7% ($n = 13$) had right radiculopathy, 53.7% ($n = 22$) left radiculopathy, 7.3% ($n = 3$) left radiculopathy and myelopathy, and 7.3% ($n = 3$) had myelopathy. Surgery was performed at the C5-C6 level in 41.5% ($n = 17$) and at the C6-C7 level in 58.5% ($n = 24$) of the cases (Table 1). The mean preoperative C1-C2 angles were 32.86 ± 6.05 (Table 2). The mean postoperative C1-C2 angles were 35.68 ± 5.32 . The lordotic increase in the postoperative C1-C2 angles of the cases compared to the preoperative period was statistically significant ($P = .001$ and $P < .01$; Figure 1). The mean preoperative C2-C7 lordosis angles were 3.89 ± 14.81 (Table 2). The mean postoperative C2-C7 lordosis angles were 8.40 ± 9.25 . The increase in the lordotic direction of the C2-C7 lordosis angles after the operation was statistically significant compared to the preoperative period ($P = .004$ and

Table 2. Evaluation of Pre- and Postoperation Angle, Coronal Balance, and VAS Score Measurements

		Preoperation	Postoperation	Difference Pre-/Postoperation	P
C1-C2 angle	Minimum/maximum (median)	16.7/43 (34)	22.3/44.5 (35.9)	-5/13.6 (2.1)	^a .001**
	Mean \pm SD	32.86 \pm 6.05	35.68 \pm 5.32	2.82 \pm 3.57	
C2-C7 lordosis angle	Minimum/maximum (median)	-17.8/58.4 (2)	-8.2/32.9 (6.3)	-31.9/22.4 (7)	^b .004*
	Mean \pm SD	3.89 \pm 14.81	8.40 \pm 9.25	4.51 \pm 10.31	
T1 slope angle	Minimum/maximum (median)	8.5/34.2 (19.8)	11.4/34.5 (19.5)	-12.5/12.6 (1.9)	^a .232
	Mean \pm SD	19.76 \pm 6.83	20.95 \pm 6.06	1.19 \pm 6.27	
Coronal balance	Minimum/maximum (median)	0/2.4 (0.9)	0.1/2.5 (1.1)	-1.6/1.7 (0.1)	^a .753
	Mean \pm SD	1.08 \pm 0.70	1.12 \pm 0.67	0.04 \pm 0.74	
VAS score	Minimum/maximum (median)	6/10 (8)	1/4 (2)	3/8 (6)	^b .001**
	Mean \pm SD	8.37 \pm 1.09	2.34 \pm 0.94	6.02 \pm 1.21	

^aPaired samples *t*-test.^bWilcoxon signed ranks test.**P* < 0.05, ***P* < .01.

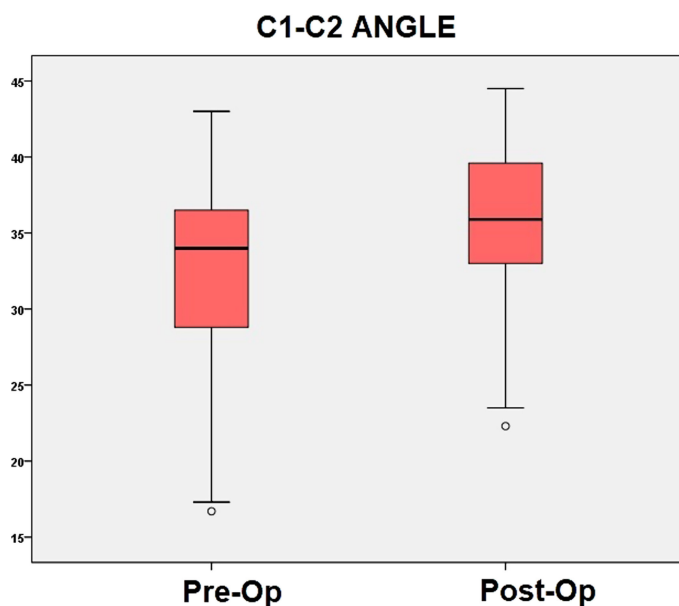
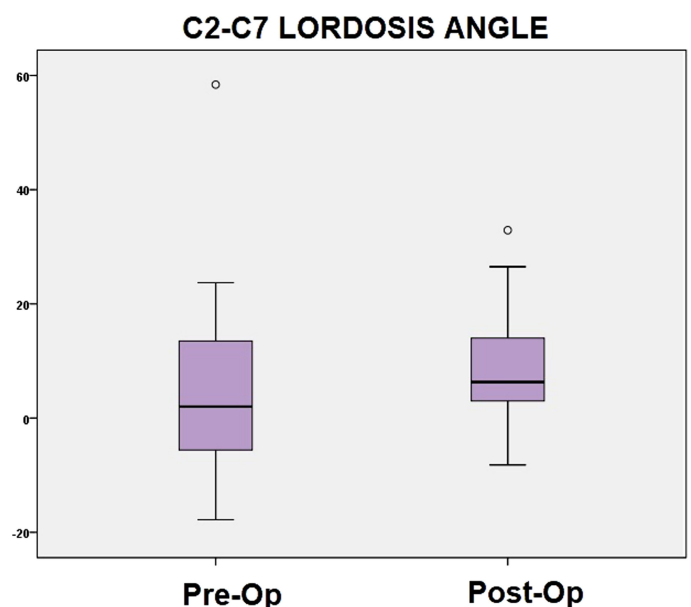
VAS, visual analog scale.

