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The Effects of Rehabilitation Following Anterior Cervical Microdiscectomy and Fusion Surgery

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ABSTRACT

AIM: To determine the effects of physical therapy and exercise programs that was performed after anterior cervical discectomy and fusion (ACDF) surgery on patient's pain treatment, a retrospective study was designed.

MATERIAL and METHODS: Of the 127 patients without neurological deficit who underwent ACDF surgery in our clinic in 2019 and 2020 for single-level cervical disc herniation, 40 patients (including 23 men and 17 women) were enrolled. The mean age of the patients was 45.5 years. The patients were separated into two groups. Group A comprised 20 patients who did not apply for a post-ACDF physical therapy and exercise program. Group B comprised 20 patients who applied for a 6-month post-ACDF physical therapy and exercise program and complied with it. The Oswestry Deficiency Index (ODI), visual analog pain scale (VAS), and C2–7 cervical lordosis angle were evaluated. The C2–7 cervical lordosis angles were individually calibrated and calculated for each patient using Surgimap. The relationships between the results were compared using Wilcoxon biostatistics test.

RESULTS: The ODI, VAS, and C2–7 cervical lordosis angle parameters of Groups A and B were statistically compared. No significant differences in the ODI, VAS, and C2–7 cervical lordosis angle 2 days after surgery and C2–7 cervical lordosis angle 6 months after surgery were observed between the two groups; however, significant differences were observed in VAS and ODI values 6 months after physical therapy in Group B and in VAS and ODI values 6 months after surgery in Group A. No significant difference in C2–7 cervical lordosis angle 6 months after surgery was observed between post-physical therapy Group B and postoperative Group A.

CONCLUSION: Physical therapy and exercise program performed early after ACDF enhances and improves pain management and does not cause any changes in the restoration of cervical misalignment.

KEYWORDS: Anterior cervical discectomy fusion, Cervical lordosis, Cervical misalignment, Physical therapy program, Restoration

ABBREVIATIONS: ACDF: Anterior cervical discectomy and fusion, **ODI:** Oswestry Deficiency Index, **VAS:** Visual analog pain scale

INTRODUCTION

The most commonly detected problem in the cervical region is cervical disk disease (4,13,15,16,21). Radiculopathy, mainly caused by cervical disk disease, responds to analgesics, physical therapy exercises, lifestyle modifications, and injection therapies administered by algology specialists (5). However, a portion of these patients does not respond to these treatments, leading to a refractory state, negatively affecting their social, private, and business lives. The loss in muscle strength makes surgical treatment obligatory (8,21). Cervical discectomy with an anterior approach is one of the most common surgical procedures to address pain management and prevent the progression of muscular strength loss (4,7,9-11,13,15-17).

The postsurgical use of cervical collars is believed to reduce postoperative pain, provide patients with a sense of security during activities of daily living, and reduce the rate of nonfusion (1).

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Rehabilitation program after cervical discectomy is a controversial issue, and no consensus has been achieved yet (12,14,20). Swanson and Leger have indicated that the onset of treatment and treatment modalities are different from each other (19). Patients' age, comorbidities, and smoking status and the number of operated levels effect postoperative recovery. However, no common standard program has been developed to help patients adapt in terms of activities of daily living (5).

In this study, we presented the effects of a treatment protocol that we developed and enhanced within years on patients who underwent single-level anterior cervical discectomy and fusion (ACDF).

MATERIAL and METHODS

Local institutional review board approved the study (Uskudar University, 61351342/August 2021-01) and written informed consents were obtained from study patients.

Patient Population

In this study, 40 patients (including 23 males and 17 females) with a mean age of 45.5 years, who underwent ACDF surgery between 2019 and 2020 in our clinic due to single-level cervical disk herniation, were enrolled. All patients enrolled in the study had single-level cervical disk herniation that impaired the quality of their daily life. All patients did not benefit from the treatments they received. Patients with neurological deficit, disk herniation at multiple levels, additional degenerative vertebral diseases, body mass index of more than 25 kg/m^2, and smoking habit were excluded from the study to obtain a homogeneous patient group as much as possible.