**(*P* < 0.05, it is highly significant)

P < .01; Figure 2). The mean preoperative T1 slope angles were 19.76 \pm 6.83 (Table 2). The mean postoperative T1 slope angles were 20.95 \pm 6.06. The change in T1 slope angles after the operation compared to the preoperative period was not statistically significant (*P* = .232 and *P* > .05; Figure 3). The mean preoperative coronal balance measurement was 1.08 \pm 0.70 (Table 2). The mean postoperative coronal balance measurement was 1.12 \pm 0.67. The change in the postoperative coronal balance measurements of the cases compared to the preoperative period was not statistically significant (*P* = .753 and *P* > .05; Figure 4). The mean preoperative VAS scores were 8.37 \pm 1.09 (Table 2). The mean postoperative VAS scores were 2.34 \pm 0.94. The decrease in the postoperative VAS scores of the cases compared to the preoperation was statistically significant (*P* = .001 and *P* < .01; Figure 5).

Discussion

Various studies have shown that cervical sagittal alignment affects clinical outcomes and patient satisfaction in patients operated for cervical disc herniation.^{2,3,4,9,11} Kyphosis that may develop after cervical spine surgery may cause an increase in the patient's pain complaints.¹² For this reason, one of the aims of ACDF surgery today is to correct the sagittal alignment.¹³ In our study, measurements were made using the C1-C2 angle, C2-C7 angle, and T1 slope angle related to the sagittal alignment. In the study conducted by Blizzard et al,¹⁴ it was emphasized that the change in this alignment was not clinically significant in the series in which a maximum 3° coronal alignment difference was observed in AP examinations in the postoperative period.

**Figure 1.** Change of C1-C2 angles before and after the operation.**Figure 2.** Change of C2-C7 lordosis angles before and after the operation.

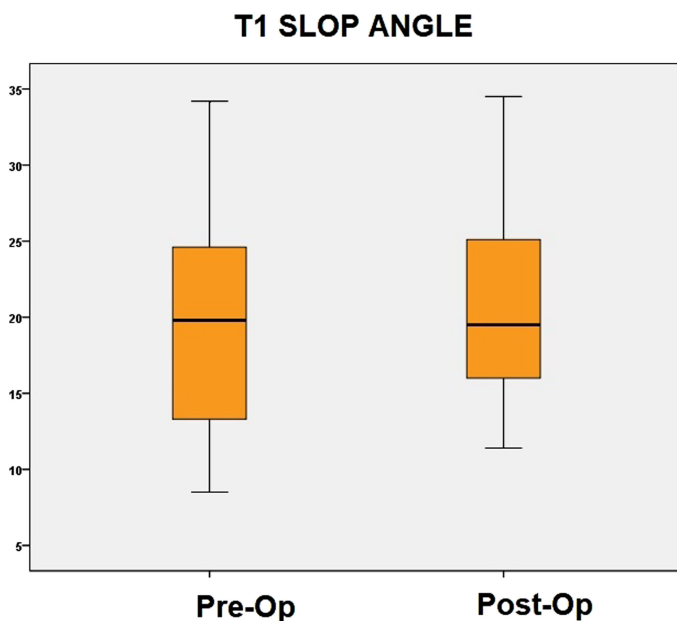


Figure 3. Change of T1 slope angles before and after the operation.

Anterior cervical discectomy and fusion is an effective procedure for restoring sagittal alignment, especially C2-C7. Jagannathan et al¹⁵ investigated clinical outcomes and sagittal alignment in 170 patients who underwent ACDF with allograft. They reported a mean change of 7.4° towards postoperative kyphosis in all 36 patients with preoperative kyphotic segmental angles. There was no significant relationship between the change in segmental angle and postoperative functional status. In addition, no significant change was detected in the mean C2-C7 Cobb angles.¹⁵ In the study of Ünsal,¹³ an improvement was found in the cervical lordosis of the patients in the postoperative period compared to the preoperative period, but the difference was not statistically significant. The researchers attributed this to the fact that the level of surgery performed in their patients was C6-C7 and the lower cervical region was less effective in

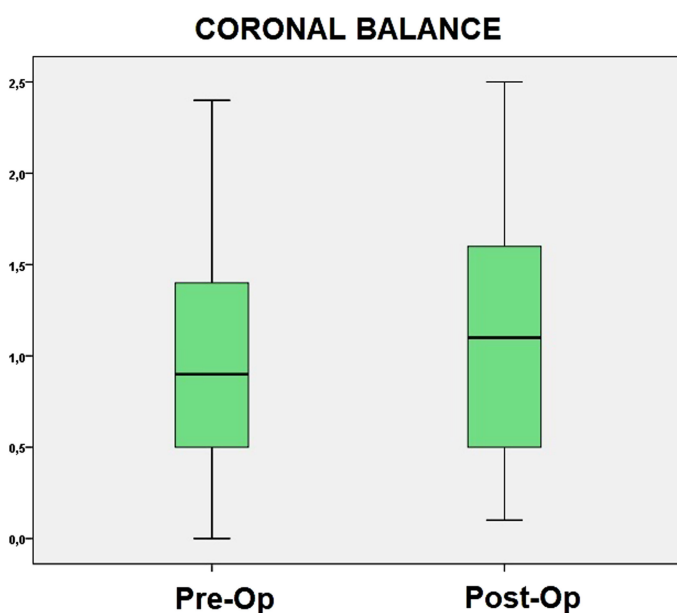


Figure 4. Change of coronal balance measurements before and after the operation.

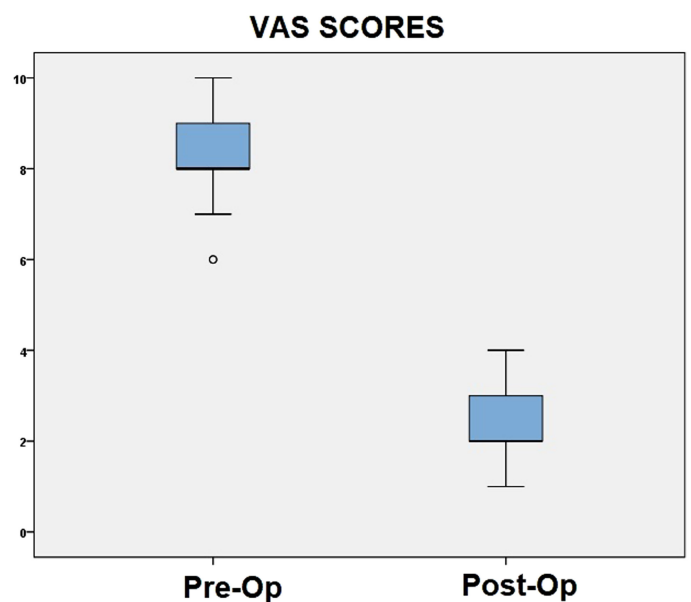


Figure 5. Changes of VAS scores before and after the operation. VAS, visual analog scale.

providing cervical lordosis than the upper cervical region. In our study, a 9.6° change was found in the C2-C7 lordosis angles and it was statistically significant. This may be due to the larger number of patients in our case series and also the fact that 17 cases were operated at the C5-C6 level. Likewise, in our study, a 5.6° difference was found in C1-C2 pre- and postoperative lordosis angles, and it was found to be statistically significant. In our study, no significant difference was found in our coronal balance measurements. In sum, the change in coronal alignment was determined below 3°. While no statistically significant change was found in the T1 slope angle for lordosis after surgery, a significant increase in the lordosis direction was found in the C1-C2 and C2-C7 angles. Consistent with the literature, this increase was accompanied by a statistically significant decrease in pain.

Conclusion

Anterior cervical discectomy and fusion is an effective method that can be used to provide cervical sagittal restoration for patients with disc disease in the cervical region, and its pain-reducing feature is accompanied by an increase in the C1-C2 and C2-C7 angles.

Ethics Committee Approval: Ethical committee approval was received from the Ethics Committee of Memorial Bahçelievler Hospital (Date: February 27, 2022, Number: 58).

Informed Consent: Informed consents were not required for retrospective review of the medical and radiological data of the patients.

Peer-review: Externally peer-reviewed.

Declaration of Interests: The author has no conflict of interest to declare.

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