Study Design

Same surgical procedure was performed in all study group by an anterior cervical microdiscectomy with a bladed polyether ether ketone (PEEK) cage [PEEK-Optima® (Invibio); blades: Ti-6Al-4V-Eli alloy], and fusion intervention with allograft bone putty (0.5mL; DBX Putty, MTF Biologics). Same peek cage sizes (#: 6, height: 6 mm, length: 13 mm: width, 15 mm), and the same amount of allografts were used.The patients were separated into two groups: Group A included patients who did not apply for post-ACDF physical therapy (n=20, including 12 men and 8 women), whereas Group B included patients who applied for postoperative physical therapy and complied with the treatment (n=20, including 11 men and 9 women). The Oswestry Disability Index (ODI), visual analog pain scale (VAS), and C2–7 cervical alignment angles were determined before surgery, 1st and 2nd days after surgery, and 6 months after surgery in all groups. The C2–7 cervical alignment angles were calculated using Surgimap on cervical lateral X-rays. Calibration was individuated for each X-ray. All patients underwent the same physical therapy exercise program. Each exercise set was taught to patients by specialist doctors of physical therapy, and standard home exercise programs were provided. Results were statistically evaluated.

Post-ACDF Program

The **first phase** is the preoperative evaluation phase where the patients are informed about the surgery. In the active resting phase (0–3 weeks), the patients were mobilized under the supervision of a physical therapist on the first postoperative day. If necessary, transcutaneous electrical nerve stimulation was used for pain control. Patients should remain mobile and change their position frequently with at least 30-min intervals. They should be informed about maintaining the correct posture on the 3rd postoperative day. It should be emphasized to avoid cervical hyperextension and keep the lumbar region straight. Moreover, they are recommended to avoid lifting, bending, and hyperextending for 6 weeks.

According to our rehabilitation protocol, cervical rotation must be restricted within the last 3 weeks. Furthermore, the patients should avoid driving for at least 2 weeks.

Strenuous nape–neck exercises are not allowed for 6 weeks postoperatively. Swimming and running can be started 6 weeks after surgery. The patients were not allowed to attend team sports for the first 6 months.

The **second phase** is the early protective phase (4–8 weeks). In this period, nape–neck curve exercises should be started within pain-free limits under a physical therapist's supervision. The importance of maintaining the correct posture and compliance to cervical protection principles should be emphasized. Patients should return to the Physical Medicine and Rehabilitation Department weekly for evaluating pain and compliance to the exercise program.

The **third phase** is the dynamic phase (8 weeks to 6 months). Cervical tilt exercises and, depending on tolerance, core stretching exercises should be started 6 weeks after surgery. Any exercise that increases pain should be excluded. Weekly control visits must be recommended until the end of the 12th postoperative week. A physical therapist and specialized doctor should conduct control examinations once every 3 weeks. Patients should be enrolled in a kinetic chain strengthening exercise program containing proprioceptive exercises, which must be customized according to their needs. Examinations should be performed at 6-week intervals after the 12th postoperative week.

The **fourth phase** is the phase where patients return to sports activities (6 months later). Patients can be allowed to attend sports activities. Low-resistance high-repeating activities are preferred. Contact sports are allowed; however, the risks of trauma and falling should be detailed. Patient's preference is an important determinant of choosing sports activities; in this respect, special precautions should be taken according to the specific activity, and the program must be customized.

Study Design and Statistical Analyses

Data were analyzed using Statistical Package for the Social Sciences, version 21. Homogeneity of variants was evaluated using Levene's test for equality of variances. Comparisons of groups with and without homogeneous variances were performed using Independent Student's t-test and Mann–Whitney U nonparametric test, respectively. Differences with p-values of less than 0.05 were considered statistically significant.

RESULTS

The number of patients who regularly complied with a 6-month physical therapy program starting in the first postoperative month was 27; three and six patients showed compliance for 4 and 3 months, respectively. Two patients showed irregular compliance for 3 months and one patient for 1 month; two patients irregularly complied for 15 days, whereas two patients did not comply at all. None of the patients had disk herniation in an adjacent segment during the 6 months of follow-up. Patients who did not continue the exercise program regularly described a longer period of pain despite improvement in pain intensity. Table I shows early postoperative VAS and ODI values, compliance to exercise, and early-stage adjacent segment disk herniation information. Demographic data and preoperative VAS and ODI values are shown in Table II.

Statistical study findings are as follows (Tables III and IV):

- No significant difference in ODI value 2 days after surgery was observed between the groups ($p>0.05$).
- No significant difference in VAS value 2 days after surgery was observed between the groups ($p>0.05$).
- No significant difference in C2–7 cervical lordosis angle value 2 days after surgery was observed between the groups ($p>0.05$).
- A significant difference was observed between post-physical therapy VAS value in Group B and postoperative VAS value in Group A ($p<0.05$) 6 months after surgery.
- A significant difference was observed between post-physical therapy ODI value in Group B and postoperative ODI value in Group A ($p<0.05$) 6 months after surgery.
- No significant difference in C2–7 cervical lordosis angle was observed between post-physical therapy Group B and postoperative Group A ($p>0.05$) 6 months after surgery.

Table I: Details of the Clinical Series of Group A

Patient No	Age	Sex	Level	Preoperative			Postoperative (at 2nd day)			Postoperative (at 6 month follow-up)		
				VAS	ODI	C2–7 lordosis angle	VAS	ODI	C2–7 lordosis angle	VAS	ODI	C2–7 lordosis angle
1	40	F	C5–6	10	82%	–23	4	35%	–10	3	27%	–11
2	39	M	C6–7	8	61%	–13	2	16%	–3	2	16%	–5
3	47	F	C5–6	9	79%	–16	3	17%	–9	3	17%	–7
4	43	M	C6–7	10	88%	18	4	37%	22	3	31%	20
5	58	M	C3–4	8	64%	–17	3	15%	–6	2	11%	–4
6	57	M	C5–6	9	77%	–13	2	12%	–4	2	12%	–5
7	38	M	C6–7	10	83%	–11	3	35%	–4	3	33%	–3
8	41	M	C4–5	9	78%	14	3	26%	18	3	24%	19
9	55	F	C3–4	8	68%	16	2	16%	21	2	18%	18
10	29	F	C5–6	7	55%	–5	3	20%	4	2	16%	7
11	62	F	C6–7	10	82%	–10	4	34%	–2	3	28%	–1
12	45	M	C5–6	9	74%	10	2	24%	14	2	28%	16
13	55	M	C6–7	7	58%	–13	2	18%	–6	2	22%	–8
14	49	F	C5–6	10	86%	–14	4	42%	–4	3	30%	–6
15	34	M	C3–4	8	66%	–11	2	18%	6	2	21%	8
16	48	F	C5–6	8	64%	5	3	33%	13	3	33%	10
17	54	M	C5–6	9	73%	–13	4	38%	–6	4	35%	–3
18	39	M	C6–7	10	82%	–8	3	28%	4	3	28%	7
19	53	F	C5–6	7	65%	6	4	32%	14	3	26%	11
20	57	F	C5–6	8	68%	–10	4	38%	4	3	30%	4

Table II: Details of the Clinical Series of Group B

Patient No	Age	Sex	Level	Preoperative			Postoperative (at 2nd Day)			Post-physiotherapy (at 6 month follow-up)		
				VAS	ODI	C2-7 lordosis angle	VAS	ODI	C2-7 lordosis angle	VAS	ODI	C2–7 lordosis angle
1	38	M	C5–6	8	68%	17	4	32%	19	2	14%	25
2	42	F	C5–6	10	84%	12	4	28%	14	3	17%	18
3	46	F	C6–7	7	72%	19	3	24%	21	1	9%	24
4	57	F	C4–5	8	66%	13	2	12%	18	1	7%	21
5	34	M	C5–6	9	77%	–12	4	35%	4	3	27%	11
6	37	M	C5–6	9	75%	–21	4	26%	–12	2	16%	–4
7	35	M	C5–6	7	53%	–12	2	16%	–6	1	9%	7
8	41	F	C4–5	7	58%	–27	4	33%	–12	3	21%	6
9	53	M	C5–6	8	68%	–16	3	25%	–8	1	6%	8
10	46	M	C6–7	9	71%	–19	3	21%	–13	1	6%	–7
11	51	F	C6–7	10	87%	–18	3	27%	–11	2	12%	–6
12	55	M	C5–6	7	59%	–18	4	32%	–10	3	30%	–2
13	48	F	C5–6	9	76%	–24	2	14%	–13	1	8%	–5
14	47	F	C6–7	9	73%	12	2	12%	16	1	8%	23
15	39	M	C5–6	10	81%	–24	3	23%	–16	1	6%	–8
16	41	M	C5–6	10	86%	–10	4	29%	8	3	24%	14
17	55	F	C6–7	7	57%	7	3	25%	14	2	18%	19
18	52	M	C4–5	8	65%	–5	3	28%	4	2	16%	12
19	33	M	C6–7	8	67%	6	3	27%	11	2	18%	17
20	27	M	C6–7	10	85%	–10	4	31%	–2	2	12%	9

DISCUSSION

Potential postoperative problems of ACDF surgery should be emphasized first (3,13,16). Surgical tissue damage and pain at the wound site are expected to increase after surgery. Surgical pain does not usually become a major problem and can be managed with moderately effective analgesics (12,14,20). The most well-known complaint of patients is dysphagia, rather than pain (12).

Patients should be closely followed after the early postoperative period. Some patients may report severe pain at the back of the head radiating to the neck and both shoulders (14,20). This is related to the surgical position of the patient. A pillow is placed under the neck and scapulae to approximate the neck and position the head backward. Muscle tissues are severely affected due to damage in these muscles during surgery, which occur in the form of nape, head, and shoulder pain (20). These patients should not be discharged immediately. A rehabilitation program is necessary during this period to facilitate patients' return to their social and business lives.

Patients indicated for cervical disk surgery majorly have concomitant cervical spinal misalignment (2,18). Cervical lordosis is impaired, the neck is flattened, and reverse kyphotic angulation occurs. This condition, totally by itself, increases the risk of hernia development by impairing the balance between the center of gravity and cervicovertebral angulation (18). The ongoing pathology is eradicated by ACDF, and the cage restores some of the segmentary lordosis angles (2). However, this restoration is usually inadequate, and a new herniation may develop in adjacent segments. Considering this, restoring the cervical spinal alignment in a fashion leading to ideal lordotic angulation is obligatory. Therefore, applying rehabilitation and physical therapy exercise programs is therefore necessary to aid in restoring cervical spinal alignment (20). This study emphasized this notion and compared cervical spinal alignment between patients who received and did not receive rehabilitation both statistically and quantitatively. The importance of restoring cervical spinal alignment has also been emphasized as a preventive approach.

Table III: Comparison of Group A Postoperative data of VAS, ODI, and C2–7 Lordosis angle with Group B Postoperative + Physiotherapy Data

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Post-physiotherapy VAS Group B -postop VAS Group A	Equal variances assumed	0.012	0.915	4.632	38	0.000	1.200	0.259	0.676	1.724
	Equal variances not assumed			4.632	37.991	0.000	1.200	0.259	0.676	1.724
Post-physiotherapy ODI Group B -postop ODI Group A	Equal variances assumed	4.335	**0.044**	4.664	38	0.000	12.50000%	2.68004%	7.07454%	17.92546%
	Equal variances not assumed			4.664	35.378	0.000	12.50000%	2.68004%	7.06130%	17.93870%
Post-physiotherapy Group B C2–7 lordosis angle - postop Group A C2–7 lordosis angle	Equal variances assumed	0.118	0.733	–1.704	38	0.096	–5.800	3.403	–12.689	1.089
	Equal variances not assumed			–1.704	37.764	0.097	–5.800	3.403	–12.690	1.090

Table IV: Comparison of Groups A and B in Terms of Postoperative VAS, ODI, and C2–7 Lordosis Angle

Independent Samples Test										
		Levene's test for equality of variances		T-test for equality of means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% confidence interval of the difference	
									Lower	Upper
Postop VAS	Equal variances assumed	0.033	0.856	–0.595	38	0.555	–0.150	0.252	–0.660	0.360
	Equal variances not assumed			–0.595	37.802	0.555	–0.150	0.252	–0.660	0.360
Postop ODI	Equal variances assumed	6.163	**.018**	.645	38	0.523	1.70000%	2.63489%	–3.63405%	7.03405%
	Equal variances not assumed			.645	34.546	0.523	1.70000%	2.63489%	–3.65162%	7.05162%
Postop C2–7 lordosis angle	Equal variances assumed	3.243	.080	.541	38	0.592	2.000	3.696	–5.482	9.482
	Equal variances not assumed			.541	36.257	0.592	2.000	3.696	–5.494	9.494

ACDF significantly improves pain that patients suffer before surgery and impairs the quality of their lives (12,14,20). Maintaining patients' return to normal social and business lives without pain is harder in the early postoperative period. The most important aspect at this stage is maintaining relaxation of fasciculated and edematous nape–neck muscles with rehabilitation and subsequently strengthening these muscles with isometric exercises (12,20). The results of this study clearly indicated that fact statistically.

One other important issue is the time neck exercises are started. We support the notion of Coronado et al. that early onset of neck exercises provokes postoperative pain (5). Exercises should be started at least 2 weeks after surgery. Considering that the fusion process completes in 3 months, early onset of exercises causes gradual loosening of the cage, graft, or plate each day by straining; this is a potential danger, especially for patients of advanced age with osteoporosis. In contrast, performing exercises with an operated neck without feeling pain remains unclear. A study from Sweden has reported that neck exercise physical therapy given by specially trained staff in the early postoperative period enhances the quality of life and improves pain management; however, patients may maintain control of neck pain better according to their neck motions during this period (6). Passive neck exercises can be started 1 month after surgery. If control X-rays in the 2nd month shows fusion, active neck movements can be started. Active sports can be started after 6 months. Home exercise programs should be continued for 2 years. Our follow-up criteria indicated good outcomes with this exercise program.

This study has a few limitations. Conducting a prospective study that enables comparison with a much bigger study cohort is ideal. Patients and groups can also be evaluated by investigating multiple cervical biomechanical parameters. Parameters that reflect reciprocally to the thoracic and lumbar regions could have been evaluated by measuring all vertebrae. This is a hypothesis that can be considered for another clinical study.

CONCLUSION

Consequently, rehabilitation and exercise programs started at the appropriate post-ACDF time are obligatory for better recovery following surgery related to the cervical region. Planning and stratification should be customized for each patient. Necessary programs should be provided in the early postoperative period for local pain management. Muscle strengthening exercises should be started after the first months for patients with cervical misalignment. Active neck exercises should not be started before 2 months; after the onset of graft osteo-integration, active program can be initiated.

AUTHORSHIP CONTRIBUTION

Study conception and design: OC

Data collection: ATB

Analysis and interpretation of results: ATB

Draft manuscript preparation: OC

Critical revision of the article: OC

Other (study supervision, fundings, materials, etc...): OC

All authors (OC, ATB) reviewed the results and approved the final version of the manuscript.

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